US Army Corps
of Engineers®
New York District

REVISED FINAL REPORT

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

July 2019

EXECUTIVE SUMMARY

This Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS) examines coastal storm risk management (CSRM) problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area, which was devastated by the impacts of Hurricane Sandy in 2012. This report is considered a General Reevaluation Report (GRR) because there is an existing, authorized project for the area that was constructed in 1977 and renourished through 2004, based upon the 1965 construction authorization. A Reformulation effort was initiated in 2003 to revisit the authorized plan, and make recommendations for a long-term solution.

Draft HSGRR/EIS: August 2016

Consistent with current U.S. Army Corps of Engineers (USACE) planning guidance, alternatives were identified and screened to address CSRM, and presented a tentatively selected plan (TSP) in the Draft HSGRR/EIS. The TSP identified overall project features, with the acknowledgement that specific dimensions of the TSP were not finalized in the Draft HSGRR/EIS, which was released to the public in August 2016. The Draft HSGRR/EIS proceeded through concurrent public review, policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR).

As a result of significant (extent and content) partner, agency, and public comments received on the TSP, as well as the feedback to the New York District resulting from the concurrent policy and technical review conducted by USACE Headquarters (HQUSACE), the New York District determined that substantial revision to the Draft HSGRR/EIS would be required in order to proceed to a final decision document.

The 25 May 2017 USACE Agency Decision Milestone (ADM) resulted in the decision to move all further evaluation of the Jamaica Bay storm surge barrier measure, a significant component of the TSP, to the ongoing New York and New Jersey Harbor and Tributaries (NYNJHATs) Feasibility Study. The NYNJHATs study was initiated in the summer of 2016, and is evaluating large-scale CSRM strategies for the New York metropolitan area, which includes Jamaica Bay. A suite of storm surge barriers is being evaluated in the NYNJHATs study, including an alignment from Breezy Point to Sandy Hook that would obviate the need for the proposed Jamaica Bay barrier. As such, any further evaluation of a storm surge barrier for Jamaica Bay is a more appropriate fit for the NYNJHATs study.

Revised Draft HSGRR/EIS: August 2018

In the Revised Draft HSGRR/EIS, documentation of the Recommended Plan was presented, which reflected changes to the TSP as described above. Also included in the Revised Draft HSGRR/EIS was a further refinement and development of 'residual risk' measures[1] in areas bordering Jamaica Bay, termed *high frequency flooding risk reduction features* (HFFRRFs). The HFFRRFs were developed to a full feasibility level of design and environmental analysis[2], and include natural and

[1] The term 'residual risk measure' was used in various discussions throughout the 2016 Draft HSGRR/EIS.

[2] The feasibility level design includes enough detail to achieve reasonable confidence to support plan formulation and the preparation of the EIS on the Recommended Plan. This level of design is prepared in order to support the decision makers in their determination on whether to authorize the implementation of the Recommended Plan. The

nature-based features, as well as an HFFRRF for an area outside of New York City in Nassau County.

Final HSGRR/EIS: December 2018 (amended the May 2019 version to include the revised Final US Fish and Wildlife Service Biological Opinion, dated July 2019)

This Final HSGRR/EIS (referred to as simply "HSGRR/EIS" throughout this document) and its recommendations are a component of the USACE response to the unprecedented destruction and economic damage to communities within the study area caused by Hurricane Sandy. The State of New York through the Department of Environmental Conservation (NYSDEC) is the non-federal sponsor, and the City of New York through the New York City Mayor's Office of Recovery and Resiliency is the local sponsor to the NYSDEC. Project partners include the New York City (NYC) Department of Parks and Recreation, and the NYC Department of Environmental Protection. The National Park Service, Gateway National Recreation Area (NPS) is a consulting party under Section 106 of the National Historic Preservation Act and a Cooperating Agency under the National Environmental Policy Act.

Based upon the review of the proposed project during the feasibility phase, the NYSDEC will require during the PED Phase further justification or component revisions to ensure the protection of water quality, habitat quality, and public access.

Study Area

The study area (Figure ES-1) consists of the Atlantic Coast of NYC between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York. The study area (unchanged from the 2016 Draft HSGRR/EIS) also includes the low lying Coney Island section of Brooklyn, which can be overtopped by floodwaters that flood the Brooklyn neighborhoods surrounding Jamaica Bay. The area is located within the Federal Emergency Management Agency (FEMA) regulated one percent Annual Exceedance Probability (AEP) floodplain, or the 100-year floodplain. The Atlantic Ocean shoreline, which is a peninsula approximately 10 miles in length, generally referred to as the Rockaways, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, NYC, and a section at the eastern end, known as Head-of-Bay, lies in Nassau County. More than 850,000 residents, over 46,000 residential and non-residential structures (which includes scores of critical infrastructure features such as schools, hospitals, and nursing homes), and additional wastewater treatment, subway, and railroad infrastructure are located within the study area.

final design will be prepared during the Preconstruction Engineering and Design (PED) Phase. Additional surveys or analyses conducted during PED may result in changes to the design. Changes to design made during PED may trigger the need for additional environmental analyses, as appropriate. Any changes which cause the overall cost to increase by more than 20% will require a Post-Authorization Change Report in order for the revised plan to remain authorized for implementation.

Figure ES-1: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Study Area

Study Area Problems

The study area was one of the areas most devastated by Hurricane Sandy – there were 10 fatalities[3], and more than 1,000 structures were either substantially damaged[4] to restrict re-entry or were destroyed by Hurricane Sandy. The NYC Department of Buildings post-Hurricane Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge[5] damage. Of all buildings city-wide identified as unsafe or structurally damaged, 37 percent were located in the southern Queens portion of the study area. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes along the Rockaway Peninsula portion of the study area.

Hurricane Sandy hit the study area at nearly high tide. Waves eroded beaches, breached boardwalks and seawalls, and broke against buildings in the oceanfront communities. Storm surge inundation reached as much as 10 feet above ground in some portions of the study area. In addition, more than 1.5 million cubic yards of sand was removed from Rockaway Beach and deposited on oceanfront communities or washed out to sea.

Floodwaters funneled through Rockaway Inlet amassing a storm surge that inundated all of the neighborhoods surrounding Jamaica Bay. The low-lying neighborhoods in the central and northern portions of Jamaica Bay, where the narrow creeks and basins provide the marine aesthetic of the neighborhood, were especially devastated by flood waters. Damage to the elevated portion of the subway system in Jamaica Bay and Rockaway (the A-line) disrupted service for over six months, affecting about 35,000 riders daily. In the southern Queens portion of the study area 37 schools were closed for up to two months.

Habitats important to waterfowl and coastal water birds, including shorebirds, wading birds, and seabirds, were also impacted by Hurricane Sandy. High winds and storm-driven water moved masses of coastal sediments, changed barrier landscapes, and breached dikes on impoundments managed specifically for migratory birds.

Study Area Opportunities

Prior to Hurricane Sandy, the Corps was undertaking a Reformulation effort to identify a long-term solution for the study area. These CSRM efforts focused on Atlantic Ocean Shoreline features with the State of New York as the local sponsor. Awareness of the need for an integrated approach to CSRM opportunities in Jamaica Bay and surrounding communities has increased since Hurricane Sandy impacted the area in 2012, and an integrated approach is presented through the combination of this HSGRR/EIS and the NYNJHATs study. As a result of the devastation associated with Hurricane Sandy, the USACE has been tasked to address "coastal resiliency" and "long-term sustainability" in addition to the traditional USACE planning report categories of "economics, risk, and environmental compliance" (USACE 2013). The goal of this HSGRR/EIS is to identify and develop solutions that will reduce vulnerability to the Atlantic Ocean Shoreline

[3] *New York Times*, 17 November 2012.

[4] Substantial damage to a structure occurs when the total cost of repair is 50 percent or more of the structure's market value prior to a storm event.

[5] Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide. (NOAA 2018, accessed at https://www.nhc.noaa.gov/surge/)

and Jamaica Bay system to storm damage over time, in a way that is sustainable over the long-term.

Study Objectives

Five principal planning objectives were identified for the study, based upon a collaborative planning approach. These planning objectives are intended to be achieved throughout the 50-year period of analysis, which is from 2020 to 2070:

1. Reduce vulnerability to coastal storm risks;
2. Reduce future coastal storm risks in ways that will support the long-term sustainability of the coastal ecosystem and communities;
3. Reduce the economic costs and risks associated with large-scale flood and storm events;
4. Improve community resiliency, including infrastructure and service recovery from coastal storm events; and
5. Improve coastal resilience and reduce the risk caused by frequent flooding.

Project Constraints

A portion of the study area falls within the boundary of Gateway National Recreation Area, Jamaica Bay. The enabling legislation for the NPS Gateway National Recreation Area requires that any plan for CSRM within park boundaries or impacts the resources of the park be mutually acceptable to the Secretary of the Army and the Secretary of the Interior. The recommended plan includes project features along the Atlantic Shorefront that are located within the park boundaries. USACE and the NPS have actively coordinated throughout the Reformulation effort and preparation of the EIS to establish a mutually acceptable plan. Coordination between USACE and NPS will continue throughout the development of Plans and Specifications. It is anticipated that mutual acceptability will be confirmed with the signature of NPS' Record of Decision, which will be based on this report and its Record of Decision.

Future Without Project Conditions

The future without project condition (FWOP) is the projection of the likely future conditions in the study area in the absence of any action resulting from the current study effort documented in this HSGRR/EIS. The FWOP is the baseline for the analysis and comparison of alternatives developed for this study. The FWOP for this study includes the following assumptions.

- Maintenance dredging of the existing federal navigation channels at East Rockaway Inlet and Rockaway Inlet (Jamaica Bay Channel) are expected to continue as authorized.
- The existing federal project from Beach 19th street to Beach 149th, which was repaired to design conditions following Hurricane Sandy, would not be renourished in the future as a federal project, since there is no current approval for renourishment.
- New York City would undertake small-scale sand placement projects if the beach erodes to where existing infrastructure is imminently threatened.

The FWOP was evaluated to identify the expected damages that are likely to occur in the absence of a project. This analysis was undertaken considering an intermediate rate of relative sea level rise in the future (approximately 1 ft. over 50 years, from 2020 to 2070). This analysis shows that

there is a potential for significant damages along the Atlantic shorefront and in Jamaica Bay. A summary of these damages is provided in Table ES-1 below.

Table ES-1
Without-Project Condition Equivalent Annual Damages ($)

Atlantic Ocean Shorefront Planning Reach	18,363,000
Jamaica Bay Planning Reach (Cross-Shore Flooding)	30,234,000
Jamaica Bay Planning Reach (Jamaica Bay Flooding)	64,137,000
Jamaica Bay Planning Reach (HFFRRF Areas)	61,918,000
Total Annual Damages	**174,652,000**

Alternative Plan Development

An array of structural and nonstructural management measures, including NNBFs, were developed to address one or more of the planning objectives. Management measures were developed in consultation with the non-federal sponsor (NYSDEC), state and local agencies, and non-governmental entities. Measures were evaluated for compatibility with local conditions and relative effectiveness in meeting planning objectives.

Since the problems and opportunities vary across the study area, alternatives were formulated for two separate planning reaches in order to identify the most efficient solution for each reach. The two planning reaches are the Atlantic Ocean Shoreline Reach, and the Jamaica Bay Reach.

Atlantic Ocean Shorefront Planning Reach

The Atlantic Ocean Shorefront Planning Reach is subject to inundation, erosion, wave attack, and overtopping along the Rockaway peninsula. Several iterations of plan formulation were undertaken for the shorefront reach, including an initial screening of measures to identify the subset of measures that should be considered in the development of alternatives. Following the initial measures screening, the approach to alternative development was to evaluate features that optimize life-cycle costs in combination with a single beach and dune template in order to select the most cost effective renourishment approach. Once the most efficient lifecycle management plan was selected, different combinations of beach, dune and reinforced dune cross-sections were evaluated to identify the most economically efficient plan, considering the level of risk reduction afforded and the lifecycle costs.

The most cost efficient alternative life-cycle management approach for the Atlantic Ocean Shorefront Planning Reach is beach restoration with renourishment, five groin extensions and the addition of 13 new groins. This alternative would provide the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life - renourishment material would be sourced from a borrow area approximately two miles offshore, south of the Rockaway peninsula. Renourishment also provides recreation benefits to beach users, which are included in the economic evaluation of the Atlantic Ocean Shorefront Planning Reach alternatives.

After the most cost-effective life-cycle approach was identified, the dimensions of the Atlantic Shorefront component were optimized to evaluate the level of CSRM provided by a range of dune

and berm dimensions and by reinforced dunes. A composite seawall in combination with beachfill and groin features was selected as the most efficient CSRM alternative. This plan reduces risks for erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding. The seawall crest elevation is +17 feet NAVD88 (North American Vertical Datum of 1988), the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet at an elevation of +8 feet NAVD88. Armor stone prescribed for the composite seawall significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls to be used in the design since the face of the wall would be completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding one layer of armor stone and extending the concrete cap up to the elevation of the armor stone, which would also raise the height of the dune. Additionally, the berm elevation can be adapted to rising sea levels by raising the elevation up to two feet.

Jamaica Bay Planning Reach: Comprehensive Plans

The communities surrounding and within Jamaica Bay are subject to storm surges that amass in Jamaica Bay by entering through Rockaway Inlet and by overtopping and flowing across the Rockaway Peninsula (the Atlantic Ocean Shorefront Planning Reach) and across Coney Island. Preliminary screening of comprehensive alternative plans for the Jamaica Bay Planning Reach in the 2016 Draft HSGRR/EIS resulted in a final array of two alternatives: a Jamaica Bay Perimeter Plan and a Storm Surge Barrier Plan. Both plans would tie into the plan features for the Atlantic Ocean Shoreline Planning Reach.

Perimeter Plan. The Perimeter Plan would create a 44 mile contiguous barrier of levees, floodwalls, and closures along the Jamaica Bay interior, with the exception of JFK Airport (JFK Airport already has infrastructure providing CSRM). The community at Broad Channel, which is effectively within Jamaica Bay - as opposed to being a community on the fringe of Jamaica Bay - would not benefit from the Perimeter Plan, as site-specific features for Broad Channel were not cost-effective and eliminated from further consideration in the initial screening. The Jamaica Bay Perimeter Plan would require 13 tributary flood gates, and five roadway flood gates. Additionally a railroad floodgate would be required at 104th Street for the Long Island Railroad.

Storm Surge Barrier Plan. The Storm Surge Barrier Plan would include a hurricane barrier across Rockaway Inlet and tie into CSRM at the Atlantic Ocean Shorefront Planning Reach. Three alternative alignments of the Storm Surge Barrier Plan were evaluated on the basis of construction, real estate, mitigation, and Operation, Maintenance, Repair, Reconstruction, & Replacement (OMRR&R) costs, and net benefits. The Storm Surge Barrier Plan selected for comparison to the Perimeter Plan included an inlet barrier 3,930 feet in length, over 28,000 linear feet of concrete floodwalls, 4,900 linear feet of levee, two sector gates, and elevated promenades.

The 2016 Draft HSGRR/EIS evaluation demonstrated that the Perimeter Plan and the Storm Surge Barrier Plan were both economically justified. The evaluation determined that the Storm Surge Barrier Plan would provide more net benefits at a lower total cost, and was selected as an element of the TSP.

As described above (under the heading of Draft HSGRR/EIS: August 2016), the result of the ADM was to move all further evaluation of the proposed storm surge barrier element of the TSP

to the NYNJHATs Feasibility Study. Going forward, the Recommended Plan documented in this HSGRR/EIS does not represent a comprehensive approach to providing CSRM solutions for the Jamaica Bay Planning Reach – a full comprehensive approach is deferred until completion of the NYNJHATs Feasibility Study.

Jamaica Bay Planning Reach: High Frequency Flooding Risk Reduction Features

Low lying coastal neighborhood areas within Jamaica Bay were identified as areas where High Frequency Flooding Risk Reduction Features (HFFRRFs) could be implemented. The Phase 1 preliminary screening and subsequent feasibility design and analysis was performed only on the areas identified as potentially having large concentrations of vulnerable homes where stand-alone projects which tie into adjacent high ground could be built.

Other parts of the Jamaica Bay shoreline that are subject to flooding were not included; such areas are characterized by natural or undeveloped areas or isolated structures. Inclusion of HFFRRF projects for such locations would garner minimal reduction to the overall flood risk within Jamaica Bay and as such only marginally contribute to the overall objective of the project. Examples of such exclusions, amongst others, are geographically much smaller areas with very few assets at risk, undeveloped urban lots adjacent to Jamaica Bay, isolated developed but privately-owned lots with one single owner, and natural shorelines and parklands.

Areas for study were identified, analyzed, and screened for feasibility. A general grouping of viable low lying coastal neighborhoods was completed, and the following six general areas were identified where HFFRRFs could be implemented:

1. Bayside of the Rockaways, which includes the Hammels, Arverne, and Edgemere neighborhoods,
2. Motts Basin, Norton Basin and the Inwood Marina Area,
3. Head of Bay and the adjoining Nassau County watershed, including Cedarhurst-Lawrence, and Meadowmere,
4. Old Howard Beach,
5. Canarsie, and
6. Broad Channel.

Within the six areas listed above, a total of twenty-three HFFRRFs were delineated and designed for economic screening. Two HFFRRFs passed final economic screening and were included in the Recommended Plan. These manage risk from frequent floods along the bayside of the Rockaways in New York City, and in the Village of Cedarhurst in Nassau County. With a project in place the risk of a flood in a given year for these areas drops to a 10% chance in 2018 and 20% chance in 2058, assuming an intermediate rate of sea level rise based on USACE projections.

Recommended Plan

The Recommended Plan documented in this HSGRR/EIS is comprised of a shorefront component and two separate HFFRRF projects: 1) Mid-Rockaway, and 2) Cedarhurst-Lawrence. The Mid-Rockaway HFFRRF is the largest and stretches across three neighborhoods/subreaches - Hammels, Edgemere, and Arverne. An overview of the project locations is provided in Figure ES-2 in order to provide a geographic reference for each of the project components.

Figure ES-2: Recommended Plan Geographic Overview

Recommended Plan: Atlantic Shorefront Component

Analyses support the recommendation for a composite seawall and associated beach restoration with increased renourishment at the Atlantic Ocean shorefront. The structure crest elevation is +17 feet NAVD88, the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet at an elevation of +8 feet NAVD88. The Atlantic Ocean Shorefront component of the Recommended Plan consists of:

- A reinforced dune (composite seawall) with a structure crest elevation of +17 feet NAVD88 and dune elevation of +18 feet NAVD88, and a design berm width of 60 feet extending approximately 35,000 linear feet (LF) from Beach 9th Street to Beach 149th Street. The bottom of dune reinforcement extends up to 15 feet below the dune crest.
- A beach berm elevation of +8 ft. NAVD88 and a depth of closure of -25 ft. NAVD88;
- A total beach fill quantity of approximately 1.6 million cy for the initial placement, including tolerance, overfill and advanced nourishment[6] with a 4-year renourishment cycle of approximately 1,111,000 cy, resulting in an advance berm width[7] of 60 feet;
- Obtaining sand from borrow area located approximately 2 miles south of the Rockaway Peninsula and about 6 miles east of the Rockaway Inlet. It is about 2.6 miles long, and 1.1 miles wide, with depths of 36 to 58 feet and contains approximately 17 million cy of suitable beach fill material, which exceeds the required initial fill and all periodic renourishment fill operations.
- Extension of 5 existing groins; and new construction of 13 new groins.

Economic metrics for the Atlantic Shorefront component is provided below in Table ES-2. Investment costs include project first costs with contingencies plus interest during construction. Annualized costs include annualized investment costs plus annual operations and maintenance costs. An overview of the Atlantic Shorefront component is shown on Figure ES-3, with additional detail shown on Figures ES-4a through ES-4d. As noted in ES-4a, there are three groin rehabilitations proposed in Riis Park west of the 149th Street terminal groin for the project. These groins are intended to offset any impacts to the sediment budget for Riis Park resulting from the project and ensure that the Recommended Plan does not induce erosion on National Park Service lands adjacent to the project.

Table ES-2
Atlantic Shorefront Component – Economic Metrics

Initial Investment ($)	Annualized Cost ($)	Annual Benefits ($)	BCR	Net Benefits ($)
356,429,000	23,010,000	60,675,000	2.6	37,665,000

FY19 Q1 effective price level, FY19 discount rate of 2.875%

[6] Initial fill quantities were estimated shortly after the USACE placed 3.5 million cubic yards of sand on Rockaway beach from Beach 19th Street to Beach 149th as an emergency repair project after Hurricane Sandy in 2014. The initial estimate was 804,000 cubic yards in 2016, which has been updated for this HSGRR/EIS due to continued erosion of the beach and to include the sand required for the tapers on either end of the Atlantic Shorefront reach. The initial beachfill volumes will be reevaluated at the start of the PED Phase based on new condition surveys.

[7] Advance berm width is the additional berm width required for advance fill. The advance fill is the expected losses between initial construction and the 1st renourishment operation.

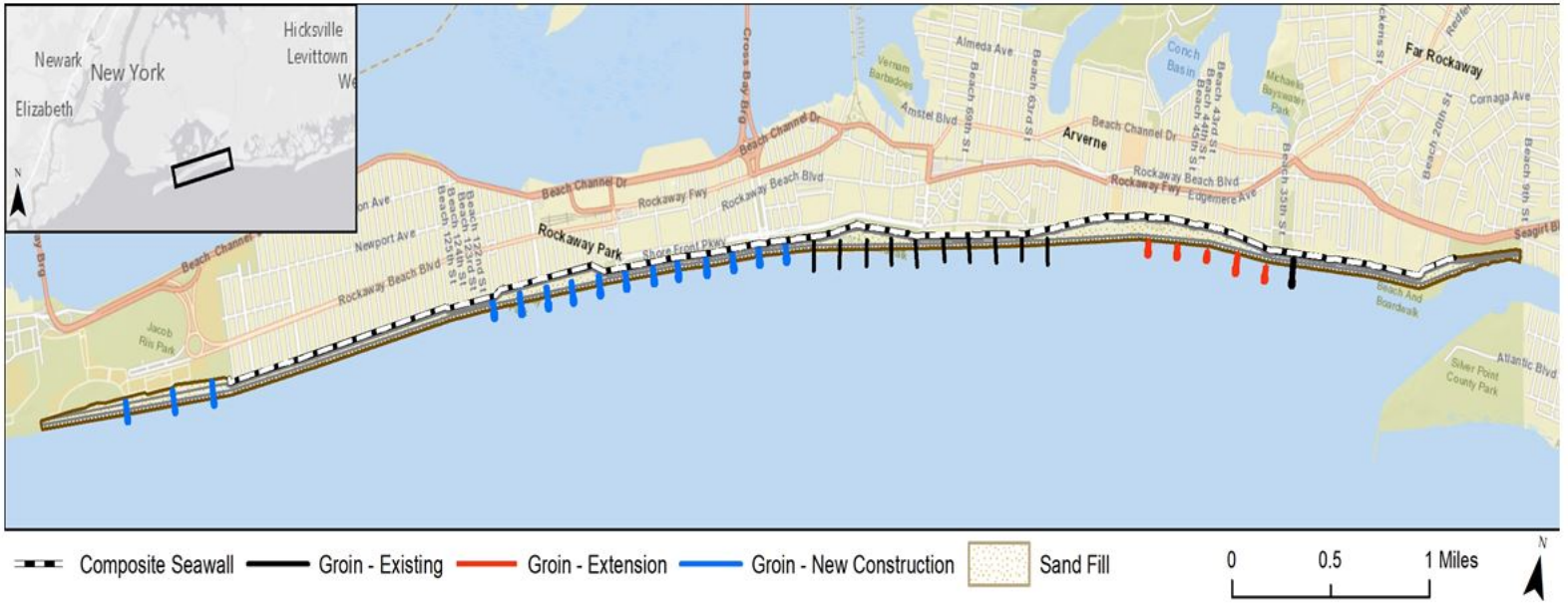


Figure ES-3: Atlantic Shorefront Component of the Recommended Plan - Overview

Figure ES-4a: Atlantic Shorefront Component of Recommended Plan (1 of 4)

Figure ES-4b: Atlantic Shorefront Component of Recommended Plan (2 of 4)

Figure ES-4c: Atlantic Shorefront Component of Recommended Plan (3 of 4)

Figure ES-4d: Atlantic Shorefront Component of Recommended Plan (4 of 4)

High Frequency Flooding Risk Reduction Measures

The Recommended Plan includes solutions to address high frequency flooding risks for communities vulnerable to high frequency events. A wide range of high frequency flooding risk reduction measures (HFFRRFs) were evaluated, and are included in the project costs, with two separate projects identified for the Recommended Plan:

- Cedarhurst-Lawrence; and
- Mid-Rockaway.

Economic data for each of the HFFRRF projects is provided below in Table ES-3, followed by a description of each of the projects. Investment costs include project first costs with contingencies plus interest during construction. Annualized costs include annualized investment costs plus annual operations and maintenance costs.

Table ES-3
HFFRRF Projects – Economic Metrics

HFFRRF Project	Investment Cost ($)	Annualized Cost ($)	Annual Benefits ($)	BCR	Net Benefits ($)
Cedarhurst-Lawrence	17,272,000	744,000	5,146,000	6.9	4,402,000
Mid-Rockaway	252,544,000	10,737,000	11,851,000	1.1	1,114,000

FY19 Q1 effective price level, FY19 discount rate of 2.875%

Cedarhurst-Lawrence

The Cedarhurst-Lawrence project (Figure ES-5) begins on the east side of the channel near the driveway to Lawrence High School. It consists of approximately 1,000 feet of deep bulkhead that follows the existing bulkhead line around the southern end of the channel at Johnny Jack Park, and continues north along the west side before being connected to high-ground behind the Five Towns Mini Golf & Batting Facility with a 23 foot segment of medium floodwall. The project is located in Nassau County and crosses the border between the Village of Cedarhurst and the town of Hempstead. Project design elevations have preliminarily been established based on expected wave exposure, and have been set at an elevation of +10.0 ft NAVD88.

There are three existing outfalls in the area where the bulkhead will be raised. Each of the outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch or drainage collection pipe, with inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station capacity is estimated to be approximately 40 cfs, which will be refined during the design phase.

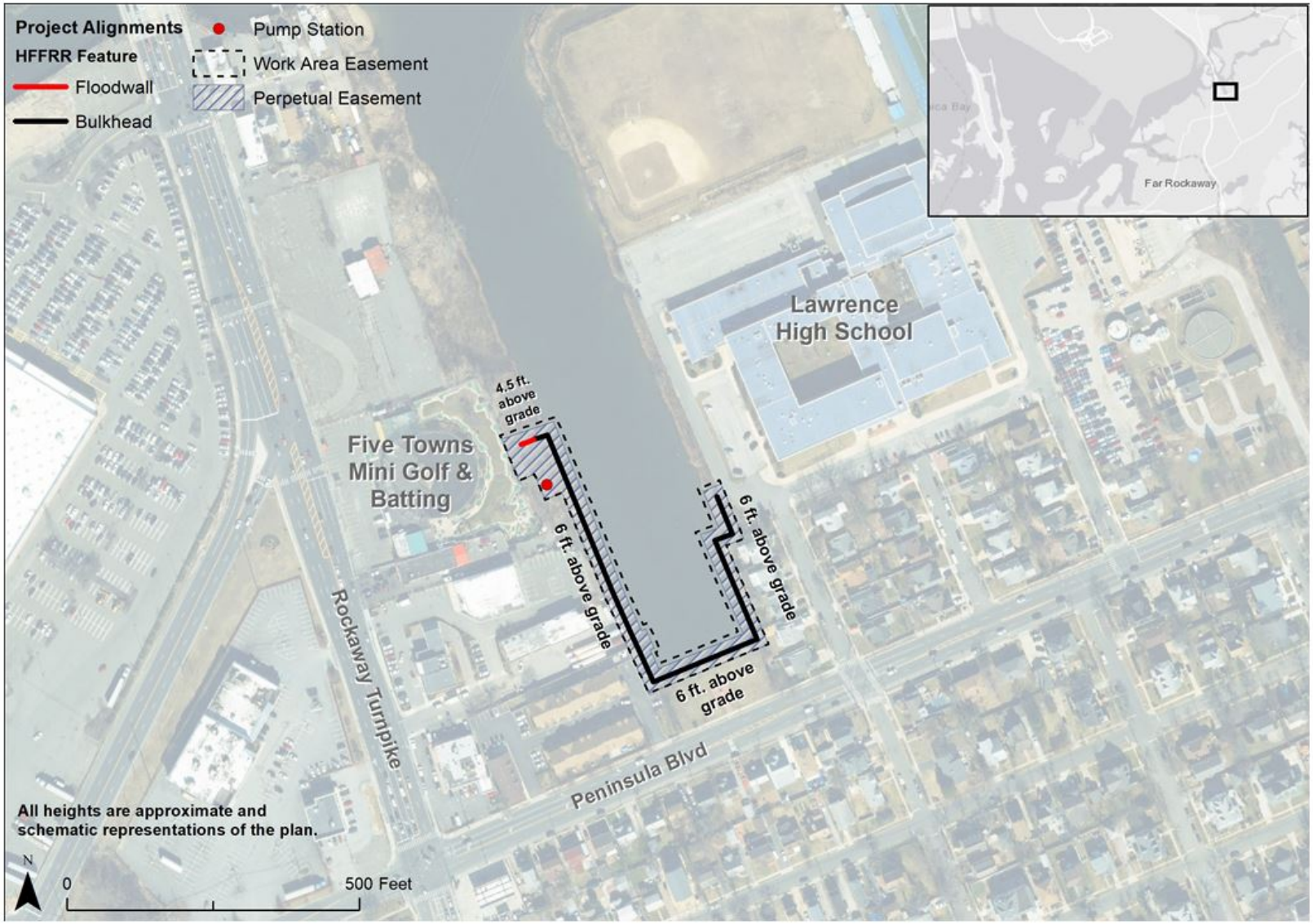


Figure ES-5: Cedarhurst-Lawrence HFFRRF Project Plan

Mid-Rockaway - Edgemere Area

The eastern end of the project area (Figure ES-6) begins at high ground near the intersection of Beach Channel Drive and Beach 35th Street. The project alignment proceeds north and then west following and parallel to Beach 35th Street before jogging to the north and crossing the abandoned portion of Beach 38th Street and continuing west. The project turns north and runs along the peninsula between Beach 43rd Street and the coastal edge. This approximately 3,200 foot section of hybrid berm has been placed as far landward as possible and weaves in and out between properties so as to ensure structural protection is provided to occupied properties while wetland impacts are minimized. The hybrid berm is strategically used at these locations to minimize and avoid impacts to existing healthy wetland habitats.

This area also has been identified as a suitable candidate for the use of *natural and nature-based features* (NNBFs) to manage coastal storm risk of frequent flooding. The NNBF design includes placement of a stone toe protection and rock sill structure just off the existing shoreline to attenuate wave action and allow tidal marsh to establish between the rock sill and the berm. In some locations the eroded/degraded shoreline (subtidal) will be regraded to allow for the development of low marsh (smooth cordgrass) to provide productive nursery habitats behind the sill structures. The shore slope behind the structure will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for establishment of a high tidal marsh, designated as scrub shrub areas in the figure. In addition, the graded habitat behind the structure will be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems.

On the north east of the Edgemere peninsula the project transitions into 200 feet of shallow bulkhead, which continues north along existing water front properties and bulkheads. Approximately 200 feet of medium elevation floodwall then turns west across, at the tip of the Edgemere peninsula. A road ramp on Beach 43rd Street has been included to maintain both pedestrian, and vehicle access to the coastal edge at north end of Beach 43rd street.

The floodwall continues in southwest direction along the coastline after which it transitions into a 750 foot section of high berm. The berm continues west from Beach 43rd Street before turning south just to the east of the unpaved extension of Beach 44th Street. The project then transitions into a 660 foot section of high floodwall which continues southwest staying as far landwards as possible to avoid an existing restoration project. Near the intersection of Norton Avenue and Beach 46th Street, north of Norton Avenue, the floodwall transitions back into a low berm which runs parallel to Norton Avenue southwest and then turns northwest along Conch Place. The area waterward of this berm has also been identified as a suitable location for the use of NNBFs and to restore high marsh habitat. Project design elevations vary and have preliminarily been established based on expected wave exposure. Project elevations range between +8.0ft and +9.5ft NAVD88.

The Edgemere interior drainage basin has two subbasins, E1 and E2 covering approximately 194 acres and 274 acres, respectively. The Edgemere drainage basin is almost fully developed and predominantly residential, except for a stretch of undeveloped, grassy area along the southern part of E1 and southwestern part of E2. Subbasin E1 was estimated to require nine outlets, which includes two existing outlets. Subbasin E2 was estimated to require six outlets, including one existing outlet. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the

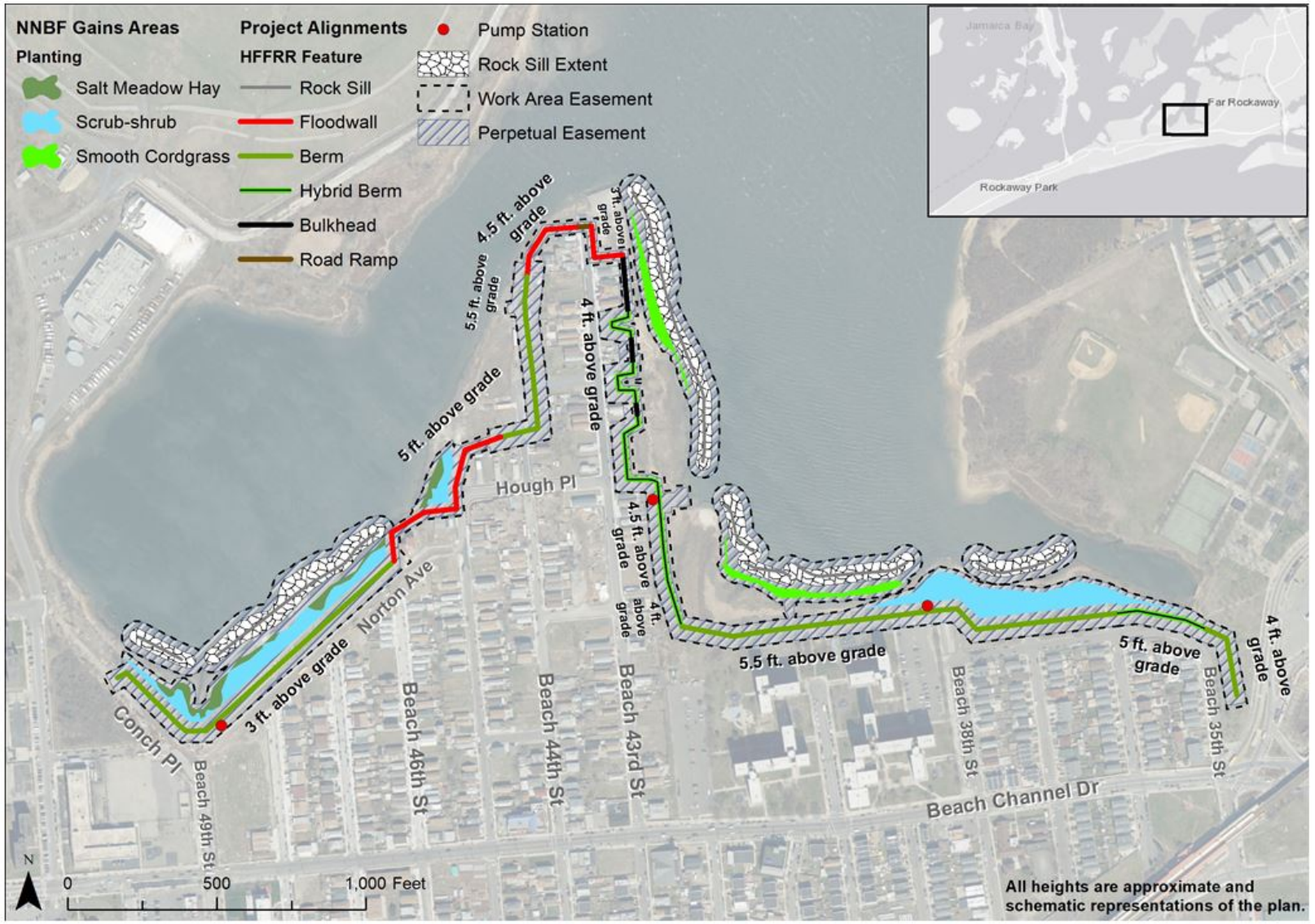


Figure ES-6: Mid-Rockaway - Edgemere Area HFFRRF Project Plan

drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts.

Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations would be required in the Edgemere Area. Due to the length of the area and difficulties in draining all of the area to a single site, drainage subbasin E1 is proposed to have two pump stations. One pump station would be located near Norton Avenue and Beach 49th Street and the other near Beach 43rd Street and Hough Place with a combined capacity of approximately 210 cfs. Subbasin E2 is proposed to have one pump station located near Beach 38th Street with an estimated capacity of 120 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

Mid-Rockaway - Arverne Area

This area of the project (Figure ES-7) begins at high ground to the north of Almeda Avenue and Beach 58th Street. An approximately 1,100 foot section of low berm runs south along Beach 58th Street. The alignment of the berm has been placed as far landward as possible to avoid healthy habitat. This segment has been identified as a candidate for the use of NNBFs to cost effectively manage the risk of frequent coastal flooding. Much of the area is identified as existing quality wetlands, but a portion of fill area has been identified where intermediate marsh (saltmeadow cordgrass) would be restored in order to improve coastal resiliency and help manage coastal flood risk.

The project then transitions to an approximately 1,200 foot long medium floodwall which, for feasibility level analysis, is purposefully sited along property boundaries at the southern end of the channel to minimize impacts to existing waterfront businesses. A road ramp has been included to maintain access to the marina. At the southwest corner of the channel the project transitions to run along the coastal edge north for approximately 1,700 feet. This segment transitions between revetments and bulkheads to match the existing coastline conditions and uses. The portion between Thursby Avenue and Elizabeth Road has been aligned such that it can be integrated into the planned NYC DPR Thursby Basin Park project.

Just north of De Costa Avenue, the project transitions to low berm for approximately 1,600 feet and runs west along De Costa Avenue and around the edges of healthy habitat while also creating an area for stormwater storage and a pump station just north of Beach 63rd Street. At the corner of De Costa Avenue and Beach 65th Street the low berm transitions into a hybrid berm to minimize habitat impacts.

The hybrid berm continues west and then north for 300 feet to the corner of Beach 65th Street and Bayfield Avenue. The project then transitions to a 2,400 foot long shallow bulkhead which travels west along the line of existing bulkheads and parallel with Bayfield Avenue in areas without existing bulkhead. The bulkhead section ends just west of the corner of Bayfield Avenue and Beach 72nd Street.

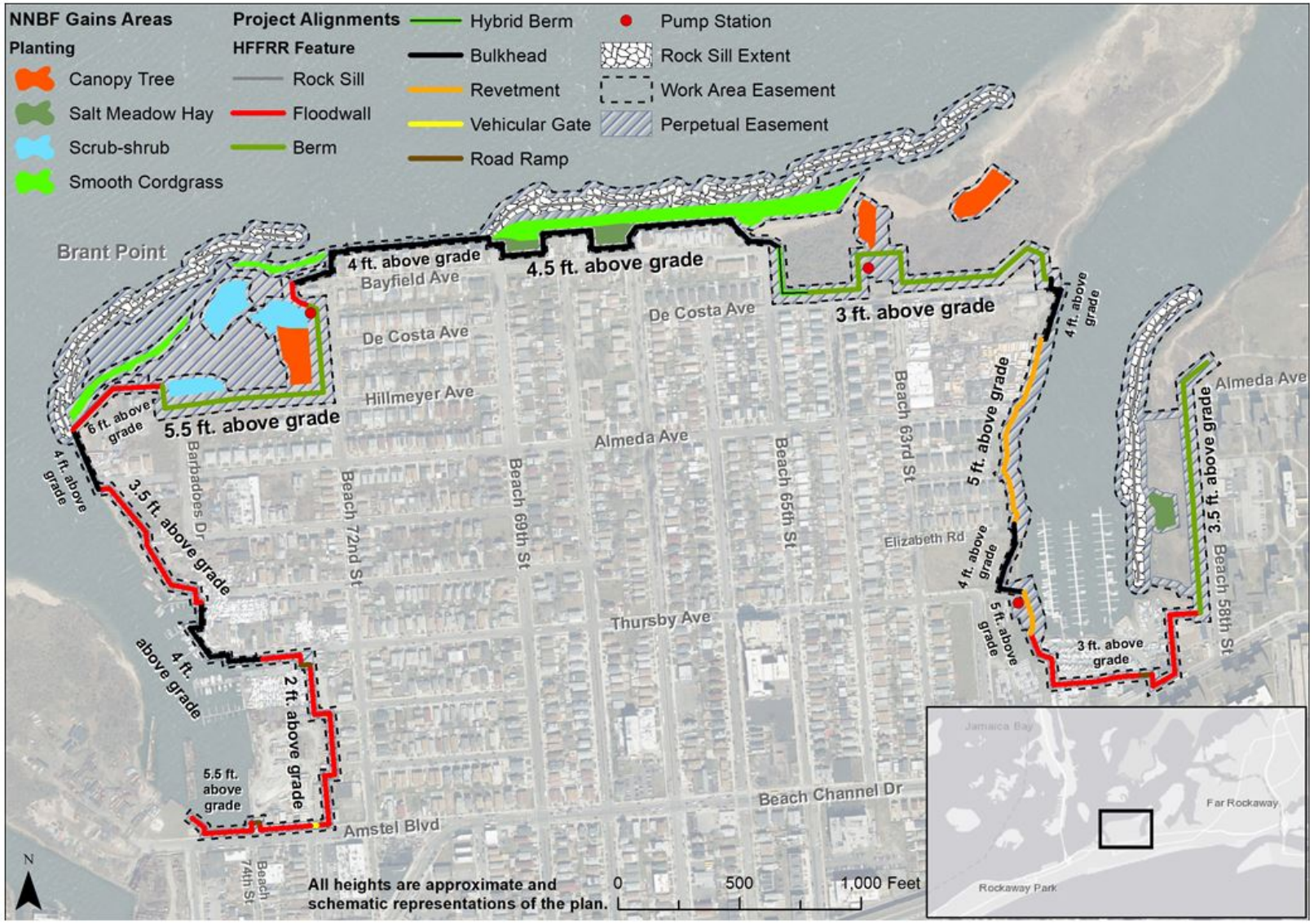


Figure ES-7: Mid-Rockaway - Arverne Area HFFRRF Project Plan

NNBFs are included as a cost effective means to manage coastal erosion and coastal storm risk from frequent flooding in the area east of Beach 69th Street and the eastern end of De Costa Ave. Based on existing elevations and profiles, a combination of either fill or excavation would be used to provide the appropriate elevations shoreward of the rock sills to maximize healthy subtidal habitats, with restoration of a transition area for low to high intertidal marsh. Eroded shorelines would be replaced with low intertidal (smooth cordgrass) habitats, and transition to either intermediate (saltmeadow cordgrass) and/or high marsh (scrub-shrub) habitats which would help to reduce coastal erosion landward of the NNBFs and attenuate wave action.

From the end of the bulkhead section, the project continues south with a 120 foot section of medium floodwall connecting the bulkhead to a 1,080 foot section of high berm. The berm runs south along Beach 72nd Street and turns west at Hillmeyer Avenue and continues west past the corner of Barbadoes Drive and Hillmeyer Avenue, where it turns north and transitions to a flood wall to minimize the project footprint. The berm section has been positioned close to the roads to minimize impacts on habitat.

The berm section transitions into a high floodwall which runs west, and then runs parallel to the coast southwest for 440 feet, ending at a bulkhead section just west of the end of Hillmeyer Avenue.

The Brant Point area includes the creation of wetlands between the berm and the rock sills that are placed just off the coastal edge. The rock sill will protect the shoreline where eroded areas will be restored to low marsh habitats protecting the existing high quality habitats shoreward and improving coastal resiliency. The areas behind the existing wetlands areas will be graded to provide a transition area to high marsh and then uplands where practical. The existing uplands areas will be replanted as necessary to provide for a high quality maritime forest habitat, with plantings of appropriate tree species. The NNBF design will improve coastal resiliency and manage coastal erosion and the risk of frequent flooding in a cost effective manner.

South of Hillmeyer Avenue the alignment follows the bulkheaded coastal edge. The project proposes a high frequency flood risk reduction bulkhead feature that follows an existing bulkhead along the coastal edge for approximately 270 feet ending just south of Almeda Avenue. From this point a low floodwall runs parallel with the coastal edge southeast for 700 feet, and then transitions into a deep bulkhead. This section of bulkhead continues southeast along the line of existing bulkhead for approximately 540 feet to the end of Thursby Avenue.

The project continues as a low floodwall for approximately 1,400 feet, traveling east along Thursby Avenue and then south, parallel with Beach 72nd Street turning west and running along Amstel Boulevard, ending just past Beach 74th street. Two road ramps and one vehicular gate are included to maintain access to the waterfront. The final segment is approximately 250 feet of medium floodwall which runs along the coastal edge and connects the low floodwall to high ground in the west. Project design elevations vary and have preliminarily been established based on the expected wave exposure. Project elevations range between +8.0ft NAVD88 and +11.5ft NAVD88.

The Arverne drainage basin has three subbasins A1, A2, and A3, covering 76 acres, 139 acres, and 209 acres, respectively. The Arverne drainage basin is almost fully developed and predominantly residential, with a few, scattered undeveloped areas. Subbasin A1 was estimated to require eight outfalls, including five existing outfalls. Subbasin A2 was estimated to require three outlets. Subbasin A3 was estimated to require five outlets, including three existing outlets.

Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations are desired in the Arverne Area. Drainage subbasin A1 is proposed to have a pump station located adjacent to De Costa Avenue near Beach 72nd Street with an estimated capacity of 70 cfs. Subbasin A2 is proposed to have one pump station located on De Costa Avenue near Beach 63rd Street with an estimated capacity of 180 cfs. Subbasin A3 is proposed to have one pump station located south of Thursby Avenue with an estimated capacity of 300 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

Mid-Rockaway – Hammels Area

Two separate segments compose the Hammels area of the Mid-Rockaway project (Figure ES-8). The east segment begins approximately 320 feet west of the intersection of Beach 75th Street and Beach Channel Drive. It is composed of approximately 1,400 feet of low floodwall, running west along the north side of Beach Channel Drive, and parallel with the Rockaway Line elevated subway track. Three road ramps have been included to maintain access to the water front properties. The west segment consists of 1,400 feet of low floodwall beginning to the west of the MTA facility Hammels Wye adjacent to the Rockaway Line. The alignment heads west and south in a stair-step fashion to avoid impacts to existing structures, ending on the north side of Beach Channel Drive just west of Beach 87th Street. Three road ramps have been included to maintain access to the waterfront. Project design elevations have preliminarily been established based on the expected wave exposure, which is expected to be low, and are set at +8.0ft NAVD88.

The Hammels drainage basin includes two subbasins, H1 and H2, approximately 105 acres and 139 acres respectively. The Hammels drainage basin is almost fully developed, except for a few scattered grassy areas and is predominantly residential, with some commercial development. Subbasin H1 was estimated to require three outlets, which include two existing outlets. Subbasin H2 was estimated to require 3 outlets, including 1 existing outlet. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that two pump stations are desired in the Hammels Area.

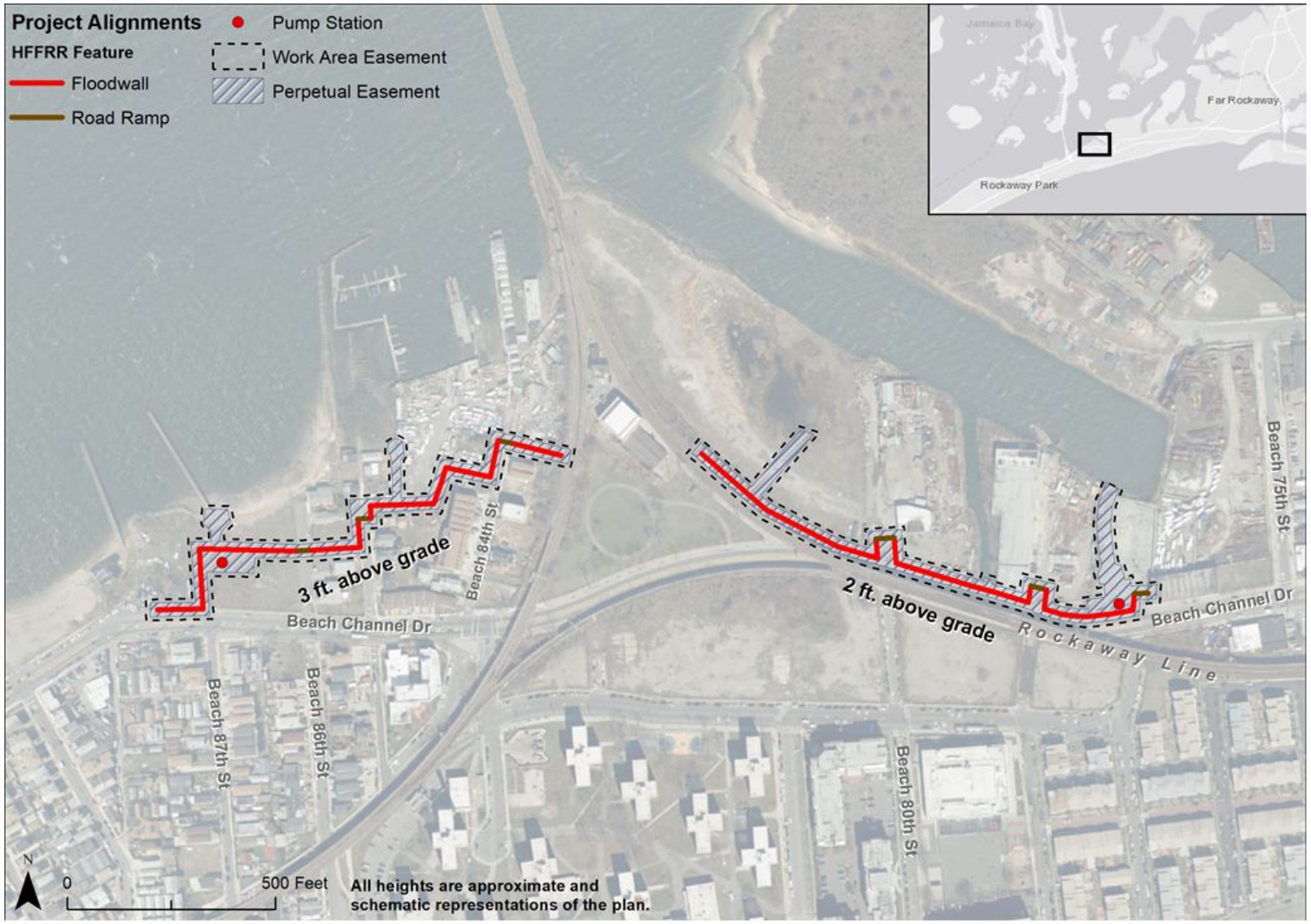


Figure ES-8: Mid-Rockaway - Hammels Area HFFRRF Project Plan

Drainage subbasin H1 is proposed to have a pump station located at the southern end of Hammels near Beach 87th Street with a capacity estimated at 100cfs. Subbasin H2 is also proposed to have one pump station which is located at the northern end of Hammels near Beach Channel Drive with an estimated capacity of 180 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlets will be refined during the project design phase.

Risk and Uncertainty

The goal of the Feasibility level design and analysis is to reduce the level of risk and uncertainty around the Recommended Plan such that decision makers are comfortable deciding whether or not to move forward with design and construction of the Recommended Plan. USACE has worked to reduce risks and uncertainties throughout the Feasibility Phase, and laid out a path to further reduce risks and uncertainties in the PED Phase. Residual risks of the project are briefly discussed below. The following categories of risk and uncertainty have been identified and assessed for this project. They are discussed and addressed in more detail in Section 6-8 of this HSGRR/EIS:

- Borrow area availability - There is a low risk that the borrow area identified for the sand needed for the project will not have sufficient sand over the life of the project. However, backup resources are available as a contingency;
- There are uncertainties associated with the impact assessment methodologies used in the evaluation of habitat impacts and mitigation requirements. These methodologies are accepted and preferred tools for feasibility level analysis;
- There are risks and uncertainties associated with how water levels are calculated and the risk and uncertainty associated with future sea level rise, which cannot be exactly known. The study team utilized USACE intermediate projections for sea level rise for the design of the HFFRRFs and USACE low projections for the initial Atlantic Shorefront design, with future adaptations as sea levels rise. The study team conducted a sensitivity analysis for how the project would perform under varying projections. The team also identified possible future adaptation strategies should sea levels rise more rapidly than assumed;
- Project cost uncertainty - In order to account for uncertainties in the final project costs, which could result from a variety of factors, all costs include an appropriate contingency on top of the actual estimated cost. For this project, a contingency of 28.36% is being utilized for initial construction and renourishments;
- Economic benefits uncertainty - There are inherent uncertainties in the methodologies used for estimating future damages from future storms that could be avoided with a CSRM plan, i.e. the benefits of a project. The HEC-FDA model used to assess benefits has been developed for this purpose and is certified for use by the Army Corps of Engineers;
- Periodic renourishment is subject to future funding by Congress; and
- Frequency and magnitude of future coastal storms is impossible to predict exactly, and plans/projects are based on extrapolations using the historical record. Storms in magnitude and frequency greater than the historical record are possible.

Residual Risks

The Recommended Plan for the Atlantic Shorefront Reach has very low residual risk, with an annual chance of exceedance of .0067%. If a storm occurs that exceeds the design of the shorefront, the composite seawall will still reduce damages by reducing cross shore flooding despite overtopping and reducing wave action. In the event of overtopping there would still be damages, but greatly reduced from the Future Without Project Condition. The risk of this size event occurring is low, though not impossible and sea level rise will increase the likelihood of this occurring over time.

The Recommended Plan HFFRRFs will greatly reduce the frequency of flooding in Hammels, Arverne, Edgemere, Cedarhurst and parts of the Town of Hempstead adjacent to the Village of Cedarhurst from flooding which likely occurs at least once a month currently. This frequent flooding is due to tidal flooding and heavy rains. With a project in place the risk of a flood in a given year for these areas drops to a 10% chance in 2018 and 20% chance in 2058.

The Recommended Plan has high residual risk for Bayside communities in the Jamaica Bay Planning Reach and for communities like Breezy Point and Coney Island. It should be noted that this study evaluated the feasibility of implementing HFFRRF plans for the communities with high residual risk, but no feasible plans were identified which would meet the policies and guidelines of USACE. The NYNJHAT study is evaluating the feasibility of constructing a storm surge barrier in Jamaica Bay that could be closed to prevent storm surge from entering the area during hurricanes and large storms, thereby greatly reducing the residual risk for the Jamaica Bay communities. Potential measures to adapt to sea level rise will also be evaluated as part of the NYNJHAT study for Bayside communities, as what would be appropriate depends largely on the ultimate recommendation for this separate study.

PERTINENT DATA

DESCRIPTION: The Recommended Plan developed in this report provides CSRM for an Atlantic Shorefront reach and four neighborhoods through high frequency flood risk reduction measures (HFFRRFs)

LOCATION: Atlantic Coast of New York City between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York

PROJECT DESIGN DATA

Atlantic Shorefront Element

Length of Composite Seawall	33,550 FT
Width of Dune at Crest	25 FT
Width of Berm	60 FT
Elevation of Dune (ft NAVD88)	18 FT
Elevation of Composite Seawall (ft NAVD88)	17 FT
Elevation of Beach Berm (ft NAVD88)	8 FT
Groin Extensions (existing groins)	5
Groin Construction (new groins)	13
Dune Slopes	
Landward	1V:3H
Seaward	1V:5H
Beach Berm Slope	1V:15H
Renourishment - every 4 years	1,111,000 CY
Total Initial Fill Beach and Dune (design, advance, overfill and tolerance)	1,596,000 CY
Total Fill Required over 50 year project	14,372,500 CY[8]

Cedarhurst-Lawrence HFFRRFs

		Total Length (linear feet)	Average Elevation (NAVD88)	Height Above Grade (feet)
Bulkheads				
Deep Bulkhead		963	10.0	4.0
Floodwalls				
Medium Floodwall		23	10.0	3.0
Interior Drainage				
Additional outfalls	1			
Pump Station Capacity (cfs)	40			

[8] Cost estimates for renourishment can accommodate quantities needed for up to intermediate sea level rise projections. The cost estimate assumes project adaptation to sea level rise, including raising the height of the seawall, dune, and berm, as discussed in Section 6.6.2 and Appendix A1, Section 7.6.1.

Mid-Rockaway HFFRRFs[9]

Edgemere Area

	Total Length (linear feet)	Average Elevation (NAVD88)	Height Above Grade (feet)
Berms			
Low Berm	1,509	8.0	2.5
Medium Berm	2,064	10.0	3.3
High Berm	81	12.5	5.5
Hybrid Berm	1,552	9.3	4.4
Bulkheads			
Shallow Bulkhead Urban[10]	192	9.0	4.0
Shallow Bulkhead	125	9.0	4.0
Floodwalls			
Medium Floodwall	478	8.8	3.8
High Floodwall	664	11.5	6.0
Road Ramps	53	8.0	4.0
Rock Sills	2,900	0.0	0.0
Interior Drainage			
Additional Outfalls	12		
Pump Station 1 Capacity (cfs)	210		
Pump Station 2 Capacity (cfs)	120		
NNBF Gains (acres)	2.0		

[9] Due to the high sensitivity of frequent flooding to sea level rise, the HFFRRFs were designed to assume intermediate USACE sea level rise rates and to function without need for additional adaptation based on those rates. The overall adaptation strategy envisioned for the Bayside will need to be integrated with any recommendation coming from the NYNJHAT study. Therefore, no cost to adapt the HFFRRFs to additional sea level rise was included for the Rockaway Reformulation as it will be part of the outcome of the NYNJHAT study.

[10] Bulkheads with design complications resulting from the urban environment are broken out separately as they have a slightly higher cost associated with them.

Mid-Rockaway HFFRRFs
Arverne Area

HFFRRF Elements		Total Length (linear feet)	Average Elevation (NAVD88)	Height Above Grade (feet)
Berms				
Low Berm		2,494	9.1	2.9
Medium Berm		1,142	12.5	5.0
Hybrid Berm		292	8.0	3.0
Bulkheads				
Shallow Bulkhead Urban		893	10.5	4.0
Shallow Bulkhead		1,939	10.6	4.0
Deep Bulkhead		1,121	11.5	4.0
Floodwalls				
Low Floodwall		3,167	8.8	2.4
Medium Floodwall		365	11.5	5.0
High Floodwall		439	11.5	5.5
Revetments		988	10.5	2.8
Road Ramps		111	8.0	2.3
Vehicular Gates		25	8.0	2.0
Rock Sills		5,177	0.0	0.0
Interior Drainage				
Additional Outfalls	8			
Pump Station 1 Capacity (cfs)	70			
Pump Station 2 Capacity (cfs)	180			
Pump Station 3 Capacity (cfs)	300			
NNBF Gains (acres)	7.0			

Mid-Rockaway HFFRRFs
Hammels Area

		Total Length (linear feet)	Average Elevation (NAVD88)	Height Above Grade (feet)
Floodwalls				
Low Floodwall		2,550	8.0	2.3
Road Ramps		218	8.0	2.8
Interior Drainage				
Additional Outfalls	3			
Pump Station 1 Capacity (cfs)	100			
Pump Station 2 Capacity (cfs)	180			

REAL ESTATE REQUIREMENTS

Atlantic Shorefront Element

Required Interest	Required Acres	Public Parcels	Public Owners
Perpetual Beach Storm Damage Reduction Easement	696.66	20	2
Temporary Construction Easement	7.92	4	1

Cedarhurst-Lawrence HFFRRFs

Required Interest	Required Acres	Private Parcels	Public Parcels
Flood Protection Levee Easement	0.35	8	3
Temporary Construction Easement	0.32	8	3
Fee excluding minerals	0.21	0	1

Mid-Rockaway HFFRRFs

Required Interest	Required Acres	Private Parcels	Public Parcels
Flood Protection Levee Easement	53.78	120	106
Bank Protection Easement	20.36	19	66
Temporary Construction Easement	2.47	18	11
Fee excluding minerals	1.84	9	9

ECONOMIC PERFORMANCE DATA

(FY19 Q1 effective price level, FY19 discount rate of 2$^{7/8}$ %)

Atlantic Shorefront Element

Project First Cost ($)	336,282,000	
Interest During Construction ($)	20,147,000	
Total Investment Cost ($)	**356,429,000**	
Annualized Investment Cost ($)		13,526,000
Annual OMRR&R Costs ($)		9,484,000
Annual Project Cost ($)		**23,010,000**
Average Annual Damage Reduction Benefits ($)		**31,333,000**
Average Annual Recreation Benefits ($)		**29,342,000**
Total Average Annual Benefits ($)		**60,675,000**
Net Excess Benefits Excluding Recreation($)		8,323,000
Net Excess Benefits ($)		37,665,000
Benefit to Cost Ratio Excluding Recreation		1.4
Benefit to Cost Ratio		2.6

Cedarhurst-Lawrence HFFRRFs[11]

Project First Cost ($)	16,979,000	
Interest During Construction ($)	293,000	
Total Investment Cost ($)	**17,272,000**	
Annualized Investment Cost ($)		655,000
Annual OMRR&R Costs ($)		89,000
Annual Project Cost ($)		**744,000**
Average Annual Benefits ($)		**5,146,000**
Net Excess Benefits ($)		4,402,000
Benefit to Cost Ratio		6.9

[11] HFFRRF benefit to cost ratios are shown separately as these are separable elements and must be incrementally justified.

Mid-Rockaway HFFRRFs

Project First Cost ($)	237,489,000	
Interest During Construction ($)	15,055,000	
Total Investment Cost ($)	**252,544,000**	
Annualized Investment Cost ($)		9,515,000
Annual OMRR&R Costs ($)		1,153,000
Annual Project Cost ($)		**10,668,000**
Average Annual Benefits ($)		**11,851,000**
Net Excess Benefits ($)		1,183,000
Benefit to Cost Ratio		1.1

Recommended Plan (Shorefront Element and HFFRRFs Combined)

Project First Cost ($)	590,750,000	
Interest During Construction ($)	35,495,000	
Total Investment Cost ($)	**626,245,000**	
Annualized Investment Cost ($)		23,765,000
Annual Shorefront OMRR&R Costs ($)		9,484,000
Annual HFFRRFs OMRR&R Costs ($)		1,235,000
Annual Project Cost ($)		**34,484,000**
Average Annual Damage Reduction Benefits ($)		**48,330,000**
Average Annual Recreation Benefits ($)		**29,342,000**
Average Annual Benefits ($)		**77,672,000**
Net Excess Benefits Excluding Recreation($)		13,846,000
Net Excess Benefits ($)		43,188,000
Benefit to Cost Ratio Excluding Recreation		1.4
Benefit to Cost Ratio		2.3

FINANCIAL DATA - RECOMMENDED PLAN FULLY FUNDED COST

Initial Construction		Project First Cost** ($)			Total Project Cost (Fully Funded) ($)		
Account	Description	Cost*	Contingency*	Total First Cost	Cost	Contingency	Total Project Cost
01	Lands & Damages	30,515,993	6,103,199	36,619,192	31,579,217	6,315,843	37,895,061
02	Relocations	4,419,294	1,253,312	5,672,605	4,575,827	1,297,704	5,873,531
10	Breakwaters & Seawalls	191,555,639	54,325,179	245,880,819	203,280,803	57,650,436	260,931,239
11	Levees & Floodwalls	99,943,553	28,343,992	128,287,545	106,487,233	30,199,779	136,687,012
13	Pumping Plant	37,327,343	10,586,035	47,913,378	39,782,541	11,282,329	51,064,870
17	Beach Replenishment	27,519,179	7,804,439	35,323,618	28,352,553	8,040,784	36,393,337
18	Cultural Resource Preservation	12,246,169	3,473,013	15,719,182	12,889,332	3,655,415	16,544,746
30	Planning, Engineering, & Design	36,219,134	10,271,746	46,490,880	37,635,987	10,673,566	48,309,552
31	Construction Management	22,470,443	6,372,618	28,843,061	25,451,710	7,218,105	32,669,814
Total Initial First Cost		**462,216,748**	**128,533,533**	**590,750,280**	**490,035,202**	**136,333,961**	**626,369,163**

Renourishment		Project First Cost** ($)			Total Project Cost (Fully Funded) ($)		
Account	Description	Cost*	Contingency*	Total First Cost	Cost	Contingency	Total Project Cost
06	Fish & Wildlife Facilities	15,124,165	4,289,213	19,413,378	27,061,089	7,674,525	34,735,614
17	Beach Replenishment	235,994,678	66,928,091	302,922,769	422,257,145	119,752,126	542,009,272
30	Planning, Engineering, & Design	24,016,689	6,811,133	30,827,822	103,665,968	29,399,669	133,065,637
31	Construction Management	13,929,680	3,950,457	17,880,137	63,214,205	17,927,549	81,141,754
Total Renourishment Cost		**289,065,211**	**81,978,894**	**371,044,105**	**616,198,408**	**174,753,868**	**790,952,276**

Total Project Cost (Initial + Renourishment)	**$ 751,281,959**	**$ 210,512,426**	**$ 961,794,385**	**$ 1,106,233,610**	**$311,087,829**	**$1,417,321,439**

* FY19 Q1 effective price level

** Project First Cost = Cost + Contingency

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Construction Authority & Reformulation Authority 1
1.2 Reformulation Purpose and Scope* 2
1.3 Non-Federal Sponsor 2
1.4 Study Area 3
1.4.1 Rockaway Peninsula 5
1.4.1 Jamaica Bay 7
1.5 Project Datum 7
1.6 Major Historical Surge Events in the Study Area 9
1.7 Prior Reports and Existing Water Projects 10
1.7.1 1965 Authorization 10
1.7.2 1974 Authorization 11
1.7.3 Section 934 and Reformulation Study 11
1.7.4 Federal Navigation Channels 12
1.7.5 Jamaica Bay Study 13
1.8 History of the Investigation 13
1.8.1 Draft HSGRR/EIS: August 2016 13
1.8.2 Revised Draft HSGRR/EIS: August 2018 14
1.8.3 Final HSGRR/EIS: December 2018 (amended the May 2019 version to include the revised Final US Fish and Wildlife Service Biological Opinion, dated July 2019) 14
2 EXISTING CONDITIONS* 15
2.1 Geologic Setting 15
2.1.1 Soils 16
2.1.2 Topography 16
2.2 Bathymetry and Sediments 17
2.2.1 Sediment Transport 17
2.2.2 Sediment Quality 18
2.3 Surface Water 18
2.3.1 Coastal Storm Hazards 18
2.3.2 Tidal Currents 22
2.3.3 Wind and Wave Climate 22
2.3.4 Sea Level Change 23
2.4 Water Quality 23
2.5 Air Quality 24

2.6 Shoreline Habitats 25
2.6.1 Subtidal Bottom 25
2.6.2 Hardened Shoreline 25
2.6.3 Mudflats 26
2.6.4 Intertidal Wetlands 26
2.6.5 Maritime Coastal Forest and Shrubland 26
2.6.6 Ruderal Uplands 27
2.6.7 Urban 27
2.7 Invertebrate and Benthic Resources 27
2.8 Finfish 28
2.9 Reptiles and Amphibians 29
2.10 Birds 29
2.11 Mammals 30
2.12 Threatened and Endangered Species 30
2.12.1 Federally-Listed Species 30
2.12.2 Critical Habitat 32
2.12.3 Migratory Birds 32
2.12.4 State-Listed Species of Concern 33
2.13 Special Management Areas 34
2.13.1 Gateway National Recreation Area 34
2.13.2 NYC Waterfront Revitalization Program 35
2.13.3 Coastal Zone Boundary 36
2.13.4 NYC Special Natural Waterfront Area 37
2.13.5 Coastal Barrier Resources Act Areas 37
2.13.6 New York State Natural Heritage Program 39
2.13.7 New York State Department of State Significant Coastal Fish and Wildlife Habitats 39
2.13.8 NYC Planning Special Purpose Districts 40
2.13.9 NYSDEC Critical Environmental Area 41
2.13.10 New York/New Jersey Harbor Estuary Program 42
2.14 Recreation 42
2.15 Navigation 44
2.16 Infrastructure 44
2.16.1 Atlantic Ocean Shorefront Planning Reach 44
2.16.2 Jamaica Bay Planning Reach 45
2.17 Hazardous, Toxic, and Radioactive Wastes (HTRW) 45
2.18 Cultural Resources 47

2.18.1 Historical Context 48
2.18.2 Areas of Potential Effect 51
2.18.3 Previous Research 52
2.18.4 Archeological Resources – Rockaway and Jamaica Bay 55
2.18.5 Native American Tribal Consultation 57
2.19 Socioeconomic Considerations 58
3 FUTURE WITHOUT-PROJECT CONDITIONS* 60
3.1 Study Area 60
3.2 Coastal Storm Risk Resiliency Efforts by Non-Federal Entities 60
3.2.1 Nassau Expressway Project 61
3.2.2 NY Rising Community Reconstruction Program 61
3.2.3 Fresh Creek Project 61
3.2.4 New York City Projects 62
3.3 Ecosystem Restoration Efforts by Non-Federal Entities 63
3.3.1 Idlewild Park 63
3.3.2 Salt Marsh Restoration 63
3.3.3 Marine Park 63
3.3.4 Rockaway Community Park 64
3.3.5 Jamaica Bay Park 64
3.3.6 Spring Creek 64
3.3.7 Sunset Cove 64
3.3.8 Bayswater 64
3.3.9 Fresh Creek 64
3.4 Economic Conditions 65
3.5 Physical Conditions 66
3.6 Life Safety 68
3.7 Critical Infrastructure 69
3.8 Sea Level Change 70
3.9 Future Without-Project Conditions Summary 72
4 PROBLEMS AND OPPORTUNITIES 73
4.1 Background 73
4.2 Problem 1 – Impacts to Human Health and Safety 76
4.2.1 Opportunity to Address Problem 1 76
4.3 Problem 2 - Projected Future Coastal Storm Impacts 76
4.3.1 Opportunity to Address Problem 2 76
4.4 Problem 3 - Insufficient Resiliency in Natural and Man-made Systems 76
4.4.1 Opportunity to Address Problem 3 77

4.5 Problem 4 – Erosion, Loss and Degradation of the System's Living Shorelines Protective Capacity 77
4.5.1 Opportunity to Address Problem 4 78
4.6 Planning Goals, Objectives, and Constraints 79
4.6.1 Planning Goals 79
4.6.2 Public Concerns 80
4.6.3 Planning Objectives 80
4.6.4 Planning Constraints 81
5 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS* 83
5.1 Development of the Array of Alternatives 84
5.2 Identification of the Tentatively Selected Plan 85
5.3 Inviting and Incorporating Public and Agency Comments into the Agency Decision on a Recommended Plan 85
5.4 Refinement of the Recommended Plan 86
5.5 Management Measures 87
5.5.1 Atlantic Ocean Shorefront Planning Reach 87
5.5.2 Jamaica Bay Planning Reach 88
5.6 Alternative Plan Formulation 91
5.6.1 Atlantic Ocean Shorefront Planning Reach 91
5.6.2 Jamaica Bay Planning Reach 99
5.7 Alternative Plan Evaluation and Comparison 104
5.7.1 Screening Criteria 104
5.7.2 Habitat Impacts and Mitigation Requirements 105
5.7.3 Atlantic Ocean Shorefront Planning Reach 106
5.7.4 Recreation Benefits 106
5.8 Identification of the Tentatively Selected Plan 107
5.9 Progression from the TSP to the Recommended Plan 112
5.9.1 Outcome of the Agency Decision Milestone 112
5.9.2 Public Review Warranted to Finalize the Recommended Plan 113
5.10 Objectives, Planning Considerations, and Screening Criteria for HFFRRF Development 113
5.11 Initial HFFRRF Screening 119
5.11.1 Prototypical Designs, HFFRRF Placements and Cost Estimates 120
5.11.2 HFFRRF CSRM Benefits 120
5.11.3 Preliminary HFFRRF Screening Results 121
5.12 HFFRRF Interior Drainage Analysis 122
5.12.1 Minimum Facility Concept 124

5.12.2 National Economic Development for Interior Drainage Facilities 124
5.12.3 Mid-Rockaway HFFRRF Project 125
5.12.4 Canarsie HFFRRF Project 130
5.12.5 Cedarhurst-Lawrence HFFRRF Project 131
5.12.6 Motts Basin North HFFRRF Project 132
5.13 Summary of Interior Drainage Economics for the Recommended Plan 132
5.14 Wave Height Analysis for HFFRRFs 134
5.15 Real Estate Considerations 136
5.16 Cost Effectiveness of NNBFs 136
5.17 Non-Structural Screening for Broad Channel 137
5.18 Final HFFRRF Screening Results 138
5.19 Consideration of Planning Objectives & Constraints 140
5.20 Consideration of the P&G Criteria 141
5.20.1 Consideration of P&G Accounts 142
5.21 Decision to be Made 143
6 RECOMMENDED PLAN 144
6.1 Atlantic Shorefront Component 144
6.1.1 Reinforced Dune – Composite Seawall 146
6.1.2 Beach Restoration 148
6.1.3 Groins 148
6.2 HFFRRF Component 156
6.2.1 Cedarhurst-Lawrence 156
6.2.2 Mid-Rockaway 158
6.3 Recommended Plan Cost Estimate 165
6.3.1 Project First Costs 165
6.3.2 Project Schedule and Interest During Construction 167
6.3.3 Operations and Maintenance 167
6.3.4 Annual Project Costs 169
6.3.5 Economic Performance 170
6.4 Real Estate Considerations 173
6.5 Habitat Impacts and Mitigation Requirements 174
6.5.1 Habitat Impacts Using Acreage as a Metric 175
6.5.2 NNBFs 177
6.5.3 Evaluation for Planned Wetlands Analysis 178
6.6 Design and Construction Considerations 179
6.6.1 Value Engineering 179
6.6.2 Design Adaptability to Relative Sea Level Change 179

6.7 Summary of Accounts 182
6.7.1 National Economic Development (NED) 182
6.7.2 Environmental Quality (EQ) 182
6.7.3 Regional Economic Development Benefits (RED) 183
6.7.4 Other Social Effects 183
6.8 Risk and Uncertainty 184
6.8.1 Residual Risks 184
6.8.2 Ecological Uncertainty 185
6.8.3 Risk and Uncertainty in Economics 185
6.8.4 Risk and Uncertainty for Project Costs 186
6.8.5 Risk and Uncertainty in Borrow Area Availability 187
6.8.6 Risk and Uncertainty in Water Level and Sea Level Rise Assumptions 187
6.8.7 Risk and Uncertainty in Future Beach Placement Activities 188
6.8.8 Risk and Uncertainty in Coastal Storms 188
6.8.9 Risk-Informed Decision Making 188
6.9 Recommendations for PED 188
6.9.1 HFFRRF Designs 188
6.9.2 Atlantic Shorefront Element Design 190
7 ENVIRONMENTAL CONSEQUENCES* 191
7.1 Geologic Setting 191
7.1.1 No Action Alternative 191
7.1.2 Recommended Plan (Atlantic Shorefront & Jamaica Bay Combined) 191
7.2 Bathymetry and Sediments 193
7.2.1 No Action Alternative 193
7.2.2 Recommended Plan – Atlantic Shorefront 193
7.2.3 Recommended Plan – Jamaica Bay 194
7.3 Surface Water 195
7.3.1 No Action Alternative 195
7.3.2 Recommended Plan - Atlantic Shorefront & Jamaica Bay Combined 195
7.4 Water Quality 196
7.4.1 No Action Alternative 196
7.4.2 Recommended Plan - Atlantic Shorefront & Jamaica Bay Combined 196
7.5 Air Quality Impacts 197
7.5.1 No Action Alternative 197
7.5.2 Recommended Plan 198
7.6 Shoreline Habitats 199
7.6.1 No Action Alternative 199

7.6.2 Recommended Plan – Atlantic Shorefront 199
7.6.3 Recommended Plan – Jamaica Bay 199
7.7 Invertebrate and Benthic Resources 200
7.7.1 No Action Alternative 200
7.7.2 Recommended Plan – Atlantic Shoreline Planning Reach 201
7.7.3 Recommended Plan – Jamaica Bay Planning Reach 202
7.8 Finfish 202
7.8.1 No Action Alternative 202
7.8.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined 202
7.9 Reptiles and Amphibians 203
7.9.1 No Action Alternative 203
7.9.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined 204
7.10 Birds 204
7.10.1 No Action Alternative 204
7.10.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined 204
7.11 Mammals 205
7.11.1 No Action Alternative 205
7.11.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined 206
7.12 Protected Species 206
7.12.1 No Action Alternative 206
7.12.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined 206
7.13 Special Management Areas 211
7.13.1 No Action Alternative 211
7.13.2 Recommended Plan 212
7.14 Recreation 212
7.14.1 No Action Alternative 212
7.14.2 Recommended Plan 213
7.15 Navigation 213
7.15.1 No Action Alternative 213
7.15.2 Recommended Plan 213
7.16 Infrastructure 214
7.16.1 No Action Alternative 214
7.16.2 Recommended Plan 214
7.17 Hazardous, Toxic, and Radioactive Waste (HTRW) 220
7.17.1 No Action Alternative 221
7.17.2 Recommended Plan 221
7.18 Cultural Resources 221

7.18.1 No Action Alternative 221
7.18.2 Recommended Plan 222
7.19 Socioeconomics and Environmental Justice 223
7.19.1 No Action Alternative 224
7.19.2 Recommended Plan 226
7.20 Aesthetics 226
7.20.1 No Action Alternative 226
7.20.2 Recommended Plan 226
7.21 Cumulative Impacts 227
7.21.1 Special Aquatic Habitat Programs Including Wetlands 228
7.21.2 Beach Front Measures 229
7.21.3 Borrow Area Usage 230
7.21.4 USACE Overall Program and Coastal Zone Habitat Modifications 231
7.21.5 Long-Term Combined Sewer Overflow (CSO) Projects 235
7.21.6 Community Development Plans 235
7.21.7 Summary of Cumulative Impacts 236
7.22 Summary of Environmental Effects 242
7.22.1 Unavoidable Adverse Environmental Impacts 242
7.22.2 Irreversible and Irretrievable Commitments of Resources 243
7.23 Short-Term Use and Long-Term Productivity of the Environment 243
7.24 Energy and Natural or Depletable Resource Requirements and Conservation Potential of Various Alternatives and Mitigation Measures 243
8 COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS 244
9 EXECUTIVE ORDER 11988 AND PUBLIC LAW 113-2 CONSIDERATIONS 253
9.1 Executive Order 11988 253
9.2 Resiliency, Sustainability, and Consistency with the NACCS 254
9.2.1 Resiliency 254
9.2.2 Sustainability/Adaptability 255
9.2.3 Consistency with the North Atlantic Coast Comprehensive Study 255
10 IMPLEMENTATION REQUIREMENTS 257
10.1 Division of Plan Responsibilities and Cost-Sharing Requirements 257
10.2 Costs for the Recommended Plan 259
10.3 Cost Sharing Apportionment 262
10.4 Views of the Non-Federal Sponsors and Others 262
10.5 Recommended Plan and Recent USACE Initiatives 263
10.5.1 USACE Campaign Plan 263
10.5.2 Environmental Operating Principles 263

11 PUBLIC INVOLVEMENT 264
11.1 Public Involvement Activities 264
11.2 Distribution List 265
12 RECOMMENDATIONS 270
12.1 Overview 270
12.2 Recommendation 270
13 REFERENCES 272
14 INDEX* 284
15 LIST OF ACRONYMS 287

LIST OF TABLES

Table ES-1 Without-Project Condition Equivalent Annual Damages ($) vi
Table ES-2 Atlantic Shorefront Component – Economic Metrics x
Table ES-3 HFFRRF Projects – Economic Metrics xvi
Table 1-1: Gauge 8518750, The Battery, New York Extreme Tide Gauge Heights 9
Table 2-1: Migratory Bird Species with Potential to Occur in or Proximate to the Study Area . 32
Table 2-2: New York State Protected Species with Potential to Occur in or Proximate to the Study Area 34
Table 3-1: Structures Within FEMA 1 Percent Annual Chance Flood Area..... 65
Table 3-2: Without-Project Condition Damages (AAEQ)..... 66
Table 3-3: Relative Sea Level Rise Impacts on Shoreline Changes and Sediment Budget 67
Table 3-4: Future Without Project Shoreline Changes 68
Table 3-5: At Risk Population Over Age 65..... 69
Table 3-6: USACE SLC Projections (feet) at The Battery, NY (Gauge: 8518750) 71
Table 4-1: Changed and Projected Water Levels in Jamaica Bay 74
Table 4-2: Problems and Objectives Matrix 81
Table 5-1: Summary of Preliminary Screening of Shorefront Measures 87
Table 5-2: Comprehensive Inventory of Measures..... 89
Table 5-3: Optimal Beachfill Life Cycle Cost Screening for Atlantic Shorefront 92
Table 5-4: Beachfill and Renourishment Quantities (cubic yards)..... 93
Table 5-5: Groin Locations and Lengths (feet)..... 94
Table 5-6: Recommended Design and Beachfill Profiles for Sand-only Dunes (Shorefront Alternatives 1-3) 95
Table 5-7: Seawall Design Alternatives Considered 96
Table 5-8: Rockaway Beach Dune and Berm Formulation Summary - Low Sea Level Rise Scenario..... 97
Table 5-9: Rockaway Beach Dune and Berm Formulation Summary - Intermediate Sea Level Rise Scenario 98
Table 5-10: Permanent and Temporary Habitat Impacts (acres) 105
Table 5-11: Atlantic Ocean Shorefront Planning Reach Equivalent Annual Damage Reduction 106
Table 5-12: Jamaica Bay Alternative Plan Average Annual Net Benefits (AAEQ) 108
Table 5-13: Jamaica Bay Reach Alternative Plan Comparison Summary 109

Table 5-14: HFFRRF Feature Placement Considerations 114
Table 5-15: HFFRRF Preliminary Screening Results ($000) 122
Table 5-16: Summary of Alternatives for Hammels Drainage Basin of the Mid-Rockaway HFFRRF 125
Table 5-17: Preferred Plan Gravity Outlets for Hammels 126
Table 5-18: Summary of Interior Drainage Alternatives Considered for Arverne 127
Table 5-19: Preferred Plan Gravity Outlets for Arverne 128
Table 5-20: Summary of Interior Drainage Alternatives Considered for Edgemere 129
Table 5-21: Preferred Plan Gravity Outlets for Edgemere 129
Table 5-22: Summary of Interior Drainage Alternatives Considered for Canarsie 130
Table 5-23: Summary of Interior Drainage Alternative Considered for Cedarhurst-Lawrence 131
Table 5-24: Preferred Plan Gravity Outlets for Cedarhurst-Lawrence 132
Table 5-25: Interior Drainage Alternatives Evaluated 133
Table 5-26: Summary of Preferred Plans for the Project Areas 134
Table 5-27: NNBF Cost Effectiveness When Compared to Gray Feature Alternatives 137
Table 5-28: Phase 2 Economic Screening Results of the Jamaica Bay HFFRRFs 139
Table 5-29: Consideration of Planning Objectives and Constraints 140
Table 5-30: Summary of Contribution of Alternatives to the P&G Criteria 142
Table 5-31: Recommended Plan Performance on P&G Accounts 143
Table 6-1: Beachfill and Renourishment Quantities (cubic yards) 148
Table 6-2: Summary of Groin Lengths for the Recommended Plan 149
Table 6-3: Recommended Plan Project First Costs 165
Table 6-4a: Shorefront Element Project First Costs 166
Table 6-4b: Mid-Rockaway HFFRRF Project First Costs 166
Table 6-4c: Cedarhurst-Lawrence HFFRRF Project First Costs 166
Table 6-5: Recommended Plan Component Schedules 167
Table 6-6: Interest During Construction 167
Table 6-7: Recommended Plan Annual OMRR&R and Monitoring Costs 168
Table 6-8: Recommended Plan Annual Project Costs 169
Table 6-9a: Shorefront Element Annual Project Costs 169
Table 6-9b: Mid-Rockaway HFFRRF Annual Project Costs 170
Table 6-9c: Cedarhurst-Lawrence HFFRRF Annual Project Costs 170
Table 6-10: Recommended Plan Economic Performance Metrics 171

Table 6-11a: Shorefront Element Economic Performance Metrics 172
Table 6-11b: Mid-Rockaway HFFRRF Economic Performance Metrics 172
Table 6-11c: Cedarhurst-Lawrence HFFRRF Economic Performance Metrics 173
Table 6-12: Recommended Plan Real Estate Impacts 174
Table 6-13: Permanent Habitat Impacts – Acreage 175
Table 6-14: Temporary Habitat Impacts - Acreage 176
Table 6-15: Restoration, Creation, & Enhancements – Acreage 178
Table 6-16: EPW Functional Assessment – FCU Losses 179
Table 6-17: EPW Functional Assessment – FCU Gains 179
Table 6-18: Range of Economic Benefits and Economic Metrics 186
Table 7-1: Recommended Plan Beachfill Quantities 194
Table 7-2: Recommended Plan Construction Emissions Estimate – Tons per Year 198
Table 7-3: Proposed Seasonal Work Restrictions – East Rockaway Inlet to Rockaway Inlet and Jamaica Bay 210
Table 7-4: Truck Trips Required for Construction of the Recommended Plan 215
Table 7-5: Baseline Traffic and Project-Related Traffic Increases 220
Table 7-6: Region of Influence for Cumulative Impact Analysis 228
Table 10-1: Recommended Plan Fully Funded Costs 260
Table 10-2 Cost Apportionment 262

LIST OF FIGURES

Figure ES-1: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Study Area iii
Figure ES-2: Recommended Plan Geographic Overview ix
Figure ES-3: Atlantic Shorefront Component of the Recommended Plan - Overview xi
Figure ES-4a: Atlantic Shorefront Component of Recommended Plan (1 of 4) xii
Figure ES-4b: Atlantic Shorefront Component of Recommended Plan (2 of 4) xiii
Figure ES-4c: Atlantic Shorefront Component of Recommended Plan (3 of 4) xiv
Figure ES-4d: Atlantic Shorefront Component of Recommended Plan (4 of 4) xv
Figure ES-5: Cedarhurst-Lawrence HFFRRF Project Plan xvii
Figure ES-6: Mid-Rockaway - Edgemere Area HFFRRF Project Plan xix
Figure ES-7: Mid-Rockaway - Arverne Area HFFRRF Project Plan xxi
Figure ES-8: Mid-Rockaway - Hammels Area HFFRRF Project Plan xxiv
Figure 1-1: Study Area Overview - Rockaway Peninsula and Jamaica Bay 4
Figure 1-2: Atlantic Shorefront Economic Reaches 6
Figure 1-3: Jamaica Bay Economic Reaches 8
Figure 1-4: Approximate Historical Study Area Inundation at Various Water Elevations 10
Figure 2-1: Preliminary FEMA Map Elevations (NAVD88) for the Study Area 20
Figure 2-2: Gateway National Recreation Area Boundary 35
Figure 2-3: NYC Waterfront Revitalization Program, Coastal Zone Boundary, and Special Natural Waterfront Areas 36
Figure 2-4: Coastal Barrier Resource System Area 39
Figure 2-5: NYS Dept. State Significant Coastal Fish and Wildlife Habitats 40
Figure 2-6: Percent of Persons Below Poverty Level 59
Figure 3-1: Future Without Project Sediment Transport Pathways at the Atlantic Ocean Shorefront Planning Reach 68
Figure 3-2: Study Area Critical Infrastructure and Hurricane Sandy Impact Area 70
Figure 3-3: One Percent Annual Chance (100-year) Flood Hazard with Intermediate SLC 72
Figure 4-1: Spring High Tide Flooding of Storm Drain 73
Figure 4-2: Newport Avenue in Rockaway Park During 25% AEP – February 2016 75
Figure 4-3: Far Rockaway During 25% AEP at High Tide– February 2016 75
Figure 4-4: Marsh and Rock Sill NNBF Concept Illustration 79
Figure 5-1: Risk-Informed Decision Making Process 83

Figure 5-2: Risk-Informed Planning Process 84
Figure 5-3: Summary of Preliminary Screening of Jamaica Bay Measures 90
Figure 5-4: Beach Restoration with Beachfill, Groin Extensions, and New Groins 92
Figure 5-5: Profile of Beach Restoration and Dune Alternatives 95
Figure 5-6: First and Second Screening Rounds of Jamaica Bay Plans 100
Figure 5-7: Alignments C-1 and C-2 102
Figure 5-8: Plan D Jamaica Bay Perimeter Plan 104
Figure 5-9: Flood Extents for High Frequency Flood Events in the Study Area 116
Figure 5-10: Profile drawing of an NNBF, or living shoreline, concept 117
Figure 5-11: NNBFs Identified for Evaluation and Screening 118
Figure 5-12: Thirteen Potential HFFRRFs Projects identified 119
Figure 5-13: Calculated Wave-heights at HFFRRF Alignments 136
Figure 6-1: Recommended Plan Geographic Overview 145
Figure 6-2: Atlantic Shorefront – Composite Seawall 147
Figure 6-3: Atlantic Shorefront – Composite Seawall (Beach 126th St. to Beach 149th St.) 147
Figure 6-4: Design Beach Profile (note: existing profile varies) 150
Figure 6-5: Atlantic Shorefront Component of the Recommended Plan - Overview 151
Figure 6-6a: Atlantic Shorefront Component of Recommended Plan (1 of 4) 152
Figure 6-6b: Atlantic Shorefront Component of Recommended Plan (2 of 4) 153
Figure 6-6c: Atlantic Shorefront Component of Recommended Plan (3 of 4) 154
Figure 6-6d: Atlantic Shorefront Component of Recommended Plan (4 of 4) 155
Figure 6-7: Cedarhurst-Lawrence HFFRRF Project Plan 157
Figure 6-8: Mid-Rockaway - Edgemere Area HFFRRF Project Plan 159
Figure 6-9: Mid-Rockaway - Arverne Area HFFRRF Project Plan 161
Figure 6-10: Mid-Rockaway - Hammels Area HFFRRF Project Plan 164
Figure 6-11: Atlantic Shorefront Component: Seawall Adaptability Measures 181
Figure 7-1: NYC Through Truck Route Network to Access Project Area 216
Figure 7-2: Local Truck Route Network Roadways to Access Project Area 217
Figure 7-3: Potential Environmental Justice Areas and Project Locations 225
Figure 8-1: Locations Associated with Children within 200 feet of the Project Area 251

LIST OF APPENDICES

Appendix A: Engineering and Design

Appendix B: Economic Benefits

Appendix C: Cost Engineering

Appendix D: Environmental Compliance

D1: USFWS Planning Aid Letter

USFWS Coordination Act Report

D2: ESA Section 7 Consultation

Biological Assessment

NMFS Not Likely to Adversely Affect Determination Concurrence

USFWS Biological Opinion

D3: Essential Fish Habitat Assessment

D4: 404(b)(1) Evaluation

D5: CZMA Federal Consistency Determination

D6: Cultural/Historic Resources - Programmatic Agreement

D7: General Conformity Applicability Analysis (Clean Air Act, Emissions Estimates)

D8: Monitoring Plan

Appendix E: Real Estate Plan

Appendix F: Public Access Plan

Appendix G: Public Engagement

Appendix H: Support from Non-Federal Sponsor, Partners, and Cooperating Agencies

Appendix I: Pertinent Correspondence

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

Final General Reevaluation Report and Environmental Impact Statement

1 INTRODUCTION

This report is an Integrated Hurricane Sandy General Reevaluation Report / Environmental Impact Statement (HSGRR/EIS) examining coastal storm risk management (CSRM) problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area, which was devastated by the impacts of Hurricane Sandy in 2012. Consistent with current U.S. Army Corps of Engineers (USACE) planning guidance, this reformulation identified and screened alternatives to address CSRM, and is presenting a Recommended Plan. This HSGRR/EIS follows a 2016 Draft HSGRR/EIS which underwent public review, policy review, Agency Technical Review (ATR), and an Independent External Peer Review. A subsequent Revised Draft HSGRR/EIS underwent a second public review and ATR. This HSGRR/EIS reflects changes from responses to review comments, and presents a recommended plan.

1.1 Construction Authority & Reformulation Authority

There is a long history of sediment placement in the study area (see Section 1.7: Prior Reports and Existing Projects). After initial construction in 1977 and subsequent beachfill placement along the Rockaway peninsula, a Reformulation was authorized by Congress in 1997 to ensure that the appropriate long-term solution was recommended.

The Reformulation Effort for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay was authorized by the House of Representatives, dated 27 September 1997, as stated within the Congressional Record for the US House of Representatives. It states, in part:

> *"With the funds provided for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York project, the conferees direct the Corps of Engineers to initiate a reevaluation report to identify more cost-effective measures of providing storm damage protection for the project. In conducting the reevaluation, the Corps should include consideration of using dredged material from maintenance dredging of East Rockaway Inlet and should also investigate the potential for ecosystem restoration within the project area."*

Public Law 113-2 (29 Jan 13), The Disaster Relief Appropriations Act of 2013 (the Act), was enacted in part to "improve and streamline disaster assistance for Hurricane Sandy, and for other purposes". The Act directed the Corps of Engineers to:

> *"...reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy"* (PL 113-2).

In partial fulfillment of the requirements detailed within the Act, USACE produced a report assessing "authorized Corps projects for reducing flooding and storm risks in the affected area that have been constructed or are under construction". The East Rockaway Inlet to Rockaway Inlet, New York project met the definition in the Act as a constructed project. In accordance with the Act, USACE is proceeding with this HSGRR to address resiliency, efficiency, risks, environmental compliance, and long-term sustainability within the study area (USACE, 2013a). The HSGRR effort is 100% federally funded, and the initial construction of project features is 100% federally funded subject to availability of funds.

1.2 Reformulation Purpose and Scope*

Prior to Hurricane Sandy, CSRM efforts focused on Atlantic Ocean Shoreline features with the State of New York through the New York State Department of Environmental Conservation as the non-federal sponsor. Awareness of the need for an integrated approach to CSRM opportunities for the entire study area including the shorefront, Jamaica Bay and surrounding communities has increased since Hurricane Sandy impacted the area in 2012. As a result of the devastation associated with Hurricane Sandy, the USACE has been tasked to address coastal resiliency and long-term sustainability when undertaking this reformulation effort, in addition to the traditional USACE planning report categories of "economics, risk, and environmental compliance (USACE, 2013a)." The goal of this HSGRR/EIS is to identify solutions that will reduce Atlantic Ocean Shoreline and Jamaica Bay vulnerability to storm damage over time, in a way that is sustainable over the long-term, both for the natural coastal ecosystem and for communities.

The relationships and interactions among the natural and built features (e.g., floodwalls, flood gates, etc.) comprising a coastal risk reduction system are important variables determining coastal vulnerability, reliability, risk, and resilience (USACE, 2013b). Improving resilience, which is a key factor in reducing risk, includes improving the ability to anticipate, prepare for, respond to, and adapt to changing conditions and to recover rapidly from disruptions (USACE, 2013c).

Natural Features (NF) are defined as features that are created and/or evolve over time through the actions of physical, biological, geologic, and chemical processes operating in nature. NF in a coastal ecosystem take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, marsh islands, dunes, beaches, wetlands, and maritime forests. Nature-based features (NBF) are defined as those features that may mimic characteristics of natural features but are created by human design, engineering, and construction to provide specific services such as coastal risk reduction. Examples of NBF include constructed wetlands, or a beach and dune system engineered for coastal storm risk management. Consistent with the North Atlantic Coast Comprehensive Study (USACE, 2013b), these features are referred to jointly throughout this study. NNBFs (natural and nature-based features) are commonly combined to implement the concept of a "living shoreline".

1.3 Non-Federal Sponsor

New York State, through the New York State Department of Environmental Conservation, is the non-federal partner. New York City (NYC), through the NYC Mayor's Office of Recovery and Resiliency, is the local sponsor to New York State. The non-federal sponsor and the local sponsor support the Recommended Plan and moving forward with Plans & Specifications and Construction. Other project partners include the NYC Department of Parks and Recreation and NYC Department of Environmental Protection. The National Park Service, Gateway National

Recreation Area (NPS) is a consulting party under Section 106 of the National Historic Preservation Act and a Cooperating Agency under the National Environmental Policy Act.

1.4 Study Area

The study area consists of the Atlantic Coast of NYC between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York – unchanged from the 2016 Draft HSGRR/EIS (Figure 1-1). The study area also includes the low lying Coney Island section of Brooklyn, which can be overtopped by floodwaters that flood the Brooklyn neighborhoods surrounding Jamaica Bay. The coastal area, which is approximately 10 miles in length, is a peninsula located entirely within the Borough of Queens, NYC. This peninsula, generally referred to as the Rockaways, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, NYC, and a section at the eastern end, known as Head of Bay, lies in Nassau County.

Effective CSRM requires that risk management measures reduce flood risk from inundation at Jamaica Bay and the Rockaway peninsula and also reduce flood risk and the effects of erosion and wave attack along the Atlantic shorefront of the Rockaway peninsula. Reducing flood risk from inundation at Jamaica Bay cannot be fully effective without also reducing flood risk at the Atlantic shorefront on the Rockaway peninsula because flood waters would be able to inundate low lying areas of the Jamaica Bay side of the Rockaway peninsula, if the Atlantic shorefront risk reduction component were not in place. Similarly, risk management measures in Jamaica Bay also require that risk reduction measures address the flood water crossing the Coney Island beach, and flanking the Jamaica Bay risk reduction measures from as far west as Coney Island Creek.

Since the problems and opportunities vary across the study area, alternatives have been formulated considering two planning reaches, to identify the most efficient solution for each reach. The two planning reaches are the Atlantic Ocean Shoreline Reach (Rockaway Peninsula), and the Jamaica Bay Reach. Integrating CSRM alternatives for the two reaches provides the most economically efficient system-wide solution for the vulnerable communities within the study area.

Much of the study area is located within portions of the Gateway National Recreation Area (GNRA), which includes the Jamaica Bay Wildlife Refuge. Both GNRA and the wildlife refuge are operated by the National Park Service (NPS). The portion of any CSRM plan that falls within GNRA boundaries or impacts the resource of GNRA should be mutually acceptable to NPS (U. S. Department of the Interior) and USACE.

Figure 1-1: Study Area Overview - Rockaway Peninsula and Jamaica Bay

1.4.1 Rockaway Peninsula

The communities located on the Rockaway peninsula from west to east include Breezy Point, Roxbury, Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammels, Arverne, Edgemere and Far Rockaway. The former Fort Tilden Military Reservation and the Jacob Riis Park (part of the Gateway National Recreation Area) are located in the western half of the peninsula between Breezy Point and Neponsit. The characteristics of nearly all of the communities on the Rockaway peninsula are similar. Ground elevations rarely exceed +10 feet NAVD88[12], except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from +5 feet NAVD88, increasing to +10 feet NAVD88 further south toward the Atlantic coast. An estimated 7,900 residential and commercial structures on the peninsula fall within the FEMA regulated 1% Annual Exceedance Probability (AEP)[13] floodplain, commonly referred to as the 100-year floodplain. Nearly the entire peninsula falls within the regulated 100-year floodplain.

The Atlantic Ocean Shorefront Planning Reach along the Rockaway Peninsula is segmented into six reaches for the purpose of this analysis. Each reach is delineated based upon site-specific physical, economic, and institutional differences. Considerations include hydrodynamic differences, coastal features, sediment transport boundaries, shoreline stability, existing projects, and development patterns. Reach designations help characterize the problems, needs, and opportunities and to identify alternatives viable for each reach. It should be noted that segmentation of the Atlantic Ocean Shorefront Planning Reach into reaches does not imply separable projects or construction areas.

The six Atlantic Ocean shorefront reaches (Figure 1-2) include:

- Reach 1: Rockaway Point to Beach 193rd Street;
- Reach 2: Beach 193rd Street to Beach 149th Street;
- Reach 3: Beach 149th Street to Beach 109th Street;
- Reach 4: Beach 109th Street to Beach 86th Street;
- Reach 5: Beach 86th Street to Beach 42nd Street; and
- Reach 6: Beach 42nd Street to Beach 9th Street.

The Rockaway peninsula east of Beach 9th Street along and north of the East Rockaway Inlet is a densely populated neighborhood that experiences flood risk from both Jamaica Bay through East Rockaway Inlet and the wetlands to the north which adjoin Seagirt Avenue, sometimes referred to as Bridge Creek. This creek is part of the Nassau County back bays and these flooding mechanisms are unique to the study area. It is recognized that a solution on the Atlantic Shorefront alone would not provide a comprehensive plan for managing flood risk in this area. Potential projects that could manage flood risk in this area are currently under investigation as part of the ongoing USACE Nassau County Back Bay CSRM Study

.

[12] North American Vertical Datum of 1988 (NAVD88).

[13] AEP denotes the probability in any given year that a flood of this magnitude would occur.

Figure 1-2: Atlantic Shorefront Economic Reaches

1.4.1 Jamaica Bay

Jamaica Bay is the largest estuarine waterbody in the NYC metropolitan area covering approximately 20,000 acres (17,200 of open water and 2,700 acres of upland islands and salt marsh). Jamaica Bay measures approximately 10 miles at its widest point east to west and four miles at the widest point north to south, including approximately 26 square miles in total. The mean depth of Jamaica Bay is approximately 13 feet with maximum depths of 60 feet in the deepest historical borrow pits. Federal navigation channels within Jamaica Bay are authorized to a depth of 20 feet. Jamaica Bay has a typical tidal range of five to six feet. The portions of NYC and Nassau County surrounding the waters of Jamaica Bay are urbanized, densely populated, and very susceptible to flooding. Over 46,000 residential and non-residential structures lie within the FEMA regulated 1% AEP Jamaica Bay floodplain.

In order to develop alternative plans and to evaluate the risk reduction provided by those plans, Jamaica Bay was segmented into six economic reaches that are defined by a common inundation elevation and existing community designations (Figure 1-3). For the development and preliminary screening of alternatives, each economic reach was defined as an area (*i.e.,* a GIS polygon) which would be inundated at a stillwater elevation of +11 feet NAVD88. Eleven feet is generally equivalent to the stillwater elevation for a storm event with one percent probability of annual occurrence in 2070 (including the intermediate rate of expected sea level rise).

Six reaches define the Jamaica Bay Planning Reach because much of the shoreline and adjacent uplands that surround Jamaica Bay are low-elevation permeated with numerous basins, tidal creeks, and inlets, which provide little proximate access to areas of high ground. Configuring the reaches defined by a common inundation elevation resulted in six separable reaches. Individual plans were developed for each of the six reaches. Structures within low-lying areas shoreward of the adjacent uplands were assigned to these distinct reaches so that coastal storm damages may be estimated for each reach.

JFK Airport was not included within any of the economic reaches for which stand-alone alternatives were developed. Federal Aviation Administration regulations preclude the construction of barriers (e.g., floodwalls and levees) on airport property, which renders any alternative to directly protect the airport infeasible on an institutional basis. In addition, the airport is on relatively high ground[14], and nonstructural solutions may be a more appropriate solution for any flooding problems. Nevertheless, the Port Authority of New York and New Jersey has been and will continue to be consulted throughout the plan formulation process.

1.5 Project Datum

All elevations referred to in this report, unless specifically noted otherwise, are based on the North American Vertical Datum of 1988 (NAVD88). All depths used in this report are at Mean Lower Low Water (MLLW) datum unless otherwise specified. The difference between MLLW and NAVD88 in Jamaica Bay is approximately 3.0 ft.

[14] JFK Airport is located above the FEMA 100-year flood level.

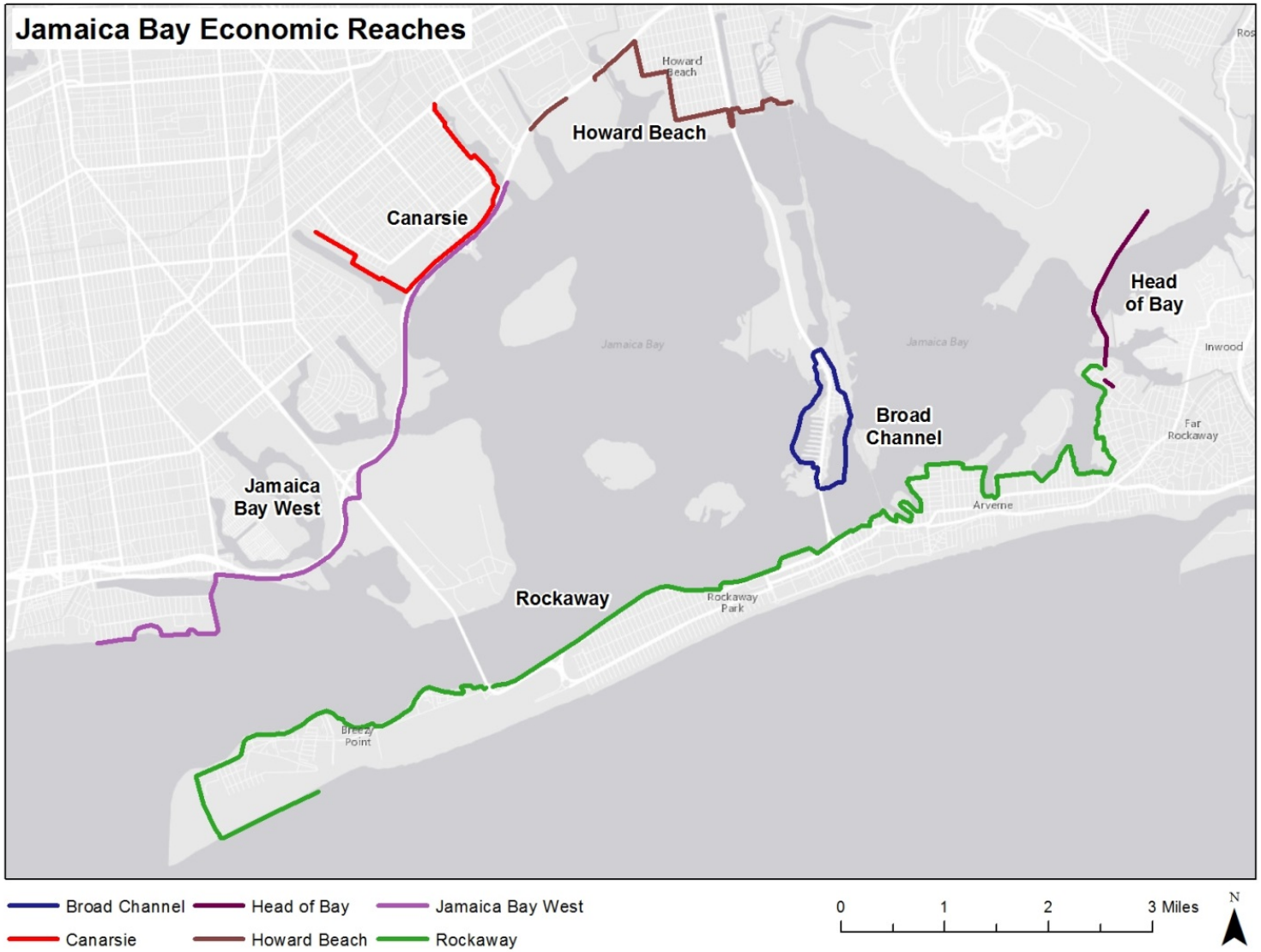


Figure 1-3: Jamaica Bay Economic Reaches

1.6 Major Historical Surge Events in the Study Area

Frequent and severe damage from tidal inundation, erosion, and wave attack at the Atlantic Ocean Shorefront Planning Reach and inundation at the Jamaica Bay Planning Reach has long been identified as a problem for the study area (USACE, 1964). Historical flood impacts include evacuations during times of flood and extensive property damage in communities along the low-lying areas throughout the study area (USACE, 1993). The entire study area, with the exception of JFK Airport, is designated as either Evacuation Zone 1 or Evacuation Zone 2, the most at-risk zones, by NYC Emergency Management (NYCEM, 2014). In response to the long history of storm damage in the study area and a particularly severe storm in 1962, a USACE Cooperative Beach Erosion Control and Hurricane Study recommended construction of a Hurricane Barrier and associated floodwalls and closures to be constructed at Rockaway Inlet (USACE, 1964). Although the Hurricane Barrier was never constructed, erosion control recommendations, consisting of beachfill along the Atlantic Ocean Shorefront Reach were implemented.

Coastal storm surges in the study area occur from hurricanes, tropical storms, and extratropical storms known as "nor'easters". High tide combined with storm surge and wind speed increases flooding (NPS, 2014). There are no long-term historical tide gauge data for the study area, however; 23 major storms have been identified as impacting the NYC region since 1815 with impacts including fatalities, widespread structural damage, and the obliteration and removal of Hog Island from offshore of the Rockaway coast (Weather2000, 2014).

Table 1-1 shows historical extreme tide gauge readings for The Battery on Manhattan Island in New York Harbor. Although there are no data identifying the areas of inundation in the study area associated with most of the storm events identified in Table 1-1, one reference point is the inundation that occurred during Hurricane Sandy (October 2012), which is associated with a tide gauge reading of 13.986 feet above MLLW at the Battery. Acknowledging that associating tide gauge readings at the Battery with inundation at study area is an approximation at best, Figure 1-4 presents approximate study area inundation based on two foot increments in tide gauge height at the Battery from 6 feet above MLLW (3 ft above NAVD88) to 14.0 feet above MLLW (11 ft above NAVD88).

Table 1-1: Gauge 8518750, The Battery, New York Extreme Tide Gauge Heights

Event	Feet above MLLW
Sep 1938	7.6
Sep 1944	7.9
Nov 1950	8.8
Nov 1953	9.3
Feb 1960	8.0
Sep 1960	10.0
Mar 1962	8.9
Oct 1991	8.7
Dec 1992	9.7
Aug 2010	8.8
Apr 2011	8.1
Aug 2011	9.4
Oct 2012	14.0

Source: http://tidesandcurrents.noaa.gov/est/est_station.shtml?stnid=8518750

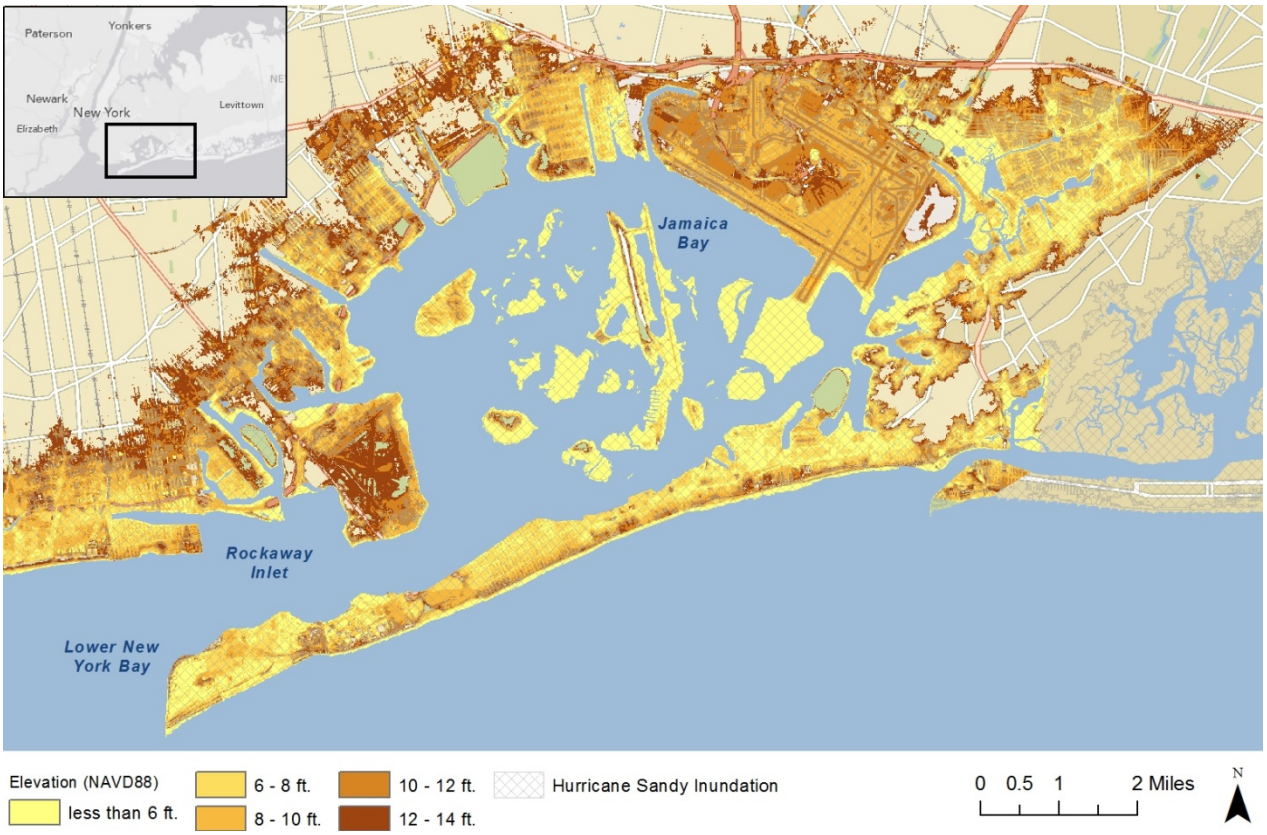


Figure 1-4: Approximate Historical Study Area Inundation at Various Water Elevations

1.7 Prior Reports and Existing Water Projects

1.7.1 1965 Authorization

The Beach Erosion Control and Hurricane Protection Project, recommended by the State of New York and USACE, was authorized by the Flood Control Act of 1965 as prescribed by House Document No. 215, 89th Congress, First Session. The project included a hurricane barrier across the entrance to Jamaica Bay and 4 million cubic yards of beach fill along the ocean front as initial construction, with 10 years of periodic renourishment.

Within the House Document 215 (1965), the District Engineer found that the Rockaway Peninsula and low-lying areas surrounding Jamaica Bay, particularly Howard Beach, were subject to frequent and severe damages from tidal inundation (flooding), and that the ocean front between East Rockaway Inlet and Rockaway Inlet was subject to considerable damage from wave attack. Improvement of the shore and provision of flood control works were needed to provide adequate beach erosion control and hurricane protection.

The problem in the study area, as identified in 1965, was a combination of shore erosion and wave attack along the Atlantic coast of the Rockaways, and storm surge inundation from both the ocean and Jamaica Bay. The inundation problem was further complicated by an inadequate storm sewer system in the Rockaways and an incomplete system in the residential areas on the north side of Jamaica Bay. This resulted in severe hardship to hundreds of families requiring evacuation during

times of flood, and extensive property damage. The most severe damages occurred in the Rockaway Peninsula, the Howard Beach area, Broad Channel, and Rosedale sections of Queens.

1.7.2 1974 Authorization

Section 72 of WRDA of 1974 authorized construction of beach erosion control portion of the project separately from the construction of hurricane protection. The beach erosion control aspect of the project provided for the restoration of a protective beach along 6.2 miles of Rockaway Beach, between Beach 149th Street on the west at the boundary with Jacob Riis Park and Beach 19th Street on the east at East Rockaway Inlet. The project authorization also provided for Federal participation in the cost of periodic beach nourishment to stabilize the restored beach for a period not to exceed 10 years after the completion of the initial beach fill.

The initial nourishment construction was completed from 1975 to 1977. The first phase of the initial construction (1975) consisted of placing 3,669,000 cubic yards of sand between Beach 110th Street and Beach 46th Street. In the second phase of construction (1976), 1,490,000 cubic yards of fill were pumped onto the beach between Beach 46th Street and Beach 19th Street. The third phase of initial construction (1977) had 1,205,000 cubic yards placed between Beach 110th Street and Beach 149th Street.

The beach erosion control features of the authorized project on the Rockaway Peninsula consisted only of a 100-foot berm width at an elevation of +10 ft. NGVD (8.9 feet NAVD88) over the peninsula's entire project length (from Beach 19th Street to Beach 149th Street). Additional width sections of 150 feet and 200 feet of the authorized project provided for separable recreation benefits.

Severe storms in 1977 and 1978 eroded areas of the beach. A Post Authorization Change recommending a modification to the authorized Beach Erosion Control Project was approved on 8 June 1979. The modification provided for the construction of a 380-foot long quarry stone groin at the western limit of the project in the vicinity of Beach 149th street. The groin design provided for a structure which would hold the project beach fill and allow for maximum bypassing to the downdrift shore. The construction of the groin was completed in September 1982 and included placement of 163,300 cubic yards of beach fill on both sides of the groin.

Nourishment operations occurred at two-year intervals during the ten years following the completion of the initial fill, with the last operation being in 1988. The authorized hurricane protection aspect of the project was never constructed, and was de-authorized by WRDA of 1986.

1.7.3 Section 934 and Reformulation Study

In response to the authority of Section 934 of WRDA 1986[15], the State of New York requested a reevaluation of the period of renourishment. This resulted in a 1993 report that approved three additional beach nourishments in 1996, 2000, and 2004. The project design was limited to a 100-foot berm, which was determined to be sufficient for hurricane and storm damage protection. The 1993 report also recommended a "reformulation study" to account for the changes to the project in the interest of storm damage reduction, and to identify a more cost-effective approach for addressing renourishment needs, and determine whether federal participation is needed for the

[15] Section 934 of WRDA 1986 extended the timeframe for providing periodic beach nourishment from fifteen to fifty years.

project for an additional 50 years. Due to funding limitations, the Reformulation Study started in 2003 when NYSDEC and USACE signed a cost-share agreement.

Historically, maintenance material from the navigation channel at East Rockaway Inlet has been beneficially used periodically along the Rockaway Beach shoreline both between Beach 27th Street and Beach 38th Streets, and in some instances in the areas of Beach 92nd street. This has occurred intermittently over the years with the last placement occurring in 2010.

At the time Hurricane Sandy impacted the area, the project was in an eroded condition. Following Hurricane Sandy, the Corps was authorized to repair the project to pre-storm conditions and under P. L. 113-2 was also authorized to restore the project to its original design conditions. Emergency repair and restoration in response to Hurricane Sandy was performed in 2014. Sand placement on Rockaway Beach from Beach 19th Street to Beach 149th Street consisted of 3.5 million cubic yards of material. In conjunction with this repair and restore operation, the City of New York, and State of New York provided additional funds to also establish a project dune at elevation +16 ft. NAVD88.

1.7.4 Federal Navigation Channels

There are two federal navigation channels in the study area. Federal navigation at Jamaica Bay was authorized by the Rivers and Harbors Act of 1910 and subsequently modified by the Rivers and Harbors Acts of 1945 and 1950, and includes an entrance channel at Rockaway Inlet with an authorized depth of -20 feet MLLW. The channel continues to Barren Island at a depth of -18 feet MLLW. Branch channel depths range from -12 feet to -18 feet MLLW (USACE, WCSC 2014). The Project also includes the rock jetty constructed on the east side of the entrance channel.

Dredging records for the Rockaway channel show initial construction in 1930. No maintenance dredging of the entrance channel occurred until 1976, after which records show regular maintenance of the channel. The lack of maintenance dredging until the 1976 is likely due to the impoundment capacity of the jetty at Rockaway Inlet. Once maintenance dredging began in 1976, dredging intervals varied from one year to five years. Maintenance dredge volumes have gradually increased over time and is likely due to the growth of the fillet and increasing bypassing around east jetty at Breezy Point.

According to the Waterborne Commerce of the United States, domestic commercial vessels made approximately 1,002 upbound (entered Jamaica Bay) and downbound (exited Jamaica Bay) trips in 2013 (USACE, 2013). Based on this report, no trips were made by non-domestic vessels into Jamaica Bay.

Commercial vessels primarily transport bulk fuel to several privately operated bulk fuel storage terminals located in basins at the eastern end of Jamaica Bay. Commercial vessels also transport sand and gravel to several aggregate facilities at the eastern end of Jamaica Bay and north of Coney Island.

The Federal Navigation Channel at East Rockaway Inlet was authorized by the Rivers and Harbors Act of 1930. The project allows navigation to proceed from the Atlantic Ocean into Reynolds Channel and the bays north of the Long Beach. The inlet provides for a channel 12 ft. deep and approximately 250 ft. wide; one jetty constructed on the east side of the channel; one jetty (authorized but not constructed) on the west side of the channel. Dredging records for East Rockaway channel show initial construction in 1935, maintenance dredging from 1938-1985, a channel realignment in 1988, and regular maintenance dredging from 1989 to present.

1.7.5 Jamaica Bay Study

A 1990 Study resolution for Jamaica Bay, Marine Park, and Plumb Beach New York resulted in the completion of a Reconnaissance Study by USACE New York District. The study recommended feasibility investigations for storm damage reduction in areas of areas of Arverne, Plumb Beach, Howard Beach and Broad Channel. The storm damage reduction study never advanced past the reconnaissance phase due to lack of local support at the time. The report also recommended a feasibility study for environmental restoration in Jamaica Bay, which moved forward. Some of the features recommended in the Jamaica Bay Study (now incorporated into the Hudson-Raritan Ecosystem Restoration Feasibility Study) are considered in this reevaluation study for CSRM as NNBFs.

1.8 History of the Investigation

This General Reevaluation is a result of the Section 934 analysis, which recommended project reformulation to identify the appropriate long-term solution for the study area. The Reformulation effort was initiated in 2003, and had focused on developing plans for risk reduction along the Atlantic Ocean Shoreline when Hurricane Sandy impacted the study area.

The size and energy of Hurricane Sandy caused damage not previously experienced along the Atlantic coast and left in its wake degraded coastal features, which increased risks and vulnerability from future storm events. The Disaster Relief Appropriations Act of 2013 was passed by Congress and signed into law by the President on January 29, 2013 as Public Law 113-2 (P.L. 113-2). The legislation provides supplemental appropriations to address damages caused by Hurricane Sandy and to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events.

In addition to repairing the authorized project to the original design, USACE was also directed to undertake a broad, conceptual examination of the best ideas and approaches to reducing the vulnerability to major storms over time, in a way that accounts for current science and engineering, is sustainable over the long-term, both for the natural coastal ecosystem and for communities. Evaluations of project specific measures would addresses resiliency, economics, risks, environmental compliance, and long-term sustainability. Recognizing the vulnerability of the entire study area from Rockaway Inlet to East Rockaway Inlet and Jamaica Bay, the Reformulation effort was re-scoped to consider a greater suite of alternatives along the shorefront, and plans to address Jamaica Bay and its communities following the devastation caused by Hurricane Sandy.

The Alternatives Milestone was held in October 2014, which recommended a final array of alternatives that included 1) a Perimeter Plan for CSRM structures along the shoreline within Jamaica Bay and along the Atlantic Ocean shorefront and a Storm Surge Barrier Plan at Rockaway Inlet, which also included CSRM features along the Atlantic Ocean shorefront. The tentatively selected plan (TSP) Milestone was held in March of 2016, which approved the release of the Draft HSGRR/EIS in August 2016.

1.8.1 Draft HSGRR/EIS: August 2016

Consistent with current U.S. Army Corps of Engineers (USACE) planning guidance, the study team identified and screened alternatives to address CSRM, and presented a tentatively selected plan (TSP) in the Draft HSGRR/EIS. The TSP identified overall project features, with the

acknowledgement that the specific dimensions of the plan were not finalized in the Draft HSGRR/EIS, which was released to the public in August 2016. The 2016 Draft HSGRR/EIS underwent concurrent public review, policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR). As a result of the significance (extent and content) of partner, agency and public comments received on the TSP, as well as the feedback to the District resulting from the concurrent policy and technical review conducted by USACE Headquarters (HQUSACE), the District determined that sufficient revision to the 2016 Draft HSGRR/EIS would be required in order to proceed to a final decision document.

The 25 May 2017 USACE Agency Decision Milestone (ADM) resulted in the decision to move all further evaluation of the proposed storm surge barrier measure within Jamaica Bay, a significant component of the TSP, to the ongoing New York and New Jersey Harbor and Tributaries (NYNJHATs) Feasibility Study. The NYNJHATs Feasibility Study was initiated in the Summer of 2016, and is evaluating large-scale regional CSRM strategies for the New York metropolitan area (which includes Jamaica Bay) extending upstream of the Hudson River to the federal lock and dam at Troy, New York, the Passaic River to the Dundee Dam, and the Hackensack River to the Oradell Dam. The NYNJHATs study is evaluating a suite of storm surge barriers, including one alignment from Breezy Point to Sandy Hook that would obviate the need for the Jamaica Bay barrier proposed as part of the 2016 Draft HSGRR/EIS TSP. As such, any further evaluation of a storm surge barrier for Jamaica Bay is a more appropriate fit for the NYNJHATs study.

1.8.2 Revised Draft HSGRR/EIS: August 2018

In the Revised Draft HSGRR/EIS, USACE further refined and developed the 'Residual Risk' measures for the Bayside communities, termed high frequency flooding risk reduction features (HFFRRFs), in order to bring the measures up to full feasibility level of design and environmental analysis, and to include natural and nature-based features, as well an areas in Nassau County. Taper designs to tie in the Atlantic Shorefront at each project end with the adjacent areas also were added to the design included in the Revised Draft HSGRR/EIS.

1.8.3 Final HSGRR/EIS: December 2018 (amended the May 2019 version to include the revised Final US Fish and Wildlife Service Biological Opinion, dated July 2019)

This Final HSGRR/EIS (referred to as simply "HSGRR/EIS" throughout the remainder of this document) and its recommendations are a component of the USACE response to the unprecedented destruction and economic damage to communities within the study area caused by Hurricane Sandy. This HSGRR/EIS follows the August 2018 Revised Draft HSGRR/EIS that has undergone public review and Agency Technical Review (ATR). This HSGRR/EIS reflects changes from responses to review comments.

2 EXISTING CONDITIONS*

The study area is categorized by two distinct planning reaches: the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach. Where appropriate, descriptions are categorized to identify the different conditions occurring at each reach.

The 11-mile long coastline of the Rockaway peninsula is the only unobstructed coastline of all of NYC (NYC, 2013 South Queens) and is a major recreational resource hosting millions of visitors each year[16]. The Rockaway peninsula is home to more than 110,000 residents spread across neighborhoods all along the peninsula. The Rockaway peninsula also acts as a barrier protecting Jamaica Bay communities. Jamaica Bay includes NYC's largest remaining natural marshland and 10,000 acres of parkland under the coordinated management of NYC and the National Park Service. Jamaica Bay communities cross three New York State counties, including Kings (Brooklyn), Queens, and Nassau counties with a population of more than 185,000 (NYC 2014 South Queens and Brooklyn). Many of the residences in Jamaica Bay communities were built in the 1920s in low lying areas, which are susceptible to flooding.

2.1 Geologic Setting

Both planning reaches lie within the Atlantic Coastal Plain Physiographic Province of the U.S. and includes geological deposits and regional aquifers that are bounded to the south by the Atlantic Ocean and the north by Long Island Sound.

Long Island was formed primarily by Pleistocene-age glaciations including the Wisconsin Ice Age and Laurentide Ice Sheet, which retreated approximately 10,000 years ago. Two advances of the Wisconsin ice sheet during the Upper Pleistocene Epoch of the Quaternary Period caused the island to be blanketed with glacial till, ice-contact stratified drift, outwash deposits, and other deposits composed of clay, silt, sand, gravel, and boulders. The terminal moraines and the north shore of Long Island are composed primarily of stratified glacial drift with some till. The area between the moraines and the south shore of Long Island is primarily covered by outwash deposits. Central and South Long Island are of glaciofluvial origin. These Pleistocene deposits lie atop gently dipping, metamorphic, Paleozoic or Precambrian-age rocks (Misut and Monti 1999; US Dept Interior, NPS, October 2015).

The undifferentiated igneous and metamorphic bedrock of Paleozoic or Precambrian age that underlies the Cretaceous sediments was eroded to a nearly flat or broadly undulating plain before the overlying Cretaceous-age sediments were deposited; the rock surface was later eroded by Pleistocene glaciation in north-northwestern Queens County near the East River and slopes southward at about eighty (80) feet per mile (USEPA 1983a; USEPA 1983b). This dipping bedrock surface and the depositional environment of the overlying sediments resulted in a series of southdipping, unconsolidated, morainal and outwash accumulations associated with the continental glaciers.

The Raritan Formation, consisting of the Lloyd Sand Member and an unnamed clay member, directly overlies the igneous and metamorphic bedrock. Overlying the Raritan Formation is the Magothy Formation and Matawan Group (undifferentiated), the Jameco Gravel, the Gardiners Clay, and upper Pleistocene deposits. Rockaway Peninsula and Coney Island consist of Holocene

[16] https://www.nycgovparks.org/parks/rockaway-beach-and-boardwalk

fluvial deposits. There are four primary water-bearing formations on Long Island: the Upper Glacial, Jameco, Magothy, and Lloyd aquifers.

2.1.1 Soils

The soils on the Rockaway peninsula are formed in a mantle of eolian and marine washed sand (USDA, 2001). These landforms are highly dynamic and can change readily with each coastal storm. Some areas have also been affected by human activities such as hydraulic filling or dredging to control erosion from hurricanes and nor'easters, and to maintain depth in nearby shipping channels. Soils found on the eolian and marine deposits within these portions of the park include Hooksan and Jamaica. On less stable landscapes the miscellaneous land units, Dune land and Beaches, are common. Soils formed in dredge filled areas include Bigapple, Fortress, and Barren. Verrazano soils are found where loamy fill has been placed over sandy materials. Soils within the Atlantic Shoreline Planning Reach are predominantly classified as Urban land-Verrazano and Urban land-Flatbush complexes, with 0-3% slopes and a sandy substratum, Hooksan-Dune land complex, and beaches. Soils along the perimeter of the Rockaway API are typically mucky peats susceptible to subsidence (USDA 2016a).

The Jamaica Bay Planning Reach includes one of the most urbanized estuaries in North America, and has had a long history of anthropogenic disturbances which include extensive dredging, filling, and development in and around the bay (USFWS 1997; USDA 2001; GNRA 2015). In many locations, the topography of the region has been altered by development and cut and fill activities which have created many new, man-made topographic features. Within the bay, many areas within the bay have been used historically as a borrow source for urban development. On land, native soils have primarily been excavated, covered with fill material, compressed, or covered by impervious surfaces. Historically, significant salt marsh areas throughout the Bay project area have been filled to support construction of Floyd Bennett Field, John F. Kennedy (JFK) Airport, and/or the Fountain Avenue and Pennsylvania Avenue former landfills. The New York Soil and Water Conservation District have mapped the soils surrounding the bay as almost entirely categorized anthropogenic fill.

2.1.2 Topography

In 1835, Rockaway Point was located near the present east boundary of Jacob Riis Park (FEMA 2013). East Rockaway Inlet was located 20,000 feet east of its present position, near Long Beach, New York. South of Rockaway Point, a large shoal had formed which was to provide the material for extending this point nearly four miles to the east during the next 100 years. The shoreline generally receded between 1835 and 1878 while, at the same time, Rockaway Point extended two miles westward. Jacob Riis Park acquired its present shoreline during this period. Between 1878 and 1927, the shoreline of the Rockaways advanced a small amount. Rockaway Point grew rapidly until 1902, but from 1902 to 1927, its westward expansion was only half its previous rate. From 1927 to 2007, the shoreline of the Rockaways has been stable. Nearly 12 million cubic yards of sand have been artificially placed east of Rockaway Point since that time (FEMA 2013).

The communities located on the Rockaway peninsula from west to east include Breezy Point, Roxbury, Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammels, Arverne, Edgemere and Far Rockaway. The former Fort Tilden Military Reservation and the Jacob Riis Park (part of the Gateway National Recreation Area) are located in the western half of the peninsula between Breezy Point and Neponsit. The characteristics of nearly all of the communities on the Rockaway

peninsula are similar. Ground elevations rarely exceed +10 ft NAVD88, except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from +5 ft NAVD88, increasing to +10 ft NAVD88 further south toward the Atlantic coast (USGS, 2016, based on topographic maps dated 2013).

The topography of the Jamaica Bay varies among the natural and man-made physiographic features, including the numerous basins and creeks that fringe the interior periphery of the bay; several man-made landfills and residential/commercial infilled developments along the interior periphery of the bay; and numerous salt marsh islands and island bars located within the interior of the bay. Accordingly, elevations vary on account of these features. The grades of the salt marsh islands and island bars vary from sea level to as high as +22 ft NAVD88 at Ruffle Bar and Little Egg Marsh. Inland landfills rise rapidly from the shoreline to approximately +40 ft NAVD88, while residential/commercial areas are lower than the landfills, ranging from sea level at their shoreline to approximately +20 ft NAVD88 inland (USGS, 2016, topographic maps dated 2013).

2.2 Bathymetry and Sediments

Jamaica Bay bathymetry and the anthropomorphic changes over time have been well documented (USACE 2010, Nordenson, et. al. 2014; Seavit et al. 2014). The mean depth of Jamaica Bay is approximately 13 feet with dredged channels reaching 30 to 50 feet deep (NYCDEP 2007). Dredging and filling of Jamaica Bay over the past century has significantly altered the bathymetry of Jamaica Bay. Currently, USACE only dredges the federally authorized and maintained Jamaica Bay Federal Channel in Rockaway Inlet approximately every two years. The Federal Channel is at the eastern entrance channel to Jamaica Bay and is dredged to an authorized depth of approximately 20 feet and width of 1000 feet. The interior bay channels have an authorized depth of approximately 12 feet, however many of these channels are significantly deeper and therefore, maintenance dredging is unnecessary. These navigational channels within the Bay are used by the NYCDEP sludge barges serving the municipal waste water treatment plants and dredging is infrequent due to the lack of sediment input from former tributaries and the narrow, modified morphology of the tributaries.

Jamaica Bay also has numerous deep borrow pits. Borrow pits, exceeding forty feet in depth in some locations are located at the bayside margins of both Floyd Bennett Field and JFK Airport. Other borrow pits include the Norton Basin and Little Basin Borrow Pits; as well as offshore borrow areas that include East Rockaway Inlet Rockaway Emergency Contract 1C Borrow Area, and USACE Borrow Areas A-West and A-East.

Historic dredging has increased the overall water volume within Jamaica Bay (NYCDEP 2007) and has had consequences on both the rate of flushing and sediment budget (NYCDEP 2007). The rate of flushing for an urbanized estuary is critical factor to consider as it reduces concentrations of pollutants and raises valuable oxygen levels (NPS 2015). In addition, the historic filling operations, hardening of shorelines, and eradication of natural habitats have also altered historic flow patterns and flushing time within the Bay. The effect of this historic dredging is discussed below.

2.2.1 Sediment Transport

With respect to sediments within the Jamaica Bay Planning Reach, movement is restricted due to the narrow restriction of Rockaway Inlet and little to no sediment input from the watershed (due to the urbanized land uses). At the entrance to Rockaway Inlet, the prevailing currents slow as

they enter the mouth of Jamaica Bay and turn to the east to again slow. This continual slowing of water movement reduces sediment transport throughout the Jamaica Bay Planning Reach. Consequently, sediments at the mouth of Jamaica Bay are primarily coarse sands and the remainder of the bay is finer silt sediments.

2.2.2 Sediment Quality

Historically, prior to pollution regulations, large quantities of chemicals, including heavy metals, pesticides, polychlorinated biphenyl (PCB), dichlorodiphenyltrichloroethane (DDT), and dioxin, were discharged into waters of Jamaica Bay. During the last 30 years levels of most of these contaminants have decreased on average by about an order of magnitude (Steinberg et al 2004). This decrease is due mainly to the implementation of a number of control measures required by the Clean Water Act. However, contaminants adhere to organic compounds and settle into sediments and are still found throughout Jamaica Bay (Steinberg et al. 2004). In addition to these "legacy" chemicals, chemicals from modern sources (i.e., WWTP discharges, CSOs, non-point source discharges, chemical and oil spills) are also known to adversely affect Bay sediments.

Many of these chemicals, which are readily absorbed in the fat cells of animals, can accumulate to dangerous levels. Currently, all regions of the HRE, including Jamaica Bay, have consumption advisories in some fish and shellfish species (NYSDOH 2016, NJDEP 2013). Moreover, the recent rates of decline in contaminants will be difficult to match in the future since current non-point sources of these chemicals and metals (e.g., overland runoff, atmospheric deposition) will not be as easy to control as point sources (Steinberg et al. 2004).

2.3 Surface Water

Jamaica Bay's watershed and surface waters are well documented (USACE 2010, NYCDEP 2007), and are dominated by the 36-square mile water body which historically captured water and sediment from a watershed approximately 142 square miles. Eight natural tributaries remain and which discharge directly into Jamaica Bay: Sheepshead Bay, Paerdegat Basin, Fresh Creek, Hendrix Creek, Spring Creek, Shellbank Basin, Bergen Basin, and Thurston Basin.

Jamaica Bay has been greatly influenced by the anthropogenic activities to the extent that tributaries in the traditional sense, now consist of receiving basins, sewersheds, and canals. The sources of water in Jamaica Bay are the WWTPs, CSOs, storm sewers, groundwater, precipitation, and tidal exchange through Rockaway Inlet. The most important hydrologic input to the bay remains the semidiurnal tides. However, contributions from natural tributaries, now mostly filled or diverted by urbanized development, have been replaced in importance through outflows from WWTPs, CSOs, and stormwater runoff and which will be discussed further below.

The mean tidal range along the Atlantic Ocean Shorefront Planning Reach is 4.5 ft. and the spring tidal range reaches 5.4 ft. The Mean High Water (MHW) level and Mean Low Water (MLW) level relative to NAVD88 are +1.5 ft. and -3.0 ft., respectively for the Atlantic Ocean Shorefront Planning Reach. With respect to the Jamaica Bay Planning Reach, the MHW level and MLW level relative to NAVD88 are +2.4 ft. and -3.07 ft., respectively.

2.3.1 Coastal Storm Hazards

For the purposes of the preliminary screening described in this document, major storms are identified to be those which produce storm surge and wave conditions similar to the 100-year base

flood elevation (BFE), as defined by the Federal Emergency Management Agency (FEMA), with additional consideration of projected sea-level change (SLC). FEMA has released Preliminary Flood Insurance Rate Maps (FIRMs) in the NYC portion of the study area, which includes consideration of stillwater elevations and wave conditions, and illustrate current flood risks in the study area. While these maps will not become effective FIRMs due to NYC's successful 2017 appeal, they are believed to be the best available information for defining the 100-year flood elevations. The City is in the process of developing revised Preliminary Flood Insurance Rate Maps (PFIRMs), but they are not expected to be available until after this study is complete.

The portions of the study area in Nassau County are assessed using the Nassau County 2009 Flood Insurance Study (FIS) 100-year effective Base Flood Elevation (BFE) data. These data were released in 2009 by FEMA (FEMA 2009) and include consideration of still water levels and wave action throughout Nassau County. Figure 2-1 shows the preliminary FIRMs for NYC and the effective BFEs in Nassau County.

Water levels used in the more detailed alternative evaluations were selected from the available USACE North Atlantic Coast Comprehensive Study (NACCS) data (NACCS-Simulation BasePlus96Tides). The NACCS analysis included numerical model simulations of several storms under various tidal conditions to estimate the 100-year water level in Jamaica Bay (Cialone et al. 2015). This study did not report wave conditions for the 100-year event. Instead, this study used wave conditions from the FEMA flood insurance rate map study from 2013 (FEMA 2013). This was deemed reasonable because the water levels from both studies at the 100-year recurrence interval are comparable. This conclusion is corroborated by a USACE study in Raritan Bay (USACE 2015a).

Figure 2-1: Preliminary FEMA Map Elevations (NAVD88) for the Study Area

2.3.1.1 Impacts of Hurricane Sandy

The study area was one of the areas most devastated by Hurricane Sandy. Within the study area, 10 fatalities occurred, and more than 1,000 structures were substantially damaged[17] to restrict re-entry or were destroyed by Hurricane Sandy (NYCEM, 2016). The NYC Department of Buildings post-Hurricane Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge damage. Of all buildings city-wide that were identified as unsafe or structurally damaged, 37% were located in the southern Queens portion of the study area, which is far greater than the percentage of all buildings in the Hurricane Sandy inundation zone that are located in southern Queens portion of the study area (24%). In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes at the Rockaway Peninsula portion of the study area[18] (SIRR, 2013).

Hurricane Sandy hit the study area at nearly high tide. Waves eroded beaches, breached boardwalks and seawalls, and broke against buildings in the oceanfront communities. Storm water

[17] Substantial damage to a structure occurs when the total cost of repair is 50 percent or more of the structure's market value prior to a storm event.

[18] Special Initiative for Rebuilding and Resiliency, City of New York. 2013. Available online at https://www1.nyc.gov/site/sirr/report/report.page

inundation reached as much as 10 feet above ground in some portions of the study area. In addition, more than 1.5 million cubic yards of sand was torn from Rockaway Beach and deposited on oceanfront communities or washed out to sea.

Floodwaters funneled through Rockaway Inlet amassing a storm surge that inundated all the neighborhoods surrounding Jamaica Bay. The low-lying neighborhoods in the central and northern portions of Jamaica Bay, where the narrow creeks and basins provide the marine aesthetic of the neighborhood, were especially devastated by flood waters. Damage to the elevated portion of the subway system in Jamaica Bay and Rockaway (A line) disrupted service for over six months affecting about 35,000 riders daily. In the southern Queens portion of the study area 37 schools were closed for up to two months.

In the Hurricane Sandy Coastal Projects Performance Evaluation Study (HSCPPES), the study area was identified as being within the area of Extreme Exposure during Hurricane Sandy, which is defined as an area exposed to water surface elevations greater than +9 feet mean higher high water (MHHW)[19] onshore and greater than 30 feet offshore significant wave heights (USACE, 2013d). The height of the beach and dunes on the Rockaway Peninsula at the time Hurricane Sandy hit is unknown, but project height was below design dimensions (USACE, 2013d). Although the beach berm on the Rockaway Peninsula had been overtopped, widespread flooding, inundation, and damages were also due to Bayside flooding, which had not been addressed through implementation of coastal flood risk management measures in project construction authorization (USACE, 2013d). Additional information concerning high-water marks with photos is available on the Hurricane Sandy Storm Tide Mapper website, at: http://water.usgs.gov/floods/events/2012/sandy/sandymapper.html.

The Hudson-Raritan Estuary Comprehensive Restoration Plan (HRE CRP) dated June 2016, identified that the Jamaica Bay Planning Region experienced extensive natural resource damages resulting from the storm surge associated with Hurricane Sandy.

> *"Within the interior of Jamaica Bay, coastal wetlands were littered with debris following the storm and wrack deposits were visible in many marsh areas. Initial reports and damage assessments may have underestimated the amount of wrack deposited, especially where obscured by dense reed stands or maritime woody vegetation (ALS 2012). The Jamaica Bay marsh islands, restored prior to Hurricane Sandy by the USACE in partnership with NYSDEC, NYCDEP, PANYNJ, and National Park Service (NPS), accumulated significant amounts of debris, but experienced relatively little damage to existing plantings; repairs to vegetation originally planted at Yellow Bar Island in the summer of 2012 were required in the spring of 2014. The sand placed on Rulers Bar and Black Wall islands did not experience any damage as a result of the storm. Black Wall and Rulers Bar were subsequently vegetated through a community based planting effort led by ALS, Jamaica Bay Ecowatchers, and the Jamaica Bay Guardian funded by NYCDEP in July 2013.*
>
> *The freshwater East and West Ponds of the Jamaica Bay Wildlife Refuge were breached by the storm surge during Hurricane Sandy and were inundated with saltwater. Storm waves washed away portions of the berm that separated the ponds from Jamaica Bay, transforming them into saltwater inlets. The ponds were well known for their abundance*

[19] Mean Higher High Water is defined as the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. For stations with shorter series, comparison of simultaneous observations with a control tide station is made in order to derive the equivalent datum of the National Tidal Datum Epoch.

of waterfowl and shorebirds, including snow geese (Chen caerulescens), lesser and greater scaup (Aythya affinis and A. marila), ruddy duck (Oxyura jamaicensis), ring-necked duck (Aythya collaris), green winged teal (Anas carolinensis), northern pintail (Anas acuta), American wigeon (Anas americana), and gadwall (Anas strepera). The sudden rise in salinity created an unsuitable environment for brackish water species, which may ultimately alter foraging habitats (ALS 2012). Proposed repairs to the primary and secondary breaches include replacement of the wetlands water control structure and installation of a groundwater well to provide freshwater, which will allow NPS to return West Pond to a more freshwater and resilient condition that supports a diversity of Jamaica Bay habitats and wildlife (NPS 2016)."

2.3.2 Tidal Currents

With respect to the Atlantic Ocean Shorefront Planning Reach, tidal currents are generally weak. Currents at Rockaway Inlet and East Rockaway Inlet have respective average maximum velocities of 3.1 and 2.3 knots at flood tide, and 2.6 and 2.2 knots at ebb tides.

Rockaway Inlet is the only tidal inlet into Jamaica Bay with high currents at its narrowest point which is 0.63 miles wide with an average depth of 23 feet (USFWS 1997). At the entrance to Rockaway Inlet, the prevailing currents slow as they enter the mouth of Jamaica Bay and turn to the east and again slow which significantly reduces tidal exchange. Tides in Jamaica Bay are semi-diurnal and average 5 feet. Dredging has deepened the mean depth of Jamaica Bay from approximately 3 feet in the past to 13 feet now, which has increased the residence time of water from 11 days to an average of 33 days but varying by depth and location (USFWS 1997). The maximum tidal current speeds in North Channel at Canarsie Pier are 0.5 knots (0.84 ft./s) flood and 0.7 knots (1.18 ft./s) ebb (USACE 2005). USGS observations of flow speeds at the USGS Rockaway Inlet gauge are generally 1.0 knots or less during neap tide periods and 1.7 knots or less during spring tide periods (Arcadis 2016b).

2.3.3 Wind and Wave Climate

Wind speed/direction data for the Jamaica Bay Planning Reach were available from recorded wind data at the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) for JFK Airport. Data are available beginning in the early half of the 20th century to the present. Based on the wind speed-direction occurrence, normal winds are predominantly from south clockwise to northwest quadrant, with stronger winds predominantly from west and northwest. Average monthly wind speeds range from 10 to 14 miles per hour (mph) and the maximum wind gust reached 71 mph and peak wind gusts from 47 to 71 mph with a prevailing direction from south.

The direction of wave approach to the Atlantic Ocean Shorefront Planning Reach is primarily from the south and southeast. For the Atlantic Coast of Long Island Jones Inlet to East Rockaway Inlet Long Beach Island Project, a wave height-frequency curve was developed to obtain storm wave conditions (USACE 1995). Breaking wave heights were calculated for the 10, 25, 50, 100 and 500-year return periods. The results of these calculations indicate that the deep-water wave height for a storm having a 100-year return period would be 21 ft. (USACE 2015).

Due to the length and orientation of Rockaway Inlet, the Jamaica Bay Planning Reach is largely sheltered from ocean waves. The majority of waves in Jamaica Bay are locally generated due to wind/water surface interaction or produced by vessels navigating the interior channels. The wind

climate varies from calm and light to potentially dangerous winds of a winter nor'easter or a late summer hurricane. The wind, waves, and currents have significant bearing on the sustainability of the marsh within Jamaica Bay. To varying degrees, the stability of the vegetative cover and the conservation of sediment depend on these coastal processes. The wave climate may be considerably different from year to year, resulting in very different erosion rates from year to year.

2.3.4 Sea Level Change

Local relative sea level change (SLC) was considered in all aspects of the analyses included in this HSGRR/EIS based on the guidance contained in Engineer Technical Letter (ETL) 1100-2-1 and Engineering Regulation (ER) 1100-2-8162 (USACE 2013e) – the successor to Engineering Circular (EC) 1165-2-212 (USACE 2011). This set of guidance requires the consideration of a range of relative SLC including the historic rate of SLC, and projections of increased rates of SLC. The current rate of local SLC, including subsidence, at the Sandy Hook, NJ gauge is 3.99 millimeters/year (.013 feet/year)[20]. A more detailed discussion of the range of SLC and the effects of SLC is discussed in Section 3.8 Sea Level Change.

2.4 Water Quality

For the Atlantic Ocean Shorefront Planning Reach, water quality is influenced by ebbing waters from East Rockaway Inlet to the east and from semi-diurnal tidal fluctuations characteristic of the Atlantic coast. The study area is outside of and to the east of the three miles of the Atlantic coastline along New York State that are subject to shellfish water quality impairments from CFOs (NYSDEC 1998).

Recent water quality data collected from coastal stations at Far Rockaway and Atlantic Beach, as part of the USEPA helicopter-monitoring program, show that overall bacteriological water quality is very good. In addition, the NYC and Nassau County Public Health Departments report good overall water quality in the Atlantic Ocean Shorefront Planning Reach (Jacobs 1999, Luke 1999). However, geometric mean densities (1989 through 1998) of fecal coliform and enterococci are well below acceptable federal guidelines for primary contact recreational uses (USEPA 1999b).

With respect to the Jamaica Bay Planning Reach, the bay continues to be threatened by poor water quality. Almost the entire watershed is urbanized such that Jamaica Bay receives pollution from point and non-point sources around the bay, such as the CSOs, runoff from the roads and the airport, leachate from landfills, windblown trash, and other sources. Specifically, 240–340 million gallons per day of treated sewage effluent flow into Jamaica Bay from four Wastewater Treatment Plants (WWTP) (GNRA 2013). This continues to be a major source of pollution, including treatment byproducts such as chlorine, and heavy metals and other contaminants that are not eliminated by water treatment facilities (NPCA 2007a). In addition, large rain events can overwhelm the sewer system capacity, resulting in untreated wastewater and raw sewage. Other sources within the Jamaica Bay Planning Reach include landfill leaching, runoff from JFK Airport, as well as atmospheric deposition (NPCA 2007, USACE and PA 2009).

Water quality in Jamaica Bay has been extensively studied and characterized, as it is a critical component to the Jamaica Bay Watershed Protection Plan (NYCDEP 2007). While nitrogen and phosphorus are characteristically limiting nutrients in estuarine ecosystems, their quantities within Jamaica Bay are exaggerated by WWTP inputs. As such, nutrient loading can lead to

[20] http://marine.rutgers.edu /geomorph/geomorph/pages/slr.html

eutrophication. High nitrogen levels can also decrease root production in salt marsh plants, and in turn decrease their ability to accumulate organic material and hold sediments within tidal marshes. High nitrogen levels also increase microbial decomposition, reducing the accumulation of organic matter and limiting the ability of saltmarshes to maintain an elevation that keeps pace with relative sea level change (SLC) (Rafferty, Castagna, and Adamo 2010).

High nutrient levels are also a major contributor to low DO levels in Jamaica Bay. DO ranges from 3.5 to 18.5 milligrams per liter (mg/L), sometimes falling below the 5.0 mg/L threshold specified by state water quality standards for waters suitable for recreation and fishing. Long periods of low DO can harm or kill larval fish and shellfish, and lead to odor problems from production of H2S gas in oxygen-deficient sediments. High concentrations of DO in the water column can also indicate poor water quality, and typically occur when algal blooms near the surface create very high to supersaturated DO concentrations as a byproduct of photosynthesis. While there is high year-to-year variability in measured DO concentrations, long-term monitoring suggests DO levels are trending toward improvement (NYCDEP 2007).

The NYSDEC assigns classifications to all of the waterbodies within its jurisdiction. These classifications are assigned such that "the discharge of sewage, industrial waste or other wastes shall not cause impairment of the best usages of the receiving water as specified by the water classification at the location of the discharge and at other locations that may be affected by such discharge." Three of the classifications developed by NYSDEC apply to waters within Jamaica Bay: Class SB, Class SC and Class 1.

- Class SB – includes the open waters of Jamaica Bay, Shellbank Creek, Gerritsen Creek, Mills Basin, and East Basin (NYSDEC 2011). The best usages of Class SB waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival.
- Class SC – Motts Basin (NYSDEC 2011). The best usage of Class SC waters is fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.
- Class 1 - Hendrix Street Canal, Fresh Creek, Hendrix Creek, Spring Creek, Paerdegat Basin, Bergen Basin, Sheepshead Basin, and Thurston Basin (NYCDEC 2011). Impairment is due to nitrogen levels, oxygen demand, and presence of pathogens. The best usages of Class I waters are secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival. In addition, the water quality shall be suitable for primary contact recreation, although other factors may limit the use for this purpose.

2.5 Air Quality

Based on the National Ambient Air Quality Standards (NAAQS), Queens, Kings, and Nassau Counties located in the New York, Northern New Jersey, Long Island, ozone nonattainment area are currently classified as 'moderate' nonattainment for the 2008 8-hour ozone standard and 'maintenance' of the 2006 particulate matter less than 2.5 microns ($PM_{2.5}$) standard and 1971 carbon monoxide standard (40CFR§81.333). These counties are part of the Ozone Transport Region. Ozone is controlled through the regulation of its precursor emissions, which include

oxides of nitrogen (NO_x) and volatile organic compounds (VOC). Sulfur dioxide (SO_2) is a precursor for $PM_{2.5}$.

2.6 Shoreline Habitats

Jamaica Bay, formed by the barrier created by the Rockaway Peninsula, and its saltmarsh islands form one of the most recognizable and striking natural features within the urban landscape of NYC. Prior to the extensive urban development occurring over the past 150 years, tidewater grasslands colonized postglacial outwash plains at the ends of many creeks and streams in Jamaica Bay creating fringing salt marshes which encircled Jamaica Bay. Extensive saltmarsh islands and many more thousands of acres of fringing marshes and transitional uplands once adjoined the mainland, and the Rockaway peninsula did not extend much past what is now Jacob Riis Park. Under current conditions, the Rockaway peninsula has been substantially extended to the west, creating a more funnel shaped Rockaway Inlet; islands have been removed by dredging or extended to the nearby mainland by fill; shorelines have been altered by dredge and fill activities; bulkheads have been installed to stabilize and protect shorelines; channels and borrow areas have been dredged, altered bottom contours affecting flows; and natural tributaries have essentially disappeared causing sediment input from these tributaries to be mainly silts and particulates from urban runoff (DEP, 2007).

Existing coastal habitats within both planning reaches generally occur along an ecological continuum dependent upon tidal influence. The critical tidal elevations that help define these habitats include MLLW, MHW, and mean high water springs (MHHS).

Biological communities were classified into seven distinct habitat types that were identified and mapped throughout the study area. They represent the range of conditions and habitat quality observed throughout the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach, including both native habitats and those resulting from long-term anthropogenic disturbances. Specifically, the Atlantic Ocean Shorefront Planning Reach consists of oceanfront beach habitat with isolated dune habitats. Most of the study area is devoid of vegetation and is significantly impacted by human use of the area for recreational activities and significant development that abuts the upper beach zone in most of the Study Area. The Jamaica Bay Planning Reach consists of a diverse mosaic of the seven habitat types. While many native communities can be found throughout Jamaica Bay, it is also characterized by dense urban development that has altered and/or created new habitats indicative of the historic anthropogenic disturbance.

2.6.1 Subtidal Bottom

Subtidal bottom includes open water areas below the MLLW line (i.e., -3.1 feet NAVD88). This habitat type represents a significant area throughout Jamaica Bay, as well as a significant variation of water depths (both naturally occurring and anthropogenic). Specific to this habitat type, historic anthropogenic disturbances have commonly altered this habitat and its connection to adjacent intertidal and upland habitats. In addition, managed navigation channels occur throughout Jamaica Bay to support commerce.

2.6.2 Hardened Shoreline

Throughout both reaches of the study area, many natural shorelines have been replaced with hardened structures such as groins, bulkheads, revetments, or rip rap. These hardened structures have interrupted the naturally occurring ecological continuum and caused an unnatural transition

from upland areas (i.e., usually impervious surfaces associated with urban areas) immediately into deep subtidal area. These shorelines provide limited habitats and services to a suite of resources identified as critical to the Jamaica Bay ecosystem.

2.6.3 Mudflats

Mudflats are broad, shallow areas which are un-vegetated and exposed twice daily (i.e., semi-diurnal) at or near low tide. This habitat provides a crucial ecological transition between intertidal wetlands and subtidal bottom areas, as well as provides services related to shoreline protection, water quality improvement, fisheries resources, and habitat and food sources for migratory and resident animals. Tidal mudflats support a wide diversity of both terrestrial and aquatic life.

Specific to this habitat, mudflats commonly occur within Jamaica Bay in the historic location of intertidal wetlands. The loss of coastal wetlands has resulted in expansive mudflats along the shorelines edge in many locations throughout Jamaica Bay. While differing from the historical condition, mudflats still provide suitable habitat for a wide assemblage of benthic macroinvertebrates which then provide a critical food resource to fish, birds, as well as crustaceans.

2.6.4 Intertidal Wetlands

Intertidal wetlands are vegetated areas tidally influenced and connected to open waters that are inundated or saturated by surface- or ground-water frequently enough to support vegetation that thrives in wet soil conditions. Intertidal wetlands for purposes of this HSGRR/EIS include both low and native high salt marsh communities. The low salt marsh community generally occurs between mean low and mean high water, and is inundated twice daily by normal high tides. Low marsh communities are typically dominated by saltmarsh cordgrass *(Spartina alterniflora*). The native high marsh community occurs between MHW and the MHHS, which is only occasionally flooded during major storms or during extreme (i.e., spring) high tides. High marsh vegetation is dominated by salt marsh hay (*Spartina patens*) with saltgrass (*Distichlis spicata*) and/or marsh elder (*Iva frutescens*) occasionally mixed throughout.

Unfortunately, much of the native high marsh salt marsh community has been invaded by common reed throughout Jamaica Bay. Given the expansive monotypical stands of common reed, as well as the reduced level of services and functions that this community affords to the Jamaica Bay ecosystem, non-native intertidal wetlands have been defined as a separate habitat type. Common reed can cover many acres, and effectively out-compete native species that historically occurred throughout the high marsh. Through development of these expansive monotypical communities, this species also significantly reduce hydrologic complexity by altering and/or limiting intertidal channels and pools. Finally, these large monotypical stands also raise the elevation of these historic marsh communities by trapping sediment as well as the annual decomposition of the significant above ground biomass produced by this species.

2.6.5 Maritime Coastal Forest and Shrubland

Historically, a mosaic of the maritime forests/shrubland/grassland habitats was a large component of the undisturbed Jamaica Bay complex. They supported and therefore increased the value of the wetland and aquatic habitats by providing cover, alternate food sources and breeding habitats to many of the species that characteristically inhabit adjacent salt marshes, mudflats and shallow water habitats. They additionally act as a buffer area for the salt marsh communities. This benefit is integral to a full functioning integrated estuarine system, adding to the benefits of the adjacent

habitats and increasing overall connectivity between and among similar habitats and multiple habitats used by the same species. They provide a critical resource for migratory passerine bird species, as well as other resident and migratory birds, mammals, and sensitive insect species Unfortunately, these maritime forests and grasslands, with beach and dune complexes, are now the rarest habitat type and often the subject of long-term restoration goals throughout Jamaica Bay. When they do exist in both planning reaches, their understory vegetation is commonly dominated by common reed and other invasive species.

2.6.6 Ruderal Uplands

As Jamaica Bay remains one of the most urban estuaries throughout North America, many upland habitats (which are not yet impervious surfaces) have been modified by historic and current anthropogenic disturbances. Ruderal upland habitats found extensively throughout both study area reaches represent upland areas that are (1) dominated by invasive species, (2) managed as lawns or landscape features, and/or (3) disturbed soil and/or rock and gravel.

2.6.7 Urban

A great deal of area within both study area reaches has been paved with impervious surface due to urban development. This urban habitat type is inclusive of the following, and not necessarily limited to: roads; paved trails; recreational courts; commercial and residential buildings; parking lots; and laydown yards. This habitat type is assumed to provide little to no services or functions to the Jamaica Bay ecosystem.

2.7 Invertebrate and Benthic Resources

Terrestrial and marine invertebrates have many important functions as key lower food web components in coastal and marine ecosystems. Terrestrial and benthic invertebrates serve as food resources for birds, mammals, and fish (Waldman 2008). Blue crab (*Callinectes sapidus*) and American lobster (*Homarus americanus*) are food resources for predatory fish and birds (Bain et al 2007; Waldman 2008; USACE 2009), and commonly found in subtidal bottom and shellfish reef habitats. Horseshoe crab (*Limulus polyphemus*), and specifically the large quantities of horseshoe crab eggs produced during spawning, are key food resources for fish, reptiles, and migrating shorebirds like the red knot (Botton et al 2006). Horseshoe crabs utilize multiple habitats along the shoreline from subtidal bottoms, into intertidal mudflats, and along sandy beaches.

Clams (for example softshell, *Mya arenaria*, and quahog, *Mercenaria mercenaria*) are important food resources for other food web components and also perform water quality functions (USFWS 1997a). Blue mussels (*Mytilus edulis*) are found in intertidal shallows along the shorelines attached to hard substrates, while ribbed mussels (*Geukensia demissa*) are found in soft sediments and have an important mutualism with cordgrass species. Both mussel species are important food resources for fish and birds and as filter-feeders they improve water quality (Bain et al. 2007; Waldman 2008; USACE 2009; NYC Department of Environmental Protection 2014). Oysters (*Crassostrea virginica*) filter particulate matter from the water column, enhance subtidal habitats like eelgrass beds, and function as food resources for fish and birds.

With respect to the Atlantic Ocean Shorefront Planning Reach, the primary shellfish with important commercial or recreational value in the near shore portion of the study area are the hardshell clam [Quahog], softshell clam, bay scallop (*Argopencten irradiens*), American lobster, and blue crab (MacKenzie 1990). Surf clam (*Spisula solidissima*), razor clam (*Ensis directus*) and

tellin (*Tellina agillis*) occur in the vicinity of the offshore borrow area. Surveys conducted by the USACE in 2003 and by the NYSDEC in 2012 indicate that the borrow area itself contains very small, to no, localized populations of surf clam.

With respect to the Jamaica Bay Planning Reach, horseshoe crabs are known to utilize sandy beach habitats. Ribbed mussels are dominant in certain areas associated with shoreline banks vegetated with smooth cordgrass. As noted above, while oyster reefs no longer exist in the study area, scattered live oysters can be found in localized areas. Specific to the project area, a spat-on shell reef was established off the shoreline of Dubos Point in 2010.

2.8 Finfish

Primary fish species of the Atlantic Ocean Shorefront Planning Reach and borrow area include black sea bass (*Centropristis striata*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus*), weakfish (*Cynosion regalis*), bluefish (*Pomatomus saltatrix*), scup (*Stenotomus chrysops*), striped bass (*Morone saxatillis*), and Atlantic mackerel (*Scomber scombrus*). In addition, other common species in near shore waters include tautog (*Tautoga onitis*), northern puffer (*Sphoeroides maculates*), windowpane (*Scophthalmus aquosus*) and American eel (*Anguilla rostrata*). A number of migrant anadromous and catadromous species are found throughout both study area reaches. Common migrant species include the Atlantic sturgeon (*Acipenser oxyhinchus*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), Atlantic silverside (*Menidia menidia*), striped bass, and American eel (Woodhead 1992).

Jamaica Bay habitats are highly productive and support a large number of fish species that serve as key resources for other Jamaica Bay ecosystem components. Forage fish (*Fundulus sp*.) are important middle food web components and function as food resources for birds and predatory fish including resident (e.g., flounder sp.) and anadromous (e.g., shad, herring, Atlantic sturgeon, striped bass) species (USFWS 1997b; Waldman 2008; USACE 2009).

Winter flounder was the most important commercial and recreational fish to use Jamaica Bay in great numbers during all life stages; Jamaica Bay is also believed to be a significant breeding area for this species. Forage fish species with high abundances, including Atlantic silverside (*Menidia menidia*), bay anchovy (*Anchoa mitchilli*), mummichog (*Fundulus heteroclitus*), Atlantic menhaden (*Brevoortia tyrannus*), and striped killifish (*Fundulus majalis*), form a prey base for other fish and birds that use the area. Both the nearshore and offshore waters of the study area support seasonally abundant populations of many recreational and commercial finfish (USFWS 1989, 1995, USACE 1995). Some of the other common species found in surveys and recreational landings include scup, bluefish, windowpane, tautog, weakfish, black sea bass, summer flounder, American eel, and searobin (*Prionotus spp*.). Anadromous species that use the area include blueback herring, Atlantic sturgeon, alewife, American shad, striped bass, and Atlantic mackerel (*Scomber scombrus*).

The Atlantic sturgeon is a federally endangered species that is vulnerable to various impacts because of their wide-ranging use of rivers, estuaries, bays and the ocean throughout the phases of their life. In addition, they have been commercial over-harvesting for years and which likely has contributed to population declines. Further information is discussed in the Protected Species section below.

2.9 Reptiles and Amphibians

The diamondback terrapin (*Malaclemys terrapin*) are medium sized turtle species that inhabits brackish waters of estuaries, tidal creeks, and salt marshes along the northeastern coast of North America. Unfortunately, and its populations are declining throughout their range (Waldman 2008; USACE 2009). Diamondback terrapin use habitats within the Jamaica Bay Planning Reach for nesting and feeding.

Other amphibians and reptiles species that may potentially be present in the study area include Fowler's toad (*Bufo woodhousii fowleri*), spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor*), green frog (*Rana clamitans*), spotted salamander, redback salamander (*Plethodon cinereus*), northern brown snake (*Storeria d. dekayi*), smooth green snake (*Opheodrys vernalis*), eastern hognose snake (*Heterodon platirhinos*), eastern milk snake (*Lampropeltis triangulum triangulum*), northern black racer (*Coluber c. constrictor*), snapping turtle (*Chelydra serpentina*), eastern painted turtle (*Chrysemys p. picta*), and eastern box turtle (*Terrapene c. carolina*).

Five species of threatened and endangered marine turtles have habitat ranges that overlap with the near shore coastal waters of the study area during summer and early fall. Species include the federally-listed Kemp's ridley (*Lepidochelys kempii*, endangered), leatherback (*Dermochelys coriacea*, endangered), green (*Chelonia mydas*, threatened), loggerhead (*Caretta caretta*, threatened), and hawksbill (*Eretmochelys imbricata*, endangered). The most common are Kemps ridley that prefer coastal areas, and leatherbacks, which commonly found nearby in offshore Long Island waters (NYS DEC 2016a), while the hawksbill is considered to be the rarest encountered in NY waters (NYS DEC 2016b). Sea turtles may utilize coastal resources in the study area for foraging. However, nesting is unlikely to occur along beaches in the Atlantic Ocean Shorefront Planning Reach, as breeding grounds for all species are located in warmer waters to the south.

2.10 Birds

Several different groups of bird species use both the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach. Wading birds (herons, stilts), seabirds (terns, cormorants), waterfowl (ducks, geese), shorebirds (plovers, sandpipers), passerines (terrestrial songbirds) and raptors are dependent upon the different types of coastal and upland habitats found in these areas (Waldman 2008; USACE 2009; NYC Audubon 2015). Both resident and migratory bird species use Jamaica Bay (including Floyd Bennet Field, Gateway National Wildlife Refuge), Rockaway Beaches and Breezy Point.

A wide diversity of bird species is likely to occur within, and in the vicinity of, the study area. The most common species in the study area are habitat generalists that are tolerant of development and that utilize beach habitat along the shoreline and deepwater habitats. Common species include herring gull (*Larus argentatus*), greater black-backed gull (*Larus marinus*), American crow (*Corvus brachyrhynchos*), American robin (*Turdus migratorius*), barn swallow (*Hirundo rustica*), black-bellied plover (*Pluvialis squatarola*), black scoter (*Melanitta nigra*), bufflehead (*Bucephala albeola*), common grackle (*Quiscalus quiscula*), common yellowthroat (*Geothlypis trichas*), double-crested cormorant (*Phalacrocorax auritus*), European starling (*Sturnus vulgaris*), gray catbird (*Dumetella carolinensis*), mourning dove (*Zenaida macroura*), rock dove/pigeon (*Columba livia*), sanderling (*Calidris alba*), song sparrow (*Milospiza melodia*), house sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), and tree swallow (*Iridoprocne bicolor* [USACE 1998, 2003, USFWS 1992]). Permanent avian residents of the surrounding area include

various species of gulls, crows, pigeons, and sparrows, which are commonly associated with developed areas and areas of high human activity (USFWS 1992, USACE 1998, 2003). Numerous migratory bird species of conservation concern are likely to be found breeding, foraging or migrating through the study area and are listed in Section 2.9.3.

2.11 Mammals

Although mammals are a less visible component of study area ecosystems, the study area serves as important habitat for many species. Bat species like hoary bat (*Lasiurus cinereus*), red bat (*Lasiurus borealis*), little brown bat, (*Myotis lucifugus*), and silver-haired bat (*Lasionycteris noctivagans*) may be present (Waldman 2008) in upland habitats adjacent to Jamaica Bay. Other terrestrial mammals in the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach include opossum (*Didelphis virginiana*), black-tailed jackrabbit (*Lepus californicus*) escaped from JFK Airport cargo, eastern cottontail rabbit (*Sylvilagus floridanus*), eastern chipmunk (*Tamias striatus* - introduced), gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), muskrat (*Ondatra zibethicus*), and house mouse (*Mus musculus*).

Nearshore coastal and the borrow areas serve as habitat for several marine mammals. Federally-listed cetaceans that may occur in the study area include the endangered North Atlantic right whale (*Eubalaena glacialis*); the endangered humpback whale (*Megaptera novaeangliae*); and the endangered fin whale (*Balaenoptera physalus*) (USACE 2015). Non-listed cetacean species with nearshore coastal New York water habitats include finback (*Balaenoptera physalus*), minke (*B. acutorostrata*), and pilot (*Globicephala melaena*) whales as well as several dolphin species, including common (*Delphinus delphis*), bottle-nosed (*Tursiops truncatus*), white-sided (*Lagenorhynchus acutus*), and striped (*Stenella coerulealba*), and harbor porpoise (*Phocoena phocoena*) (Edinger et. al. 2014). Other marine mammals that are found in coastal waters include seals. Harbor seals, the most abundant seal species found within New York State waters, frequently winter in nearshore waters of the study area and can be found basking on sand bars, rocks, or remote beaches (NYS DEC 2016c). Although not as frequent, grey seal (*Halichoerus grypus*) habitat also overlaps with the study area.

2.12 Threatened and Endangered Species

2.12.1 Federally-Listed Species

The USFWS, through its formal consultation with USACE regarding implementation of the project, identified three threatened and endangered (T&E) species as being present on or near the project area:

- Piping plover (*Charadrius melodus*), federally threatened;
- Seabeach amaranth (*Amaranthus pumilus*), federally threatened; and
- Rufa Red Knot (*Calidris canutus*), federally threatened.

A Biological Assessment pertaining to these three species is included as Attachment D2a within the Environmental Compliance Appendix. In addition, the state-listed threatened common tern (Sterna hirundo) and least tern (*Sterna antillarum*) and the federally and state-listed Endangered roseate tern (*Sterna dougallii*), have been identified as species that may occur in the Project Area ; specifically utilizing beach habitat similar to that of the piping plover and sea beach amaranth

(USACE 1998, USFWS 1995a). Additionally, the state species of special concern, black skimmer (*Rynchops niger*), also is known to nest on coastal beaches and frequently nests in or near tern nesting areas (NatureServe 2002). None of these species have been identified by the USFWS as species requiring further ESA consultation through the Biological Assessment (USFWS 1995a).

Seasonal avian surveys are conducted by NYC Parks and Recreation at the Atlantic Ocean Shorefront Planning Reach. In 2014 piping plovers used approximately 2 miles of beach. There are three continuous management zones: Far Rockaway (B9-B35 Street), Arverne (B35-B73 Street) and Rockaway (B73- B149 Street). In most years, including 2014, plovers bred between Beach 56th to Beach 19th Streets. 2014 breeding season netted 12 pairs. 54 eggs, 44 chicks and 25 fledglings (Productivity Rate of 2.08 fledglings/pairs). In addition, the NPS completed seasonal avian surveys for Reach 1 (Rockaway Point to Beach 193rd Street) and Reach 2 (Beach 193rd Street to Beach 149th Street). Nineteen nesting pairs were identified between April 22 and June 8, 2014. Within Reach 1 & 2, NPS documented 81 eggs, 64 chicks, and 21 fledglings.

Migrating red knot populations use the beach habitat within the Atlantic Ocean Shorefront Planning Reach to forage on horseshoe crab eggs laid on beaches in Jamaica Bay, Breezy Point, and Rockaway Beaches. The red knot is only present in the study area during migration and does not breed there.

More than 90 percent of New York State's population of roseate terns is made up by a single colony on Great Gull Island, off Long Island's eastern end. The remainder occurs in small groups of often just one or two breeding pairs in variable locations along the south shore of eastern Long Island (Mitra 2008). Roseate terns have sporadically nested within the Jamaica Bay estuary in the past (e.g., 2 pairs in 1996; Wells 1996), but during the most recent Breeding Bird Atlas, they were not documented anywhere west of Suffolk County (Mitra 2008). Roseate terns are not among the beach-nesting bird species that nest on Rockaway Beach (Boretti et al. 2007). The Jamaica Bay estuary provides feeding and nesting habitat. The potential for roseate terns to occur in the study area is considered low and limited to migrants moving through the area en route to nesting sites elsewhere in the region or to wintering grounds in the southern hemisphere.

The Atlantic Ocean Shorefront Planning Reach supports one of the largest seabeach amaranth populations in New York State (Young 2000). During field surveys conducted by NYSDEC biologists in 2000, 26 sea beach amaranth plants were identified on the beach between Beach 22nd and Beach 39th Streets (Young 2000). A larger population of approximately 2,000 plants was also identified further west, between Beach 44th and Beach 66th streets. Seabeach amaranth is an annual plant that prefers beach habitats, and is subject to competitive exclusion by beach grass and other vegetation.

In addition, the federally-endangered Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*, endangered) is listed in the New York Bight. Specifically, adult and subadult can be found within the study area. Numbers of Atlantic sturgeon in the New York Bight distinct-population segment are extremely low compared to historical levels and have remained so for the past 100 years. Currently, the existing spawning population in the Hudson River is estimated to have 870 adults spawning each year (600 males and 270 females). There is no population estimate for the Delaware River, but it is believed to have less than 300 spawning adults per year. The spawning population of this distinct population segment is thought to be one to two orders of magnitude below historical levels. Additionally, the shortnose sturgeon (Acipenser brevirostrum), in the adult

and sub-adult life stages, may also be present in these waters. The shortnose sturgeon is endangered throughout its range. Both species may occur in the study area periodically and seasonally.

As noted above, two federally listed whales and four federally listed sea turtles also may occur in the study area, periodically and seasonally.

2.12.2 Critical Habitat

No federally designated critical habitat is found within or near the study area. Jamaica Bay and Breezy Point have been designated Significant Coastal Fish and Wildlife Habitat by the New York State Department of State (NYSDOS), Division of Coastal Resources. Jamaica Bay, Breezy Point, and Rockaway Beaches have also been designated globally Important Bird Areas by Audubon New York.

2.12.3 Migratory Birds

Migratory birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. Any activity that results in the take of migratory birds or eagles is prohibited unless authorized by USFWS. The results of a data search through USFWS' Information for Planning and Consultation (IPaC) which identified 68 migratory birds which could potentially be affected by a project in the study area are shown as Table 2-1.

Table 2-1: Migratory Bird Species with Potential to Occur in or Proximate to the Study Area

Scientific Name	Common Name	Presence	Breading Season
Haematopus palliatus	American Oystercatcher	Year round	Breeds Apr 15 to Aug 31
Sterna paradisaea	Arctic Tern	Seasonal	Breeds May 20 to Aug 15
Haliaeetus leucocephalus	Bald Eagle	Year round	Breeds Oct 15 to Aug 31
Cephhus grylle	Black Guillemot	Seasonal	Breeds May 15 to Sep 10
Melanitta nigra	Black Scoter	Year round	Breeds elsewhere
Rynchops niger	Black Skimmer	Seasonal	Breeds May 20 to Sept 15
Coccyzus erythropthalmus	Black-billed Cuckoo	Seasonal	Breeds May 15 to Oct 10
Rissa tridactyla	Black-legged Kittiwake	Seasonal	Breeds elsewhere
Dolichonyx oryzivorus	Bobolink	Seasonal	Breeds may 20 to Jul 31
Chroicocephalus philadephia	Bonaparte's Gull	Year round	Breeds elsewhere
Onychoprion anaethetus	Bridled Tern	Seasonal	Breeds Apr 15 to Sep 20
Pelecanus occidentalis	Brown Pelican	Seasonal	Breeds Jan 15 to Sep 30
Calidris subruficollis	Buff-breasted Sandpiper	Seasonal	Breeds elsewhere
Cardellina canadensis	Canada Warbler	Seasonal	Breeds May 20 to Aug 10
Dendroica cerulea	Cerulean Warbler	Seasonal	Breeds Apr 29 to Jul 20
Rallus crepitans	Clapper Rail	Seasonal	Breeds Apr 10 to Oct 31
Somateria mollisima	Common Elder	Seasonal	Breeds Jun 1 to Sep 30
Gavia immer	Common Loon	Year round	Breeds Apr 15 to Oct 31
Sterna hirundo	Common Tern	Seasonal	Breeds May 10 to Sep 10
Calonectris diomedea	Cory's Shearwater	Seasonal	Breeds elsewhere
Phalacrocorax auritus	Double-crested Cormorant	Year round	Breeds Apr 20 to Aug 31
Alle alle	Dovekie	Seasonal	Breeds elsewhere
Calidris alpine arcticola	Dunlin	Year round	Breeds elsewhere
Coccothraustes vespertinus	Evening Grosbeak	Seasonal	Breeds elsewehere
Aquila chrysaetos	Golden Eagle	Seasonal	Breeds elsewhere
Vermivora chrysoptera	Golden-winged Warbler	Seasonal	Breeds May 1 to Jul 20

Scientific Name	Common Name	Presence	Breading Season
Larus marinus	Great Black-backed Gull	Year round	Breeds Apr 15 to Aug 20
Puffinus gravis	Great Shearwater	Seasonal	Breeds elsewhere
Gelochelidon nilotica	Gull-billed Tern	Seasonal	Breeds May 1 to Jul 31
Larus argentatus	Herring Gull	Year round	Breeds Apr 20 to Aug 31
Limosa haemastica	Hudsonian Godwit	Seasonal	Breeds elsewhere
Oporornis formosus	Kentucky Warbler	Seasonal	Breeds Apr 20 to Aug 20
Oceanodroma leucorhoa	Leach's Storm-petrel	Seasonal	Breeds May 15 to Nov 20
Sterna antillarum	Least Tern	Seasonal	Breeds Apr 20 to Sep 10
Tringa flavipes	Lesser Yellowlegs	Seasonal	Breeds elsewhere
Asio otus	Long-eared Owl	Seasonal	Breeds elsewhere
Clangula hyemalis	Long-tailed Duck	Seasonal	Breeds elsewhere
Puffinus puffinus	Manx Shearwater	Seasonal	Breeds Apr 15 to Oct 31
Ammodramus nelson	Nelson's Sparrow	Seasonal	Breeds May 15 to Sep 5
Morus bassanus	Northern Gannet	Seasonal	Breeds elsewhere
Stercorarius parasiticus	Parasitic Jaeger	Seasonal	Breeds elsewhere
Dendroica discolor	Prairie Warbler	Seasonal	Breeds May 1 to Jul 31
Protonotaria citrea	Prothonotary Warbler	Seasonal	Breeds Apr 1 to Jul 31
Calidris maritima	Purple Sandpiper	Seasonal	Breeds elsewhere
Alca torda	Razorbill	Seasonal	Breeds Jun 15 to Sep 10
Phalaropus fulicarius	Red Phalarope	Seasonal	Breeds elsewhere
Mergus serrator	Red-breasted Merganser	Year round	Breeds elsewhere
Melanerpes erythrocephalus	Red-headed Woodpecker	Seasonal	Breeds May 10 to Sep 10
Phalaropus lobatus	Red-necked Phalarope	Seasonal	Breeds elsewhere
Gavia stellata	Red-throated Loon	Seasonal	Breeds elsewhere
Larus delawarensis	Ring-billed Gull	Year round	Breeds elsewhere
Sterna dougallii	Roseate Tern	Seasonal	Breeds May 10 to Aug 10
Thatlasseus maxiumus	Royal Tern	Seasonal	Breeds Apr 15 to Aug 31
Arenaria interpres morinella	Ruddy Turnstone	Seasonal	Breeds elsewhere
Euphagus carolinus	Rusty Blackbird	Seasonal	Breeds elsewhere
Ammodramus caudacutus	Saltmarsh Sparrow	Seasonal	Breeds May 15 to Aug 20
Ammodramus mritimus	Seaside Sparrow	Seasonal	Breeds May 10 to Aug 20
Calidris pusilla	Semipalmated Sandpiper	Seasonal	Breeds elsewhere
Limnodromus griseus	Short-billed Dowitcher	Seasonal	Breeds elsewhere
Bubo scandiacus	Snowy Owl	Seasonal	Breeds elsewhere
Onychoprion fuscatus	Sooty Tern	Seasonal	Breeds Mar 10 to Jul 31
Melanitta perspicillata	Surf Scoter	Seasonal	Breeds elsewhere
Uria lomvia	Thick-billed Murre	Seasonal	Breeds Apr 15 to Aug 15
Numenius phaeopus	Whimbrel	Seasonal	Breeds elsewhere
Melanitta fusca	White-winged Scoter	Seasonal	Breeds elsewhere
Tringa semipalmata	Willet	Seasonal	Breeds Aug 20 to Aug 5
Oceanites oceanicus	Wilson's Storm-petrel	Seasonal	Breeds elsewhere
Hylocichla mustelina	Wood Thrush	Seasonal	Breeds May 10 to Aug 31

2.12.4 State-Listed Species of Concern

A review of New York State-listed threatened, endangered, and rare species and species of concern in Nassau, Queens, and Kings Counties was conducted using the NYDEC website (http://www.dec.ny.gov/animals/7494.html, accessed April 6, 2016), and are summarized in Table 2-2.

The state-listed endangered least tern (*Sterna antillerum*) is known to occur in the same type of habitat as the piping plover and roseate tern (see Section 2.3.9 Threatened and Endangered

Species) (USACE 1993). Least terns are known to nest in areas in the vicinity of Beach 45th Street and westward along the beach (USFWS 1999). Other state-listed threatened species that occur in the general area include the northern harrier (*Circus cyaneus*), osprey (*Pandion haliaetus*), and common tern (*Sterna hirundo*).

In addition, the piping plover (state endangered), peregrine falcon (state endangered), roseate tern (state endangered), and the bald eagle (state threatened) are present in the study area.

Two species of state-listed plants are known to occur in the vicinity of the study area (Young 2000). Seabeach knotweed (*Polygonum glaucum*, state status: rare) and dune sandspur (*Cenchrus tribuliodes*, state status: threatened) have been observed by NYSDEC biologists in the same type of habitat along the East Rockaway beaches as the federally-listed sea beach amaranth (Young 2000).

Table 2-2: New York State Protected Species with Potential to Occur in or Proximate to the Study Area

Scientific Name	Common Name	NY-listed (county)
Gavia immer	Common Loon	SC
Podilymbus podiceps	Pied-billed Grebe	T
Botaurus lentiginosus	American Bittern	SC
Ixobrychus exilis	Least Bittern	T
Haliaeetus leucocephalus	Bald Eagle	T
Accipiter cooperii	Cooper's Hawk	SC
Accipter striatus	Sharp-shinned hawk	SC
Buteo lineatus	Red-shouldered Hawk	SC
Circus cyaneus	Northern harrier	T
Falco peregrinus	Peregrine Falcon	E
Pandion haliaetus	Osprey	SC
Bartramia longicauda	Upland sandpiper	T
Rynchops niger	Black skimmer	SC
Sterna antillarum	Least tern	T
Sterna hirundo	Common tern	T
Asio flammeus	Short-eared owl	E
Eremophila alpestris	Horned lark	SC
Ammodramus maritimus	Seaside sparrow	SC
Ammodramus savannarum	Grasshopper sparrow	SC
Charadrius melodus	Piping Plover	E
Sterna dougallii dougallii	Roseate Tern	E

SC – Species of Concern; T – Threatened; E - Endangered

2.13 Special Management Areas

2.13.1 Gateway National Recreation Area

The following sections identify Gateway National Recreation Area property that falls within either the Jamaica Bay Planning Reach or the Atlantic Ocean Shorefront Planning Reach.

2.13.1.1 Atlantic Ocean Shorefront Planning Reach

The Gateway National Recreation Area property located within the Rockaway Atlantic Ocean Shorefront Planning Reach includes Fort Tilden, Jacob Riis Park, and Breezy Point Tip (Figure 2-2).

2.13.1.2 Jamaica Bay Planning Reach

The Gateway National Recreation Area property located within the Jamaica Bay Planning Reach includes Jamaica Bay Wildlife Refuge, Floyd Bennett Field, Plumb Beach, Bergen Beach, Canarsie Pier, and the Frank Charles Memorial Park (Figure 2-2). In addition to these specific properties, Figure 2-2 also shows that the northern perimeter of Jamaica Bay and the majority of the waters of Jamaica Bay fall within the jurisdictional boundaries of the GNRA.

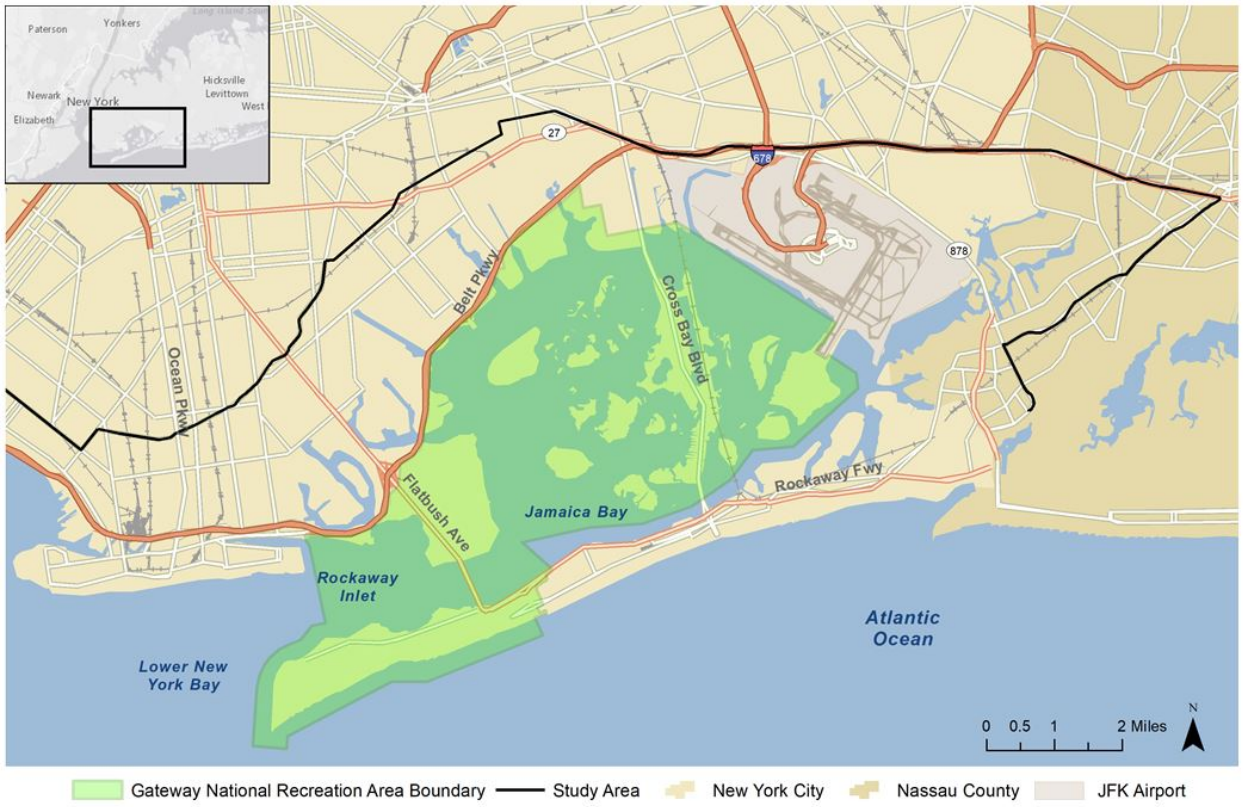


Figure 2-2: Gateway National Recreation Area Boundary

2.13.2 NYC Waterfront Revitalization Program

This Discussion incorporates both Planning Reaches. The NYC Waterfront Revitalization Program (WRP) is the city's principal coastal zone management tool. It establishes the City's policies for development and use of the waterfront. Most city, state and federal discretionary actions in the Coastal Zone must be reviewed for consistency with these policies.

On February 3, 2016, the NYS Secretary of State approved the revisions to the NYC Waterfront Revitalization Program. This set of policies and maps should be used for consistency review of all local and state actions. The US Secretary of Commerce concurred with the State's request to incorporate the WRP into the NYS Coastal Management Program.

Although the NYC WRP policies are intended to be used to evaluate proposed actions to promote activities appropriate to various waterfront locations, evaluating the consistency of existing land use with those policies can be used to anticipate future waterfront conditions. Ten policies are included in the Program: (1) residential and commercial redevelopment; (2) water-dependent and industrial uses; (3) commercial and recreational boating; (4) coastal ecological systems; (5) water quality; (6) flooding and erosion; (7) solid waste and hazardous substances; (8) public access; (9) scenic resources; and (10) historical and cultural resources.

As originally mapped and adopted in 1982, the coastal zone boundary defines the geographic scope of the WRP (Figure 2-3).

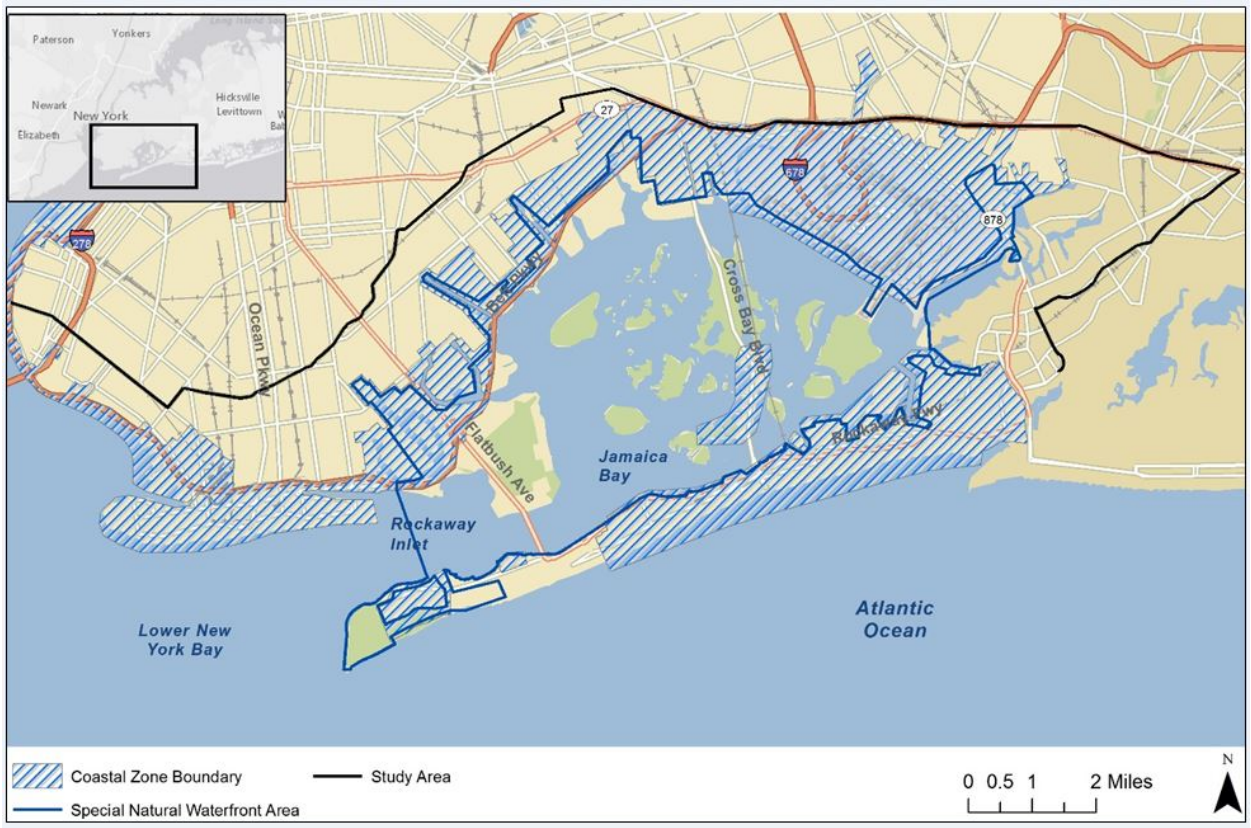


Figure 2-3: NYC Waterfront Revitalization Program, Coastal Zone Boundary, and Special Natural Waterfront Areas

2.13.3 Coastal Zone Boundary

This discussion incorporates both Planning Reaches. As originally mapped and adopted in 1982, the coastal zone boundary defines the geographic scope of the WRP. Pursuant to federal statute, the boundary encompasses all land and water of direct and significant impact on coastal waters.

The coastal zone boundary extends from the Westchester and Nassau County and New Jersey boundaries seaward to the three-mile territorial limit in the Atlantic. The boundary extends landward to encompass the following coastal features:

- Significant Maritime and Industrial Areas
- Significant Coastal Fish and Wildlife Habitats

- Special Natural Waterfront Areas (e.g. Jamaica Bay)
- Staten Island Bluebelts
- Intertidal and Freshwater Wetlands
- Coastal Floodplains and Flood Hazard Areas
- Erosion Hazard Areas
- Coastal Barrier Resources Act Areas
- Steep Slopes
- Parks and Beaches
- Visual Access and Views of Coastal Waters and the Harbor
- Historic, Archaeological, and Cultural Sites Closely Associated with the Coast
- Special Zoning Districts.

In developed areas devoid of these features, the coastal zone boundary is generally defined as the nearest legally mapped street at least 300 feet landward of the Mean High Tide Line. In undeveloped areas devoid of these features, the landward boundary is delineated at the legally mapped street nearest to the first major man-made physical barrier. Exceptions to these guidelines include City Island, Broad Channel Island, and the Rockaway Peninsula which are included within the coastal zone in their entirety. Federal lands and facilities are excluded from the coastal zone and consistency review in accordance with federal legislation. However, should the federal government dispose of any coastal property, it would be included in the coastal zone.

2.13.4 NYC Special Natural Waterfront Area

This discussion incorporates both Planning Reaches. Jamaica Bay, including the Rockaway peninsula, is a NYC-designated Special Natural Waterfront Area (SNWA). A SNWA is a large area with concentrations of important coastal ecosystem features such as intertidal wetlands, habitats and buffer areas, many of which are regulated under other programs. The New Waterfront Revitalization Program (NYC Department of City Planning [NYCDCP] 1999b) defines SNWAs as coastal areas with special characteristics identified in NYC's Comprehensive Waterfront Plan that "have particular natural habitat features that should be considered in connection with any waterfront activity." It further directs that "activities that protect and restore these features would be consistent with waterfront policy for these areas." Accordingly, the WRP encourages public investment within the SNWA to focus on habitat protection and improvement and discourages activities that interfere with the habitat functions of the area. Acquisition of sites for habitat protection is presumed consistent with the goals of this policy. Similarly, fragmentation or loss of habitat areas within an SNWA should be avoided.

2.13.5 Coastal Barrier Resources Act Areas

This discussion incorporates both planning reaches. In the 1970s and 1980s, Congress recognized that certain actions and programs of the federal government have historically subsidized and encouraged development on coastal barriers, resulting in the loss of natural resources; threats to human life, health, and property; and the expenditure of millions of tax dollars each year (USFWS, 2016). To remove the federal incentive to develop these areas, the Coastal Barrier Resources Act (CBRA) of 1982 designated relatively undeveloped coastal barriers along the Atlantic and Gulf coasts as part of the John H. Chafee Coastal Barrier Resources System (CBRS), and made these

areas ineligible for most new federal expenditures and financial assistance. CBRA encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting federal expenditures that encourage development, such as federal flood insurance. Areas within the CBRS can be developed provided that private developers or other non-federal parties bear the full cost.

The CBRA was amended by the Coastal Barrier Improvement Act of 1990 which added a new category of coastal barriers called Otherwise Protected Areas (OPAs). OPAs are undeveloped coastal barriers that are within the boundaries of an area established under federal, state, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes.

Federal expenditures are allowable within the CBRS, if it meets any of the following exceptions (16 U.S.C. § 3505(a)(6)) and is also consistent with the three purposes of the CBRA (e.g. to minimize [1] the loss of human life, [2] wasteful expenditure of federal revenues, and [3] the damage to fish, wildlife, and other natural resources associated with coastal barriers) :

- Projects for the study, management, protection, and enhancement of fish and wildlife resources and habitats, including acquisition of fish and wildlife habitats, and related lands, stabilization projects for fish and wildlife habitats, and recreational projects.
- Establishment, operation, and maintenance of air and water navigation aids and devices, and for access thereto.
- Projects under the Land and Water Conservation Fund Act of 1965 (16 U.S.C. § 460l-4 through 11) and the Coastal Zone Management Act of 1972 (16 U.S.C. § 1451 et seq.).
- Scientific research, including aeronautical, atmospheric, space, geologic, marine, fish and wildlife, and other research, development, and applications.
- Assistance for emergency actions essential to the saving of lives and the protection of property and the public health and safety, if such actions are performed pursuant to sections 5170a, 5170b, and 5192 of title 42 and section 1362 of the National Flood Insurance Act of 1968 (42 U.S.C. § 4103) and are limited to actions that are necessary to alleviate the emergency.
- Maintenance, replacement, reconstruction, or repair, but not the expansion (except with respect to U.S. route 1 in the Florida Keys), of publicly owned or publicly operated roads, structures, and facilities.
- Nonstructural projects for shoreline stabilization that are designed to mimic, enhance, or restore a natural stabilization system.

The western portion of the Rockaway peninsula and all of Jamaica Bay are located within the designated CBRA (Unit NY-60P) (Figure 2-4). Since this area is designated as an Otherwise Protected Area (OPA), the restrictions on federal expenditures are far less. The only restriction in OPAs is in issuance of Federal Flood Insurance. There is no requirement to demonstrate that the project meet the above exemptions when the work is within an OPA, and CBRA does not impact alternative development or plan selection.

Figure 2-4: Coastal Barrier Resource System Area

2.13.6 New York State Natural Heritage Program

This discussion incorporates both Planning Reaches. The New York State Natural Heritage Program, in conjunction with The Nature Conservancy, recognizes two Priority Sites for Biodiversity within the Jamaica Bay and Breezy Point habitat complex: Breezy Point Tip (B2 - very high biodiversity significance) and Fountain Avenue Landfill (B3 - high biodiversity significance). The Breezy Point Tip is located in the Atlantic Ocean Shorefront Planning reach and the Fountain Avenue Landfill is located in the Jamaica Bay Planning Reach.

2.13.7 New York State Department of State Significant Coastal Fish and Wildlife Habitats

This discussion incorporates both planning reaches. Jamaica Bay and Breezy Point Tip have been designated as Significant Coastal Fish and Wildlife Habitats by the New York State Department of State (NY Department of State, Planning and Development, 2016) (Figure 2-5).

Figure 2-5: NYS Dept. State Significant Coastal Fish and Wildlife Habitats

Note: Green shaded area indicates Significant Coastal Fish and Wildlife Habitats
Source: NY Department of State, Planning and Development, 2016.

2.13.8 NYC Planning Special Purpose Districts

In addition to standard zoning, the NYC Department of City Planning (DCP) has designated special zoning districts to achieve specific planning and urban design objectives in defined areas with unique characteristics[21]. Special districts respond to specific conditions; each special district designated by the Commission stipulates zoning requirements and/or zoning incentives tailored to distinctive qualities that may not lend themselves to generalized zoning and standard development. Any CSRM measures developed within a special purpose district would require consultation with the NYC Planning Commission.

2.13.8.1 Atlantic Ocean Shorefront Planning Reach

No NYC-designated special purpose districts were identified within the Rockaway Area of Potential Effect (APE) (NYC Planning, 2016).

2.13.8.2 Jamaica Bay Planning Reach

Within the Jamaica Bay APE, the NYC Planning-designated special purpose districts are located to the west of Marine Parkway Bridge, and include the following areas:

- Sheepshead Bay District. The Sheepshead Bay district was identified to protect and strengthen that neighborhood's waterfront recreation and commercial character. New commercial projects and residential development must meet conditions that will support

[21] NYC Planning, 2016, http://www1.nyc.gov/site/planning/zoning/districts-tools/special-purpose-districts.page

the tourist-related activities along the waterfront. Provision for widened sidewalks, landscaping, useable open space, height limitations, and additional parking.

- Ocean Parkway District. The Ocean Parkway Special District encompasses a band of streets east and west of the parkway extending from Prospect Park in the north to Brighton Beach on the south. The purpose of the Special District is to enhance the character and quality of this broad landscaped parkway, a designated Scenic Landmark.
- Coney Island District. The Special Coney Island District was created as part of a comprehensive, long-range plan to re-establish famed Coney Island as a year-round, open entertainment and amusement destination. Outside of the entertainment area, the district fosters neighborhood amenities and new housing opportunities, including affordable housing through the Inclusionary Housing designated areas Program.
- Coney Island Mixed Use District. The Special Coney Island Mixed Use District was established to stabilize existing residential development and protect the industries within an area, zoned M1-2, north of Neptune Avenue. The district allows existing residential buildings to be improved and enlarged, and new residential infill housing to be developed if adjacent to an existing residence or community facility. Certain manufacturing uses and most commercial uses are allowed as-of-right on lots adjacent to existing commercial and manufacturing uses, and along certain streets that allow commercial uses.
- Bay Ridge District. The Special Bay Ridge District maintains the neighborhood's existing scale in conjunction with contextual and lower-density zoning districts mapped throughout the district. Beyond the underlying district controls, the neighborhood streetscape is preserved by limitations on the maximum permitted floor area ratio and the height of community facilities, which is limited to 32 feet in contextual zoning districts.
- Special Coastal Risk District. DCP designated two special coastal risk districts in the study area in 2017: Hamilton Beach and Broad Channel. The Special Coastal Risk District was created to address coastal areas that are currently at exceptional risk from flooding and may face greater risk in the future. The Special District places limits on new development in these vulnerable areas and, in certain instances, to protect sensitive natural areas and ensure that new development is consistent with open space and infrastructure plans.

2.13.9 NYSDEC Critical Environmental Area

This discussion incorporates both Planning Reaches. Jamaica Bay, including the Rockaway peninsula, is recognized by the NYSDEC under the State Environmental Quality Review Act as a Critical Environmental Area (CEA) (NYSDEC, 1990). The NYSDEC states that Jamaica Bay and its tributaries, tidal wetlands, and regulated adjacent areas are considered to be a CEA. The tributaries leading into Jamaica Bay (e.g., Gerritsen Creek) and their tidal wetlands and regulated adjacent areas are considered as part of this CEA. The NYSDEC defines a CEA as having "exceptional or unique character." The distinct characteristics associated with Jamaica Bay are: 1) a natural setting (e.g., fish and wildlife habitat, forest and vegetation, open space and areas of important aesthetic or scenic quality) and 2) an inherent ecological, geological or hydrological sensitivity to change that may be adversely affected by any change.

2.13.10 New York/New Jersey Harbor Estuary Program

This discussion incorporates both Planning Reaches. The New York/New Jersey Harbor Estuary Program (HEP) has also recognized the importance of the Jamaica Bay watershed, which includes the Rockaway Peninsula as one of the three watershed areas "of primary concern and ecological importance". HEP has adopted the HRECRP as the restoration strategy for the Program with the Jamaica Bay identified as one of the eight Planning Regions within the HRECRP study area.

2.14 Recreation

Major parks on the Rockaway Peninsula include Rockaway Beach as well as parts of the Gateway National Recreation Area. Rockaway Beach, along the southern edge of the peninsula, is operated or under the authority of NYC Parks. Located along the last stops of the A-line, the beach stretches from Beach 9th Street in Far Rockaway, to Beach 149th Street in Neponsit. It is open year round, but peak beach usage is between Memorial Day and Labor Day. During beach season, lifeguards are employed from 10 AM to 6 PM. Amenities include concessions stands, mobile charging stations, a street hockey rink, a skate park, several play grounds, handball courts a boardwalk, and surf beaches. The City's only legal surfing beaches are on Rockaway Peninsula, between 67-69 Streets and 87-92 Streets.

Beach attendance data provided by the Department of Parks and Recreation (DPR), City of New York, indicates that approximately 7,738,500 beach visits per year occur on the Rockaway Peninsula at Rockaway Beach. Additional details on recreation use and valuation are located in the Economics Appendix.

Several parks on the western portion of Rockaway Peninsula are within the Jamaica Bay unit of GNRA. These are Fort Tilden, Jacob Riis Park, and Breezy Point Tip.

The major recreational areas in Jamaica Bay include Gateway National Recreation Area and New York City parks. The Jamaica Bay Unit of the Gateway National Recreation Area includes the following areas: Jamaica Bay Wildlife Refuge, Floyd Bennett Field, Plumb Beach, Bergen Beach, Canarsie Pier, and the Frank Charles Memorial Park. Summary information about these parks is provided below, followed by additional recreation resources in the Jamaica Bay area.

Jamaica Bay Wildlife Refuge encompasses approximately 9,000 acres that include a portion of the bay itself, several islands, two brackish ponds (East Pond and West Pond –now breached), trails, and a visitor center. The refuge is composed of saltmarsh, natural inlets, grassy hassocks, sand dunes, small beaches, and upland habitats. The Jamaica Bay Wildlife Refuge is located along the Atlantic flyway and is a significant bird sanctuary with sightings of over 300 species of songbirds, shorebirds, and waterfowl over the last 30 years. Shoals, bars, and mud flats provide habitat for a number of small mammals, reptiles, and amphibians. The Jamaica Bay Wildlife Refuge is the only wildlife refuge in the National Park System, and is also home to an impressive array of native reptiles, amphibians, small mammals, over 60 species of butterflies and one of the largest populations of horseshoe crabs in the Northeast. The refuge provides opportunities for recreation, scenic vistas, birding, visitor orientation, environmental education, national recreation area maintenance, and ranger operations.

Floyd Bennett Field has a variety of nature programs that include urban camping, ecology walks, astronomy and gardening events and kayak trips, which launch from the Seaplane Ramp into Jamaica Bay. Ranger-led walks through the wild North Forty highlight the site's unique, sensitive ecology and give visitors the opportunity to get as close as possible to amazing flora and fauna

without causing harm. Bird lovers especially appreciate the wild grassland areas; these uncut sections provide a variety of rare species with essential native habitat. Additionally, the Floyd Bennett Field Garden Association runs Brooklyn's largest community garden, where members plant and tend their own plots. Other park recreational activities include horseback riding at Jamaica Bay Riding Academy, golf and mini golf, archery, biking, softball, and fishing. Visitors also make use of the Jamaica Bay Greenway, a multi-use pathway adjacent to Floyd Bennett Field for walking, jogging, or biking.

Plum Beach is located at the mouth of Jamaica Bay, along the north shore of Rockaway Inlet, in the New York City borough of Brooklyn. It is a stretch of shoreline, tidal mudflats, low saltmarsh areas, a tidal lagoon, a dune system, and woodland thickets at the entrance to Gerritsen Creek adjacent to the Belt Parkway. There is a community of kite surfers that use that beach and adjacent shallow water areas for recreation.

Canarsie Pier offers several recreational opportunities. There is a kayak launch from which many ranger-led Canarsie Pol paddle trips embark and the sheltered coast next to the pier offers a safe space for the park's summer kayak tryouts. Seasonal kite flying activities, youth group paddling, fishing and a summer concert series also take place.

Bergen Beach is located on the north shore of Jamaica Bay (not to be confused with the bordering neighborhood of the same name) is also nearby and within the unit's boundary, supporting the Jamaica Bay Riding Academy concession (horses). Bergen Beach was originally an island later connected to the Brooklyn mainland by landfill.

Frank Charles Memorial Park and Hamilton Beach were originally created as municipal parks and include playgrounds and ball fields along with shoreline access for fishing, as well as some sensitive marshlands.

The Jamaica Bay API also includes many parks owned by New York City and managed by the NYC Department of Parks and Recreation, including, but not limited to:

- Idlewild Park Preserve, including Hook Creek park
- Coney Island Boat Basin
- Calvert Vaux Park
- Bensonhurst Park
- Belt Parkway/Shore Parkway
- Sheepshead Bay Piers/Shore Boulevard
- Manhattan Beach Park
- Marine Park
- Four Sparrow Marsh
- Joseph T. McGuire Park
- Paerdegat Basin Park
- Fresh Creek Park
- Spring Creek Park and Addition
- Broad Channel American Park
- Hook Creek Park/Wildlife Sanctuary
- Tucker Place
- John J. Carty Park
- Dyker Beach Park
- Bensonhurst Park

2.15 Navigation

Rockaway Inlet connects Jamaica Bay to the New York Harbor at the southwest corner of the bay. Rockaway Inlet is the only entrance into the bay from the Atlantic Ocean/New York Harbor. Most of Jamaica Bay is a shallow body of water, primarily navigable only by shallow draft vessels. Over the last century, the various entities, including USACE dredged a number of channels through Jamaica Bay. At the mouth of Jamaica Bay, Rockaway Inlet branches into four channels that vary in depth from 20 to 40 feet. On the west side of the bay, the larger channels fork into smaller channels that run through and around the various marsh islands that are typically 10 to 16 feet deep.

According to USACE data, domestic commercial vessels made approximately 1,002 upbound (entered Jamaica Bay) and downbound (exited Jamaica Bay) trips in 2013. Based on these data, no trips were made by non-domestic vessels into Jamaica Bay. Commercial vessels primarily transport bulk fuel to several privately operated bulk fuel storage terminals located in basins at the eastern end of Jamaica Bay. Commercial vessels also transport sand and gravel to several aggregate facilities at the eastern end of Jamaica Bay and north of Coney Island.

Recreational navigation includes motor, sail, and paddle boats. Recreational traffic includes vessels traveling to and from many private and one municipally-owned marinas offering permanent storage (slips or moorings), as well as transient (temporary) storage associated with restaurants located along the shoreline of Jamaica Bay and Rockaway peninsula.

2.16 Infrastructure

2.16.1 Atlantic Ocean Shorefront Planning Reach

2.16.1.1 Roads

The Rockaway peninsula is accessible from roadways on the eastern end of the peninsula and two bridges crossing over Jamaica Bay from the north. From the north, the primary roadways leading to and from the Rockaway Peninsula include Flatbush Avenue, which crosses over the Marine Parkway Memorial Bridge (Gil Hodges Bridge), and Cross Bay Boulevard, which crosses over the Cross Bay Veterans Memorial Bridge. Marine Parkway-Gil Hodges Bridge is a vertical-lift bridge connecting Rockaway Peninsula to Flatbush Avenue, Floyd Bennett Field, Belt Parkway, and Marine Park. The Cross Bay Veterans Memorial Bridge is a high-level fixed bridge connecting Cross Bay Boulevard from Broad Channel in Jamaica Bay to the Rockaway Peninsula.

From the east, the primary roadway is Rockaway Beach Boulevard, which extends west through the central portion of the peninsula to Jacob Riis Park. Beach Channel Drive on the southern side of the peninsula extends west terminating at Breezy Point Tip. Shore Front Parkway (State Route 908L) is a 1.5-mile roadway that provides access to portions of Rockaway Beach on the northern side of the peninsula.

2.16.1.2 Trains

The Rockaway Park Shuttle is a shuttle service of the New York City Subway operating in Queens. From the Cross Bay Veterans Memorial Bridge, it connects with the A train at Broad Channel station and is the latest iteration of the Rockaway Shuttle services that have been running in the Rockaway peninsula since 1956. This shuttle train provides service to the western part of the

peninsula, with a terminus at Rockaway Park – Beach 116th Street, and to the eastern part with a terminus at Far Rockaway-Mott Avenue. The Long Island Rail Road extends into the eastern portion of the Rockaway peninsula at Far Rockaway, but this train does not connect with the New York City Subway stop at Far Rockaway-Mott Avenue.

2.16.2 Jamaica Bay Planning Reach

2.16.2.1 Airports

John F. Kennedy (JFK) International Airport is a 5,000-acre major international airport located in Queens, New York City. The airport is 12 miles southeast of lower Manhattan and is located within the Jamaica Bay API. Over 70 airlines operate from the airport and have destinations in all six inhabited continents. JFK International Airport is accessible via Route 678 by car, or via the MTA subway and buses and the Long Island Railroad which connect to the JFK AirTrain system, which makes several stops throughout the airport and is operated by the Port Authority of NY & NJ.

2.16.2.2 Roads

The Jamaica Bay API is located in Kings, Queens, and Nassau Counties. Vehicles travel through this area via several key routes and bridges. Within the Jamaica Bay Unit of the Gateway National Recreation Area, the Belt Parkway and Flatbush Avenue provide access to Canarsie Pier and Floyd Bennett Field districts from the north, east, and west (NPS, 2013). Continuing across the Marine Parkway Bridge allows access to the Rockaway Peninsula. Belt Parkway and Woodhaven Boulevard provide access to the Jamaica Bay Wildlife Refuge from the north, east, and west. These routes connect to Cross Bay Boulevard, which extends across the Joseph Addabbo-North Channel Bridge into the Jamaica Bay Wildlife Refuge. The primary roadways to and from Coney Island include Cropsey Avenue and Ocean Parkway.

2.16.2.3 Trains

The New York City Subway provides transit services throughout Kings and Queens Counties. Within the Jamaica Bay API, the L line provides access to Canarsie Park. The New York City Subway also provides access from northern areas to Coney Island, including the Broadway Local N line, Broadway Express Q Line, the 6 Avenue Express D Line, the 6 Avenue Local F Line, and the B line.

2.17 Hazardous, Toxic, and Radioactive Wastes (HTRW)

A review was conducted of publically available databases for selected federal- and state-regulated sites with hazardous, toxic, and radioactive waste (HTRW) for both planning reaches. USEPA's Superfund Information System contains several databases with information on existing Superfund sites, including the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), the National Priorities List (NPL), Resource Conservation and Recovery Act Information (RCRAinfo), and the Brownfields Management System. In addition, the NYSDEC has records of RCRA sites. In summary, RCRA sites were investigated with the EPA Clip N Ship Application. The NYSDEC Remediation Site Boundary layer was used to investigate Superfund, Brownfields and Voluntary Cleanup sites within the study area. The

Department of Energy database was reviewed for radioactive waste sites (http://energy.gov/em/cleanup-sites).

Summary findings of the review are provided below.

The following entries were found for the Atlantic Ocean Shorefront Planning Reach:

- 47 inactive RCRA sites and 49 active sites (EPA 2016). The generation and disposal of hazardous waste should not have an effect on the environment if in compliance with RCRA.
- 3 Brownfield Cleanup Sites (NYSDEC 2016). Of those sites, two sites are active, none are closed and one is No Further Action Taken.
- 5 State Superfund Sites (NYSDEC, 2016). Three of those sites are "Registry" Sites and the remaining two are Non-Registry Sites.
- Three Voluntary Cleanup Sites (NYSDEC 2016). One is active and the remaining two are closed.
- No radioactive waste sites were identified.

The following entries were found for the Jamaica Bay Planning Reach:

- Nearly 1,000 inactive RCRA sites and nearly 700 active sites were found (EPA 2016). The generation and disposal of hazardous waste should not have an effect on the environment if in compliance with RCRA.
- Ten Brownfield Cleanup Sites (NYSDEC 2016). Of those sites, six sites are active, three are closed and one is no further action taken.
- Twenty four State Superfund Sites (NYSDEC 2016). Nine of those sites are "Registry" Sites and the remaining 15 are Non-Registry Sites.
- Twelve Voluntary Cleanup Sites (NYSDEC 2016). Just one site is no further action at this time, six are active and the remaining five are closed.
- Spring Creek South (NYSDEC 2018). Radiological contamination was recently discovered at Spring Creek Park which is under the jurisdiction of the NPS. Soil sampling results for the Spring Creek Resilience and Ecosystem Restoration Project (FEMA Hazard Mitigation Grant Program) previously identified contaminants in the soil, including pesticides, PCBs, and various metals (e.g., lead). Based on these results and what is known of the landfill history at the site, NPS initiated its authority under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

Additionally, during preparation of the Federal Energy Regulatory Commission (FERC) EIS for the M&R facility, FERC received a comment from the NPS that a tar-like substance associated with an "old factory site" was located on the south shore of Floyd Bennett Field east of the Marine Parkway Bridge (FERC, 2013). No additional information about this site or actions taken was available in the file material.

2.18 Cultural Resources

"Cultural resources" is an umbrella term for many heritage-related resources, including prehistoric and historic archaeological sites, buildings, structures, districts, or certain objects. Cultural resources are discussed in terms of archaeological resources, architectural resources, or resources of traditional cultural significance.

Federal laws applicable to this project include the National Historic Preservation Act of 1966, as amended, the American Indian Religious Freedom Act (1978), the Abandoned Shipwreck Act (1987), Native American Graves Protection and Repatriation Act (1990), Presidential Memorandum "Government to Government Relations with Native American Tribal Government (1994), and Executive Order 13175 "Consultation and Coordination with Tribal Governments" (2000).

The National Register of Historic Places (National Register) is the official list of the properties in the United States that are significant in terms of prehistory, history, architecture, or engineering. The National Register is administered by the National Park Service.

Generally, resources must be more than 50 years old to be considered eligible for the National Register. To meet the evaluation criteria for eligibility to the National Register, a property needs to be significant under one or more National Register evaluation criteria (36 CFR Part 60.4), and retain historic integrity expressive of the significance. More recent structures might be eligible for listing in the National Register if they are of exceptional importance or if they have the potential to gain significance in the future per special National Register considerations.

The New York City landmarks law gives the New York City Landmarks Preservation Commission (NYCLPC) authority to designate City landmarks, Interior landmarks, Scenic landmarks, and Historic Districts, and to regulate any construction, reconstruction, alteration, or demolition of them. Projects that might physically affect City landmarks or are within landmark Historic Districts require review by NYCLPC. Archaeological resources also are considered by the NYCLPC. Criteria for City landmarks are different from National Register evaluation criteria, and consider properties 30 years of age or older that meet certain criteria, compared to the National Register evaluation of properties of at least 50 years of age or older.

Section 106 of the National Historic Preservation Act requires a federal agency official to take into account the effects of its undertaking on historic properties, and afford the Advisory Council on Historic Preservation (Advisory Council), an independent federal agency, an opportunity to comment. This is done in accordance with the regulations of the Advisory Council implementing Section 106 process, 36 CFR Part 800, "Protection of Historic Properties". Additionally, consultation with the New York State Historic Preservation Office (SHPO) and consulting parties including local governments is required regarding the identification and evaluation of potentially affected historic properties, determination of potential effects of an undertaking on historic properties, and resolution of any adverse effects. Under the Section 106 process, the City of New York would also be a consulting party for the proposed project.

The Section 106 review requires an assessment of the potential impact of an undertaking on historic properties that are within the proposed project's Area of Potential Effect (APE). The APE is defined as the geographic area(s) "within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist."

The APEs are based on location of each proposed project element (represented in Section 6 below as Figures 6-1, and 6-5 through 6-11) and the areal extent over which construction and operation of the element would reasonably be expected to occur. In general, the APEs for each project element are considered to be within or immediately adjacent to the element, because construction and operation of each element is not anticipated to require disturbing the ground surface beyond the immediate "footprint" of the element. A description of the APEs are provided in the following sections.

2.18.1 Historical Context

The following information for the Cultural Resources sections were excerpted from Hunter, Richard and Tvaryanas, Damon. 2002 Phase 1A Cultural Resource Documentary Study For Gerritsen's Creek Ecosystem Restoration, Borough of Brooklyn, Kings County, New York. Report on file with the U.S. Army Corps of Engineers, New York, New York. This information was reported in the USACE Gerritsen's Creek EA.

The following information pertains to the area encompassing both the Rockaway and Jamaica Bay project areas.

2.18.1.1 Native American and Early European History

Roughly 5,000 to 6,000 years ago (circa 3,000 to 4,000 B.C.), the Atlantic shoreline lay some 25 miles to the east; by around A.D. 500 to 1000, less than 1,500 years ago, the coastline began to roughly resemble that of the present day, and Jamaica Bay and its neighboring drainages will have been largely tidal (Hunter and Damon 2002).

Native American occupation of the Lower Hudson Valley and Long Island is likely to have followed on soon after the retreat of the last glacier, although clear cut evidence of such activity during the Paleo-Indian (circa 10,000-8,000 B.C) and Archaic (circa 8,000-2,000 B.C.) periods is generally sparse (Hunter and Damon 2002).

Throughout the Late Woodland period, circa AD 1000-1600, camp sites and shell middens were a common feature within the tidal landscape of southern Long Island and evidence of Native American occupation of this period has been recorded all around the periphery of Jamaica Bay (Hunter and Damon 2002). Further inland on Long Island, a few larger sites, probably permanent base camps, have also been identified, including one locus in Flatlands with an Iroquois style longhouse considered to be a ceremonial center and meeting house. Both longhouses and smaller round houses have been noted on Late Woodland period sites on Long Island. The majority of the documented sites were noted in the late nineteenth and early twentieth centuries, in particular as a result of the work of Reginald Bolton (1920, 1922, 1934), with several subsequent studies confirming their existence (Hunter and Damon 2002).

Towards the end of the Late Woodland period, continuing into the seventeenth century when contact with Europeans was occurring on a regular basis, the Native American population of Long Island began to come more clearly into focus as a part of recorded history (Hunter and Damon 2002). The Brooklyn area was inhabited by a group known as the Canarsie (or Canarsee), a branch of the Algonquian-speaking Lenape, a series of loose-knit and semi-sedentary tribes spread across much of the area between the Delaware and Lower Hudson Rivers and extending east into Long Island (Hunter and Damon 2002).

The Jamaica Bay area supported villages of Canarsie and Rockaway American Indians, who engaged in cultivation, fishing, gathering shellfish, and possibly the manufacture of wampum from the seashells (Hunter and Damon 2002). In the seventeenth century, the Canarsie participated in a complex of web of trading relationships involving the Lenape, other Native American peoples further to the west and north, the Dutch and eventually the English. The two key commodities traded by the Canarsie for European goods were furs and wampum (polished shell beads used for jewelry and as currency), the latter being of particular importance in view of the abundance of shellfish in and around Jamaica Bay. The general area (southern Long Island) was settled by the Dutch in the 1630s and 1640s (Hunter and Damon 2002). In the 1630s and 1640s, however, the Canarsie began to lose their hold over land in southern Long Island, ceding property to Dutch farmer-settlers. By century's end, their numbers, probably never more than a few thousand, were severely reduced as a result of disease, conflict (notably Kieft's War of 1643-46) and the general dislocation visited upon them by Europeans. Over the course of the eighteenth century, the surviving Canarsie moved west and out of the Hudson Valley altogether.

A detailed and more expansive history of the transition from American Indians to European occupancy is available in *Jamaica Bay: A History, Gateway National Recreation Area, New York--New Jersey* (Black, 1981), as well as the *Cultural Resources Baseline Study, Jamaica Bay Ecosystems Restoration Project, Kings, Queens and Nassau Counties, New York* (Panamerican 2003a).

2.18.1.2 19th and 20th Century History

The section provides a summary of development in the Rockaway and Jamaica Bay areas during the 19th and early 20th centuries.

Rockaway

Although a part of Queens, Rockaway was settled by Europeans separately and earlier than other areas around Jamaica Bay (NYCDEP 2011). In 1833, the Rockaway Association purchased most of the oceanfront property on the Richard Cornell homestead to construct an oceanfront resort called the Marine Hotel in Far Rockaway. Transportation to and from Rockaway originally consisted of horses and horse-drawn carriages, but by the mid-1880s, railroad access was provided, terminating at the present Far Rockaway station of the Long Island Railroad. Land values increased and business expanded rapidly as a consequence, and the population of Far Rockaway was large enough to apply for incorporation in 1888. On July 1, 1897, the Village of Rockaway Park was incorporated into the City of Greater New York. Streets were graded and sections of Rockaway Park, Belle Harbor, and Neponsit began to be developed. Completion of the Cross Bay Bridge in 1925, further development of the beach and boardwalk in 1930, the opening of the Marine Parkway Bridge in 1937, and improvements to the railroad services in 1941 all made Rockaway more accessible, encouraging population growth, development, and urbanization (NYCDEP 2011).

In the second half of the nineteenth century, the Rockaway Peninsula developed as a popular seaside resort for the growing middle-class New Yorkers, who filled its seaside bungalows and amusement parks (Structures of Coastal Resilience [SRC] 2014). Transportation access to the oceanfront beaches became an issue. Ferry service and deepened navigational channels were established by the Canarsie Railroad Line, and by 1887 a cross-bay train trestle was constructed by the New York, Woodhaven, and Rockaway Railroad. This line was sold in 1886 to the Long Island Railroad, which renamed it the New York and Rockaway Beach Railway. It was purchased

in 1955 by the City of New York, reconstructed, and incorporated into the city's subway service as the IND Rockaway Line; it now carries the Metropolitan Transportation Authority's A and S trains across Jamaica Bay. The trestle pilings caused some obstruction of the bay's creeks and waterways, as did the development of the Flynn Cross-Bay Roadway (now the Cross Bay Boulevard) traversing the bay. Yet the Canarsie Line, the train trestle, and the Cross Bay Boulevard led to the transformed perception of the bay itself as an enjoyable place of recreation. Many believed that the waters of the bay were healthier and safer for swimming than the Atlantic beachfront of the Rockaway Peninsula (SCR 2014).

Fort Tilden was established in 1917 and provided a coastal location from which to defend New York City and the harbor from sea and air attacks during World War I through the Cold War era, when a Nike Missile Launch Site was installed. Fort Tilden was decommissioned in 1967 and in 1974 was transferred to the National Park Service and became part of the Gateway National Recreation Area (NPS 2014).

Jamaica Bay

A review of historical maps shows that the area of Brooklyn adjacent to Jamaica Bay was largely undeveloped marshland until the turn of the 20th century (NYCDEP 2011). The neighborhoods of East New York and Flatbush were the closest developed areas of Brooklyn to Jamaica Bay, although limited development had occurred in Canarsie Landing and Bergen Beach on high ground that extended into the marshes of Jamaica Bay. Brooklyn was originally inhabited by the Lenape, American Indians who planted corn and tobacco and fished in the rivers. The Dutch settled in Manhattan in the early 1600s, and subsequently founded five villages on Long Island: Bushwick, Brooklyn, Flatbush, Flatlands, and New Utrecht. A sixth village, Gravesend, was founded in 1643 by an Englishwoman. The British captured the Dutch territory in 1674, and incorporated the six villages into Kings County, which is now part of New York City. A 1698 census counted 2,017 people in Kings County, about half of whom were Dutch (NYCDEP 2011).

Brooklyn quickly became an important commercial port, in part due to the supply of foods grown on Long Island to New York City (NYCDEP 2011). The Navy opened a shipyard on Wallabout Bay in 1801, and Robert Fulton began a steam-ferry service across the East River in 1814. The Village of Brooklyn was incorporated in 1816, roughly encompassing what is now known as Brooklyn Heights. By 1860, 40 percent of Brooklyn's wage earners worked in Manhattan, and ferries carried more than 32 million passengers a year. The intense pressure on ferry service led to the construction of the Brooklyn Bridge, which opened in 1883, spawning a surge in population and development. The City of Brooklyn, created in 1834, expanded to accommodate the new population, eventually encompassing all of Kings County. Brooklyn was incorporated into the City of New York in 1898 (NYCDEP 2011).

The early 20th century saw a vast expansion in the population and urbanization of Brooklyn (NYCDEP 2011). New bridges, trolley lines, elevated railroads, and subway lines went further into the borough. Each expansion opened new settlement and development areas. The rural character of Brooklyn quickly vanished. By the 1930s, the tributary waterbodies had been dredged, straightened, and armored, and by about 1960, most of the shoreline area was developed and expanded around Jamaica Bay (NYCDEP 2011).

In Queens, as in Brooklyn, expansion of mass transportation system influenced growth and urbanization in Queens dramatically (NYCDEP 2011). By 1915, most of Queens came within

reach of the New York City subway. The Interborough Rapid Transit service opened to Long Island City (1915), Astoria (1917), and Queensboro Plaza (1916). Another branch extended along Queens Boulevard and Roosevelt Avenue, reaching Corona (1917) and Flushing (1928). In southern Queens, the Brooklyn Rapid Transit Company built an elevated line along Liberty Avenue through Ozone Park and Woodhaven to Richmond Hill in 1915 and along Jamaica Avenue from the Brooklyn border through Woodhaven and Richmond Hill to Jamaica during 1917-1918 (NYCDEP 2011).

These improvements in transportation promoted rapid growth (NYCDEP 2011). During the 1920s, the population of Queens more than doubled, from 469,042 to 1,079,129. Farms and open areas were replaced with urban street grids aligned without regard to streams, marshes, and other waterbodies that would have to be buried or filled. While the Great Depression of the 1930s ended this boom, transportation improvements continued with new bridges (the Triborough Bridge in 1936 and the Bronx-Whitestone in 1939), roadways (the Interboro Parkway in 1935 and the Grand Central Parkway in 1936), and airports (LaGuardia Airport in 1939 and Idlewild in 1948) (NYCDEP 2011).

Floyd Bennett Field was constructed in 1928-1931 on Barren Island and served as New York City's first municipal airport. It was sold by the City to the US Navy in 1941, and became the most active Naval Air Station in the US during World War II. In 1972, it was transferred to the National Park Service and became part of the Gateway National Recreation Area (http://www.nyharborparks.org/visit/flbe.html).

Plumb Beach is located along the north shore of Rockaway Inlet in Brooklyn. It is a stretch of shoreline, tidal mudflats, low saltmarsh areas, a tidal lagoon, a dune system, and woodland thickets at the entrance to Gerritsen Creek adjacent to the Belt Parkway. Originally an island, the creek separating it from the land was filled in the 1930s. In 1924, New York City acquired the property for use as a park, but instead leased it to a contracting company, which parceled and rented the land. In 1972 it became part of Gateway National Recreation Area, though the parking lot and greenway that provide primary access to the shore are the responsibility of the New York City Department of Parks and Recreation and the New York City Department of Transportation.

The Marine Parkway-Gil Hodges Memorial Bridge was opened by the Marine Parkway Authority in 1937 to provide access to the Rockaway Peninsula, which previously could be reached only by ferry or by a circuitous route around the eastern end of Jamaica Bay (NYC MTA 2016). The bridge is approximately 3,985 feet long, and is designed with a vertical lift-through truss. The land at both ends of the bridge is part of the Gateway National Recreation Area. In 1978, Gil Hodges' name was added to the bridge in honor of the Brooklyn Dodgers' great first baseman and Mets manager. Average daily traffic is approximately 20,000 vehicles.

2.18.2 Areas of Potential Effect

2.18.2.1 Rockaway

The APE for Rockaway consists of the ocean-side (Atlantic shorefront) onshore and immediate near shore areas. It also includes the proposed off-shore borrow area located in the Atlantic Ocean approximately two miles south of the Rockaway peninsula. The shorefront extends from Beach 19th Street to Beach 169th Street and includes the beach and existing groins, as well as the near shore sand placement area. Based on the current proposed alignment, the APE is limited to a

relatively narrow strip within the Rockaway peninsula. However, the APE for the offshore borrow area includes the entire borrow area.

2.18.2.2 Jamaica Bay

The APE for the high-frequency flood risk reduction features within Jamaica Bay include the footprint of the measures recommended for Cedarhurst-Lawrence, and Mid-Rockaway Edgemere, Arverne and Hammels (represented in Section 6 below as Figures 6-7 through 6-10.

2.18.3 Previous Research

This section summarizes the findings of previous research investigations for cultural resources within or in close proximity to the APEs for Rockaway and Jamaica Bay, with a primary emphasis on historic properties—those that are listed or eligible for listing on the National Register, followed by a secondary focus on NYCLPC landmarks not on the National Register. This section also describes research findings for archaeological resources (pre-contact sites) and submerged sites within the APEs.

Large portions of both APEs are located within the Jamaica Bay Unit of the Gateway National Recreation Area. The NPS has reported that evidence of Paleo-Indian use in Gateway is sparse. Although manifestations of Paleo-Indian use of the general region are evident, no Paleo-Indian sites have been recorded (NPS 2014). The NPS also reported that although manifestations of human occupation of northern New Jersey and the New York Harbor during the Archaic period have been recorded, no archeological sites dating definitively to this period have been recorded in Gateway. Several sites dating to the Woodland period have been identified within Gateway and are characterized by the presence of ceramic sherds (fragments), lithic artifacts, and shell middens indicative of the period. Several Contact period sites are known to have existed in the area around Gateway, but none have been recorded within Gateway (NPS 2014). Contact period settlements typically include small amounts of European goods (metal kettles, glass beads, bottles, etc.) intermixed with larger amounts of indigenous-material cultural items.

2.18.3.1 Rockaway

Prior cultural resource assessments have been conducted for beach nourishment projects along sections of Rockaway (e.g. between Beach 19th Street and Beach 149th Street; Kopper 1979) (USACE 1979; USACE 1993; Kopper 1979). These prior studies concluded that no existing prehistoric or historic sites and no archaeological sites were present, and that, "…cultural resources reconnaissance surveys were deemed unnecessary considering the great erosive forces…" in those specific project areas (USACE 1979; Kopper 1979). The USACE has also determined for similar nourishment projects that sand placement should not have an adverse effect as long as it does not interfere with any features in historic districts.

<u>Historic Districts Listed on the National Register</u>

Fort Tilden, the US Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis Park, and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th, and 26th Streets) are historic districts on the Rockaway Peninsula. These districts are listed on the New York State Register of Historic Places (State Register) and the National Register.

Historic districts are defined by NPS as resources that possess a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development.

Fort Tilden, Breezy Point Surf Club, the Silver Gull Beach Club, the US Coast Guard Far Rockaway, and Jacob Riis Park are located within the Gateway National Recreation Area and are managed by the National Park Service. Only the Jacob Riis Park and the Far Rockaway Beach Bungalow Historic District are located within or adjacent to the Rockaway APE. The Gil Hodges Bridge, which has been determined by the SHPO to be eligible for the National Register is located adjacent to the Rockaway APE.

Jacob Riis Park Historic District. The Jacob Riis Park Historic District, listed in 1981, is considered an "excellent, though greatly deteriorated, example of … municipal recreational planning the 1930s" (NPS, 2014). Its historical significance derives from its association with New York City's Commissioner of Parks, Robert Moses, as well as it being a notable work of landscape architecture. The park was completed through the WPA (Works Progress Administration) and is associated with this important social and government program (NPS 1979b). The park landscape has lost much of its integrity and has not been well maintained (Olmsted Center for Landscape Preservation, 2002). In 2012, Hurricane Sandy resulted in heavy wind and water damage to Jacob Riis Park facilities, including flooding; broken windows; blown out walls, sand deposition in the bathhouse; missing ceramic tiles in the bathhouse; and sand and other debris deposited in structures and across the landscape. The brick courtyard wall was destroyed and heavy erosion is evident along the boardwalk (IMT 2012a).

The 220-acre Jacob Riis Park occupies a mile-long section of the Rockaway Peninsula and provides a variety of recreational activities. The park's three significant recreational buildings were constructed between 1932 and 1937.

The original bathing pavilion—commonly known as the bathhouse—is the dominant feature of the park. The T-shaped, one-story brick masonry structure was completed in 1932. In 1936–37, it was enlarged by a long, two-story addition on the south side of the structure. The entrance to the bathhouse is located on the north wall. The front of the bathhouse is faced with a long arcade supported by pillars and topped with two octagonal turrets (NPS 1979b).

The mall focuses on a crescent-shaped extension of the boardwalk. The twin central mall buildings—constructed of brick and tile masonry—face each other at the southern end of the mall. Constructed in 1936–1937, both are two-story, square buildings, flanked by one- story wings, and connected to a rectangular, single-story wing to the south by a single- story, semicircular wing. Both have flat concrete roofs, concrete cornices, and concrete floors (NPS 1979b).

In addition, a broad promenade plaza adjacent to the original bathhouse was opened in 1932. During an expansion of the original park in 1936–1937, a continuous walkway (the length of the beach) was created, connecting all areas of the park. Both the promenade and boardwalk are considered integral elements of the park and contribute to its historic significance (Lane, Frenchman, and Associates 1992). Another striking feature of the park is the 72-acre parking lot located north of the bathhouse. With a 12,000–14,000 car capacity, it was believed to be the largest in the world at that time (NPS 1979b). The parking lot still retains its original integrity and is a contributing element to the district. (Please refer to NPS 1979b; Lane, Frenchman, and Associates 1992; and the Olmsted Center for Landscape Preservation 2002 for greater detail on the Jacob Riis Park Historic District).

Far Rockaway Beach Bungalow Historic District. The Far Rockaway Beach Bungalow Historic District is located along Beach 24th, 25th, and 26th Streets in Far Rockaway in Queens County. It was listed on the National Register of Historic Places in 2013 (NPS 2013). It includes summer beach bungalows near the oceanfront of Far Rockaway. They are smaller than the usual domestic bungalows of the 1920s. They were built in 1921 using pattern book designs incorporating uniform facades, compact interiors, integrated porches and exposed rafters. Their architect, Henry Hohauser, became better known in the 1930s as a designer of Art Deco hotels in Miami Beach. The district was hit by Hurricane Sandy in 2012, but survived without major damage.

New York City Landmark Structures

Landmark structures include buildings and sites and may be eligible for or listed on the New York State and the National Registers or those listed only by the NYC Landmark Preservation Commission. These landmark structures and sites include the Richard Cornell Burial Ground (1457 Greenport Road, Far Rockaway) (listed by the NYC Landmark Preservation Commission, http://www.neighborhoodpreservationcenter.org/db/bb_files/richard-cornell-graveyard.pdf), and National Register listed or eligible structures include the Rockaway Courthouse (90-01 Beach Channel Drive), the Temple of Israel Synagogue (1-88 Beach 84th Street), US Post Office-Far Rockaway (1836 Mott Avenue), Trinity Chapel (1847 Mott Avenue), and the Russell Sage Memorial Church (1324 Beach 12th Street).

Local landmarks (not formally listed) include the Waterfront Tribute Park (9/11 memorial) at the corner of Beach 116th Street and Beach Channel Drive and American Airline Flight 587 Memorial (southern end of Beach 116th Street near the beachfront).

2.18.3.2 Jamaica Bay

Prior cultural resource assessments have been conducted in the area of the Jamaica Bay APE (FERC, 2013; NPS, 2014; Bernstein, 2009). Documented sites include the Equendito Native American village site and the nineteenth century Rendering Plant on Dead Horse Bay. Bernstein indicated that the area around Barren Island had an "overall low sensitivity for intact prehistoric and historic period archaeological deposits…" but "The area of highest sensitivity for archaeological sites is near the southern end (the west side of Flat Bush Avenue near the entrance to Floyd Bennett Field), where historic maps indicate that former Barren Island was dry land and fill may not be as deep as elsewhere in the APE" (Bernstein, 2009). Bernstein also reported that undisturbed portions Barren Island, if they exist, would have a moderate to high sensitivity for the presence of prehistoric resources. However, it is likely that any prehistoric deposits are now very deeply buried beneath landfill (greater than six feet below sediment surface). Excavation about six feet was anticipated to have relatively low potential for impact to any prehistoric resources (Bernstein 2009).

No historic districts are within the Jamaica Bay APE. Floyd Bennett Field and other locations within the NPS Jamaica Bay unit are located in the vicinity of the Jamaica Bay APE. Three eligible properties, the New York City Transit System Building, Hammel Pier, and 2 Beach 85th Street, are all located adjacent to the Hammels high-frequency flood risk reduction measure APE. The Marine Parkway - Gil Hodges Memorial Bridge, which has been determined by the SHPO to be eligible for the National Register is located outside of the Jamaica Bay APE.

Landmark Structures

Landmark structures include buildings and sites and may be eligible for or listed on the National Register and the NYC Landmark Preservation Commission. These landmark structures and districts are listed below by county. These properties are located adjacent to or nearby the Jamaica Bay APE.

Queens County

- Landmark Structures
    - Trans World Airlines Flight Center at JFK International Airport

Nassau County

- Landmark Buildings and Sites
    - Rock Hall

2.18.4 Archeological Resources – Rockaway and Jamaica Bay

The NPS has reported that archeological resources in the Jamaica Bay Unit of the Gateway National Recreation Area date primarily to later pre-contact (Woodland period) and historical periods (NPS 2014). Cultural manifestations include both surface and subsurface materials. However, many of the archeological resources identified in earlier studies can no longer be located, due to a combination of inaccurate data records, natural processes (e.g., erosion), and landfilling throughout the region in the late 19th and 20th centuries (NPS 2014).

2.18.4.1 Pre-Contact Archeological Sites

Most of the recorded pre-contact sites in Gateway were described as lithic scatters, lithic/ceramic scatters, campsites, or shell middens (NPS, 2014). Most of these remain undated or are believed to date to the Woodland period. Isolated finds believed to date to the Paleo-Indian period have also been recovered. The NPS has stated that the potential for encountering pre-contact archeological resources in the future is dependent on the original sensitivity and later historical use of the area (NPS 2014).

Although the APEs for Rockaway and Jamaica Bay are relatively narrow, the APEs extend for several linear miles through Gateway. Accordingly, it is possible that pre-contact archeological sites are present in the APE.

2.18.4.2 Historical Archaeological Sites

The potential for the discovery of additional in situ archeological resources in Gateway is influenced by a variety of natural and human factors (NPS 2014). These include ancient and historical sea-level fluctuations, erosion and sediment transport due to tidal/wave action, and land filling/land-modification activities in the 19th and 20th centuries. All these factors affect the potential for the discovery of buried archeological resources, and their influence varies by geographic location. Although many natural coastal park areas have been buried beneath deep fill deposits, there are also areas where intact soils and archeological deposits have been recorded. For these reasons, the potential for the identification of intact archeological deposits in the park is strongly dependent on the types and effects of past and ongoing natural and human processes. The potential for discovery of archeological resources in each specific area of the park should be evaluated based on each area's unique set of circumstances.

Recent and comprehensive archeological assessments that considered the issue of the potential for archeological resources in Gateway included area-specific analyses of the sensitivity for such resources (NPS 2014). These studies have included consideration of both natural and human impacts on specific park areas, and they have speculated on where the areas of highest potential for archeological resources may be (NPS 2014).

2.18.4.1 Submerged Archeological Resources (Shipwrecks and Submerged Sites)

Rockaway

The Rockaway beach nourishment and reformulation proposed action may obtain sediment from one or more off-shore borrow locations, as well as from onshore sources shipped overwater via barge to the site by one or more commercial aggregate suppliers (USACE 2016). Accordingly, and pursuant to guidelines established by the NHPA and the National Environmental Policy Act of 1969, potential impacts to any significant cultural resources in a proposed borrow area must be addressed.

Based on a borrow source investigation, USACE identified three suitable offshore borrow areas approximately three miles south of the Rockaway peninsula. The borrows are identified as Borrow Area A West, Borrow Area A East, and Borrow Area B West. The average dredging depth would be approximately 18 feet below the seafloor.

The area for Borrow Area A-West is roughly rectangular in shape approximately 4,800 feet from east to west, and 4,000 feet from north to south. Borrow Area A-East is roughly rectangular (5,000 feet in the alongshore direction by 4,000 feet in the on-offshore direction), and is approximately 1 mile east from Borrow Area A West. Borrow Area B-West is roughly a 1,200 by 1,200 feet box, and is approximately 4 miles west of Borrow Area A West (USACE 2016).

Panamerican conducted a remote sensing survey at Borrow Area A-West and A-East in 2005 (Panamerican, 2005). Sixty-seven magnetic anomalies were recorded within the project area. Based on signal characteristics, three anomalies have the potential to represent significant cultural resources. Panamerican recommended avoidance of all three targets. If avoidance is not an option, additional archaeological investigations are recommended to identify the source of the magnetic anomalies. Additional work should consist of remote-sensing target refinement and diver assessment of the refined target location. Diver assessment should consist of a visual and tactile investigation of the ocean bed at the center of highest gamma deviation for each. In the event that there is no source of magnetic deflection located directly on the ocean bed, sub-ocean bed investigations should be conducted with a probe or hydroprobe to a depth sufficient to either meet proposed project requirements or to locate and delineate the anomaly source. All targets should be assessed as to historical significance, relative to NRHP criteria. The remaining anomalies represent debris deposited for fish havens along and in the western edge of the project area, as well as a pipeline that parallels the southern project area boundary (Panamerican 2005).

A remote sensing survey has not been conducted at Borrow Area B-West. If USACE plans to use this borrow area, a remote sensing survey will be conducted prior to dredging any material. USACE will share the results with the SHPO and provide recommendations for avoidance or additional investigation, as warranted.

Previous reports suggest there is the potential for shipwrecks in the general area off of the Rockaway peninsula (e.g. Engebretsen's shipwreck inventory on the Greater New York Harbor; Engebretsen, 1982, as referenced in Panamerican Consultants, 2003a and 2003b; Panamerican Consultants, 2006). Based on an analysis of shipwrecks compiled by Riess and Pickman, Panamerican concluded, "Considering the amount of vessels wrecked off of Coney Island/Ambrose Channel (west of Borrow Area 2) and the number of vessels wrecked to the east of [Borrow Area 2], it can be inferred that the potential for wrecks off of Rockaway Beach remains high" (Panamerican Consultants, 2003). Additionally, Panamerican reported that a diver's guide to shipwrecks within the general area of Rockaway Beach lists seven wreck sites, including: *Princess Anne, Robert A. Snow, Cornelia Soule, Rascal, Black Warrior, Mistletoe,* and *Margaret* (in Daniel Berg's Wreck Valley Vol. II, 1990) (Panamerican Consultants, 2003a and 2003b). USACE has previously stated that "*twenty-three vessels were known to have been wrecked or stranded off Rockaway and Rockaway Beach. No wrecks have been located in the East Rockaway channel inlet itself. Because this inlet has been dredged in the past [prior to 1993], no resources will be impacted* (Kopper 1979*)*" (referenced in Appendix F in USACE, 1993).

The Rockaway APE also includes creation of groins and lengthening of existing groins along the Atlantic Ocean shoreline, on the eastern portion of the Rockaway peninsula. Based on the preliminary construction design, constructing new or extending groins will require deepening of the seafloor up to 10-12 feet below existing grade, over a width of approximately 50 feet.

Jamaica Bay

A recent survey within the waters of Jamaica Bay, including waters under the jurisdiction of Gateway, found no significant magnetic anomalies or sonar targets that might indicate the presence of buried/submerged cultural resources (PBS&J, 2009, in NPS, 2014). However, the authors provided information on several shipwrecks that are known to be present in waters adjacent to lands managed by the NPS. These include the *Mistletoe*, the *Black Warrior*, the *Ajace*, and the *Cornelia Soule*, all of which sank, burned, or were grounded between 1859 and 1924. New York State also maintains a list of shipwrecks in Jamaica Bay. These submerged historic resources are also subject to disturbance from weather, development (construction of undersea utility lines, structures, etc.), and dredging activities (NPS 2014).

2.18.5 Native American Tribal Consultation

USACE has contacted Native American Tribes to solicit input regarding the Recommended Plan and for information about historical properties and archaeological resources within the Rockaway and Jamaica Bay APEs. The Native American Tribes consulted include the federally-recognized Shinnecock Indian Nation, Stockbridge-Munsee Community Band of Mohican Indians, Delaware Tribe of Indians, and the Delaware Nation. The Unkecheug Indian Nation, a NY state-recognized Tribe, was also contacted as an interested stakeholder. The Montauk Indian Nation, who have applied for State recognition, were also contacted as an interested stakeholder.

Although no comment has been received as a result of this or previous notification, coordination and consultation with these groups will continue as required by the Programmatic Agreement.

2.19 Socioeconomic Considerations

The NYSDEC identifies "Potential Environmental Justice Areas (PEJAs)" as census block groups meeting one or more of the following NYSDEC criteria in the 2000 U.S. Census (NYSDEC, 2016):

- 51.1% or more of the population are members of minority groups in an urban area;
- 33.8% or more of the population are members of minority groups in a rural area, or;
- 23.59% or more of the population in an urban or rural area have incomes below the federal poverty level.

The NYSDEC publishes county maps identifying PEJAs, including Kings, Queens, and Nassau counties (NYSDEC 2016). The following section discusses the NYSDEC PEJAs for the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach. Figure 2-6 identifies the proportion of persons below the poverty level for census blocks within study area communities.

The Atlantic Ocean Shorefront Planning Reach contains several PEJAs identified by the NYSDEC (NYSDEC 2016). Almost the entire area between the eastern end of the reach and Beach 116th Street near the central portion of the peninsula is identified as a PEJA (see Section 7). There are no communities identified as a PEJA by the NYSDEC to the west of Beach 116th Street.

The Jamaica Bay Planning Reach contains several PEJAs identified by the NYSDEC (NYSDEC 2016). In Nassau County, a small PEJA is present the municipality of Hempstead, west of the Valley Stream neighborhood; however, the area south of Route 27 within the Jamaica Bay Planning Reach appears to contain few if any residences. In Queens County, the majority of the Jamaica Bay Planning Reach north and east of JFK airport is identified as a PEJA, while the neighborhoods west of JFK airport are not (Howard Beach, Lindenwood, Hamilton Beach). Likewise, the majority of the Jamaica Bay Planning Reach within Kings County is identified as a PEJA, including the communities surrounding the Gateway National Recreation Area, a large portion of Coney Island, and in and around the Fort Hamilton municipality.

Map created by the Science and Resilience Institute

Figure 2-6: Percent of Persons Below Poverty Level

3 FUTURE WITHOUT-PROJECT CONDITIONS*

The USACE is required to consider the Future Without-Project (FWOP) alternative (called the "No Action Alternative") during the planning process and assessment of impacts to comply with USACE regulation and guidance for planning as well as NEPA. With the FWOP, it is assumed that no project would be implemented by the federal government or by local interests to achieve the planning objective. The FWOP forms the basis against which all other alternative plans are measured.

The FWOP condition assumes the continuation of existing conditions for the resources listed in the preceding section; no comprehensive intervention to reduce the impacts of storm surge on vulnerable populations (such as the elderly, low income, and public transportation dependent populations) and infrastructure of the study area; and no large-scale ecosystem restoration efforts to improve the sustainability of fragile coastal systems and attenuate storm surge.

It should be noted though that planned community resilience and wetland restoration efforts conducted under other authorities in in Jamaica Bay, such as restoration projects constructed by non-federal entities outlined in this section, are projected to be implemented in the FWOP. Along the Atlantic Ocean Shorefront Planning Reach, it is assumed that maintenance dredging of the existing federal navigation channels at East Rockaway Inlet and Rockaway Inlet (Jamaica Bay Channel) continue as authorized. The existing, authorized, and constructed project from Beach 19th street to beach 149th will not be renourished in the future as a federal Project. In the absence of federal renourishment, it is expected that New York City would undertake small-scale emergency sand placement projects if the beach erodes to a point that the existing infrastructure along the shorefront is imminently threatened.

3.1 Study Area

The study area has a resident population of 850,000 persons based on the 2010 census, and is expected to grow. Projected population growth (2010 – 2040) for the study area is based on projections for the boroughs of Brooklyn and Queens (Kings County and Queens County, respectively) developed by the NYC Department of City Planning. The total resident population of Brooklyn is projected to increase by 11.3% and the population of Queens is projected to increase by 7.2%. The school age population for each of the two boroughs is project to increase by 7.1%. The population 65 years and older is projected to increase by 45.6% in Brooklyn and by 30.8% in Queens (NYC 2013).

3.2 Coastal Storm Risk Resiliency Efforts by Non-Federal Entities

Numerous coastal storm risk resiliency efforts by non-federal entities are expected to be completed in the FWOP conditions. The Governor's Office of Storm Recovery (GOSR) and the Dormitory Authority of the State of New York (DASNY) have implemented projects within the study area to make the Rockaway Peninsula more resilient to coastal storm risks. The state of New York sustained major damages in the years of 2011 and 2012 with three consecutive hurricanes: Irene, Lee, and Sandy. Federal agencies have committed to funding recovery in New York, and GOSR is managing this effort.

Within Queens County, the GOSR is tracking a total of over $2.3 billion of committed funds for recovery investments. The majority of these investments (80.6%) are for infrastructure and environmental projects. The remaining projects cover housing, community reconstruction,

economic development, and human services. There are two major programs contributing to infrastructure and environment projects: FEMA Public Assistance (over $1.8 billion), and the CDBG-DR Non-Federal Match Program (approximately $262 million).

3.2.1 Nassau Expressway Project

The New York State Department of Transportation (NYSDOT) is proposing a project along a 0.57-mile section of the interim Nassau Expressway (NY878) between Burnside Avenue and Rockaway Turnpike in the Town of Hempstead, Nassau County. The Nassau County Expressway is a key evacuation route for surrounding areas and this project will reduce the flood risk to the evacuation route and improve overall resiliency in the area. The project is on time to be completed by November 20, 2019. The current construction contract cost is $93,500,000. This project will function together with the Cedarhurst-Lawrence HFFRRF to manage the risk of frequent flooding in the Village of Cedarhurst and parts of the Town of Hempstead.

The objective of the project is safety and operational improvements for coastal flood evacuation, improved drainage, shared use path, signal improvements, and pavement improvements. The project will be a retaining wall on the western side of the Nassau Expressway with a centerline elevation ranging from 11 ft NAVD88 to 12.5 feet NAVD88. This project would prevent water from crossing over the expressway into the Lawrence neighborhood.

3.2.2 NY Rising Community Reconstruction Program

The Dormitory Authority of the State of New York provides construction, financing, and allied services to serve the public good of New York. The NY Rising Community Reconstruction (NYRCR) Program was established to provide additional re-building and revitalization assistance to communities severely damaged during the 2011-2012 hurricanes. This program has received Community Development Block Grant Disaster Recovery funding from the U.S. Department of Housing and Urban Development. Of this grant, NY State has allotted up to $11.9 million to fund project developed to improve the resiliency of the Canarsie neighborhood in the project area, which was heavily damaged during Hurricane Sandy. Many of projects have been developed by NYRCR to help Canarsie become more resilient to sea level rise. These include: Fresh Creek Coastal Protection, Fresh Creek Long-Term Restoration and Resiliency, Canarsie Pier Access Improvements, Canarsie Pier and Beach Community Enhancements, Canarsie Youth and Environmental Education Program, Canarsie and Southeast Brooklyn Waterfront Stormwater Study and Pilot Projects, Recovery Community Center, Critical Facility Upgrades Program, Canarsie Corps Program, Homeowner Audit and Grant Program, Resiliency Workforce Development, and Resilient Streetscaping.

3.2.3 Fresh Creek Project

The Fresh Creek project is very similar in objective to the HFFRRF developed by the USACE, which was screened out of the Recommended Plan because it was not considered to be economically justified based on the federal level USACE authority and policy. However, DASNY's Fresh Creek project, developed with slightly different modeling and planning criteria, is moving forward. The DASNY project focuses on nature-based flood risk management measures including living shorelines, bioswales, and berms to improve community resiliency and improve ecological systems. Flood protection measures are recommended for the entire western shore of

Fresh Creek extending to the Creek mouth, further downstream of the HFRRF project limits. The project is expected to be completed by 2022.

3.2.4 New York City Projects

3.2.4.1 Broad Channel Road Raising Project

New York City expects to invest approximately $60 million in two phases of road raising projects in Broad Channel, Queens. Phase 1 of the project, expected to be complete in 2019, includes the elevation of West 11th St, West 12th St, and West 13th St as well as utility relocation and bulkhead reconstruction and raising. Phase 2 of the project is currently in design and includes similar road raisings and bulkhead work for West 14th St, West 15th St, West 16th St, and West 17th St.

3.2.4.2 Build it Back Program

The NYC Mayor's Office of Housing Recovery Operations and the Build It Back Program are dedicated to helping New Yorkers living in communities affected by Hurricane Sandy. Through the repair, rebuilding, and elevation of homes, the Build It Back program is working to enhance resiliency in New York City's waterfront neighborhoods. Funded by the US Department of Housing and Urban Development (HUD) Community Development Block Grant disaster recovery funds (CDBG-DR), Build It Back aids homeowners after all other forms of disaster assistance have been exhausted. Build It Back's single-family program is helping 8,300 homeowners and landlords of 1 to 4 unit homes, including the elevation or reconstruction of about 1,300 homes and the acquisition of about 250 properties. Within the HSGRR/EIS study area, the Build It Back program is in the process of elevating or rebuilding approximately 850 residential structures.

3.2.4.3 Breezy Point Hazard Mitigation Grant Program

The City is working with the Breezy Point Cooperative to implement an approximately $60M flood risk reduction project for the communities of Breezy Point and Roxbury. The project, which is funded through a combination of FEMA Hazard Mitigation Grant Program and HUD CDBG-DR funds, will include a combination of dunes, berms, and floodwalls as well as potential erosion control measures.

3.2.4.4 New York City Parks

Bayswater Park Reconstruction: NYC Parks, with funding from FEMA, will reconstruct Bayswater Park implementing resilient design features.

Rockaway Community Park Reconstruction: NYC Parks, with funding from FEMA, will reconstruct the shoreline of Rockaway Community Park implementing resilient design.

Beach 88th Street Park Construction: NYC Parks, with funding from FEMA, will construct a new park that will implement resilient design features aimed to protect the nearby community against frequent flooding from Jamaica Bay due to storm surge and sea level rise. The new park features will manage stormwater runoff, provide ecological diversity, and provide recreational amenities.

Thursby Basin Park Construction: NYC Parks, with funding from FEMA, will construct a new park that will implement resilient design features aimed to protect the nearby community against frequent flooding from the Somerville Basin due to storm surge and sea level rise. The new park

features will manage stormwater runoff, provide ecological diversity, and provide recreational amenities.

3.2.4.5 Spring Creek Hazard Mitigation Grant Proposal

The Department of Environmental Conservation (DEC) was the sub-recipient of $3,334,610 in Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP) funding for engineering, design and permitting to reduce flooding and coastal storm risk for the community of Howard Beach, which was heavily damaged by Hurricane Sandy in 2012. The Spring Creek South Storm Resilience and Ecosystem Restoration project incorporated natural and nature-based features such as an earthen berm to a maximum elevation of 19' NAVD88, expansion of tidal marsh from 20 to 40 acres, restoration of native vegetation, the creation of three freshwater wetland forest areas that were designed to provide stormwater runoff storage, and the stabilization of shoreline with a vegetated rip-rap revetment. Currently, the 237-acre site is dominated by the common reed *Phragmites australis*, which poses a fire risk due to its quick growth and dense biomass. The nature-based resilience strategy improves the environmental quality of this former landfill site and facilitates enhanced public use and safety as part of Gateway National Recreation Area. Design was completed in December 2018, however Phase 2 construction was not approved by FEMA. At the time of this report, the NPS and DEC have not determined how this project will move forward. At a minimum, the NPS will need to address the site through the CERCLA process.

3.3 Ecosystem Restoration Efforts by Non-Federal Entities

Numerous ecosystem restoration efforts by non-federal entities are expected to be completed in the FWOP conditions, as outlined below. In some cases the projects were completed while the Rockaway Reformulation was underway.

3.3.1 Idlewild Park

NYC Parks, with funding from the Port Authority, will be performing comprehensive ecosystem restoration in the upland and coastal forest areas of Idlewild Park with the primary goal of establishing low growing plant communities that are compatible with FAA height restrictions associated with JFK runways. Timeline: 2016 - 2026

3.3.2 Salt Marsh Restoration

NYC Parks, with funding from the Department of State, will pilot a salt marsh restoration technique aimed at counteracting salt marsh loss. This project aims to restore approximately 1 acre of salt marsh through placement of clean sediment to raise the elevation of the drowning marsh plane and planting of native salt marsh grasses. Timeline: 2017-2020

3.3.3 Marine Park

NYC Parks is currently in the process of restoring 11 acres of coastal forest and forested freshwater wetland habitat in Marine Park, in areas adjacent to the Salt Marsh Nature Center degraded by invasive species. Removal of invasive species will be followed by planting of native trees, shrubs and herbaceous groundcover in Fall 2020. Timeline: 2019-2022

3.3.4 Rockaway Community Park

A project to improve shorelines and some internal natural areas is currently in design. Large upland restoration work was completed in 2014.

3.3.5 Jamaica Bay Park

Over two acres of coastal maritime forest have been restored at this small community park since spring of 2014, including the planting of 6,500 native trees and shrubs. NYC Parks staff continue to expand from this prior investment, through trail management and community engagement in conjunction with the Natural Areas Conservancy. A new nature trail was created in this park in Fall 2018 and is being reinforced in 2019. Timeline: 2013 – 2019 (ongoing)

3.3.6 Spring Creek

NYC Parks, with funding from the Department of the Interior-National Fish and Wildlife Foundation, has restored six acres of coastal forest and transitional salt marsh habitat along Spring Creek in areas that have been severely degraded by dumping and invasive vegetation and will construct two bio-retention basins along the street edge to reduce inland flooding and a low-elevation vegetated berm along the Belt Parkway beginning in August 2019 to May 2020. Each of these components are designed to be complementary to future work completed by the Army Corps of Engineers and provide added resiliency benefits to the ecosystem and surrounding communities.

3.3.7 Sunset Cove

NYC Parks, with funding from the Department of the Interior-National Fish and Wildlife Foundation, removed hazardous and contaminated fill material, construction debris, and concrete from Sunset Cove - a former marina shuttered for illegal dumping—and restored 7 acres of salt marsh and transitional wetland and 5 acres of coastal maritime forest, scrub shrub, and grassland; rehabilitated approximately 100 feet of hardened shoreline; and constructed a perimeter berm to provide resiliency benefits and pedestrian access to the site. Timeline: 2013-2019 (completed)

3.3.8 Bayswater

Natural Areas Conservancy, in partnership with NYC Parks, restored one acre of salt marsh in Bayswater Park with funding from the Jamaica Bay-Rockaway Parks Conservancy. This project removed concrete and construction debris from the site and planted native salt marsh vegetation. A new nature trail was established through the coastal upland habitat. Timeline: 2017-2019 (completed)

3.3.9 Fresh Creek

Partner Projects on Parkland Two projects, one for flood mitigation managed by the Dormitory Authority of the State of New York (DASNY) to implement the New York Rising plan for Canarsie, Brooklyn, and a salt marsh mitigation project by NYC Dept. of Environmental Protection are planned in Fresh Creek. The DASNY project focuses on nature-based flood risk management measures including living shorelines, bioswales, and berms to improve community resiliency and improve ecological systems. Flood protection measures are recommended for the entire western shore of Fresh Creek extending to the Creek mouth, further downstream of the HFRRF project limits. The project is expected to be completed by 2022.

3.4 Economic Conditions

The FWOP economic conditions are based on the assumption that the USACE will not implement a system wide CSRM project in the study area. Comprehensive measures by the USACE to provide CSRM to vulnerable communities and populations with the study area are not included in the FWOP economic conditions. Because a USACE CSRM project would not be in place, projected FWOP damages create a baseline against which alternative plans can be evaluated. The number and type of structures in the study area (Table 3-1) is projected to be the same under FWOP conditions and with alternative plans in place. Table 3-2 presents the expected annual damages for the 1% storm in the study area.

Table 3-1: Structures Within FEMA 1 Percent Annual Chance Flood Area

Structure Type	Atlantic Ocean Shorefront Planning Reach	Jamaica Bay Planning Reach	Total
Banks / Professional Services	39	231	270
Church/Non-Profit	54	108	162
Colleges/Universities	54	1	55
Dormitories, Nursing Homes, Temp Lodging	17	20	37
Entertainment & Recreation	4	36	40
Gov't Emergency Response & Offices	11	11	22
Grade Schools	25	60	85
Hospitals, Clinics	5	12	17
Industrial	27	108	135
Parking (Garages)	9	19	28
Repair Services (Service Station / Shop)	9	46	55
Residential: Single Family	3,307	22,106	25,413
Residential: Multi-Family (Duplex)	3,364	11,931	15,295
Residential: Multi-Family (3-4 Units)	729	2,470	3,199
Residential: Multi-Family (5-49 Units)	125	128	253
Residential: Multi-Family (over 50 Units)	44	123	167
Retail Trade	168	790	958
Wholesale Trade (Warehouses)	6	85	91
Total Structures	**7,997**	**38,285**	**46,282**

Table 3-2: Without-Project Condition Damages (AAEQ)

Atlantic Ocean Shorefront Planning Reach	18,363,000
Jamaica Bay Planning Reach (Cross-Shore Flooding)	30,234,000
Jamaica Bay Planning Reach (Jamaica Bay Flooding)	64,137,000
Jamaica Bay Planning Reach (HFFRRF Areas)	61,918,000
Total Annual Damages*	**174,652,000**

* The total AAEQ without condition damages of $174,652,000 are the cumulative total for the four separately listed reaches.

3.5 Physical Conditions

Under without-project conditions natural processes will continue to be impacted by anthropomorphic conditions, which will result in net loss of beach at the Atlantic Ocean Shorefront Planning Reach and net loss of wetlands in the Jamaica Bay Planning Reach, as discussed below.

Identifying the FWOP at the Atlantic Ocean Shorefront Planning Reach is particularly challenging because the historical conditions include a federal project with a history of renourishment. Therefore, historical data alone may not be used to describe the shoreline and beach conditions if no actions are taken in the study area. Instead, a shoreline change model (GENESIS-T) is used to simulate longshore sediment transport and shoreline changes that are likely to occur in the FWOP.

In defining the FWOP, the following assumptions are made to establish the framework of what is likely to occur:

- Beachfill Placement (P): As defined by existing federal or state navigation authorities, the existing inlets (Rockaway Inlet and East Rockaway Inlet) and their corresponding approach and navigation channels in Jamaica Bay will be maintained near the present widths depths, and locations. Approximately 230,000 cubic yards of material will be dredged from East Rockaway Inlet every 2 years and placed in Reach 6a.
- Natural Inlet Bypassing (BP) A natural inlet bypassing rate of 100,000 cy/year at East Rockaway Inlet is used to characterize the FWOP. This bypassing rate provided the best calibration in GENESIS-T and is within the range of previous estimates (OCTI 2011; USACE NYD 2012).

GENESIS-T is designed to simulate long-term shoreline change based on spatial and temporal differences in longshore sediment transport induced primarily by wave action while accounting for coastal structures and beach fills. The GENESIS-T model was calibrated to historical conditions from 1996-2010.

A 16-year GENESIS-T simulation was performed to characterize the FWOP. Wave conditions for the 16-year period are based on the wave conditions from 1996 to 2012. The predicted net annual longshore sediment transport from GENESIS-T is used in the FWOP sediment budget. The FWOP simulations include both natural inlet bypassing and inlet maintenance dredging, both of which reduce the shoreline erosion in Reach 6a. The GENESIS-T simulations do not include the impact of relative sea level change or any other cross-shore coastal processes.

The FWOP sediment budget was developed based on modeled shoreline changes, modeled net annual longshore sediment transport rates, relative sea level rise, and inlet bypassing and inlet maintenance dredging assumptions.

Cross-shore sediment losses due to relative sea level rise (RSLR) are incorporated in the sediment budget after Bruun (1962). The FWOP sediment budget uses the historic rate of RSLR at the NOAA Tide Gage at Sandy Hook, NJ. The sensitivity of the FWOP to higher rates of sea level rise is shown based on current USACE guidance (ER 1100-2-8162). Future RSLR rates were evaluated for a 50-year period from 2018-2068. Table 3-3 provides an overview of the impact of sea level rise.

Table 3-3: Relative Sea Level Rise Impacts on Shoreline Changes and Sediment Budget

RSLR Scenario	RSLR over 50 years (ft)	Shoreline Change (ft/yr)	Volumetric Loss (cy/yr)
USACE Low (Historical)	.064	-0.78	53,000
USACE Intermediate	1.09	-1.32	90,000
USACE High	2.80	-3.07	209,000

The seven-cell FWOP sediment budget provides a detailed look at the sediment budget and identifies erosional hotspots along the Atlantic Ocean Shorefront Planning Reach. The net annual longshore sediment transport rates are similar to the Historical Conditions, and increase from east to west along Rockaway Beach peaking in Reach 3. The steady increase in net annual longshore transport rate creates a sediment deficit in Reaches 3, 4, 5, and 6a. The overall trend in longshore sediment transport is driven by the alongshore variability in the wave conditions. Figure 3-1 shows the alongshore variability in the net annual longshore sediment transport problems.

The primary difference between the FWOP and Historical Conditions sediment budgets is that there is no beachfill in the FWOP to offset the sediment deficit created by the overarching trend longshore sediment transport. Table 3-4 shows the corresponding shoreline change rates based on the FWOP sediment budget. The most striking cell is sub-reach 4, which is predicted to erode by 17.5 ft/yr. This erosion hotspot is caused by 1) overarching trend in longshore sediment transport along eastern Rockaway Beach, and 2) sediment impoundment of updrift groin field in sub-reach 5[22]. Note also that shoreline change in sub-reach 6a would be much greater without beachfill from inlet maintenance dredging.

[22] During the Pre-Construction Engineering and Design Phase, additional sediment transport modeling will be conducted based on new surveys of the beach conditions to further refine the erosion control features of the design. NPS has indicated that the sediment transport modeling conducted as part of this Feasibility analysis which found Riis Beach to be stable does not concur with their own analysis. The Recommended Plan therefore includes three rehabilitated groins in Riis Park in order to offset any potential losses in the sediment budget that could be caused by the Recommended Plan. This is considered to be a conservative decision, with the option to scale down the design as warranted. The PED analysis will determine the final design for NPS property which is guided by the constraint that the Recommended Plan cannot induce erosion on NPS property.

Table 3-4: Future Without Project Shoreline Changes

Atlantic Shorefront Sub-reach	Shoreline change (ft/yr)
1	+9.0
2	+4.4
3	-3.2
4	-17.5
5	-3.8
6a	-5.3
6b	+9.4

Figure 3-1: Future Without Project Sediment Transport Pathways at the Atlantic Ocean Shorefront Planning Reach

Wetland loss at Jamaica Bay has been occurring for decades, with a measured loss of vegetated marsh islands of 63% (1,471 acres) from 1951 to 2003 (2,347 acres to 876 acres). During this time of wetland loss, the rate of marsh loss has increased from 17 acres lost per year from 1951 - 1974 to 33 acres lost per year from 1989 – 2003 (NPS 2007). An alternative measure of marsh island loss indicates that during the five years from 1994 to 1999, an estimated 220 acres of marsh were lost at a rate of 47 acres per year (USACE 2016). At that rate of loss USACE projects that marsh islands would vanish from the Jamaica Bay Planning Reach by 2025.

Numerous initiatives, including beneficial use of dredged material from the NYNJ Harbor Deepening Project have been implemented to restore Jamaica Bay's marsh islands. To date more than 155 acres of marsh island have been restored (USACE 2016), however the potential for long term net loss vegetated wetlands in the Jamaica Bay Planning Reach is likely.

3.6 Life Safety

Hurricane Sandy caused 10 fatalities in the study area. The overall resident population at risk in the study area is 850,000 based on the 2010 census blocks that intersect the damageable properties in

the study area. Among the most vulnerable of the population at risk include the population over age 65 (Table 3-5). This population was based on the 2010 census blocks that intersect NYC Community Board boundaries in the study areas and on the 2010 census population for Inwood, Census-Designated Place (CDP). This demonstration of those at risk does not include transportation routes for population evacuating or those at work in commercial or industrial areas.

Table 3-5: At Risk Population Over Age 65

Atlantic Ocean Shorefront Planning Reach	
Community Board	Population
QC 14	15,319
Atlantic Ocean Shorefront Planning Reach Total	**15,319**
Jamaica Bay Planning Reach	
Community Board	Population
QC 10	15,044
BK 13	22,547
BK 15	26,319
BK 18	22,908
Inwood CDP	1,155
Jamaica Bay Planning Reach Total	**87,973**
Study Area Total	**103,292**

Other considerations include high-risk areas that have populations/residents with special needs, hospitals, nursing homes, and schools. These types of populations were not fully defined in this study; however, the existing structures (hospitals, nursing homes, and schools) were inventoried in the study area. These structures are listed in Table 3-1 are within the FEMA 1% Annual Chance Flood Area.

3.7 Critical Infrastructure

Figure 3-2 presents critical infrastructure within the study area and critical infrastructure within the Hurricane Sandy area of impact.

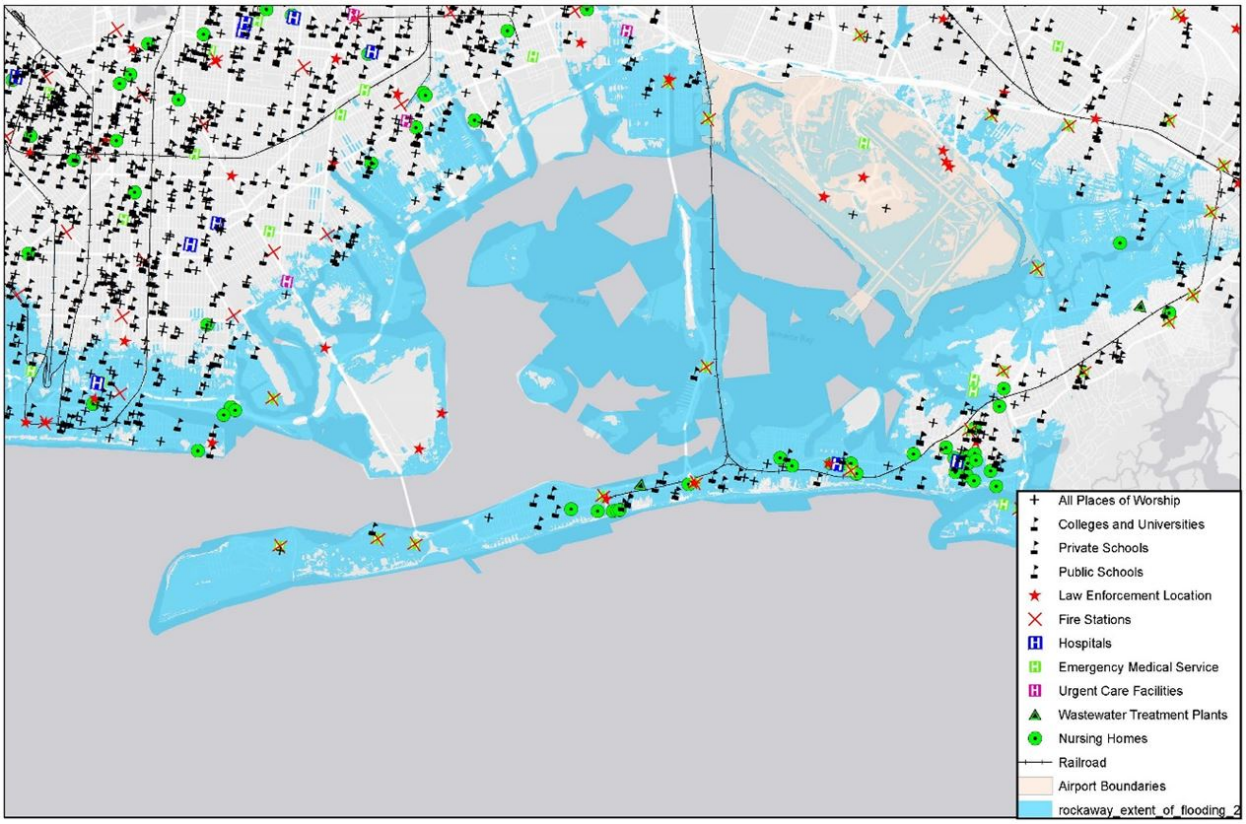


Figure 3-2: Study Area Critical Infrastructure and Hurricane Sandy Impact Area

3.8 Sea Level Change

Local relative sea level change (SLC) was considered in the screening of measures based on the guidance contained in ETL 1100-2-1 and ER 1100-2-8162 (USACE 2013e). Per ER 1100-2-8162:

> Planning studies and engineering designs over the project life cycle, for both existing and proposed projects, will consider alternatives that are formulated and evaluated for the entire range of possible future rates of SLC, represented here by three scenarios of "low," "intermediate," and "high" SLC. These alternatives will include structural, nonstructural, nature based or natural solutions, or combinations of these solutions. Alternatives should be evaluated using "low," "intermediate," and "high" rates of future SLC for both "with" and "without" project conditions.

ER 1100-2-8162 considers the historic rate of SLC as the low rate. The intermediate and high rates are computed from the modified National Research Council (NRC) Curve I and III respectively, considering both the most recent Intergovernmental Panel on Climate Change (IPCC) projections and modified NRC projections with the local rate of vertical land movement added.

For the purposes of this study, the first year of construction is assumed to be 2020, with a design life of 50 years. Table 3-6 shows the USACE SLC data for 2010 to 2100 at The Battery, NY based on ER 1100-2-8162. The intermediate SLC rate is used to calculate equivalent annual flood damages. The sensitivity of the project to the historic rate of RSLC and the high rate of

RSLC is also described. Hence, a SLC of 1.3 feet in 2070, as compared to the 1992 sea level values, or slightly greater than one foot as compared to the 2014 sea level value, is added to the 1% AEP storm elevations to identify future risk levels.

Table 3-6: USACE SLC Projections (feet) at The Battery, NY (Gauge: 8518750)

Year	Low	Intermediate	High
2010	0.17	0.20	0.29
2015	0.22	0.27	0.42
2020	0.27	0.34	0.56
2025	0.32	0.41	0.72
2030	0.36	0.49	0.90
2035	0.41	0.58	1.10
2040	0.46	0.66	1.31
2045	0.51	0.76	1.55
2050	0.56	0.85	1.80
2055	0.60	0.96	2.07
2060	0.65	1.06	2.37
2065	0.70	1.17	2.67
2070	0.75	1.29	3.00
2075	0.80	1.41	3.35
2080	0.84	1.53	3.71
2085	0.89	1.66	4.10
2090	0.94	1.79	4.50
2095	0.99	1.93	4.92
2100	1.03	2.07	5.36

Values shown to hundredth of foot per direct calculations from EC 1165-2-212, Equation 2: $E(t) = 0.0017t + bt^2$ and illustrate the incremental increase of sea level change over time.

With the addition of SLC to the current floodplain, the floodplain for the region expands in area and depth. Regions currently in the floodplain are at risk of higher flood depths during storm events. Similarly, the floodplain will extend further inland, increasing the number of assets at risk of flooding. Figure 3-3 depicts the current and projected future area of inundation, which would occur during a 1% annual chance flood hazard event (also referred to as the 100-year event) in the study area.[23]

[23] Water levels were established using FEMA stage frequency curves (2013), which were adopted and used to define the Atlantic Shorefront and Bayside stage frequency curves in the study area (see Appendix A1, Section 4.3 for more information).

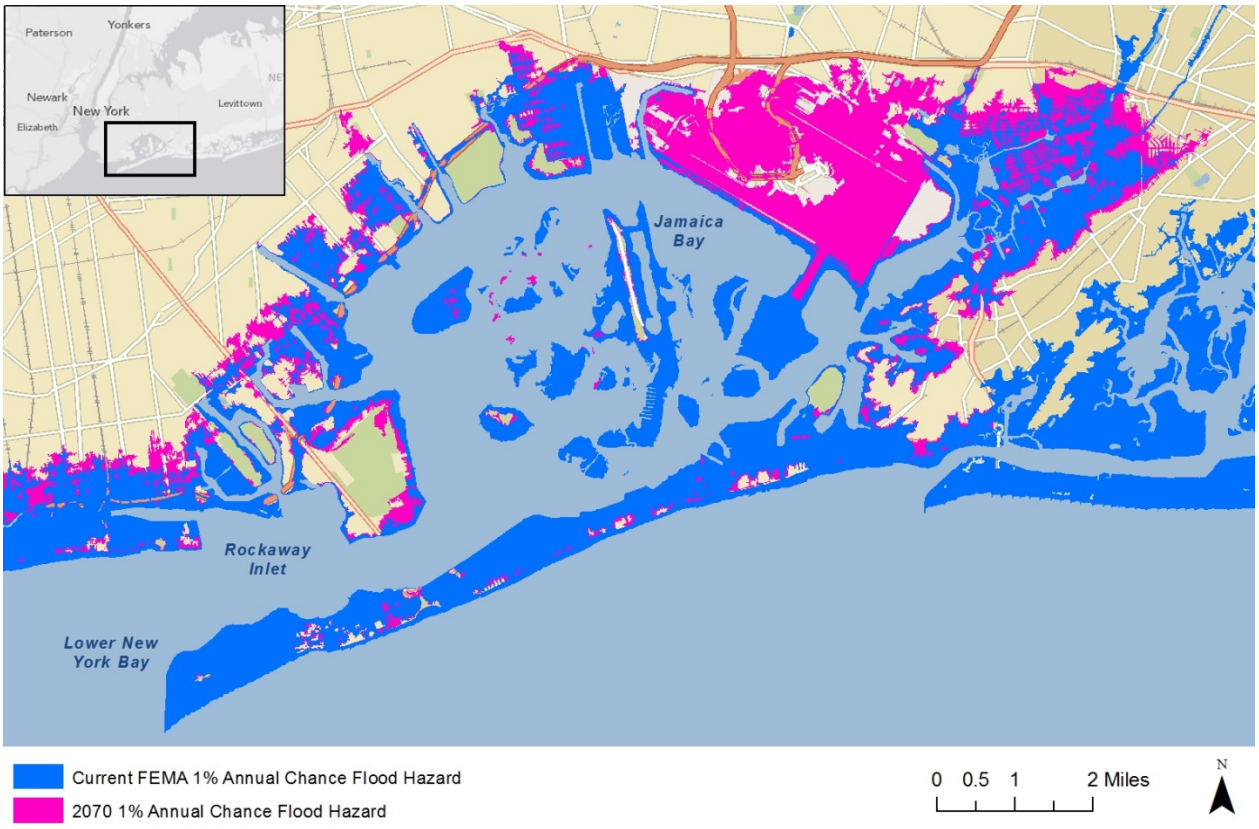


Figure 3-3: One Percent Annual Chance (100-year) Flood Hazard with Intermediate SLC

3.9 Future Without-Project Conditions Summary

Based on the evaluation of the FWOP conditions, there is the potential for significant economic damages in the Atlantic Ocean Shorefront and Jamaica Bay Planning Reaches. There are also concerns for life-safety, damages to critical infrastructure, sea level changes, and impacts on significant environmental resources. These can be further characterized as problems and opportunities for the federal government or local interests to implement projects. The FWOP forms the basis against which all potential projects are measured.

The FWOP conditions in the study area do not provide system-wide CSRM to communities devastated by Hurricane Sandy. Within the study area, 10 fatalities and more than 1,000 structures were substantially damaged to restrict re-entry or were destroyed by Hurricane Sandy. The NYC Department of Buildings post-Hurricane Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge damage. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes at the Atlantic Ocean Shorefront Planning Reach. Damage to the elevated portion of the subway system which connects the Atlantic Ocean Shorefront Planning Reach with the Jamaica Bay Planning Reach (A line) disrupted service for over six months affecting about 35,000 riders daily. In the Atlantic Ocean Shorefront Planning Reach and in part of the Jamaica Bay Planning Reach 37 schools were closed for up to two months. Nothing in the FWOP condition prevents this level of devastation from recurring.

4 PROBLEMS AND OPPORTUNITIES

This section presents results of the first step of the planning process: the specification of water and related land resources problems and opportunities in the study area. Problems are the undesirable conditions that effective plans avoid, reduce/minimize, or mitigate. Opportunities are occasions to beneficially influence future conditions.

4.1 Background

The project area consists of naturally low-lying topography that is densely populated, including extensive low-lying infrastructure. The coastal ecosystems which historically provided some natural flood risk management by buffering inland communities, reducing wave action, and more, have been degraded by development, hardening shorelines, erosion, and other impacts to coastal processes.

The combination of degraded coastal ecosystems around the densely developed low-lying areas means that communities in the project area are vulnerable to extensive inundation from storm surges during coastal storms and experience high levels of risk to human life, infrastructure, and property from coastal flooding. In some areas, the problem is so bad that high tides can cause flooding which cannot drain because the interior drainage is below the high tide, which relies on gravity to drain rainwater out of streets and neighborhoods. Figure 4-1[24] illustrates this problem and shows a storm drain in Hamilton Beach (at the end of 161st Avenue) completely flooded by the high spring[25] tide. This type of problem is only worsening with sea level rise in this area.

Figure 4-1: Spring High Tide Flooding of Storm Drain

[24] Source: Curbed New York, "In Queens, chronic flooding and sea-level rise go hand in hand," October 12, 2017, Nathan Kensinger.

[25] Spring tides occur twice a month, during full and new moons when the Earth, sun, and moon are nearly in alignment. When this occurs the gravitational pull of the sun combines with the gravitational pull of the moon on the earth and high tides become higher and low tides become lower. In areas that experience tidal flooding, the spring tide is also the time when the flooding, irrespective of rainfall, would be worst.

Coastal storm damages can include storm water overtopping of storm risk management features, flooding, wave attack, and erosion. In addition, projected future climate changes are expected to exacerbate existing problems. Projected future climate changes, including sea level rise, will increase coastal storm flooding, erosion and wetland loss (NPS 2014). In the communities surrounding Jamaica Bay, an intermediate USACE sea level change estimate shows the frequency of lower level inundation flooding to more or less double as the sea level would rise roughly 1.1 feet in this scenario.

Table 4-1 shows how the water levels measured in Jamaica Bay have increased roughly .34 feet since 1992. The last column projects a potential future water level for Jamaica Bay, based on the USACE intermediate sea level rise curve. The chance of a flood elevation of roughly seven feet occurring is projected to double in 50 years and go from a 10 percent annual chance of exceedance to a 20 percent chance in a given year. Section 2 of the Engineering and Design Appendix A2 discusses this issue in more detail.

Table 4-1: Changed and Projected Water Levels in Jamaica Bay

Annual Exceedance Probability	Water Level based on 1992 MSL (Feet, NAVD88)	Water Level based on 2018 sea levels (Feet, NAVD88)	Water Level based on 2068 sea levels (Feet, NAVD88)
33%	4.3 ft	4.64 ft	5.74 ft
20%	5.5 ft	5.84 ft	6.94 ft
10%	6.6 ft	6.94 ft	8.04 ft
5%	7.6 ft	7.94 ft	9.04 ft

With the problem of coastal flood risk and the likelihood that this risk will only increase with time, there also comes the opportunity for federal and local governments to work together to help manage this risk. In addition, there is an overall opportunity to complement ongoing system recovery and efforts by state and local agencies to manage coastal storm risk, as well as bolster the natural resiliency of coastal ecosystems.

Figures 4-2[26] and 4-3[27] show flooding Rockaway Park and Far Rockaway after the winter storm of 2016, which had an AEP of 25%. This level flood event is a frequent occurrence. High tides and storm waters resulted in prolonged inundation that took over 24 hours to subside. The federal government does not have a mission to work on interior drainage problems like those pictured in Figure 4-1, since stormwater infrastructure is managed by local governments. However, where smaller storms produce significant damages that stand to worsen with sea level rise, there is also significant life safety risks, which is a priority mission area of the USACE. Areas that suffer from nuisance flooding have increased risk during large storms due to their lower elevation and poor

[26] Source: Source: ABC7NY news story, "High tide brings significant flooding to parts of Queens, New Jersey" dated February 8, 2016. Photo credit: Angelia Roggie.
[27] Source: The Yeshiva World News, "More Coastal Flooding Hits NYC –Parts of Far Rockaway Under Water Tuesday Morning, February 9, 2016.

interior drainage. Similarly, low lying areas with tidal inundation experience significant damages at higher AEP storms (i.e. smaller level storms that occur more frequently) and have an opportunity for an economically justified CSRM plan that addresses frequent flooding. For a plan to be economically justified the National Economic Development (NED) benefits of the project must exceed the costs over the 50-year life of the project.

Figure 4-2: Newport Avenue in Rockaway Park During 25% AEP – February 2016

Figure 4-3: Far Rockaway During 25% AEP at High Tide– February 2016

4.2 Problem 1 – Impacts to Human Health and Safety

- Hurricane Sandy storm surge resulted in ten deaths in the Rockaway study area and 43 deaths in New York City; many victims drowned in their homes during the Hurricane Sandy storm surge (New York Times, 17 November 2012);
- Service disruptions due to the Hurricane Sandy storm surge and inundation, included critical electricity, water, heat, transportation, and health services (SIRR, 2013);
    - Power outages lasted more than 20 days
    - More than 37 schools closed for two months
    - Subway system damages required months of repairs, impacting 35,000 riders daily
- Coney Island Hospital was evacuated due to the Hurricane Sandy storm surge and inundation (SIRR 2013).

4.2.1 Opportunity to Address Problem 1

Enhance human health and safety by improving the performance of critical infrastructure and natural features during and after storm surge events.

4.3 Problem 2 - Projected Future Coastal Storm Impacts

- The Hurricane Sandy water levels peaked at nearly +13 NAVD88, which is as much as 10 feet above ground in some places, and waves resulted in extensive shorefront damages and inundation of neighborhoods in Brooklyn and Queens, and hamlets in Nassau County (SIRR 2013); and
- Storm-related flooding and wave damages also occur with more frequent storms of less intensity than Hurricane Sandy.

4.3.1 Opportunity to Address Problem 2

Prevent or reduce future coastal storm impacts and related damages. Reduce the risk of coastal storm damage to buildings and infrastructure, which are subject to damages due to storm surge, waves and erosion from the ocean and storm surge in Jamaica Bay.

4.4 Problem 3 - Insufficient Resiliency in Natural and Man-made Systems

- Recovery from the damage caused by the Hurricane Sandy storm surge and inundation was inconsistent across the region, with some systems taking an unacceptable time to recover (SIRR 2013); and
- Long lasting service disruptions (healthcare, transportation, telecommunications, electricity, liquid fuels, water supply, wastewater treatment) due to the Hurricane Sandy storm surge impacted communities within and outside of the storm surge inundation area (SIRR 2013).

4.4.1 Opportunity to Address Problem 3

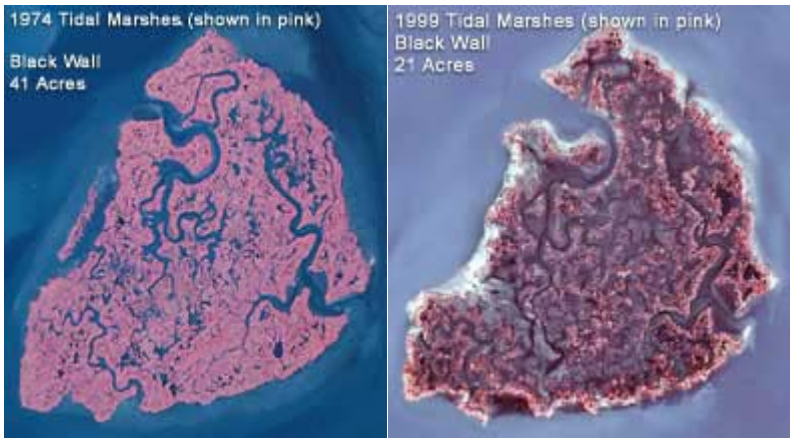
Improve the community's ability to recover from damages caused by storm surges by reducing the duration of interruption in services provided by man-made and natural systems.

4.5 Problem 4 – Erosion, Loss and Degradation of the System's Living Shorelines Protective Capacity

- Between 1951 and 2003 Jamaica Bay lost 63-percent of its vegetated wetlands and salt marshes, which provide a natural storm surge buffer (USACE, 2009); These protective wetlands continue to diminish at a high rate threatening their long term stability (DOI, 2013) and further exacerbating coastal flood risk in the process; DEC has observed significant losses of vegetated tidal wetlands dating back even further, principally *Spartina alterniflora* (Intertidal Marsh), in marsh islands of Jamaica Bay. Examination of historic maps reveals that between 1857 and 1924, the intertidal marsh islands area varied in size without trend, with average changes of up to 10 acres per year. During periods of significant storms, there were losses of marsh islands. But during quiescent years, the marsh islands were able to rebuild (DEC 2018)[28].

- Accelerating rates of wetland erosion—DEC summarizes the accelerating rates of wetland loss:

  From 1924 to 1974, 780 acres of marsh islands were lost due to direct dredging and filling (which were unregulated activities up to 1974) and 510 acres were lost (approximately 10 acres per year) due to other reasons. This information was obtained through analysis of aerial photography. Since 1974, the study shows that the rate of loss of intertidal marsh islands is accelerating. Between 1974 and 1994, 526 acres of marsh islands were lost at an average rate of 26 acres per year. Between 1994 and 1999, 220 acres were lost at an average rate of 44 acres per year. The vegetated intertidal marsh is being converted to nonvegetated underwater lands. Photographs illustrating this conversion are shown below.



[28] This information was obtained by scanning into a computer tidal wetland boundaries on historic US Coast and Geodetic Survey Maps and aerial photography. Source: New York State DEC, available at http://www.dec.ny.gov/lands/5489.html, accessed on 19 June 2018.

These photographs show the twenty acres of tidal marshes lost between 1974 and 1999 on Black Wall Marsh in Jamaica Bay.

- Maritime and coastal forests within Jamaica Bay, which provide a natural storm surge buffer while also protecting adjacent coastal wetland habitats (DOI 2013) have also become increasingly rare;
- Projected FWOP erosion will substantially impact communities along the Atlantic Ocean Shorefront Planning Reach, can be costly to address, and contribute to increased risk from coastal storms. Evidence of scarping along existing natural shoreline, the increasing rates of erosion as documented by DEC, and the lack of living reefs and structures to break up wave action on marshes indicate that without intervention, shorelines will continue to erode, further reducing natural coastal storm risk management and resiliency from coastal storms.

4.5.1 Opportunity to Address Problem 4

Manage coastal storm risk and erosion problems with *natural and nature-based features* (NNBFs) such as wetlands, oyster and/or ribbed mussel reefs, vegetated dunes, beaches, maritime or coastal forests, where appropriate. NNBFs can manage flood risk by breaking up wave action, slowing and storing would be flood waters and even providing elevated protective features that help to keep water out of communities. Figure 4-4[29] below illustrates how a marsh and rock sill NNBF concept, one of the many types considered in this study, can reduce erosion and help in the management of coastal storm risk.

[29] Source: New York Department of Environmental Conservation and New York State Department of State, 2018

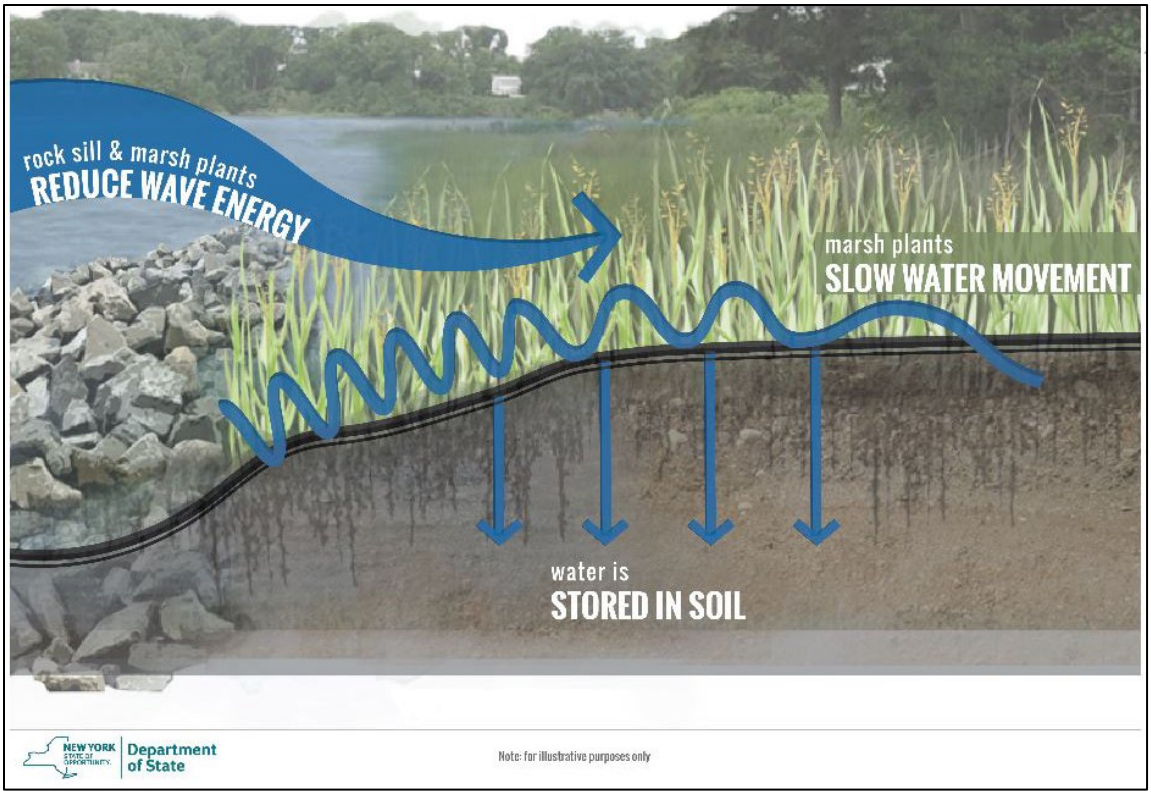


Figure 4-4: Marsh and Rock Sill NNBF Concept Illustration

4.6 Planning Goals, Objectives, and Constraints

4.6.1 Planning Goals

The main goals of this project are to reduce the risk to lives and property associated with coastal storms within the project area. Achievement of these goals includes the formulation of alternative plans for water resource problems to maximize contributions to NED. Contributions to NED are increases in the net value of the national output of goods and services expressed in monetary units. Contributions to NED are the direct net economic benefits that accrue in the planning area and in the rest of the nation. NED benefits for CSRM projects are the reduction in projected future coastal flooding-related damages (USACE 2000). Not all project benefits and costs are quantified in monetary units, and some are only captured qualitatively. Because of this, the NED benefits for some of the CSRM measures likely understate the benefit to the nation of a proposed plan. For example, NNBFs help manage coastal storm risk and increase the system's resiliency after a storm—they also have other 'incidental benefits' to the environment, such as ecosystem services like improving water quality, ecosystem restoration, aesthetic improvements, and more. Additionally, some of the CSRM benefits of NNBFs are infeasible to measure at this time. The USACE planning paradigm is to develop sufficient level of detail and analysis to make a decision. Therefore if a measure can be shown to be economically justified and cost effective, it is not necessary to expend additional time and money to try and capture all of the benefits in their entirety. Since the additional benefits from NNBFs are not factored into the NED benefits in the benefit-to-cost ratio, it would be possible for the most efficient alternative not to be the plan with

the greatest monetary net benefits. Planning objectives; therefore, were not limited to monetary contributions to NED. Similarly, the plan formulation analysis includes descriptions of the additional benefits that are either infeasible to measure or not captured in the NED benefits yet may still prove valuable to decision makers (USACE 2013e).

4.6.2 Public Concerns

Public scoping meetings were held in April 2015 following the Alternatives milestone, to obtain feedback on the alternatives under consideration. Common concerns expressed during public scoping meetings included the sense of urgency to construct a coastal flood risk management feature as quickly as possible. Some expressed concerns about the coordination among multiple agencies addressing CSRM issues. Other concerns included maintaining access to the water, preserving views, and balancing risk management with environmental impacts. Public concerns identified during scoping were used to scope the study.

4.6.3 Planning Objectives

Objectives are the measurable outcomes of effective plans to avoid, reduce, or mitigate the problems; planning objectives must address the identified problems. In addition, planning objectives must be measurable so that alternative plans may be evaluated on their effectiveness and efficiency in meeting planning objectives over the 50-year period of analysis for the project, from 2020 to 2070.

In the aftermath of Hurricane Sandy, the study team held numerous meetings with communities and other stakeholders and conducted a thorough review of the published literature to support the development of planning objectives to guide the study. Five principal planning objectives were identified and include:

- Reduce vulnerability to coastal storm impacts;
- Reduce future coastal storm risk in ways that will support the long-term sustainability of the coastal ecosystem and communities;
- Reduce the economic costs and risks associated with large-scale flood and storm events;
- Improve community resiliency, including infrastructure and service recovery from storm effects; and
- Improve coastal resilience and reduce the risk caused by frequent flooding.

Each of these objectives has the potential to address at least two of the identified problems. All of the problems may be addressed if multiple objectives are achieved. Table 4-2 depicts the problems addressed by each objective.

Table 4-2: Problems and Objectives Matrix

Objectives	Problem 1: Human Health & Safety Impacts	Problem 2: Storm Damages	Problem 3: Insufficient Resiliency	Problem 4: Erosion of system's living shorelines protective capacity
Reduce Vulnerability	X	X	-	-
Reduce Flood Risk while Supporting Sustainability	X	X	-	X
Reduce Economic Costs and Risks	-	X	X	-
Improve Community Resiliency	X	X	X	X
Improve Coastal Resiliency and Reduce Frequent Flood Risk	-	X	X	X

The Disaster Relief Appropriations Act of 2013, which this Reformulation Study is authorized and funded under, directs the USACE to support long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events. In order to accomplish this directive, the study team integrated measures for reducing coastal risks along with measures that would increase human and ecosystem community resilience. Structural traditional CSRM measures were combined with natural and nature-based measures, as well as non-structural measures like buy-outs and home relocations, house raisings, and flood proofing. Various combinations of measures were developed into an array of alternatives to be analyzed, evaluated and screened in order to arrive at a recommended plan. These measures are fully defined in Section 5.5 Management Measures.

Alternative plans are developed to achieve the planning objectives. In order to measure the effectiveness and efficiency with which alternative plans achieve these objectives, the study team develops metrics for the evaluation. For a CSRM study like this one, reductions in vulnerability are evaluated by measuring projected reductions in coastal storm risk and associated reductions in projected monetary damages.

Improvements to resiliency also are evaluated, in part, by measuring projected reductions in coastal storm risk and associated reductions in projected monetary damages. Improvements to resiliency are often a function of reducing the time-to-recovery and can be influenced by bringing the more important systems back on-line before other services.

4.6.4 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that limit what could be done and are recognized as constraints because they should

not be violated in the planning process. The planning constraints identified in this study are as follows:

- Do not negatively impact ongoing recovery, ecosystem restoration, and risk management efforts by others;
    - There are multiple agencies, which are planning and constructing infrastructure, ecosystem, and risk management improvements within the project area. Some of this work is in response to Hurricane Sandy, other efforts are part of other ongoing programs (e.g., National Park Service's Gateway National Recreation Area General Management Plan (NPS, 2014), NYC Department of Environmental Protection's Jamaica Bay Watershed Protection Plan (NYCDEP, 2007);
- CSRM plans that fall within the boundaries of or impact the resources of the Gateway National Recreation Area must be mutually acceptable to the Department of the Interior and the Department of the Army[30];
- Do not negatively impact navigation access through Rockaway Inlet;
    - The federal navigation channel serves navigation interests including commercial cargo transport, charter fishing fleets, and recreational boaters, which use marinas within Jamaica Bay as their homeport;
- Do not induce flooding in areas not currently vulnerable to flooding and do not induce additional flooding in flood-prone areas;
- Do not reduce community access and egress during emergencies;
    - Island and peninsular communities within the study area currently have limited access, egress, and emergency evacuation routes;
- Do not impact operations at John F. Kennedy International Airport.
- Do not negatively affect plants, animals, or critical habitat of species that are listed under the Federal Endangered Species Act or a New York State Endangered Species Act.

[30] The authorizing legislation (P.L. 92-592, 1972) for GNRA recognized the potential need for water resource development projects within the Corps mission to be undertaken within its boundaries by establishing that that there must be agreement between the two agencies.

The authorizing language states that "The authority of the Secretary of the Army to undertake or contribute to water resource developments, including shore erosion control, beach protection, and navigation improvements (including the deepening of the shipping channel from the Atlantic Ocean to the New York harbor) on land and/or waters within the recreation area shall be exercised in accordance with plans which are mutually acceptable to the Secretary of the Interior and the Secretary of the Army."

5 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS*

This section describes the plan formulation process for this study, which was conducted in accordance with the national objectives as stated in the USACE Planning Guidance Notebook (Engineer Regulation 1105-2-100, 22 April 2000). The planning process consists of six major steps: (1) Specification of water and related land resources problems and opportunities; (2) Inventory, forecast and analysis of water and related land resources conditions within the study area; (3) Formulation of alternative plans; (4) Evaluation of the effects of the alternative plans; (5) Comparison of the alternative plans; and (6) Selection of the recommended plan based upon the comparison of the alternative plans. Water resources project planning is an iterative process, such that any of the six major steps may be revisited as additional information comes to light during the performance of a subsequent step. Once the problems and opportunities had been assessed and study objectives established, the conditions and existing information inventoried, forecasted and analyzed for the study area.

The iterative planning process is combined with risk-informed decision making, as depicted in Figure 5-1, in order to balance the needs for data and analysis with swift progress sound investment of resources. Figure 5-2 below captures the risk-informed planning process as the decision makers gather evidence to support risk-informed decision making in order to progress through the study process.

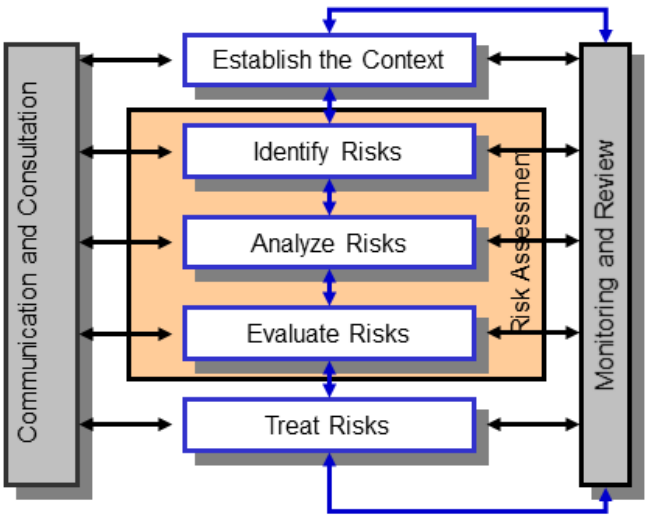


Figure 5-1: Risk-Informed Decision Making Process

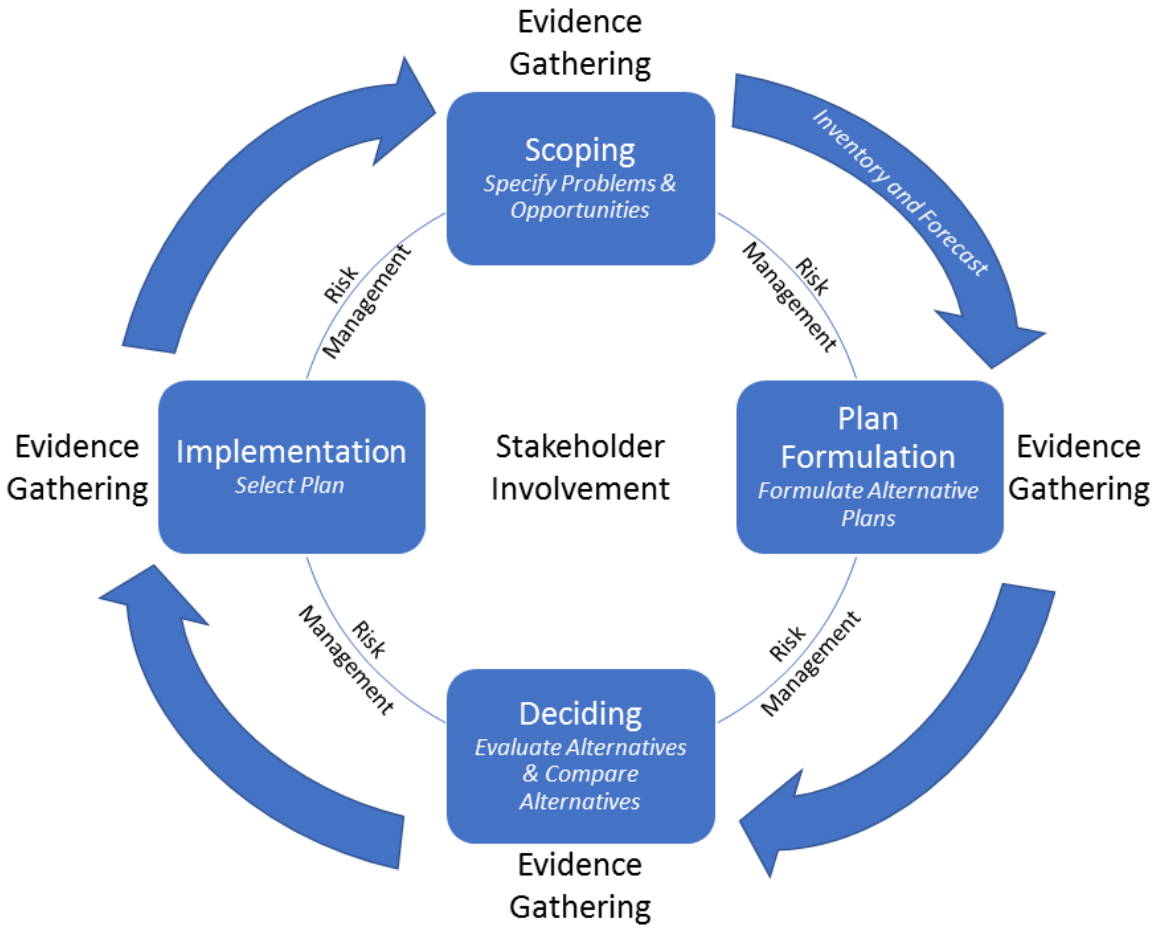


Figure 5-2: Risk-Informed Planning Process

5.1 Development of the Array of Alternatives

In consultation with the non-federal sponsor (NYSDEC), the City of New York, state and local agencies, and non-governmental entities, structural and non-structural management measures, including NNBFs, were developed to address one or more of the planning objectives. Measures were evaluated for compatibility with local conditions and relative effectiveness in meeting planning objectives. Effective measures were combined to create CSRM alternatives for two distinct planning reaches: the Atlantic Ocean shorefront and Jamaica Bay. Integrating CSRM alternatives for the two reaches provides the most economically efficient system-wide solution for the vulnerable communities within the project area. Any comprehensive approach to CSRM in the study area must include an Atlantic Ocean shorefront component because overtopping of the Rockaway peninsula is a source of flood waters into Jamaica Bay. Efficient CSRM solutions were formulated specifically to address conditions at the Atlantic Ocean shorefront. The most economically efficient solution for the Atlantic Ocean Shorefront Planning Reach was included as a component of the alternative plans for the Jamaica Bay Planning Reach.

The array of alternative plans, which resulted from the Alternatives Milestone Meeting, included alternative alignments for the Storm Surge Barrier Plan and a Jamaica Bay Perimeter Plan. Design details for the array of alternative plans were refined to address key uncertainties prior to plan

evaluation. Evaluation of the array of alternative plans was based on criteria developed for the Alternatives Milestone, including CSRM effectiveness and efficiency and environmental impacts.

5.2 Identification of the Tentatively Selected Plan

The evaluation of the array of alternatives resulted in the identification of a *tentatively selected plan* (TSP) and included:

1. A reinforced vegetated dune and beachfill for the Atlantic Shorefront of the Rockaway peninsula from Beach 9th Street to Beach 149th Street to manage risk from coastal flooding using a nature-based feature. The vegetation on the dune will help stabilize it and reduce erosion, as well as trap sand for natural accretion. The dune and widened beach have additional recreation and environmental benefits of providing both space to recreate and habitat. The proposed dune would be reinforced with a composite seawall core, which provides resiliency to the system.
2. Groin construction and extensions are proposed to help keep sand in place and reduce the frequency of beach renourishment required to maintain the beach berm at design width and grade to protect the dune from erosion.
3. A storm surge barrier across Rockaway Inlet, with tie-ins was proposed as part of the TSP to keep storm surge from large storms and hurricanes from entering the Rockaway Inlet and flooding the densely populated communities surrounding Jamaica Bay.
4. Finally, residual risk features are proposed to protect against the residual flood risk that would persist even with a barrier in place as the barrier would only be operated at or beyond a certain threshold of storms.

5.3 Inviting and Incorporating Public and Agency Comments into the Agency Decision on a Recommended Plan

The TSP was described in the 2016 Draft HSGRR/EIS, which was released for agency and public review in August 2016 and followed by a series of public meetings. The project delivery team received copious and significant comments from the public and agencies on the TSP. Comments strongly voiced the need for additional study and analysis of the proposed storm surge barrier. Conversely, comments strongly urged the need for urgency and haste in constructing coastal storm risk management features in the study area.

Around the same time that the 2016 Draft HSGRR/EIS was released, a new study was kicked off, the New York/New Jersey Harbor and Tributaries Study, or NYNJHATS, looking at reducing regional coastal storm risk. One of the proposed alternatives for this study, the NY/NJ Outer Harbor Barrier, is a storm surge barrier that would stretch from Sandy Hook, New Jersey to Breezy Point on the Rockaway peninsula and obviate the need for a storm surge barrier across Rockaway Inlet. Therefore it makes more sense from an agency perspective to analyze the proposed Rockaway storm surge barrier in comparison to other regional solutions being studied in the New York/New Jersey Harbor and Tributaries Study. Furthermore, the Rockaway Reformulation and 16 other USACE studies and projects are 100% federally funded by the Sandy Recovery Improvement Act of 2013 (Public Law 113-2), yet the proposed Rockaway storm surge barrier cost would exceed the entire appropriation of that Act and would therefore require additional authority and appropriations from Congress to be built. It is unlikely that Congress would appropriate the roughly three billion dollars estimated for construction of this storm surge barrier

until the NYNJHAT study had at the minimum screened out the alternative that would make the Rockaway barrier redundant and duplicative. Therefore, as an outcome of the Agency Decision Milestone (ADM) the proposed storm surge barrier across Rockaway Inlet is not going to be further analyzed nor recommended under the Rockaway Reformulation Study, but instead under the separate ongoing NYNJHAT Study.

5.4 Refinement of the Recommended Plan

Once the decision was made to move the storm surge barrier feature out of the Rockaway Reformulation recommended plan, the project delivery team (PDT) sought to identify stand-alone incrementally justified features to manage coastal flood risk for the communities of Jamaica Bay, who remain at substantial risk without a storm surge barrier in place, even with the proposed Atlantic Shorefront features. The communities in and around Jamaica Bay are low-lying communities who experience frequent flooding. Jamaica Bay is an erosive environment, as evidenced by the high rates of wetland loss and shoreline erosion. Causes include anthropogenic changes to the system over time, sea level change, and local natural conditions, but the bottom line is that the resiliency of the system has been compromised over time and is now densely populated and subject to frequent flooding and high risk for residents.

High frequency flooding risk reduction features (HFFRRFs) were developed using the residual risk concepts of the TSP and expanding upon them to 1) include areas in Nassau County, 2) to evaluate for three different high frequency flood extents, and 3) to develop and include in the screening NNBFs as CSRM features to be considered as required[31]. The HFFRRFs were designed to be stand-alone features that are incrementally justified from an economic standpoint yet would complement a potential future storm surge barrier. The rationale is that if and when a proposed storm surge barrier is built, it would still not be closed for every storm event. Barrier closures incur economic impacts to transportation and are directly linked to increased maintenance costs. The development and screening of the HFFRRFs begins in Section 5.11.

The revised Recommended Plan includes:

1) A reinforced vegetated dune and beachfill for the Atlantic Shorefront of the Rockaway peninsula from Beach 9th Street to Beach 149th Street to manage risk from coastal flooding using a nature-based feature.

2) Groin construction and extensions are proposed to help keep sand in place and reduce the frequency of beach renourishment required.

3) HFFRRFs to manage the risk of frequent flooding from smaller storms and high tide. HFFRRF locations include 1) the mid-Rockaway peninsula bay-side, including NNBFs, floodwalls, bulkheads and stormwater drainage pump stations, and 2) bulkheads and a stormwater drainage pump station at Cedarhurst-Lawrence in Nassau County. All HFFRRFs also include measures to manage the interior drainage, such as added or extended stormwater outfalls.

[31] CECW-CE Memorandum for Commanders, Major Subordinate Commands dated 28 September 2017, Subject: Implementation Guidance for Section 1184 of the Water Resources Development Act of 2016 (WRDA 2016), Consideration of Measures

The following sections describe the plan formulation steps in detail, which have been summarized above.

5.5 Management Measures

5.5.1 Atlantic Ocean Shorefront Planning Reach

The following measures were identified for consideration as CSRM features along the Atlantic Ocean Shorefront Planning Reach.

1. No Action (FWOP)
2. Sand Bypassing / Inlet Management
3. Vegetated Dune with Beach Fill
4. Breakwaters
5. Groins
6. Removal or Modification of Groins
7. Bulkhead under/near the boardwalk
8. Seawalls / Reinforced Dunes
9. Non-structural Measures (i.e. floodproofing, structure raising, relocations)
10. Boardwalk Relocation

A preliminary screening was undertaken based upon the specific problems and opportunities in each reach, to identify those measures that are applicable to the specific needs. Table 5-1 provides a summary of the measures that were identified for consideration in each reach during the initial formulation process. Each measure marked with an "X" was recommended for further consideration within that Reach.

Table 5-1: Summary of Preliminary Screening of Shorefront Measures

Measures for consideration	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
No Action	X	X	X	X	X	X
Inlet Management	X					X
Vegetated Dune with Beach Fill	X	X	X	X	X	X
Breakwaters			screened			
Groins		X		X		X
Groin Modification		X	X	X	X	X
Bulkhead under/near the boardwalk			screened			
Seawalls / Reinforced dunes			X	X	X	X
Non-structural (floodproofing, structure raising, and relocations)			screened			
Non-structural (Boardwalk Relocation)						X

Preliminary screening criteria were developed from the planning objectives, including:

- Can the measure provide CSRM benefits in accordance with USACE Civil Works missions and authorities?
- Is the measure effective in providing CSRM benefits (reduce vulnerability, flood risk, and economic costs associated with coastal storms) either as a stand-alone measure or as a part of a larger system when joined with other measures?
- Is the measure efficient for lifecycle costs when compared to other measures?
- Are there areas where NNBF measures for CSRM are feasible, and could minimize overall project impacts to the environment, reduce potential mitigation requirements, or reduce the long-term O&M costs of the project?

Figure 5-1 presents a summary of the measures screened for the Atlantic Shorefront Planning Reach, shown in red. Inlet management would entail placing channel maintenance dredged material from Rockaway and East Rockaway Inlet channels on the beach to perform CSRM. This measure would likely function in conjunction with the vegetated dune with beach fill measure and serve as a source for borrow material (i.e. sand) and was retained as a cost effective measure for CSRM for further consideration. The vegetated dune and beach fill measure met all four of the preliminary screening criteria and was retained. Preliminary engineering analysis indicated that breakwaters[32] would be less effective and more expensive than groins[33] and/or groin modification for providing CSRM benefits, in combination with other measures and was screened from further analysis. Similarly, preliminary engineering analysis showed that bulkheads under or near the boardwalk were not as effective as the seawall / reinforced dune measure because it would not withstand intense wave exposure, nor combat ongoing erosion the way a vegetated dune with beach fill would. Thus the bulkhead measure was screened in favor of more effective remaining measures. Finally, the preliminary screening also removed non-structural measures involving individual modifications to development from further consideration on the Atlantic Shorefront. When viewed as a system, non-structural measures such as floodproofing, structure raising, and relocations, did not compare favorably against structural solutions for the Atlantic Shorefront given the density of development in most of the reaches, the low-lying floodplain of the planning reach, and the high cost of real estate for this area. Boardwalk relocation was retained for further analysis as a potential non-structural measure in combination with other structural measures. Measures which can help manage erosion on the beach, such as construction of new groins and modification to existing groins were also retained for further analysis.

5.5.2 Jamaica Bay Planning Reach

The USACE Project Delivery Team used previous USACE investigations, Rockefeller Foundation analyses supporting the Science and Resiliency Institute at Jamaica Bay's "Towards a Master Plan for Jamaica Bay" initiative, and meetings with local stakeholders to identify the universe of potential measures that may be applicable to the Jamaica Bay planning reach. A comprehensive

[32] Breakwaters are offshore rubble-mound structures which reduce the wave energy reaching the shoreline

[33] Groins are coastal structures normally constructed perpendicular to the shoreline which retard longshore sediment transport, helping to trap sand in place and stabilize beaches.

inventory of proposals compiled as part of the stakeholder outreach facilitated by the Science and Resiliency Institute at Jamaica Bay was reviewed to identify the breadth of measures to be considered for the reformulation effort. The measures evaluated in this analysis are listed in Table 5-2.

Table 5-2: Comprehensive Inventory of Measures

Non-structural Measures	**NNBF Measures**
Acquisition	Living shoreline
Managed Retreat	Wetland
Floodplain zoning	Maritime forest
Floodproofing	Reef
Flood warning system	Dunes[1] and Beaches
Structural Measures	Swale/Channel
Flood gate	**Other Measures**
Hurricane barrier	Bay shallowing
Levee	Storm water improvement
Floodwall	Wastewater treatment
Bulkhead/Seawall	Park access and recreation
Breakwater	Evacuation routes
Sediment management	No action
Groins	
Beach nourishment	

[1]Includes reinforced dunes

Preliminary screening criteria were developed from the planning objectives, including:

- Can the measure provide CSRM benefits in accordance with USACE Civil Works missions and authorities?
- Is the measure effective in providing CSRM benefits (reduce vulnerability, flood risk, and economic costs associated with coastal storms) either as a stand-alone measure or as a part of a larger system when joined with other measures?
- Can the measure provide improvements in resiliency sustainability which include reductions of the time-to-recovery for the natural coastal ecosystem and for communities?

- Are there areas where NNBF measures for CSRM are feasible, and could minimize overall project impacts to the environment, reduce potential mitigation requirements, or reduce the long-term O&M costs of the project?

Figure 5-3 presents a summary of the measures screened for the Jamaica Bay Planning Reach. For measures that achieved the particular screening criterion, a solid, blue marker was placed in the appropriate row and column and that measure was retained for further evaluation. If a measure likely achieves the particular screening criterion only during high frequency storm events, a green marker used to indicate this detail and the measure also is retained for further evaluation. Measures identified by a grey box are not carried forward for further evaluation, including swale/channel, bay shallowing, storm water improvement, wastewater treatment, park access and recreation, and evacuation routes. The authority for this General Reevaluation is a CSRM authority so the USACE restoration mission benefits cannot be used to justify measures, though the benefits to ecosystems and other social effects are described in order to support decision makers with full information to include incidental benefits.

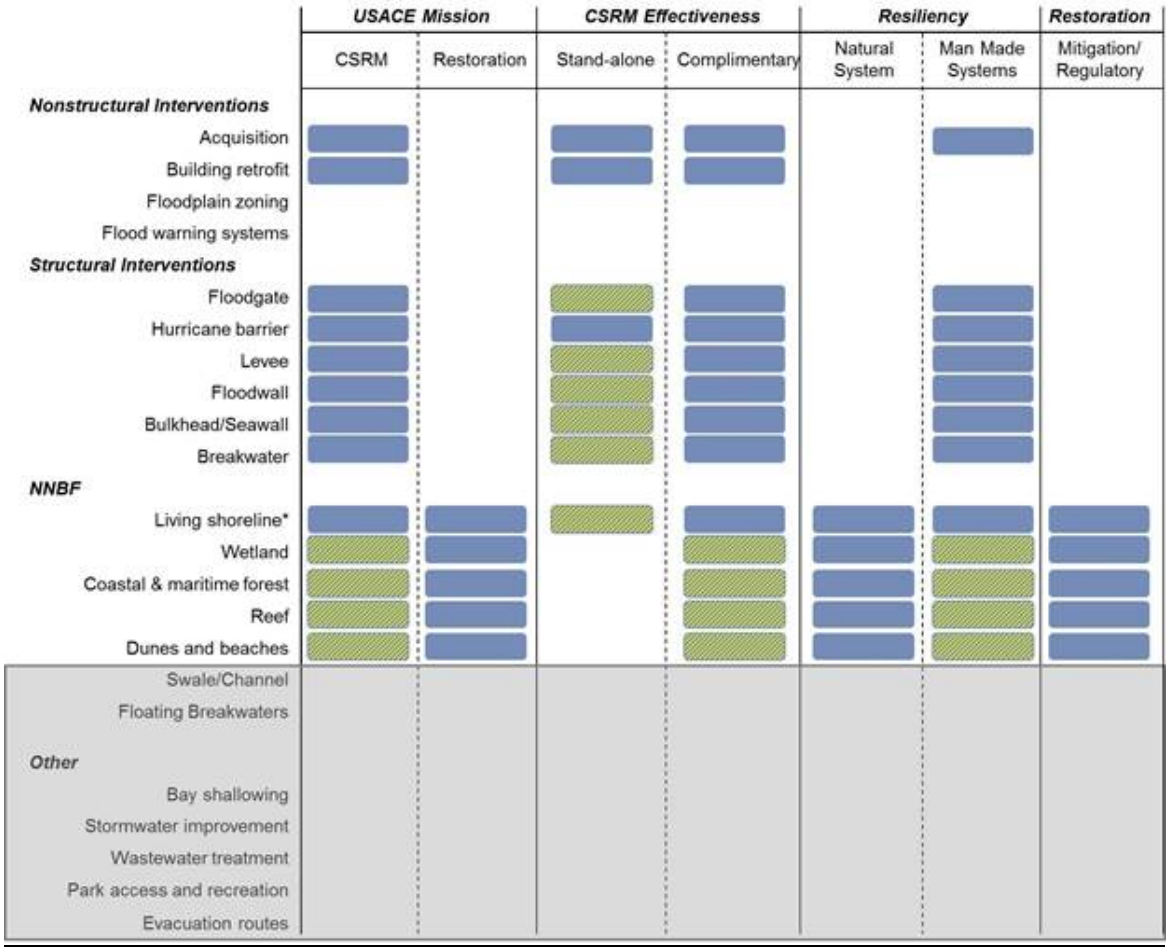


Figure 5-3: Summary of Preliminary Screening of Jamaica Bay Measures

5.6 Alternative Plan Formulation

This section describes the development of alternative plans based on combinations and refinements of screened measures. Measures were combined to create CSRM alternatives for two distinct reaches: the Atlantic Ocean shorefront and Jamaica Bay. A comprehensive approach to CSRM in the study area must include an Atlantic Ocean shorefront component because overtopping of the Rockaway peninsula is a source of flood waters into Jamaica Bay; therefore, the first step was to formulate efficient CSRM solutions specifically to address conditions at the Atlantic Ocean Shorefront Planning Reach. The best solution for the Atlantic Ocean Shorefront Planning Reach was then included as a component of the alternative plans for the Jamaica Bay Planning Reach.

5.6.1 Atlantic Ocean Shorefront Planning Reach

The general approach to developing CSRM alternatives along this reach was to evaluate features that optimize life-cycle costs in combination with a single beach and dune template to select the most cost effective renourishment approach. From the measures described above, this includes beachfill, groins, groin modifications, and boardwalk relocation. Inlet management is also included in these alternatives as the inlet which is maintained by the USACE is considered as a borrow source of sand for beachfill in these alternatives. Once the most efficient lifecycle management plan was selected, different combinations of beach, dune and reinforced dune cross-sections were evaluated to identify the most economically efficient plan for the planning reach, considering both the level of risk reduction afforded and the lifecycle costs.

5.6.1.1 Life-Cycle Cost Optimization: Beachfill

Three lifecycle management alternatives were short-listed by the PDT and selected to be evaluated in detail. These alternatives included the following:

- Beachfill Alternative 1: Beach Restoration; consisting of a beach and dune with renourishment.
- Beachfill Alternative 2: Beach Restoration, Groin Modifications, and Boardwalk Relocation; consisting of a beach and dune with renourishment, shortening of existing groins, and relocation of the boardwalk.
- Beachfill Alternative 3: Beach Restoration, Groin Modifications, and Construction of New Groins; consisting of a beach and dune with renourishment, extension of existing groins, and construction of new groins.

The screening level design was used to optimize life-cycle costs, which consisted of developing layouts, cross-sections, quantities, and costs. The objective of the design was to develop enough detail regarding the designs to be able to reliably estimate the life-cycle costs. The life-cycle cost optimization (Table 5-3) does not consider storm damage reduction benefits since all of the alternatives are based on the same design profile, and all provide a comparable level of risk reduction.

Based upon this comparison of costs, the optimal life-cycle cost feature is Beachfill Alternative 3, which includes beach restoration with renourishment, extension of existing groins, and the construction of new groins (Figure 5-4). This feature had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life (Beachfill Alternative 3 in Table 5-3). The Beachfill Alternative without groins has higher annualized costs over the life

cycle of the project due to the additional beachfill that would be needed to maintain the project without groins (see Engineering Appendix, Section 7.2.8 for more detail). Renourishment material would be sourced from a borrow area approximately two miles offshore (south) of the Rockaway peninsula.

Table 5-3: Optimal Beachfill Life Cycle Cost Screening for Atlantic Shorefront

		Beachfill Alternative 1	Beachfill Alternative 2	Beachfill Alternative 3
Initial Cost	Initial Construction	$24,016,000	$128,177,000	$60,801,000
	IDC	$125,000	$2,204,000	$1,273,000
	Investment Cost	**$24,141,000**	**$130,381,000**	**$62,074,000**
Annualized Cost	Initial Construction	$1,006,000	$5,434,000	$2,587,000
	Renourishment (Planned/Emergency)	$7,708,000	$5,936,000	$5,740,000
	O&M	$403,000	$403,000	$573,000
	Major Rehab	$332,000	$332,000	$332,000
	SLR Adaptation	$0	$0	$0
	Total Annual Cost	**$9,449,000**	**$12,105,000**	**$9,232,000 (lowest lifecycle cost)**

Figure 5-4: Beach Restoration with Beachfill, Groin Extensions, and New Groins

Beachfill quantities required for initial construction of the selected alternative were estimated based on the expected future shoreline positions. It is impossible to predict exact shoreline positions since the wave conditions vary from year to year and affect shoreline change rates. The future shoreline position was estimated based on a two and a half year GENESIS-T simulation representative of typical wave conditions. Beachfill quantities are based on the difference in the design shoreline position (including advance fill) and the predicted future shoreline. For every foot that the projected shoreline needs to be translated seaward 1.22 cubic yards per foot (cy/ft) of fill would be required. This is based on a berm elevation of +8 ft NAVD88 and a depth of closure of

-25 ft NAVD88. Beachfill quantities (Table 5-4) include an overfill factor of 11% based on the compatibility analysis for the borrow areas (see the Engineering Appendix for more detail). Namely, as finer materials wash out more readily back into the ocean after placement, larger losses of initial fill are incurred with finer grain sizes. Therefore, the initial fill quantities will overfill a certain percentage to make up for the amount that is estimated to be lost based on the grain size of the material to be placed.

A renourishment interval of four years was developed, which is projected to result in minimum berm widths of approximately 60 feet along the placement area. Renourishment for Reach 6a is assumed to be supplemented by annual East Rockaway Inlet dredging, which is projected to place 115,000 cubic yards of material on Reach 6a annually. Renourishment for Reaches 3, 4, 5, and 6a, once authorized, are subject to O&M funding of authorized O&M activities. Reach 6b appears to accrete naturally based on site-specific natural morphological processes and was not identified as having erosion issues warranting renourishment. The 'major rehab' is a projected cost to repair damage to the project due to large events that may occur over the life of the project.

Table 5-4: Beachfill and Renourishment Quantities (cubic yards)

Reach	Beachfill	Renourishment per Cycle
West Taper	306,000	0
Reach 3	356,000	475,000
Reach 4	294,000	149,000
Reach 5	321,000	476,000
Reach 6a	250,000	11,000
Reach 6b	20,000	0
East Taper	49,000	0
Totals	**1,596,000**	**1,111,000**

Note: Renourishment would occur on a four-year cycle

5.6.1.2 Life-Cycle Cost Optimization: Groins

Generally a groin is comprised of three sections: 1) horizontal shore section (HSS) extending along the design berm; (2) an intermediate sloping section (ISS) extending from the berm to the design shoreline, and (3) an outer sloping section (OS) that extends from the shoreline to offshore. The head section (HD) is part of the OS and is typically constructed at a flatter slope than the trunk of the groin and may require larger stone due to the exposure to breaking waves. Table 5-5 presents the location and length of groin sections depicted in Figure 5-4 (above).

Table 5-5: Groin Locations and Lengths (feet)

Street	HSS	ISS	OS	Total	Description
34th	90	108	328	526	New 526’
37th	90	108	328	526	Extension 175’
40th	90	108	328	526	Extension 200’
43rd	90	108	228	426	Extension 75’
46th	90	108	228	426	Extension 150’
49th	90	108	228	426	Extension 200’
92nd	90	108	128	326	New 326’
95th	90	108	128	326	New 326’
98th	90	108	128	326	New 326’
101st	90	108	128	326	New 326’
104th	90	108	128	326	New 326’
106th	90	108	128	326	New 326’
108th	90	108	128	326	New 326’
110th	90	108	153	351	New 351’
113th	90	108	178	376	New 376’
115th	90	108	178	376	New 376’
118th	90	108	178	376	New 376’
121st	90	108	128	326	New 326’

5.6.1.3 Atlantic Ocean Reach Optimization

Optimization was performed by evaluating the level of overall CSRM provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with Beachfill Alternative 3 (Beach Restoration with Groin Rehabilitation and Construction of New Groins) to optimize CSRM at the Atlantic Ocean Shorefront Planning Reach.

Five shorefront coastal storm risk management alternatives were considered:

1. Beach Restoration, +16 ft NAVD88 sand-only dune, 60 foot berm
2. Beach Restoration, +18 ft NAVD88 sand-only dune, 80 foot berm, with boardwalk relocation to extend the available beach area landward and reduce the amount of beach renourishment needed
3. Beach Restoration, +20 ft NAVD88 sand-only dune, 100 foot berm
4. Beach Restoration, +18 ft NAVD88 reinforced dune – buried seawall, 60 foot berm
5. Beach Restoration, +18 ft NAVD88 reinforced dune – composite seawall, 60 foot berm

All of the alternatives include the most cost effective beach fill and groin features described in Sections 5.1.2.1 and 5.1.2.2 (Beachfill Alternative 3).

Three sand-only beach restoration alternatives were considered initially in order to assess the most efficient way to maintain a design beach profile. The smallest design beach fill profiles alternatives under consideration is slightly narrower than the Flood Control and Coastal Emergencies (FCCE) project but wider than the prior WRDA 1974 and Section 934 projects, with a dune height of +16

ft NAVD88 and a berm width of 60 feet. The two additional design beach fill profiles under consideration have wider berms and higher dunes (Figure 5-5). The dimensions of the three design beach profiles and associated level of protection is provided in Table 5-6.

Table 5-6: Recommended Design and Beachfill Profiles for Sand-only Dunes (Shorefront Alternatives 1-3)

Shorefront Alternative	Dune Size	Dune Height (feet, NAVD88)	Design Berm Width (feet)	LORR[1] (years)	Annual Exceedance Probability (AEP)
Shorefront Alternative 1 (sand-only dune)	Medium	+16 ft	60 ft	44	2.2%
Shorefront Alternative 2 (sand-only dune)	Large	+18 ft	80 ft	70	1.4%
Shorefront Alternative 3 (sand-only dune and boardwalk relocated landward)	XL	+20 ft	100 ft	100	1%

[1] Level of Risk Reduction

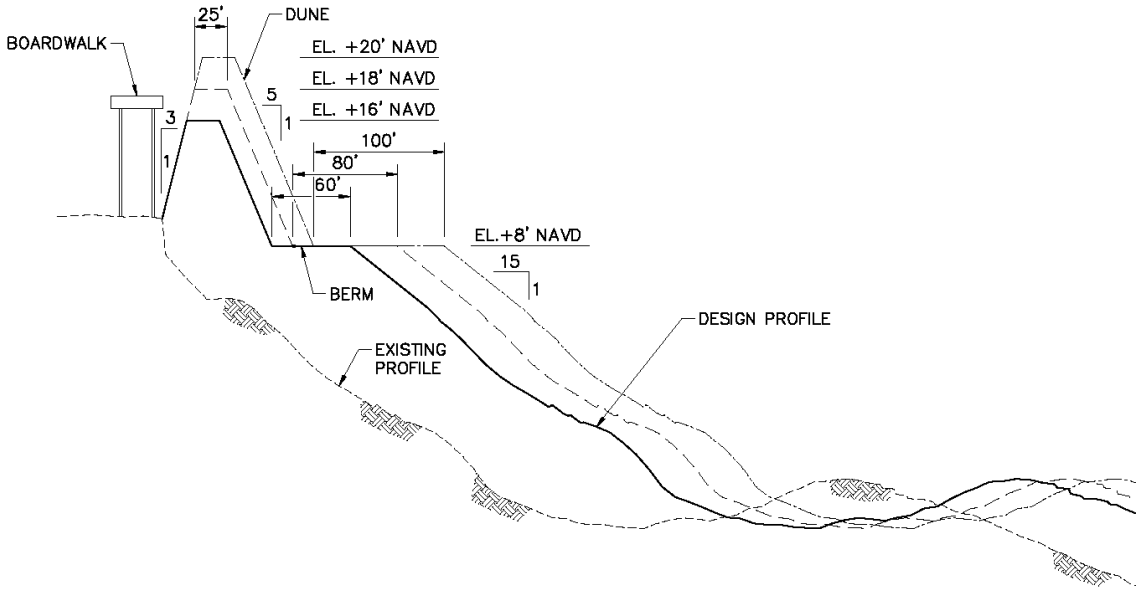


Figure 5-5: Profile of Beach Restoration and Dune Alternatives

Two reinforced dune concepts were proposed and considered for Rockaway Beach as part of the effort to optimize the design in order to maximize net benefits. The first type is a buried seawall the second type is a buried composite seawall. Both designs increase the resiliency of the dune as a CSRM feature if back-to-back storms by reinforcing the dune with non-erodible material.

Buried seawalls are essentially dunes with a reinforced rubble mound core and were developed as an alternative to larger standalone seawalls. Buried seawalls are designed to function in conjunction with beach restoration projects and dunes and are a more natural nature-based alternative to a standalone seawall. The primary advantage of buried seawalls over traditional dunes is the additional protection against erosion and wave attack provided by the stone core. Since the purpose of the buried seawall is wave protection, it may be constructed intermittingly along the shoreline in the most vulnerable areas. By vegetating the dune, erosion is further limited and the vegetation has a stabilizing effect on the dune, as well as increasing the dune's natural ability to trap sand and accrete. The vegetated dune also provides incidental benefits to the coastal habitat and aesthetics of the beach, though they do have a larger footprint which limits space for beach recreation on the flatter berm portion of the beach. The buried seawall, however, is permeable and will not stop cross-island flooding nor storm surge inundation.

The second reinforced dune concept considered is a composite seawall with an impermeable core (i.e. steel sheet pile). The purpose of the composite seawall is to not only protect against erosion and wave attack but also to limit storm surge inundation and cross-island flooding. The composite seawall provides a high level of protection that may not be practical to achieve with a sand-only dune because of the necessary height and footprint of such a dune. In addition, the composite seawall is compatible with a comprehensive storm surge barrier for Jamaica Bay.

Table 5-7: Seawall Design Alternatives Considered

Shorefront Alternative	Structure Type	Structure Crest Elevation (feet, NAVD)	Dune Elevation	Design Berm Width (feet)	LORR[1] (years)	AEP
Shorefront Alternative 4	Buried Seawall	+16	+18	60	70	1.4%
Shorefront Alternative 5 *(Recommended)*	Composite Seawall	+17	+18	60	150	.67%

[1] Level of Risk Reduction

The cost and benefits for each of the alternatives were evaluated. Among the beach restoration and dune alternatives, the highest net benefits are provided by the largest alternative considered. The results of the comparison are presented in Table 5-8 under a low sea level rise scenario and Table 5-9 under an intermediate sea level rise scenario. The results showed that all of the alternative plans are cost effective and that the highest net benefits are provided by Shorefront Alternative 5, the composite seawall, under both sea level rise scenarios.

The buried seawall design in Shorefront Alternative 4 was intended to help optimize the plan. However, analysis of the cross-island flooding benefits showed that this factor was an important damage driver and since the Shorefront Alternative 4 design did not reduce cross shore flood damage compared to the sand-only dune of the same height (because it is permeable), it did not increase net benefits. Alternatively, the composite seawall design in Shorefront Alternative 5, though it is a more expensive design, is very effective at reducing cross-shore flood damages because it is impermeable, and this difference helped to maximize the net benefits of this alternative.

Table 5-8: Rockaway Beach Dune and Berm Formulation Summary - Low Sea Level Rise Scenario

		Without-Project (No Action)	16 Foot Dune Shorefront Alt 1	18 Foot Dune Shorefront Alt 2	20 Foot Dune Shorefront Alt 3	Buried Seawall Shorefront Alt 4	Composite Seawall Shorefront Alt 5 NED Plan
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	Interest During Construction (IDC)	$0	$1,307,000	$2,129,000	$3,462,000	$3,752,000	$6,760,000
	Investment Cost	**$0**	**$72,324,000**	**$97,626,000**	**$150,661,000**	**$159,235,000**	**$227,748,000**
Annual Costs	Initial Construction (annualized)	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/ Emergency)	$867,000	$5,950,000	$6,392,000	$6,829,000	$5,950,000	$5,950,000
	O&M	$0	$579,000	$598,000	$621,000	$727,000	$836,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaptation	$0	$0	$0	$0	$0	$0
	Total Annual Cost	**$867,000**	**$9,540,000**	**$10,938,000**	**$13,363,000**	**$12,907,000**	**$15,554,000**
Damages	Damages (Shorefront)	$17,502,000	$8,389,000	$5,180,000	$2,752,000	$5,097,000	$1,986,000
	Damages (Cross-Shore Flood Damages)	$28,757,000	$26,393,000	$19,350,000	$15,413,000	$19,350,000	$11,360,000
	Bayside Damages	$65,548,000	$65,548,000	$65,548,000	$65,548,000	$65,548,000	$65,548,000
	Total Damages	**$111,807,000**	**$100,330,000**	**$90,078,000**	**$83,713,000**	**$89,995,000**	**$78,894,000**
CSRM Benefits	Total Benefits (Reduced Damages)	-	$9,113,000	$12,322,000	$14,750,000	$12,405,000	$15,516,000
	Cost Avoided (Emergency Nourishment)	-	$867,000	$867,000	$867,000	$867,000	$867,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$9,980,000	$13,189,000	$15,617,000	$13,272,000	$16,383,000
	Cross-Shore Flood Damage Reduced	-	$2,364,000	$9,407,000	$13,344,000	$9,407,000	$17,397,000
	Total Storm Damage Reduction Benefits	-	$12,344,000	$22,596,000	$28,961,000	$22,679,000	$33,780,000
Recreation Benefits		-	$29,430,000	$29,430,000	$29,430,000	$29,430,000	$29,430,000
Total Benefits		-	**$41,774,000**	**$52,026,000**	**$58,391,000**	**$52,109,000**	**$63,210,000**
Net Benefits (Total Storm Damage Reduction Benefits minus Costs)		-	**$2,804,000**	**$11,658,000**	**$15,598,000**	**$9,772,000**	**$18,226,000**
BCR		-	**4.4**	**4.8**	**4.4**	**4.0**	**4.1**
BCR (CSRM Damage Reduction Only)		-	**1.3**	**2.1**	**2.2**	**1.8**	**2.2**

Table 5-9: Rockaway Beach Dune and Berm Formulation Summary - Intermediate Sea Level Rise Scenario

		Without-Project (No Action)	16 Foot Dune Shorefront Alt 1	18 Foot Dune Shorefront Alt 2	20 Foot Dune Shorefront Alt 3	Buried Seawall Shorefront Alt 4	Composite Seawall Shorefront Alt 5 NED Plan
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	Interest During Construction (IDC)	$0	$1,307,000	$2,129,000	$3,462,000	$3,752,000	$6,760,000
	Investment Cost	**$0**	**$72,324,000**	**$97,626,000**	**$150,661,000**	**$159,235,000**	**$227,748,000**
Annual Costs	Initial Construction (annualized)	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/ Emergency)	$943,000	$6,364,000	$6,801,000	$7,243,000	$6,364,000	$6,364,000
	O&M	$0	$579,000	$598,000	$621,000	$728,000	$836,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaptation	$0	$210,000	$373,000	$377,000	$1,020,000	$1,453,000
	Total Annual Cost	**$943,000**	**$10,164,000**	**$11,720,000**	**$14,154,000**	**$14,342,000**	**$17,421,000**
Damages	Damages (Shorefront)	$18,512,000	$8,644,000	$5,405,000	$2,916,000	$5,296,000	$2,494,000
	Damages (Cross-Shore Flood Damages)	$27,384,000	$25,191,000	$18,515,000	$14,794,000	$18,515,000	$10,947,000
	Bayside Damages	$70,505,000	$70,505,000	$70,505,000	$70,505,000	$70,505,000	$70,505,000
	Total Damages	**$116,401,000**	**$104,340,000**	**$94,425,000**	**$88,215,000**	**$94,316,000**	**$83,946,000**
CSRM Benefits	Total Benefits (Reduced Damages)	-	$9,868,000	$13,107,000	$15,596,000	$13,216,000	$16,018,000
	Cost Avoided (Emergency Nourishment)	-	$943,000	$943,000	$943,000	$943,000	$943,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$10,811,000	$14,050,000	$16,539,000	$14,159,000	$16,961,000
	Cross-Shore Flood Damage Reduced	-	$2,193,000	$8,869,000	$12,590,000	$8,869,000	$16,437,000
	Total Storm Damage Reduction Benefits	-	$13,004,000	$22,919,000	$29,129,000	$23,028,000	$33,398,000
Recreation Benefits		-	$29,430,000	$29,430,000	$29,430,000	$29,430,000	$29,430,000
Total Benefits		-	**$42,434,000**	**$52,349,000**	**$58,559,000**	**$52,458,000**	**$62,828,000**
Net Benefits (Total Storm Damage Reduction Benefits minus Costs)		-	**$2,840,000**	**$11,199,000**	**$14,975,000**	**$8,686,000**	**$15,977,000**
BCR		-	**4.4**	**4.5**	**4.1**	**3.7**	**3.6**
BCR (CSRM Damage Reduction Only)		-	**1.3**	**2.0**	**2.1**	**1.6**	**1.9**

CSRM at the Atlantic Ocean Shorefront Planning Reach consists of optimized beach fill with groins plus a composite seawall, which provides the highest net benefits of all Atlantic Ocean shorefront alternatives considered for all three sea level rise scenarios analyzed, which included low, intermediate, and high USACE curves (Table 5-8 and 5-9, see Engineering Appendix, Section 7.2.8 and Table 7-8 of this appendix for more detail, as well as the Benefits Appendix Tables 8-1 through 8-3). Net benefits are the total storm damage reduction benefits minus the cost of reducing the damages. The USACE seeks to maximize net benefits with the NED alternative. Shorefront Alternative 5 with the composite seawall, which has the lowest life cycle costs of the alternatives considered, is the NED alternative for the shorefront because it provides the maximum net benefits. The armor stone in horizontally composite structures, as included in Shorefront Alternative 5, significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls to be used in the design if the face of the wall is completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding one layer of armor stone and extending the concrete cap up to the elevation of the armor stone.

A sand-only dune design with equivalent or greater level of risk reduction was considered in beach reaches with a very wide beach berm of roughly 200 feet versus the more typical minimum berm width of 60 feet in many parts of the Atlantic shorefront. However, this design would be less resilient in the face of back-to-back overtopping events due to the erodability of sand, and would need to be modified to the buried composite seawall dune design if and when the proposed storm surge barrier is authorized for construction under the New York and New Jersey Harbor and Tributaries Study. The modification cost would exceed the relatively minimal cost savings for initial construction of the sand-only design therefore this design approach was not carried forward (see Engineering Appendix for more detail). The 'major rehab' is a projected cost to repair damage to the project due to large events that may occur over the life of the project[34].

The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-island flooding. The structure crest elevation is +17 feet NAVD88, the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet. The composite seawall alternative provides effective and efficient CSRM at the Atlantic Ocean Shorefront Planning Reach and is a necessary component of comprehensive CSRM in the project area.

5.6.2 Jamaica Bay Planning Reach

The alternative plans for the Jamaica Bay Planning Reach include the best solution for the Atlantic Ocean Shorefront Planning Reach, which would substantially reduce overtopping of the Rockaway peninsula as a source of flood waters into Jamaica Bay. However, in order to identify a comprehensive solution, the team also developed plans to keep water from Jamaica Bay from flooding Bayside communities. Four plans were initially developed (A – D) to manage flood risk for the communities in and around Jamaica Bay, also referred to as the Bayside or Back-bay:

1. Plan A is the no Action Alternative.
2. Plan B consists of non-structural alternatives such as buy-out, flood-proofing, home raising, etc.

[34] This was calculated as an annual probability weight cost. More information on this can be found in the Engineering and Design Appendix.

3. Plan C is a storm surge barrier at Rockaway Inlet with complementary CSRM features to address residual flood risk that would remain during smaller rainfall events or high tide when a storm surge barrier would likely remain open.
4. Plan D is a perimeter barrier along the Jamaica Bay shoreline.

Plan B was screened out due to the high density of development and structure types not being conducive to non-structural measures in many areas. The final array of alternatives for the Jamaica Bay Planning Reach that resulted from the Alternatives Milestone included the Perimeter Plan, the Storm Surge Barrier Plan (Plan C), and the No Action Alternative (Plan A).

5.6.2.1 Perimeter Plan (Plan D) and the Storm Surge Barrier Plan (Plan C)

Figure 5-6 gives a summary of the first and second screenings as well as further changes to the Recommended Plan that occurred subsequent to the ADM, after the TSP was identified and received public comments. The public and agency comments received on the TSP resulted in the agency decision to move the storm surge barrier component of Plan C into a different, new and ongoing study for further analysis while moving forward with the implementation for the Jamaica Bay features that address frequent flooding from smaller events.

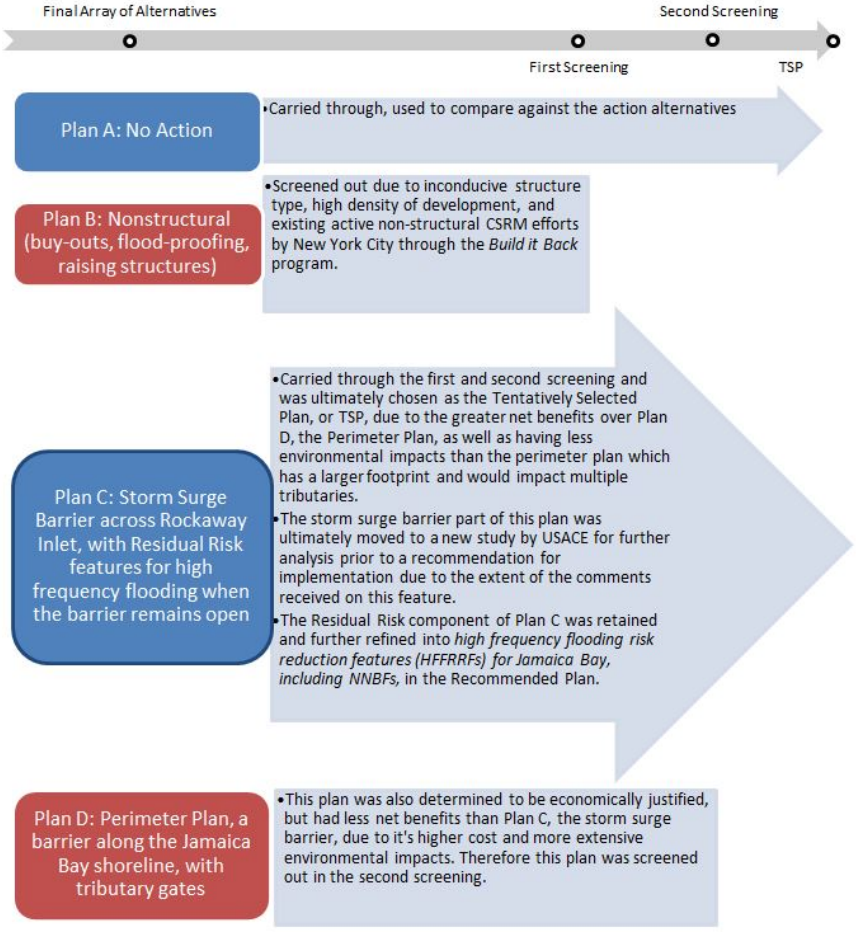


Figure 5-6: First and Second Screening Rounds of Jamaica Bay Plans

Storm Surge Barrier Alternative (Plan C)

The storm surge barrier alternative includes 1) a barrier which would have both permanent in-water features that tie-in to the land, as well as gates which would remain open most of the time, and close during a "triggering event" in order to keep storm surge from passing beyond the barrier and flooding coastal communities, and 2) Residual Risk measures to address high frequency flooding that would still occur when the proposed barrier would remain open.

Two alternative alignments of the Storm Surge Barrier Plan (C-1, and C-2) were assessed prior to the ADM when the storm surge barrier was moved to the NYNJHAT study. Each alternative alignment consisted of the optimized plan for the Atlantic Ocean Shorefront Planning Reach, two tie-ins (Coney Island tie-in and the Rockaway shorefront eastern and western tie-in) and alignment-specific variations of the Jamaica Bay Northwest CSRM unit (CSRMU) and the Rockaway Bayside CSRM unit.

The C-3 alignment was screened out from the more detailed analysis conducted for alignments C-1 and C-2 because alignment C-3 proved to have higher construction costs and OMRR&R costs due to its longer in-water footprint, while providing the same level of benefits as alignments C-1 and C-2.

Alignment C-2 and two alternative alignments for C-1 (C-1E and C-1W) were analyzed using the ADCIRC numerical model to aid in the design of the storm surge barriers and consider the number of openings, evaluate changes in tidal amplitude and velocities in Jamaica Bay for various gate configurations and Storm Surge Barrier alignments (Figure 5-8). Storm Surge Barrier alignment C-1E is preferred over alignment C-1W because alignment C-1E:

- would likely result in less impact to the Gil Hodges Memorial Bridge;
- would result in less real estate and aesthetic impacts to the Roxbury Community where alignment C-1W would tie in;
- is located in a more stable channel location; and
- avoids potential impacts to submerged cables.

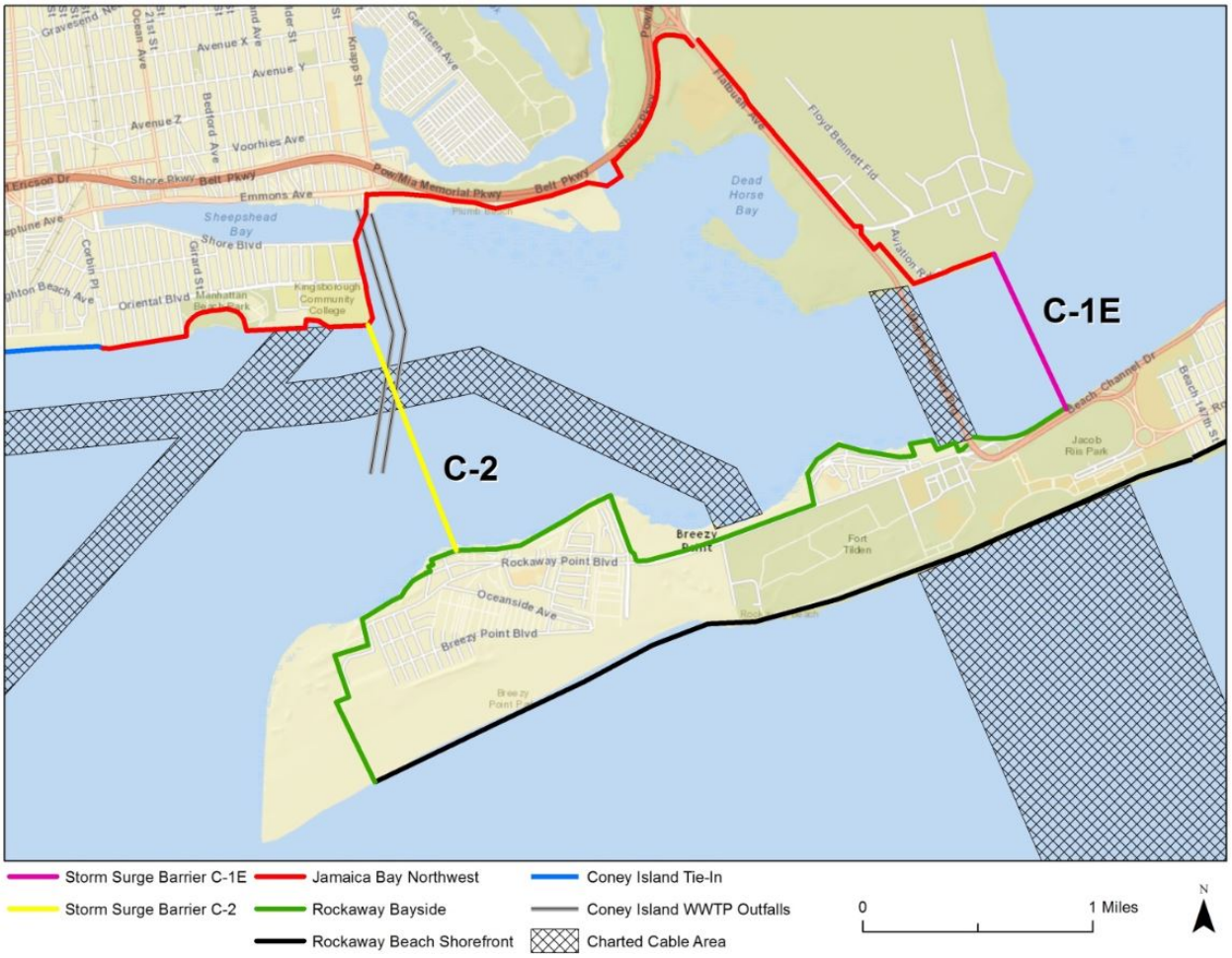


Figure 5-7: Alignments C-1 and C-2

Hydrodynamic modeling was conducted on multiple alignment and opening configurations to determine the alignment configuration pairs with the least impacts to tidal amplitude. The ADCIRC hydrodynamic modeling identified alignment C-1E with 1,100 linear feet of gate opening and alignment C-2 with 1,700 linear feet of gate opening as having the least hydrodynamic impacts to Jamaica Bay as compared to all other potential alignment and opening configurations. Both alignments C-1E and C-2 result in a maximum tidal amplitude change of 0.2 feet, which occurs only during the highest tides of a tidal cycle. This small impact to tidal amplitude indicates that there would not be any major changes in the water column throughout Jamaica Bay. Limited changes to the water column indicates that the natural environment driven by water circulation would be undisturbed and water chemistry, including the benthic layer, would be consistent with and without a Storm Surge Barrier. In addition, flow speeds and directions for both alignments are similar to without-project conditions, which imply that circulation within Jamaica Bay would be minimally impacted. This modeling effort was consistent with SMART planning guidelines as an initial step to identify and mitigate risks, and was intended to identify any significant impacts of a barrier before it was further refined and considered at the TSP Milestone. Additional water quality modeling has been undertaken and analyzed since the TSP Milestone (NYCDEP, 2016 and USACE 2018) and will be included in the NYNJHAT study prior to implementation of a

Rockaway Inlet barrier to ensure that any barrier design avoids water quality impacts while the barrier is open or closed. Comments pertaining to alignment and potential impacts of the storm surge barrier will be addressed under the NYNJHAT study.

Jamaica Bay Perimeter Plan Alternative (Plan D)

The Jamaica Bay Perimeter Plan consists of the optimized plan for the Atlantic Ocean Shorefront Planning Reach, two tie-ins (Coney Island tie-in and the Rockaway shorefront eastern and western tie-in) and three distinct CSRM units (Jamaica Bay Northwest, Head of Bay, and Rockaway Bayside).

The Jamaica Bay Perimeter Plan (Figure 5-9) creates a contiguous barrier along the Jamaica Bay interior, with the exception of JFK Airport, which chooses to manage risk from coastal storms independently. The Jamaica Bay Perimeter Plan would avert inundation at a stillwater elevation of 11 feet for communities surrounding the bay. Eleven feet is generally equivalent to the stillwater elevation for a storm event with 1% probability of annual occurrence in 2070 including intermediate sea level rise. The community at Broad Channel, which is effectively within Jamaica Bay—as opposed to being a community on the fringe of Jamaica Bay—would not benefit from the Jamaica Bay Perimeter Plan.

After the Alternatives Milestone, additional analyses were conducted to reduced uncertainties associated with the final array of alternatives. A major objective of the additional analyses was to refine alignments to minimize costs, impacts to private property, and habitat disturbances associated with the Jamaica Bay Perimeter Plan.

Figure 5-8: Plan D Jamaica Bay Perimeter Plan

5.7 Alternative Plan Evaluation and Comparison

The Jamaica Bay Perimeter Plan (Plan D) and the Storm Surge Barrier (Plan C alignments C-1E and C-2) were evaluated for habitat impacts, real estate impacts, costs (construction, mitigation, real estate, under water utility relocation, and OMRR&R), and net benefits. Both plans include the same project features along the Atlantic Ocean shoreline Planning Reach.

5.7.1 Screening Criteria

- Is the plan economically justified where the benefits to the nation exceed the cost?
- Does the plan reasonably maximize benefits to the nation?
- Is there a significant impact to the environment? What would it take to mitigate the environmental impact?
- What are the impacts to real estate if this plan is built? I.e. how many structures would need to be acquired or would have their views impacted?
- How do cost factors for construction, mitigation, and real estate vary?

- Would there be a need for significant underwater utility relocation which has significant risk involved both to project schedule, cost, and potential disruption in services or impacts to the water body?
- What would the long-term operation and maintenance of the project entail?

5.7.2 Habitat Impacts and Mitigation Requirements

Environmental impacts associated with structural alternatives were addressed by complimentary evaluations:

1. Permanent and temporary impacts using an acreage metric. This provides a traditional measure of mitigation needs, and does not account for the level of ecological service and/or functions provided by the habitat types; and
2. Evaluation for Planned Wetlands (EPW) was used to evaluate impacts to ecological functioning within coastal wetlands in in-water habitats[35].

Table 5-10 presents permanent and temporary habitat impacts using an acreage metric. The metric used during preliminary screening provided a traditional measure of impacts and mitigation needs, but did not account for the level of ecological service and/or functions provided by the habitats. Since the storm surge barrier component of Plan C is no longer part of the Recommended Plan for the Rockaway Reformulation, the functional habitat assessment and associated mitigation from potential impacts due to the barrier will not be discussed in this EIS, but will be further addressed in the NYNJHAT study instead.

Table 5-10: Permanent and Temporary Habitat Impacts (acres)

Habitat Type	Permanent			Temporary		
	C-2	C-1E	D	C-2	C-1E	D
Subtidal Bottom	37.7	34.6	45.1	0.1	1.2	13
Intertidal Mudflat	3.3	7.5	25.1	3.8	8.8	24.2
Intertidal Wetlands	0	0	9.4	0	0.1	7
Non-Native Wetlands	0	0.4	3.5	0	0.4	0.3
Beach	0	13	17	61	69.9	69.6
Dune	3.1	4	6.8	10.4	11.3	10.3
Maritime Forest/Shrub	6.71	20.6	31.5	3.9	11.4	30.3
Total	**50.81**	**80.1**	**138.4**	**79.2**	**103.1**	**154.7**

The acreage of habitat impacts was used to provide a rough estimate of mitigation costs for the screening of the final array of alternatives to arrive at the TSP. Future functional habitat modeling can facilitate refinement of any mitigation costs for any Rockaway barrier if one is ultimately

[35] EPW has been regionally certified by USACE for use in studies.

recommended by the NYNJHAT study. All further analysis would be conducted under the NYNJHAT study. However, the work done in the Rockaway Reformulation to determine that the storm surge barrier was the tentatively selected plan, preferable to a perimeter plan for Jamaica Bay would remain unchanged. Comments on the storm surge barrier were focused more on the alignment, design, and operation considerations for the storm surge barrier, with many commenters expressing a desire to ensure that impacts to the environment and viewscape aesthetics are minimized. Furthermore, comments included calls for further analysis on sediment transport, and potential impacts to Gil Hodges Bridge, etc., based on the alignment of the storm surge barrier to ensure no negative scour impacts to the bridge would occur.

5.7.3 Atlantic Ocean Shorefront Planning Reach

The benefit estimates for Atlantic Ocean shorefront coastal storm risk reduction include reduced damages for the Atlantic Ocean shoreline, reduced damages from cross island flooding, and reduced future maintenance costs (Table 5-11). For the Atlantic Ocean shoreline areas the Beach-fx models incorporate each design profile and were adjusted for future profiles to reflect the planned renourishment, which maintains the design profile into the future. The reduced damage due to cross shore flooding was estimated by using the HEC-FDA levee function to truncate/eliminate damages for storm events that would not generate significant overtopping volumes (1.0 cfs). Because the project will maintain the design profile there will be no need for non-federal actions to repair the design profile after major storm events. These future costs avoided are estimated to add $812,000 in average annual benefits to each plan. The composite seawall was selected as a common element of each alternative plan because it provides the highest net benefits of the alternative shorefront elements.

Table 5-11: Atlantic Ocean Shorefront Planning Reach Equivalent Annual Damage Reduction

	Composite Seawall
Total Benefits (Reduced Damages)	$13,896,000
Cost Avoided (Emergency Nourishment)	$812,000
Shorefront Benefit (Reduced Damage Plus Cost Avoided)	$14,708,000
Cross Shore Flood Damage Reduced	$17,309,000
Total Storm Damage Reduction Benefits	$32,017,000
Net Benefits (Damage Reduction Only)	**$16,222,000**

5.7.4 Recreation Benefits

Implementation of the shorefront component of the project will maintain the beaches within the study area that were restored and renourished after Hurricane Sandy in 2012. Maintaining the width of existing beaches will create an enhanced recreation experience (relative to the future condition of the beach without maintenance) which is reflected in an increase in willingness to pay (WTP) for the recreation experience and an increase in visitation.

In the future without-project condition Rockaway beaches would not be maintained at presently renourished beach widths since future renourishment has not been approved. Without renourishment, the beach will experience erosion and will eventually be half the width of the existing beach. The shorefront element of each alternative plan will maintain the beaches in the study area against erosion, to a minimum width of 60 feet of beach.

The Travel Cost Method (TCM) is used to estimate economic use values associated with sites that are used for recreation. The basic premise of the TCM is that the time and travel cost expenses that people incur to visit a site represent the 'price' of access to the site. An individual TCM approach was used, based on survey data from individual users at Rockaway Beach. Data was gathered on the location of the visitor's home ZIP Code, how far they traveled to the site, how many times they visited the site during the season, the length of the trip, travel expenses, the method of travel to the site, the person's income and other socioeconomic characteristics.

Beach attendance data was provided by the Department of Parks and Recreation (DPR), City of New York. Based on the total Rockaway Beach visitation provided by DPR, and information from the survey (corrected for trip bias), 2015 beach attendance was estimated by method of travel to the beach. The without project condition of not maintaining Rockaway Beach against erosion results in a substantial number of existing beach goers not willing to visit. Those willing to visit under the without project condition slightly reduce their number of beach visits compared with their existing beach visits. The number of visits not taking place under the without project condition at Rockaway Beach is 4,512,512. The average value per visit is estimated through the TCM as $4.64.

The without-project future condition assumes the lack of beach maintenance against erosion. Rockaway Beach would continue to experience erosion at a rate of about 10 feet per year. Based on responses to beach surveys completed in the summer of 2015, it is estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by 4,512,512 visits. Beach visits per year were interpolated between these two points based on survey responses. The reduced beach width would, in turn, reduce the user willingness to pay for the remaining 3,225,988 visits to a substantially lower $1.91 per visit. The average annual equivalent value of the recreation component of NED benefits is $29,342,000 at a 2.875 percent discount rate (see the Recreation Appendix for benefits estimation method and calculations).

5.8 Identification of the Tentatively Selected Plan

Table 5-12 presents the average annual costs, benefits, net benefits, and benefit-to-cost ratio for each of the alternative plans considered for the Jamaica Bay planning reach prior to the TSP milestone. Though the storm surge barrier will now be further evaluated under the NYNJHAT study, the analysis that made it part of the previous TSP is presented in Table 5-12.

Table 5-12: Jamaica Bay Alternative Plan Average Annual Net Benefits (AAEQ)

Plan Name	Total Cost*	Benefits+	Net Benefits+	BCR
Barrier C-1E	$163,638,000	$509,233,000	$345,595,000	3.1
Barrier C-2	$163,710,000	$509,233,000	$345,523,000	3.1
Perimeter-D	$227,416,000	$497,582,000	$270,166,000	2.2

+Effective price level used for the benefits calculation was January 2016, with the fiscal year 2016 discount rate of 3.125%.

*Cost estimates were prepared in July 2016 with effective price levels of October 2015 (utilized prior version Cost Appendix).

The Storm Surge Barrier Plan has $75.4 million more net benefits than the Perimeter Plan and is a significantly more efficient plan for comprehensively managing risk from coastal flooding for the study area. However, both the Perimeter Plan and the Storm Surge Barrier Plan are economically justified with the benefit to the national economy exceeding the cost to the nation. Storm Surge Barrier Plan alignment C-1E provides the greatest net benefits of the final set of alternative plans, but is very close when compared to alignment C-2. There were three additional compelling factors that made Storm Surge Barrier Plan alignment C-1E the TSP:

- The costs for C-1E include far less uncertainty that the costs for C-2. There is no need for submerged cable relocations for alignment C-1E.
- Although the real estate costs for alignment C-2 are lower than real estate costs for C-1E, real estate costs do not account for the severe impact to water views that would be imposed on the Breezy Point neighborhood by alignment C-2. Storm Surge Barrier Plan alignment C-1E is nearly one-half mile away from residential structures on the Rockaway peninsula with proximity to the existing in-water infrastructure—the Gil Hodges Bridge.
- Alignment C-1E provides flexibility in the determination of whether to include and to what extent to include Breezy Point and Jacob Riis Park into the project. The Rockaway peninsula terminus of alignment C-2 cannot be removed from Breezy Point in a cost effective manner. In other words, alignment C-2 requires the inclusion of and impacts to Breezy Point, particularly to the viewshed. The Rockaway terminus of alignment C-1E is approximately one-half mile from Breezy Point. There are numerous potential configurations of the Rockaway Bayside and the Rockaway Shorefront CSRM units that can provide alternative levels of CSRM at Breezy Point.

Additionally, Storm Surge Barrier alignment C-1E may be constructed with alternative tie-in locations, which provide flexibility for the final design. Therefore the Storm Surge Barrier Alignment C-1E, which includes CSRM at the Atlantic Ocean Shorefront Planning Reach, was chosen as the TSP.

Table 5-13 presents a summary of comparisons among the three final alternatives, which supported selection of Storm Surge Barrier Plan C-1E as the TSP.

Table 5-13: Jamaica Bay Reach Alternative Plan Comparison Summary

Category	Alternative C-1E (TSP)		Alternative C2		Alternative D	
Construction Cost*	**$3,328,135,000 (least cost)**		$3,361,337,000		$4,467,352,000	
Net Benefits+	**$345,595,000 (greatest net benefits)**		$345,523,000		$270,166,000	
Benefit-to-Cost Ratio	3.1 (economically justified)		3.1 (economically justified)		2.2 (economically justified)	
On-land structures (linear feet)	44,000		15,000 (smallest on-land footprint)		125,000 (largest structural footprint)	
In-water structures (linear feet)	4,900 (smallest in-water structural footprint)		7,900		11,000 (largest in-water structural footprint)	
Number of tributary gates	3		N/A		16 (most tributary gates)	
Number of barrier gates	9		14		N/A	
Geomorphology	**Pro**	**Con**	**Pro**	**Con**	**Pro**	**Con**
	Hardened shoreline makes longshore sedimentation a smaller risk than C-2	Marine Parkway - Gil Hodges Memorial Bridge may require scour protection	Bridge foundation scour not likely	Longshore sedimentation a greater risk than C-1E		

Category	Alternative C-1E (TSP)		Alternative C2		Alternative D	
Utilities	**Pro**	**Con**	**Pro**	**Con**	**Pro**	**Con**
	No conflict with charted submarine cable area	Potential Coney Island WWTP effluent line conflict near Sheepshead Bay – some realignment required		**Conflicts with charted submarine cable area** **Current alignment, which has smallest in-water footprint, conflicts with Coney Island WWTP effluent line; substantial realignment required to avoid conflict**	**No conflict with charted submarine cable area**	Potential Coney Island WWTP effluent line conflict near Sheepshead Bay – some realignment required
Environmental Impact (Permanent Impact to Habitat Acres)	**Pro**	**Con**	**Pro**	**Con**	**Pro**	**Con**
		Moderate level of environmental impact (130 acres)		**Lowest level of environmental impact** **(62 acres)**	**Facilitated incorporation of 8 living shoreline projects within alignment.**	**Highest level of environmental impact** **(247 acres)**

Category	Alternative C-1E (TSP)		Alternative C2		Alternative D	
	Pro	Con	Pro	Con	Pro	Con
Mitigation*	Moderate Level Mitigation Costs. $90,833,000. (Includes carrying forward Floyd Bennett Field Wetlands Creation and Elders Island as examples.)	Potential impacts to tidal amplitude in most up-gradient reaches of tidal inlet channels. Unlikely but potential impact to dissolved oxygen /water quality with prolonged closure exceeding 48 hours. Further analysis will be done to assess the potential impacts and required mitigation in the NYNJHAT study.	Lowest required mitigation costs. $75,538,000. (Includes carrying forward Dead Horse Bay and Duck Point as examples.)	Potential impacts to tidal amplitude in most up-gradient reaches of tidal inlet channels. Unlikely but potential impact to dissolved oxygen /water quality with prolonged closure exceeding 48 hours.		Highest required mitigation costs. $123,383,000. (Includes carrying forward Dead Horse Bay and Floyd Bennett Field Wetlands Creation as examples.) Unknown, potential impacts to water quality and tidal amplitude in most up-gradient reaches of tidal inlet channels. Excess mitigation recommended to account for this unknown.
Annual OMRR&R Costs	$7,424,000		$7,124,000		$14,954,000 (worst)	

+Effective price level used for the benefits calculation was January 2016, with the fiscal year 2016 discount rate of 3.125%.
*Cost estimates were prepared in July 2016 with effective price levels of October 2015 (utilized prior version Cost Appendix).

5.9 Progression from the TSP to the Recommended Plan

The TSP was selected and presented in the Draft Report which underwent a series of reviews by the public, local, state and federal agencies, including the non-federal sponsors, USACE policy reviewers, an interdisciplinary technical review team within USACE which was not involved in the study called the Agency Technical Review (ATR) team, and an Independent External Peer Review (IEPR) panel which consist of reviewers outside of USACE. The comments received during review are an integral part of the decision making process at the Agency Decision Milestone, or ADM, where a USACE Senior Leader Panel decides on a Recommended Plan to be further refined with detailed feasibility-level design and shared in the Final Report.

USACE guidance requires selection of the TSP as the Recommended Plan unless there are other federal, state, local, or international concerns that make another alternative viable to recommend at full cost sharing. In addition, there is an opportunity for the local sponsor to request implementation of a locally preferred plan (LPP) in which they would fully fund the cost above the NED plan if it were higher, or the plan would be reduced in cost if they preferred a smaller plan. Any plan other than the NED Plan would require a waiver from the Assistant Secretary of the Army for Civil Works.

5.9.1 Outcome of the Agency Decision Milestone

The Agency Decision Milestone, or ADM, is the checkpoint at which the USACE reviews the breadth and content of the comments received during the review period and uses that input to either verify for modify the TSP. The ADM results in an agency decision on a *Recommended Plan*, which is then further refined and developed to the full feasibility level of design. This includes the additional design of the recommended plan that is necessary to reduce risk and uncertainty with cost data, engineering effectiveness, environmental impacts, and economic benefits.

For this study, the outcome of the ADM was to move the further study and potential recommendation of the storm surge barrier feature across the inlet to Jamaica Bay, along with the necessary tie-ins to high ground, into the New York and New Jersey Harbor and Tributaries Study (NYNJHATs) that had been initiated in the late Summer of 2016. The NYNJHATs is considering, among other alternative plans, a storm surge barrier alignment from Breezy Point in the Rockaways to Sandy Hook, New Jersey. This alignment would obviate the need for the Jamaica Bay / Rockaway Inlet storm surge barrier. Additionally, the estimated $3 billion cost to construct the proposed Rockaway Inlet storm surge barrier exceeds full amount of the existing Sandy Bill appropriation, which is being used to fund multiple projects and studies. Therefore the proposed barrier component of the Rockaway TSP would have needed additional funding and authority in order to be implemented. However, prior to being considered implementable, the proposed storm surge barrier would need to be designed to the full feasibility level of design with enough detail to sufficiently analyze all of the potential impacts and to address the copious comments received. This would have added significant time to complete the Rockaway Reformulation.

Since the NYNJHAT study is considering an alignment that would make the Rockaway Inlet barrier redundant, and is considering multiple barrier alignments it is more appropriate to consider these large infrastructure investments within the same study. These factors informed the agency decision to move all further consideration of the proposed Rockaway Inlet storm surge barrier to the NYNJHAT study.

Nonetheless, without the Jamaica Bay storm surge barrier, there would be significant residual risk to residents living in and around Jamaica Bay that could gain significant flood risk reduction from the construction of the barrier. Therefore, the study team sought to identify and refine Bayside measures that could still be constructed under the Rockaway Reformulation and reduce this residual risk. The concept of the Residual Risk measures from the TSP were expanded upon and refined to the Feasibility level design so that they could be implemented under the Rockaway Reformulation. Since they are being recommended in advance of the agency decision on whether or not to construct a storm surge barrier, any Bayside features would need to be stand alone. They would also need to be able to complement the potential storm surge barrier if it is recommended and built through the NYNJHATs study. Because the storm surge barrier was already determined to be more economically efficient way of addressing system-wide coastal flood risk than the Perimeter Plan, the Bayside measures would not be optimized to maximize net benefits. This is because optimization of the Bayside measures would result in the Perimeter Plan that was analyzed for a comprehensive CSRM Bayside plan, and which was economically justified but less cost effective than the Storm Surge Barrier Plan. The design levels of the Bayside measures needed to be based on an assumption of when a barrier would be operated. The Bayside measures would be designed to complement the future barrier by addressing the flooding that would still occur when the barrier would remain open, i.e. the high frequency regular flooding that some Bayside communities experience. The *high frequency flooding risk reduction features,* or HFFRRFs, were thus developed along this rationale. In addition to being able to function independent of future and uncertain infrastructure investments, each HFFRRF must also be shown to be economically justified.

5.9.2 Public Review Warranted to Finalize the Recommended Plan

Due to the significance of the changes to Recommended Plan since the public last had a chance to comment, the New York District released the Revised Draft HSGRR/EIS in August 2018 for a second public comment period prior to finalization of the Recommended Plan. The Revised Draft HSGRR/EIS underwent public, agency, and ATR reviews, and the study team addressed comments from those reviews in this HSGRR/EIS.

5.10 Objectives, Planning Considerations, and Screening Criteria for HFFRRF Development

Objectives

1. Reduce the risk of high frequency flooding that occurs in the project area and would not be addressed by the storm surge barrier currently being studied and potentially recommended under the NYNJHAT study.
2. Improve the systems coastal resiliency.

It is important to note that the HFFRRFs will reduce the frequency of inundation that residents of these neighborhoods experience; however, unless a storm surge barrier is built to reduce risk from more extreme events, these features are expected to overtop frequently and residents will still be faced with serious flood risk during larger flood events.

Planning Considerations

Feature type and placement considers existing shoreline and structural features.

In determining what feature type is most appropriate for a given location, the study team first looked at the existing condition of the shoreline. Where the existing shoreline was natural, contained parks or wetlands, and had not been 'hardened' by man-made structures, the study team evaluated NNBF feature types as a potential measure to reduce the risk of high frequency flooding while also improving the systems natural resiliency. NNBF measures would need to not only be feasible for a given area, but also cost effective as means of CSRM. Where the shoreline was already hardened and there are existing dilapidated, non-functioning or poorly functioning CSRM structures (such as bulkheads or revetments), the team evaluated new CSRM features to appropriately match the slope and bathymetry of the area (see Table 5-14, HFFRRF Feature Placement Considerations).

Table 5-14: HFFRRF Feature Placement Considerations

	HFFRR-Feature										
Existing Shoreline and Structural Features	Low Flood Wall	Medium Flood Wall	High Flood Wall	Shallow Bulkhead	Deep Bulkhead	Revetment	Natural and Nature Based Feature (NNBF): Berm & Limited Seaward Marsh Extension (Type A)	NNBF: Berm & Limited Landward Marsh Extension (Type B)	NNBF: Berm & Full Seaward marsh extension (Type A)	NNBF: Berm & Full Landward Marsh Extension (Type B)	Non-Structural (house raisings, buyouts, and/or flood-proofing)
Natural Shoreline	√	√	√				√	√	√	√	
Revetment						√					
Bulkhead				√	√						
Parks or Wetlands	√						√	√	√	√	
Street End	√	√	√	√	√						
Urban Waterfront Development	√	√	√	√	√						
Industrial Waterfront Development	√	√	√	√	√						
Separate Single Family Homes Not Densely Configured											√

Non-structural measures reduce risk not by stopping or redirecting floodwaters, but rather by changing the condition on the ground such that damages from flooding are reduced. Non-structural measures include (but are not limited to) raising homes, buyouts to move people out of the floodplain, and/or flood-proofing measures like raising generators and other infrastructure above the flood elevations. The study area is not very conducive to non-structural measure implementation in general as a means to reducing flood risk. Given the type and high density of development in this area it is often infeasible to raise or flood-proof all of the structures. For example, connected row houses with multiple homeowners, homes on lot sizes not big enough to stage construction (i.e. to fit the cranes or other construction equipment needed to raise a home), and large apartment buildings are all difficult, if not infeasible to raise. Also, in densely populated areas it is usually not cost effective to use non-structural measures compared with building a shoreline measure to protect the development behind it. However, in areas that pose difficulties for structural measures, such as Broad Channel which is situated in the middle of Jamaica Bay at very low elevations and is not as densely developed, non-structural was also considered.

HFFRRFs are intended to complement a potential future storm surge barrier and must establish what level of flood event is an appropriate compliment for this area.

In determining an appropriate size or elevation of the HFFRRFs, the study team analyzed the flood extents of various high frequency AEP flooding events to see which type of event triggered significant flooding in concentrated pockets of developed areas (Figure 5-9). Analyzing these flood extents shows that the future 33% AEP / current 20% AEP %[36] flood incurs some flooding, but not extensive (shown in yellow in Figure 5-9), and much of the flooding is in natural areas such as the wetlands off of JFK airport, with the exception of Broad Channel which floods broadly even at this lowest level event. Whereas the future 20% AEP (5 year RP in 2068), which amounts to a 10% AEP in 2018, or a 10 year RP incurs more significant and widespread flooding. This is shown in blue in Figure 5-9 and also encompasses the yellow areas. The future 10% AEP (10 year RP) / current 5% AEP (20 year RP) flood is the largest high frequency flood event analyzed and is shown in red in Figure 5-9, but also encompasses the blue and the yellow shaded areas. The future 10% AEP event causes extensive flooding throughout the coastal areas, but especially into Old Howard Beach/Hamilton Beach area, parts of Nassau County, the entire Rockaway Peninsula, and Broad Channel. This level of flooding would require a more comprehensive CSRM perimeter plan to address it.

Since the study team's analysis has already shown that the more extensive flooding (which includes the red, but also the blue and yellow shaded areas of Figure 5-9) is more efficiently addressed with a storm surge barrier, the future 20% AEP flood event was chosen as the level of flood at which the HFFRRFs would be designed, based on the assumption that more extensive flooding is better addressed by closing a proposed storm surge barrier to be further studied and potentially recommended in the NYNJHAT Study. However, closing a proposed storm surge barrier for the future 20% AEP event would not address the widespread inundation during smaller more frequent flood events that occurs on Broad Channel. Since Broad Channel has a lower density of structures than other areas, which are largely single-family dwellings that can be raised, non-structural measures were also considered here, namely home raising.

[36] Table 4-1 summarizes the probability of a certain flood occurring now versus in the future given the intermediate USACE projection of sea level rise in this area. In short, the likelihood of a given high frequency flood in this area is expected to roughly double over a fifty year period.

Figure 5-9: Flood Extents for High Frequency Flood Events in the Study Area

Investigate opportunities to improve coastal resiliency and reduce the risk of frequent flooding

NNBFs, or living shorelines, can help reduce the risk of smaller, more frequent coastal storms. They have the added benefit of being inherently resilient, and can fare better and recover on their own more than traditional hard structures in many instances (Gittman et al. 2014). For this reason they are an excellent measure for managing risk from high frequency flooding, if they can be sited appropriately. To meet the objective of improving the system's coastal resiliency to storms, the PDT evaluated NNBFs as a measure for managing frequent flooding. Potential NNBF locations were identified by looking at:

- Clusters of high frequency flooding—because this project has the objective of managing coastal storm risk, not ecosystem restoration, the NNBFs were sited in the areas where they would help manage risk for communities. Traditional restoration projects will restore wetlands and site those efforts based on the ability to maximize the functional habitat values per dollar invested, which can result in restoration being targeted in less developed areas. For NNBFs, the placement is made with consideration for how to best manage risk from coastal storms.
- Existing bathymetry and lateral space—a desktop analysis was performed to assess whether there was enough space and appropriate underwater bathymetry offshore to fit an NNBF. If the depths dropped off quickly once offshore, then the bathymetry was not considered to be suitable for the NNBF concept envisioned (see Figure 5-10 and 5-11)

- Site suitability—consideration was also given to whether the site conditions lent themselves to the appropriate NNBF type being able to persist. If the site has a heavy presence of anthropogenic infrastructure along shoreline (e.g. docks, piers), then that was also not considered a suitable site since it is not feasible to maintain a wetland in conjunction with docks and piers and the heavy traffic that they typically produce.
- Wave attenuation and erosion control—NNBFs were particularly considered as a cost effective means for attenuating wave action and thus reducing erosion on a proposed berm. Since the HFFRRFs are designed to be overtopped frequently unless the proposed storm surge barrier is built, they must be designed to withstand the wave action and overtopping they will encounter. Earthen berms, which are made of erodible material, particularly benefit from a wetland and rock sill complex in front of them to help reduce erosion and the required maintenance over time. The NNBF design shown in Figure 5-10 was demonstrated to be more cost effective than a comparably sized floodwall, which is less erodible (Table 5-29). The NNBF design has additional incidental benefits when compared to floodwalls in that they provide habitat, improve local aesthetics, and even improve water quality since wetlands help to filter water. Where berms are the proposed measure, the wetland and rock sill components are integral design features of the overall HFFRRF.

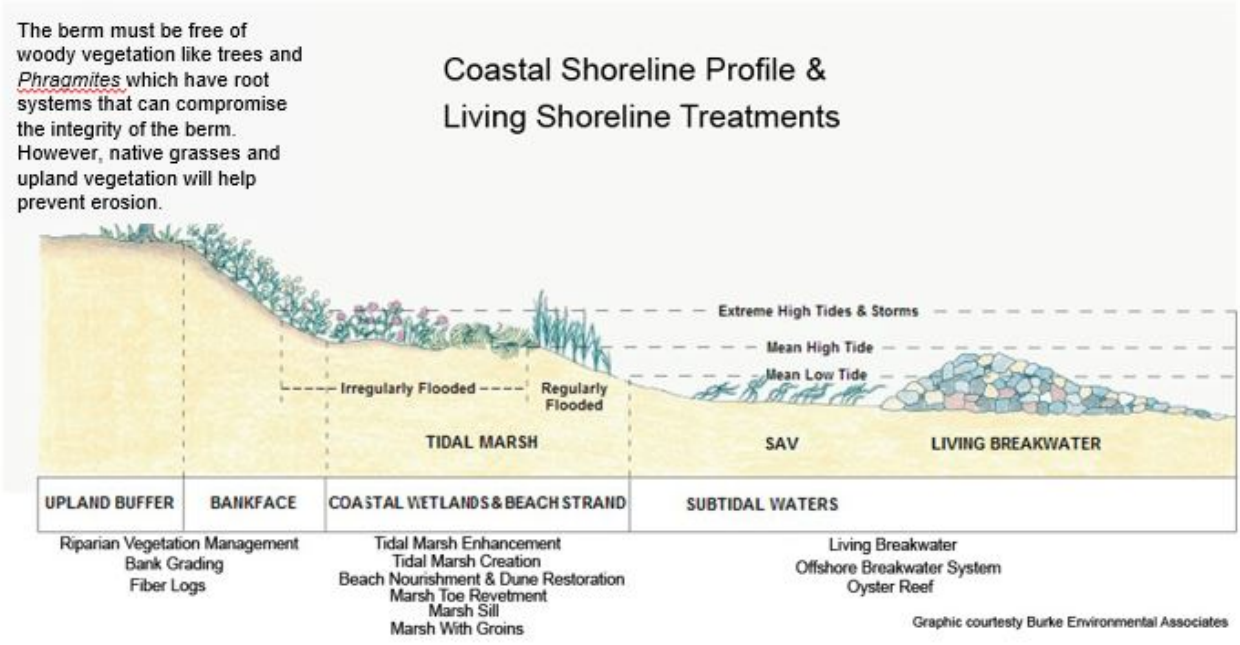


Figure 5-10: Profile drawing of an NNBF, or living shoreline, concept

Source: Burke Environmental Associates

Given these considerations in siting NNBFs, the PDT identified eight potential areas for NNBFs (see Figure 5-11). These were evaluated and screened in conjunction with the other HFFRRFs identified. Three sites in Arverne, one site in Edgemere, one in Norton Basin, and one in Bayswater were identified, as well as one in Motts Basin North and one in Motts Basin South.

Figure 5-11: NNBFs Identified for Evaluation and Screening

Constraints

Do not create redundant federal CSRM investments.

HFFRRFs should complement, but not replicate the function of the storm surge barrier currently being considered under NYNJHAT Study. The Perimeter Plan considered in this study, though economically justified, was shown to be significantly less cost effective than a storm surge barrier across Rockaway Inlet. HFFRRF measures that were considered included shoreline, or perimeter-based features, but the size and level of risk reduction of these features was constrained such that the larger floods would still be addressed by the proposed barrier, which was already shown to be the more efficient means of addressing this type of flooding.

Do not increase risk of wildlife hazards to JFK airport.

Jamaica Bay is home to JFK International Airport, one of the most important economic travel hubs for the nation. Flights coming in and out of JFK International Airport already have a risk to avian collisions which can damage or down a plane. This risk is actively managed by JFK airport. The Rockaway HFFRRFs must be designed such that they do not increase risk of wildlife hazard to airport traffic. In order to not increase the risk of a bird hitting a plane, any NNBFs designed in this area must limit vegetation types to those suitable for foraging, but not nesting.

Do not site NNBFs in environmentally sensitive areas where a habitat transfer to an NNBF habitat site would negatively impact an existing valuable ecosystem.

If the existing habitat at a coastal edge is high functioning and valuable habitat, then NNBFs will either be screened or their design adjusted to avoid negatively impacting high quality habitats.

Furthermore, existing high functioning habitat are likely to already provide CSRM services and can be expected to enhance the function of a co-located CSRM project and reduce the risk of erosion to a proposed project.

5.11 Initial HFFRRF Screening

Thirteen sites were identified for HFFRRFs based on the current 10% AEP flood extent (shown in blue in Figure 5-12). Feature types were chosen and aligned in order to develop rough cost and benefit numbers for a preliminary screening to see which sites were economically justified.

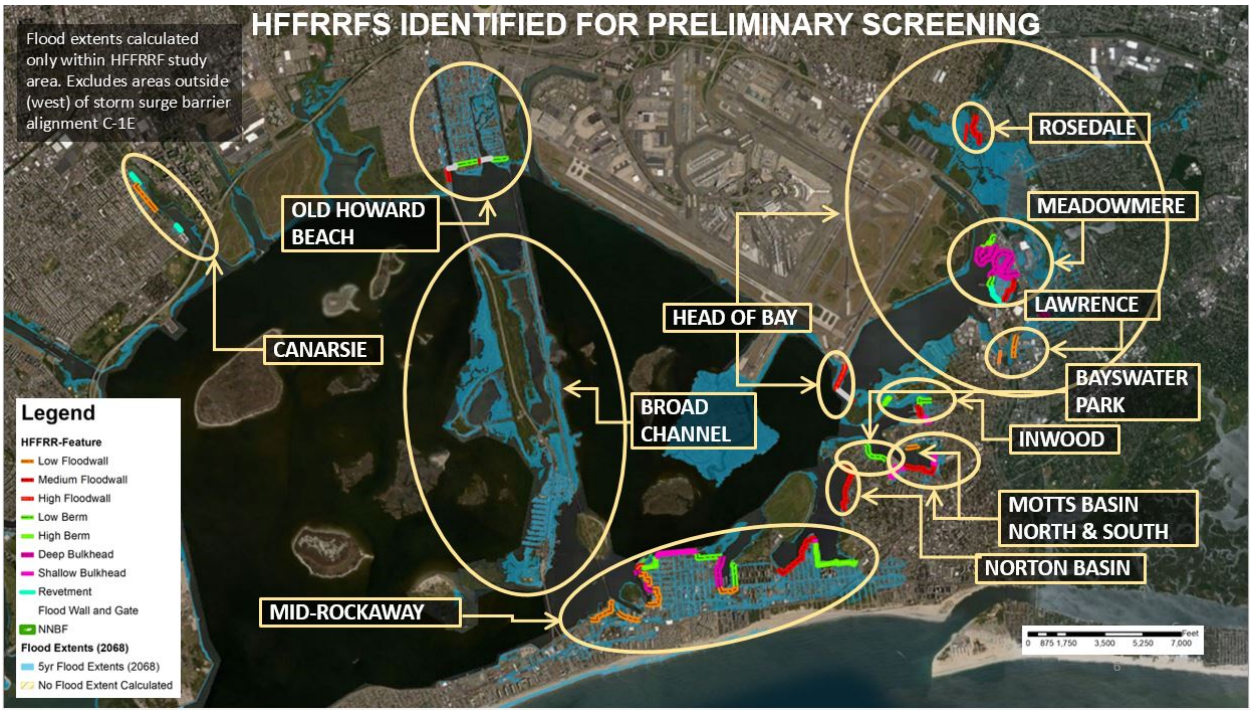


Figure 5-12: Thirteen Potential HFFRRFs Projects identified

In the initial screening, the study team identified the following thirteen HFFRRFs (shown in gold circles on Figure 5-12).

1. Canarsie
2. Old Howard Beach (which includes Hamilton Beach)
3. Broad Channel
4. Mid-Rockaway (including Hammels, Arverne, and Edgemere neighborhoods)
5. Norton Basin
6. Motts Basin South
7. Motts Basin North (shown in one circle above with Motts Basin South)
8. Inwood
9. Bayswater Park
10. Cedarhurst-Lawrence
11. Meadowmere (three parts of Meadowmere were designed and screened)
12. Rosedale
13. Head of Bay

Various feature types were developed which mostly focused on smaller, targeted perimeter measures, to include NNBFs. The Head of Bay HFFRRF included a large in-water gate to block storm surge and tidal flooding for smaller events, which would reduce flood risk for the entire area behind the gate. However, smaller HFFRRFs were also developed and analyzed for neighborhoods in Nassau County that would be covered by the Head of Bay gate should that not pass the initial screening (which it did not).

The Old Howard Beach HFFRRF also included in-water gates to block surge from entering the canals and inundating the communities that live along and adjacent to the canals. A rough estimate of the cost to construct bulkheads along the shorelines in this community instead was also prepared, but it was determined to be more expensive than the gate measure and was therefore not developed further.

The elevations of the top of features to reduce risk for a current 10% AEP flood vary based on the ground elevation and local topography of the various HFFRRF sites as well as expected wave exposure. For example, a very low-lying area with high wave exposure would need a higher feature to provide the same level of risk reduction as a feature on higher ground with low wave exposure. The features are all designed to the same flood event to avoid a "weak" point in the alignment where overtopping would occur first.

For the Cedarhurst-Lawrence location, the canal behind Park Lane in Cedar Bay Park east of the proposed Cedarhurst-Lawrence HFFRRF was also analyzed but does not appear to be contributing to the vast majority of the current inundation problems. In fact the analysis showed that the western canal where the HFFRRF is proposed contributes to flooding south of the Peninsula Boulevard and east of Arlington Road using the design conditions stated above and that the majority of the flooding east of Park Lane does not appear to be originating from the canal's low lying shorelines. There is a planned pump station to be built by the Governor's Office of Storm Recovery which will help to address the residual flood issues east of Park Lane. Therefore no HFFRRFs were proposed along the eastern canal just east of Lawrence High School.

5.11.1 Prototypical Designs, HFFRRF Placements and Cost Estimates

In order to evaluate and screen the HFFRRFs, prototypical designs as well as cost per linear foot estimates were developed for each type of HFFFRF (low floodwall, medium floodwall, low bulkhead, etc.). The features were aligned based on the existing space and elevations in order to reduce risk for the most amount of people and infrastructure, while avoiding adverse impacts to existing habitats. The linear feet and thus costs were then calculated for each proposed HFFRRF (See Engineering Appendix).

These initial costs did not include real estate or interior drainage costs since it is time consuming and can be complicated to estimate these costs. The rationale was that the cost to obtain all necessary LRRDDS and to drain any interior stormwater resulting from the project would be assessed for the HFFRRFs that made it through the initial screening. If a project is not economically viable without those costs included, then it certainly would not be viable with them included and doing the screening in two phases was more efficient.

5.11.2 HFFRRF CSRM Benefits

In support of the first round of screening of the HFFRRF projects the economic benefits were analyzed. The without-project annual and equivalent annual damage for areas initially identified

as potential HFFRRF locations were calculated in HEC-FDA assuming the intermediate sea level change scenario. For Phase 1 screening purposes, the Coastal Storm Risk Management (CSRM) benefits were estimated based on truncation all damages below the design still water level and there was no analysis of residual interior flooding. Benefits modeling is detailed in the Economic Benefits Appendix (Appendix B).

5.11.3 Preliminary HFFRRF Screening Results

Four sites passed the preliminary screening, which is summarized in Table 5-15. The sites that passed the preliminary screening are:

1. Mid-Rockaway—this is the largest of the HFFRRF sites considered and includes a total of 1,505 structures in Hammels, Arverne, and Edgemere neighborhoods. The Mid-Rockaway design includes multiple NNBF locations and passed the initial screening with a BCR of 1.8.
2. Canarsie—this HFFRRF location in Brooklyn was designed to reduce flood risk for 222 structures and passed the initial screening with a BCR of 3.4.
3. Cedarhurst-Lawrence—located in Nassau County in the Village of Cedarhurst and the Town of Hempstead, adjacent to Lawrence High School. This HFFRRF would manage risk to 128 structures and had an initial BCR of 8.3.
4. Motts Basin North—The Motts Basin North HFFRRF would help manage risk for frequent flooding for 18 structures and had an initial BCR of 1.8. This site originally included an NNBF as part of the design, but upon closer consideration the existing habitat was considered to be high functioning mudflats, which provide some NNBF habitat and function already and would be adversely impacted if this habitat were converted to intertidal marsh. Therefore, the NNBF part of the design was removed.

Ten sites were screened out because their preliminary BCRs were less than one, meaning it would cost more to build and maintain the HFFRFF than the benefit to the national economy from the coastal damage reduction that the HFFRRF would provide. The sites that were screened out in the preliminary screening as not economically justified included Bayswater, Norton Basin, Motts Basin South, Inwood Marina, Head of Bay, three sites in Meadowmere, Rosedale, and Broad Channel. Finally, the Old Howard Beach project had a BCR of 1.0, which is technically positive. However, this did not include real estate and interior drainage costs. Once those costs were added, the BCR is very like to decrease below unity.

Additionally, for the Howard Beach (inclusive of Hamilton Beach) area, the total project cost is estimated to exceed $259 million (without real estate and interior drainage costs). Part of the rationale for formulating and building HFFRRFs in the first place was that they would complement a storm surge barrier solution and would reduce the frequency with which the proposed storm surge barrier across Rockaway Inlet would need to be closed. Frequent closure of storm surge barriers has been shown to greatly increase the cost to both operate and maintain them, given the increased wear and tear of operation (personal communication with barrier operators, 2018). It thereby follows that a sizable civil works investment for Old Howard Beach that would incur expensive operations and maintenance itself is at odds with the objective of constructing HFFRRFs to reduce the frequency with which a barrier would need to be operated and the associated costs (and potential environmental impacts) of frequent operation.

However, if the NYNJHAT Study does not recommend an alternative that addresses risk from large storms and storm surge entering Jamaica Bay, then this Old Howard Beach alternative would warrant further investigation. A CSRM alternative for Old Howard Beach with a more comprehensive objective to manage coastal storm risk for a full suite of storms—both large and small—is likely to result in a larger plan that would optimize the net benefits for this area. Namely, the in-water gates that were considered to keep surge out of the canals at Old Howard Beach and Hamilton Beach could be sized up, which would increase the benefits of such a plan. This analysis has been deferred to the NYNJHAT Study.

Table 5-15: HFFRRF Preliminary Screening Results ($000)

Project	Annual Benefits*	Annual Costs**	Net Benefits*	BCR	Passed (Y/N)	Number Structures
Canarsie	1,244	367	877	3.4	YES	222
Mid-Rockaway +	9,086	5,040	4,046	1.8	YES	1,505
Motts Basin North	137	77	60	1.8	YES	18
Old Howard Beach	10,892	10,719	173	1.0	NO++	986
Bayswater +	16	225	-209	0.1	NO	9
Norton Basin +	29	828	-799	0.0	NO	19
Motts Basin South +	281	1,055	-774	0.3	NO	118
Inwood Marina	343	553	-210	0.6	NO	60
Head of Bay Gate	14,422	32,423	-18,001	0.4	NO	1,368
Cedarhurst- Lawrence	2,936	352	2,584	8.3	YES	128
Meadowmere	523	1,814	-1,291	0.3	NO	99
Meadowmere North	579	1,399	-820	0.4	NO	38
Meadowmere East	324	565	-241	0.6	NO	25
Rosedale	348	423	-75	0.8	NO	104
Broad Channel	3,237	10,622	-7,385	0.3	NO	764

\+ NNBF included in potential project evaluation
* Benefits were calculated using April 2018 price levels, with a discount rate of 2.75%.
** Costs were calculated using first quarter 2018 price levels.

5.12 HFFRRF Interior Drainage Analysis

Additional analyses were completed in the next phase to progressively converge to higher level of detail after completion of the preliminary screening. The second phase of the screening included:

- *An analysis of existing drainage infrastructure and an analysis of impacts to the existing drainage system as a result of the construction of HFFRRF Projects.*

  The reason this is needed is that a CSRM alignment keeps water from the bay from entering the adjoining neighborhoods, but it also can have the unintended effect of keeping stormwater from within the neighborhood from draining back out into the bay after it rains or the alignment overtops. Therefore the project must assess whether the existing drainage system can accommodate any changes to the interior drainage that would result from the project. If not, the project design must include a *Minimum Facility* improvement to deal with any increases in stormwater. See Section 6 of the HFFRRF Interior Drainage Appendix for more detail on the interior drainage analysis, which is summarized in this section (Section 5). Interior drainage analyses were conducted in accordance with USACE Policy Guidance Letter No. 37, which clarifies the proper classification of interior drainage facilities as either project components or betterments.

- *A cost estimate to account for modifications to the existing drainage infrastructure and/or construction of new drainage infrastructure as part of the HFFRRF projects*

  An explanation of how these cost estimates were developed can be found in the Interior Drainage Sub-Appendix E to the Engineering and Design Appendix A.

- *Analysis of wave height for the project areas and establishing the required freeboard for the features and the height of the rock sills for the NNBFs*

  Part of the wave analysis was to provide guidance on the elevation of the rock sill such that it is capable of protecting existing and newly established marsh during normal operational events and to minimize the cumulative impact of storms for a 1-2 year period. Following the guidance in Miller et al, 2016, the Sub-Appendix A2-D describes sill height estimates using wave modeling analysis to protect the habitat during normal operational periods, keeping the transmitted wave height at 0.5 feet or less except during extreme storms. Freeboard heights were also calculated using the wave modeling and freeboards were reduced based on the wave attenuation provided by the rock sills.

- *A more detailed analysis of the potential impacts to wetland habitat and a more detailed analysis of the NNBF designs that are part of the screened HFFRRF Projects*

  Site visits were conducted at each HFFRRF site that passed the preliminary screening and the HFFRRFs were adjusted to minimize any potential impacts to wetlands from the footprint of the CSRM alignments. The NNBF designs were further analyzed and refined to help inform the environmental impact analysis described in Sections 6 and 7 of this HSGRR/EIS.

- *Rough costs to acquire all necessary LRRDDS for the HFFRRFs were developed and included in the final screening.*

  The Real Estate Appendix details the analysis that was done pertaining to real estate for this project.

- *Non-structural (buyouts, relocations, home raising) measure evaluation for Broad Channel*

  When the structural measure for Broad Channel did not pass the preliminary screening, the PDT also investigated the feasibility of implementing non-structural measures on Broad Channel since the *Build it Back* program has had a high success rate there and raised approximately half of the homes on Broad Channel. Also, Broad Channel has the worst risk of high frequency flooding in the study area, as it becomes almost completely inundated at the current 20% AEP, while most of the other areas are inundated during the current 10% AEP flood. The non-structural plan was ultimately screened out and the rationale is described in Section 5.17.

5.12.1 Minimum Facility Concept

As stated in U.S. Army Corps of Engineers EM 1110-2-1413, "Hydrologic Analysis of Interior Areas", the design *Minimum Facility* should provide interior flood relief such that during low exterior stages (at gravity conditions for normal astronomic tide) the local storm drainage system (typical 10-year design storm) functions essentially as it would without the Coastal Storm Risk Management System in place.

The Minimum Facility is intended to ensure that the existing drainage system performs the same with and without the project put in place as to avoid induced flood damages. This is the starting point from which all additional interior drainage alternatives can be evaluated. Additional interior drainage measures may be designed to further reduce interior water levels beyond the Minimum Facility. These additional interior facilities must be incrementally justified.

5.12.2 National Economic Development for Interior Drainage Facilities

The benefits accrued from interior drainage alternatives are attributable to the reduction in the residual flood damages that may have remained under the Minimum Facility condition. Finally, a preferred drainage alternative is selected based on meeting National Economic Development (NED) objectives.

Interior Drainage Plan Formulation

The formulation of interior plans was an iterative process that considered a full range of measures for each drainage area. Only measures that are reasonably likely to meet the Minimum Facility or NED criteria discussed above were considered at any location. In areas with relatively low damage, the construction of expensive pump stations or large excavated ponds were not considered. Given the relatively low-lying elevations in the Bayside communities, the relatively high water table, and very limited space for natural ponding/stormwater surface storage, green infrastructure measures such as rain gardens, bioswales were not deemed to have sufficient capacity to meet the Minimum Facility in this area. Each minimum facility plan for the HFFRRFs includes modification of existing gravity outlets to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipe will be replaced if the design phase indicates it is necessary due to the condition of the pipe or a need for additional capacity.

5.12.3 Mid-Rockaway HFFRRF Project

The Mid-Rockaway project area covers approximately 1,135 acres and includes three drainage basins: Hammels, Arverne, and Edgemere. The following sections describe the process of the interior drainage plan formulation.

5.12.3.1 Hammels Area

The Hammels drainage basin is almost fully developed, except for a few scattered grassy areas and is predominantly residential, with some commercial development. Two pump stations are proposed to handle the interior drainage in this area. The Minimum Facility plan for the Hammels drainage basin consists of six gravity outlets (including three existing outlets) through the line of flood protection that will drain the system when the pump stations are not being operated. Each of the existing outlets will be modified to prevent high tides or storm surge from flooding through the drainage system. The proposed pump station for Subbasin H1 has the capacity to drain approximately 100 cubic feet per second (cfs) and would be located at the southern end of Hammels near Beach 87th Street. The proposed pump station for subbasin H2 would have approximately 180 cfs capacity and would be located at the northern end of Hammels near Beach Channel Drive. Table 5-16 shows the evaluation of the pump alternatives considered for the Hammels portion of Mid-Rockaway.

Table 5-16: Summary of Alternatives for Hammels Drainage Basin of the Mid-Rockaway HFFRRF

Items	Subbasin H1	Subbasin H2	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative2*
Damage ($)	209,280	333,290	249,500
Benefits ($)	674,320	384,920	468,710
Pump Size (cfs)	100	160	180
Pump Cost ($)	4,688,500	5,561,900	6,200,666
Annualized Pump Cost ($)	173,670	206,020	229,680
Annual O&M Cost ($)	93,800	111,200	124,000
Total Annual Pump Cost ($)	267,470	317,220	353,680
Net Benefits ($)	406,850	67,700	115,030
Benefit to Cost Ratio	2.5	1.2	1.3

* denotes the Preferred Plan
50-year period of analysis, 2.75% discount rate, October 2017 price levels
O&M costs include interest during construction and annual costs include annualized replacement costs (see Cost Appendix for more information)

Table 5-17 shows the proposed location of the gravity outlets for Hammels.

Table 5-17: Preferred Plan Gravity Outlets for Hammels

Hammels Subbasin	Gravity Outlets Description
H1	Existing Outlet ROC-656
H1	Proposed Outlet H1-1, approximately 70 feet east of Beach 85th Street
H1	Existing Outlet ROC-657
H2	Proposed Outlet H2-1, approximately 350 feet west of Beach 80th Street
H2	Proposed Outlet H2-2, approximately 100 feet west of Beach 79th Street
H2	Existing Outlet ROC-653

Note: Size and location of gravity outlets will be refined during the project design phase

The Equivalent Annual Damages (EAD) for the Hammels drainage basin with the Preferred Plan in place is estimated to be approximately $460,000, which is a roughly $1.1 million reduction in annual damages compared to the Minimum Facility condition.

5.12.3.2 Arverne Area

The Arverne drainage basin has three subbasins A1, A2, and A3, covering approximately 76 acres, 139 acres, and 209 acres, respectively. The Arverne drainage basin is almost fully developed and predominantly residential, with a few scattered and undeveloped areas.

The Minimum Facility plan for the Arverne drainage basin consists of 16 gravity outlets through the line of flood protection (including eight existing). Each of the existing outlets will be modified to prevent high tides or storm surge from flooding through the drainage system. Three pump stations are also proposed which would drain the system when the outlets become overwhelmed. Table 5-18 summarizes the analysis of the pump alternatives in Arverne at Mid-Rockaway. Pump Alternative 1, with an estimated pump capacity of 70 cfs, is the Preferred Plan for Subbasin A1. The proposed pump station for Subbasin A1 would be located adjacent to De Costa Avenue, near Beach 72nd Street. Pump Alternative 2, with an estimated pump capacity of 180 cfs, is the Preferred Plan for Subbasin A2. The proposed pump station for Subbasin A2 would be located on De Costa Avenue, near Beach 63rd Street. Pump Alternative 2, with an estimated pump capacity of 300 cfs, is the Preferred Plan for Subbasin A3. The proposed pump station for Subbasin A3 would be located south of Thursby Avenue.

Table 5-18: Summary of Interior Drainage Alternatives Considered for Arverne

Items	Subbasin A1	Subbasin A2		Subbasin A3	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
Damage ($)	103,810	491,420	213,570	952,840	566,400
Benefits ($)	192,810	752,610	1,030,460	1,122,830	1,509,270
Pump Size (cfs)	70	120	180	200	300
Pump Cost ($)	2,532,200	4,246,700	6,200,666	6,200,700	9,769,642
Annualized Pump Cost ($)	93,800	157,300	229,680	229,680	361,880
Annual O&M Cost ($)	50,600	84,900	124,000	124,000	195,400
Total Annual Pump Cost ($)	144,400	242,200	353,680	353,680	557,280
Net Benefits ($)	48,410	510,410	676,780	769,150	951,990
Benefit to Cost Ratio	1.3	3.1	2.9	3.2	2.7

* denotes the Preferred Plan

50-year period of analysis, 2.75% discount rate, October 2017 price levels

O&M costs include interest during construction and annual costs include annualized replacement costs (see Cost Appendix for more information)

Table 5-19 shows the proposed gravity outlets for the Arverne area of Mid-Rockaway.

Table 5-19: Preferred Plan Gravity Outlets for Arverne

Arverne Subbasin	Gravity Outlets Description
A1	Existing Outlet ROC-633
A1	Existing Outlet ROC-634
A1	Existing Outlet TEMP40062
A1	Proposed Outlet A1-1, located at the end of Hillmeyer Avenue
A1	Proposed Outlet A1-2, located adjacent to Hillmeyer Avenue and Barbadoes Avenue
A1	Existing Outlet ROC-658
A1	Proposed Outlet A1-3, located 250 feet west of Beach 69th Street
A1	Existing Outlet ROC-659
A2	Proposed Outlet A2-1, located on Bayfield Avenue 150 feet west of Beach 65th Street
A2	Proposed Outlet A2-2, located at the east end of De Costa Avenue
A2	Proposed Outlet A2-3, located at the east end of Burchell Road
A3	Existing Outlet, located at the east end of Thursby Avenue
A3	Existing Outlet ROC-636
A3	Proposed Outlet A3-1, located 250 north of Beach Channel Drive on 58th Street
A3	Existing Outlet ROC-635
A3	Proposed Outlet A3-2, located 50 feet south of Beach Channel Drive on 58th Street

Note: Size and location of gravity outlets will be refined during the project design phase

The Equivalent Annual Damages (EAD) for the Arverne drainage basin with the Preferred Plan in place is estimated to be approximately $885,000, which is a roughly $2.7 million reduction in annual damages compared to the Minimum Facility condition.

5.12.3.3 Edgemere Area

The Edgemere drainage basin has two subbasins, E1 and E2 covering approximately 194 acres and 274 acres, respectively. The Edgemere drainage basin is almost fully developed and predominantly residential, except for a stretch of undeveloped, grassy area along the southern part of E1 and southwestern part of E2.

The Minimum Facility plan for the Edgemere drainage basin consists of 15 gravity outlets through the line of flood protection, including three existing. Each of the existing outlets will be modified to prevent high tides or storm surge from flooding through the drainage system. In addition to the gravity outlets, three pump stations are proposed for Edgemere. Due to the length of the subbasin along the line of protection and the difficulty in draining all of runoff to a single location, two pump stations are proposed for Subbasin E1, with a combined capacity of about 210 cfs. One pump station would be located near Norton Avenue and Beach 49th Street and the other near Beach 43rd Street and Hough Place. Pump Alternative 2, with an estimated pump capacity of 120 cfs, is the Preferred Plan for Subbasin E2. The proposed pump station for Subbasin E2 would be located near Beach 38th Street. Table 5-20 summarizes the pump alternatives evaluated for Edgemere.

Table 5-20: Summary of Interior Drainage Alternatives Considered for Edgemere

Items	Subbasin E1		Subbasin E2	
	Pump Alternative 1	Pump Alternative 2 (split between two stations)*	Pump Alternative 1	Pump Alternative 2*
Damage ($)	462,550	263,520	137,050	238,420
Benefits ($)	1,018,700	1,217,730	400,060	298,690
Pump Size (cfs)	140	210	180	120
Pump Cost ($)	4,910,600	7,135,270	6,200,700	4,246,738
Annualized Pump Cost ($)	181,890	264,300	229,680	157,300
Annual O&M Cost ($)	98,200	142,700	124,000	84,900
Total Annual Pump Cost ($)	280,090	407,000	353,680	242,200
Net Benefits ($)	738,610	810,730	46,380	56,490
Benefit to Cost Ratio	3.6	3.0	1.1	1.2

* denotes the Preferred Plan
50-year period of analysis, 2.75% discount rate, October 2017 price levels
O&M costs include interest during construction and annual costs include annualized replacement costs (see Cost Appendix for more information)

Table 5-21 lists the gravity outlets proposed for Edgemere.

Table 5-21: Preferred Plan Gravity Outlets for Edgemere

Edgemere Subbasin	Gravity Outlets Description
E1	Existing Outlet ROC-648
E1	Proposed Outlet E1-1, located on Norton Avenue between Beach 47th and 48th Streets
E1	Proposed Outlet E1-2, located on Norton Avenue between Beach 46th and 45th Streets
E1	Proposed Outlet E1-3, located on Beach 45th Street north of Hough Place
E1	Proposed Outlet E1-4, located on the north end of Beach 45th Street
E1	Proposed Outlet E1-5, located adjacent to Beach 43rd Street, 550 feet north of Hough Place
E1	Proposed Outlet E1-6, located adjacent to Beach 43rd Street, 500 feet north of Hough Place
E1	Existing Outlet ROC-637
E1	Proposed Outlet E1-7, located 700 feet north of Beach 40th Street
E2	Existing Outlet ROC-638
E2	Proposed Outlet E2-1, located 50 feet east of Beach 37th Street
E2	Proposed Outlet E2-2, located 50 feet east of Beach 37th Street
E2	Proposed Outlet E2-3, located 50 feet east of Beach 36th Street
E2	Proposed Outlet E2-4, located 50 feet east of Beach 36th Street
E2	Proposed Outlet E2-5, located between Beach 36th Street and Beach 35th Street

Note: Size and location of gravity outlets will be refined during the project design phase

The Equivalent Annual Damages (EAD) for the Edgemere drainage basin with the Preferred Plan in place is estimated to be approximately half a million dollars, which is a roughly $1.5 million reduction in annual damages compared to the Minimum Facility condition.

5.12.4 Canarsie HFFRRF Project

The Canarsie drainage basin has three subbasins C1, C2, and C3, covering approximately 120 acres, 69 acres, and 84 acres, respectively. The Canarsie drainage basin is completely developed and predominantly residential, with some commercial development.

The Minimum Facility plan for the Canarsie drainage basin consists of gravity outlets through the line of flood protection. Subbasin C1 was estimated to require 4 gravity outlets, Subbasin C2 was estimated to require 2 gravity outlets, and Subbasin C3 was estimated to require 5 gravity outlets. Each existing outlet would be modified to prevent high tides or storm surge from flooding through the drainage system. Pump Alternatives 1 and 2 for Subbasin C1 consist of pump stations with a total capacity of about 70 cfs and 150 cfs, respectively along with 4 gravity outlets. Pump Alternative 1 for Subbasin C2 consists of 2 gravity outlets and a pump station with a total capacity of about 56 cfs. Pump Alternative 1 for Subbasin C3 consists of 5 gravity outlets and a pump station with a total capacity of about 84 cfs.

Table 5-22: Summary of Interior Drainage Alternatives Considered for Canarsie

Items	Subbasin C1		Subbasin C2	Subbasin C3
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 2
Damage ($)	976,550	360,580	108,760	222,760
Benefits ($)	583,440	1,199,410	98,460	361,800
Pump Size (cfs)	70	150	56	84
Pump Cost ($)	3,314,900	3,851,340	2,664,200	3,959,400
Annualized Pump Cost ($)	122,790	142,660	98,680	146,660
Annual O&M Cost ($)	66,300	77,000	53,300	79,200
Total Annual Pump Cost ($)	189,090	219,660	151,980	225,860
Net Benefits ($)	394,350	979,750	-53,520	135,940
Benefit to Cost Ratio	3.1	5.5	0.65	1.6

50-year period of analysis, 2.75% discount rate, October 2017 price levels
O&M costs include interest during construction and annual costs include annualized replacement costs
(see Cost Appendix for more information)

Based on the evaluation of the interior water surface elevation and net benefits, no interior drainage plan that would result in a HFFRRF with a BCR above 1.0 was identified. Accordingly there is not a Preferred Drainage Plan identified for the Canarsie drainage basin. Even with the pumps and improved gravity outlet drainage system, flood elevations for a 50% AEP rainfall occurring with the design storm tide are only reduced between .1 and .2 feet. More information on the interior drainage analysis for Canarsie can be found in the HFFRRF Interior Drainage Appendix. Since residual flooding remains high for the Canarsie HFFRRF, NED benefits from the plan are not high enough to justify the federal investment, and the BCR for the whole HFFRRF drops below one despite individual pump stations at Canarsie having a positive BCR.

The Equivalent Annual Damages (EAD) for the Canarsie project area, with Minimum Facility measures in place, is estimated to be approximately 2.35 million dollars.

5.12.5 Cedarhurst-Lawrence HFFRRF Project

The Cedarhurst-Lawrence drainage basin covers approximately 64 acres. The Cedarhurst-Lawrence drainage basin is fully developed and predominantly residential, with some commercial development.

The Minimum Facility plan for the Cedarhurst-Lawrence drainage basin consists of four gravity outlets through the line of flood protection, including three existing outlets in the area where the bulkhead will be raised. Each of the existing outlets will be modified to prevent high tides or storm surge from flooding through the drainage system. Based on the evaluation of the interior water surface elevations and net benefits, Pump Alternative 1, with an estimated pump capacity of 90 cfs, is the Preferred Plan for the Cedarhurst-Lawrence drainage basin (Table 5-23). The proposed pump station for E1 would be located approximately 260 feet north of Plaza Road.

Table 5-23: Summary of Interior Drainage Alternative Considered for Cedarhurst-Lawrence

Items	Pump Alternative 1*
Damage ($)	49,250
Benefits ($)	536,860
Pump Size (cfs)	90
Pump Cost ($)	4,233,800
Annualized Pump Cost ($)	156,820
Annual O&M Cost ($)	84,700
Total Annual Pump Cost ($)	241,520
Net Benefits ($)	295,340
Benefit to Cost Ratio	2.2

* denotes the Preferred Plan

50-year period of analysis, 2.75% discount rate, October 2017 price levels

O&M costs include interest during construction and annual costs include annualized replacement costs (see Cost Appendix for more information)

The proposed gravity outlets are listed in Table 5-24.

Table 5-24: Preferred Plan Gravity Outlets for Cedarhurst-Lawrence

Cedarhurst-Lawrence Subbasin	Gravity Outlet Description
L1	Existing Outlet
L1	Existing (recently constructed) culvert, located approximately 100 feet north of Peninsula Boulevard and 150 feet west of Oxford Road
L1	Existing (recently constructed) culvert, located approximately 100 feet north of Peninsula Boulevard and 200 feet west of Oxford Road
L1	Proposed Outlet L-1, located approximately 250 feet from Peninsula Boulevard

Note: Size and location of gravity outlets will be refined during the project design phase

The Equivalent Annual Damages (EAD) for the Cedarhurst-Lawrence drainage basin with the Preferred Plan in place is estimated to be approximately $50,000, which is a roughly $540,000 reduction in annual damages compared to the Minimum Facility condition.

5.12.6 Motts Basin North HFFRRF Project

The Motts Basin North project area has a single subbasin covering approximately 28 acres. The Motts Basin North drainage basin is almost fully developed and predominantly residential, with some commercial development and a wooded area in the southeastern part of the subbasin. The Minimum Facility plan for the Motts Basin North drainage basin consists of retrofitting one existing gravity outlet which will be modified to prevent high tides or storm surge from flooding through the drainage system.

A pump station for Motts Basin North was evaluated. However, based on the analysis of the interior water surface elevations and net benefits, the pump alternative was found to have a negative net benefit and hence was eliminated from further consideration. The Preferred Plan for the Motts Basin North project (which is the Minimum Facility) consists of one retrofitting the existing gravity outfall as discussed above.

The Equivalent Annual Damages (EAD) for Motts Basin North project area with the Preferred Plan in place (i.e., the Minimum Facility condition) is estimated to be approximately $85,000.

5.13 Summary of Interior Drainage Economics for the Recommended Plan

Table 5-25 summarizes the twelve interior drainage alternatives that were considered for the HFFRRFs.

Table 5-25: Interior Drainage Alternatives Evaluated

Drainage Subbasin	Minimum Facility	Pump Alternative 1	Pump Alternative 2
Hammels H1	Gravity Outlets	Gravity Outlets + 100 cfs Pump Station	N/A
Hammels H2	Gravity Outlets	Gravity Outlets + 160 cfs Pump Station	Gravity Outlets + 180 cfs Pump Station
Arverne A1	Gravity Outlets	Gravity Outlets + 70 cfs Pump Station	N/A
Arverne A2	Gravity Outlets	Gravity Outlets + 120 cfs Pump Station	Gravity Outlets + 180 cfs Pump Station
Arverne A3	Gravity Outlets	Gravity Outlets + 200 cfs Pump Station	Gravity Outlets + 300 cfs Pump Station
Edgemere E1	Gravity Outlets	Gravity Outlets + 140 cfs Pump Station	Gravity Outlets + 210 cfs Pump Station
Edgemere E2	Gravity Outlets	Gravity Outlets + 180 cfs Pump Station	Gravity Outlets + 120 cfs Pump Station
Canarsie C1	Gravity Outlets	Gravity Outlets + 70 cfs Pump Station	Gravity Outlets + 150 cfs Pump Station
Canarsie C2	Gravity Outlets	Gravity Outlets + 56 cfs Pump Station	N/A
Canarsie C3	Gravity Outlets	Gravity Outlets + 84 cfs Pump Station	N/A
Cedarhurst-Lawrence L1	Gravity Outlets	Gravity Outlets + 90 cfs Pump Station	N/A
Motts Basin North M1	Gravity Outlets	Gravity Outlets + 26 cfs Pump Station	N/A

The effect on residual flooding for each alternative was modeled in order to assess how the interior drainage would perform under various with-project scenarios based on the alternatives presented in 5-28. Then the cost-to-benefit analysis was performed in order to help identify the preferred plan for interior drainage at each HFFRRF site. Table 5-28 summarizes the economics of the interior drainage plans for the HFFRRFs included in the Recommended Plan. All sites but Motts Basin North need pump stations in order to for the project to function as intended. The Canarsie HFFRRF had very high residual flooding, even with the interior drainage plans in place, which ultimately contributed to Canarsie being screened out of the Recommended Plan. The pump stations included in the Recommended Plan to address high frequency flooding will need to be operated and maintained by the local sponsor, which in these cases has been identified as New York City for Mid-Rockaway and the Village of Cedarhurst for the Cedarhurst-Lawrence HFFRRF.

Table 5-26: Summary of Preferred Plans for the Project Areas

Project Area	Preferred Plans[1]	First Cost	O&M Cost[2]	Total Annual Cost[3]	Annual Benefits	Net Benefits
Mid-Rockaway (Hammels, Arverne, and Edgemere Drainage Basins)						
Hammels	H1 - 100 cfs pump H2 - 180 cfs pump	$10,889,000	$218,000	$621,200	$1,143,000	$521,800
Arverne	A1 - 70 cfs pump A2 - 180 cfs pump A3 - 300 cfs pump	$18,503,000	$370,000	$1,055,400	$2,732,600	$1,677,200
Edgemere	E1 - 210 cfs pump E2 - 120 cfs pump	$11,382,000	$227,600	$649,200	$1,516,400	$867,200
Cedarhurst -Lawrence	L1 - 90 cfs pump	$4,233,800	$84,700	$241,500	$536,900	$295,400
Motts Basin North	M1 - Minimum Facility	N/A	N/A	N/A	N/A	N/A
Totals		**$45,007,800**	**$900,300**	**$2,567,300**	**$5,928,900**	**$3,361,600**

50-year period-of-analysis, 2.75% Federal Discount Rate, October 2017 price level
[1]Preferred Plans with a pump station also include gravity outlets
[2]Includes IDC and O&M Costs
[3]Includes Annualized Replacement Costs (See Cost Appendix)

5.14 Wave Height Analysis for HFFRRFs

Wave-height statistics were derived from the USACE (2015) North Atlantic Comprehensive Coastal Study (NACCS) database. As part of the NACCS, estimates of nearshore winds, waves, and water-levels, as well as the associated marginal and joint probabilities were evaluated. This was achieved by simulating a selected suite of tropical and extra-tropical storms to characterize the regional storm hazard. The modeling suite consisted of an offshore wave model (WAM) for simulation of deep-water waves, which were subsequently used to generate boundary conditions for a near-shore steady state wave model STWAVE. The STWAVE model for near-shore waves also allowed for simulation of local wind-generated waves, and was paired with the hydrodynamic circulation model ADCIRC to allow for dynamic interaction between surge and waves. While the ADCIRC model mesh extends across the western North Atlantic with approximately 3.1 million nodes, the nearshore wave model STWAVE is applied over ten domains from coastal Virginia to

Maine, including one in the upper New York Bight area. A suite of 1,150 storms including 100 extratropical events, and 1,050 synthetic tropical events were simulated for the NACCS production.

The design wave-height at each HFFRRF alignment was updated subsequent to the preliminary screening using the simulated wave-height at the feature from wave modeling that was performed.

The Simulation of Waves Nearshore (SWAN) model (Booij et al, 1996) was used to simulate the transformation of waves along 1-D transects from boundary points within the Bay to the corresponding project alignment features. The bathymetric data for the modeling was derived from high-resolution (1/9 arc seconds or 10 feet) resolution topo-bathy Digital Elevation Models (DEMs) developed by NOAA, post- Hurricane Sandy in 2012.

A map of the features denoting the updated wave-heights is shown in Figure 5-13. Wave heights range from zero to three feet. The corresponding required freeboards for the HFFRRFs were set using the overtopping criterion of one liter per second per meter.

In addition, the wave model was also applied to optimize the design of the *natural and nature-based features* (NNBFs), which are proposed to accompany select project features. Specifically, the wave model was further applied to optimize the elevation of rock-sills that are part of the Natural and Nature Base Features with the goal of minimizing wave impacts on the wetland vegetation and the berm. Following the guidance in Miller et al, 2016, a target transmitted wave-height across the feature sills of half a foot or less under operational conditions was deemed necessary to protect the habitat on the leeward side of the sill. The higher the sill, the greater the protection, however, higher sills translate into greater costs and could increase visual nuisance. It should be stressed that the rock sill in combination with a healthy wetland habitat on the landward side will provide wave protection (wave height reduction) during the design conditions (5 year Return Period water level and waves) for the berm feature. I.e. the rock sill allows for a reduction in freeboard and lower crest elevation for the upland situated berm feature. Compared to the "without rock sill scenario" the freeboard reduction is approximately 1.5 feet for a rock sill with a 4.5 foot crest elevation.

The Feasibility-level design of the rock sill is positioned at a base elevation of -2' NAVD88, a sill slope of 1 in 3, and a crest width of 6'. The NNBF area behind the sill was set at a 1 in 40 slope. Although it is recognized that the actual configuration of the NNBF rock sill and leeward wetlands and berm will vary once preliminary designs are completed, the focus of this analysis was on the transmitted wave height. The transmitted wave height is mainly a function of the incoming wave height, the bay-side bathymetric profile and the crest geometry of the rock sill. As such the schematic representation of the landward profile was deemed acceptable for the feasibility study.

The analyses documented in Sub-Appendix A2-D demonstrates a 4.5 to 5.5 foot sill will be sufficient to achieve the target wave conditions for the NNBFs, which may only be expected to be exceeded at an acceptable average rate of once in two years. This design will be further refined in the PED Phase.

Figure 5-13: Calculated Wave-heights at HFFRRF Alignments

5.15 Real Estate Considerations

The HFFRRFs were aligned, wherever possible, to avoid impacting structures, particularly occupied structures, such that homes would not need to be condemned involuntarily. Since New York City is engaged in a robust program called *Build it Back* to help with storm recovery and improve the resiliency of structures, they have been actively offering both buyouts, relocations, and house raisings throughout the project area and thus the assumption was made that if a resident had not opted in to this program for a buyout or relocation, they would be unlikely to do so for a USACE relocation. However, where *Build it Back* has already purchased and removed homes from the floodplain, the HFFRF alignments were configured to enable these areas to be restored to active floodplain, and in many cases for Mid-Rockaway become part of the NNBF designs.

In order to build the recommended HFFRRF plans, 193 construction and maintenance easements on private parcels and 64 on public parcels would need to be acquired. Additionally, three private commercial structures and six public parcels would need to be acquired in fee.

5.16 Cost Effectiveness of NNBFs

The NNBF is an integral design feature to control erosion. However, it is also a cost effective design when compared to alternative gray features that could have been included in this area. Table 5-27 demonstrates the cost effectiveness of the NNBF approach when compared to a floodwall in the same area for those NNBF sites considered. However, even these numbers underestimate the cost of the gray features, or floodwalls, because they do not include the cost to mitigate these less

environmentally friendly designs. The inclusion of marshes in our NNBF designs has allowed our HFFRRFs to be self-mitigating, since the marshes added exceed the impacts to marshes from the construction of the HFFRRFs (this is discussed in detail in Chapter 7). Furthermore, the benefits for the NNBFs are underestimated because though researchers have demonstrated the myriad benefits of NNBFs, such as wave attenuation and reduced operations and maintenance (O&M) costs, these CSRM benefits remain difficult to quantify. If the NNBFs as currently evaluated were not shown to be economically justified, the study team could attempt to quantify the additional benefits provided by wave attenuation and reduced long-term O&M. However, since this design is already economically justified and cost effective when compared to alternative designs, there is no need to perform additional analysis at this time.

Table 5-27: NNBF Cost Effectiveness When Compared to Gray Feature Alternatives

Proposed Natural and Nature-Based Feature	Cost	Alternative Gray Feature	Cost Gray Feature (Difference)
Arverne 1: High Berm + Limited Seaward Marsh Extension	$ 2,907/LF	High Floodwall	$ 4,564/LF **excludes cost of mitigation*
Arverne 2: Low Berm + Limited Landward Marsh Extension	$ 1,935/LF	Medium Floodwall	$ 3,058/LF **excludes cost of mitigation*
Arverne 3: Low Berm + Full Seaward Marsh Extension	$ 2,288/LF	Low to Medium Floodwall	$ 1,589 - $ 3,058 **excludes cost of mitigation*
Edgemere: High Berm + Full Landward Marsh Extension	$ 3,055/LF	High Floodwall	$ 4,564/LF **excludes cost of mitigation*

* Price level for cost estimates is based on first quarter 2018.

Furthermore, NNBFs provide incidental benefits of improving ecosystems, filtering water, improving aesthetics, and more, which are not taken into account in the economic analysis for this study, but are important and relevant to communities, agencies, and decision makers nonetheless.

5.17 Non-Structural Screening for Broad Channel

In assessing whether a non-structural plan is feasible for Broad Channel, the USACE considered data from Build it Back work on Broad Channel. Roughly 50% of the homes on Broad Channel have been raised out of the 1% AEP floodplain through Build it Back. This information was used as input into the non-structural design, and in the evaluation of the plans. NYC indicated that the nature of the development on Broad Channel was such that many homes did not have sufficient structural integrity to be elevated without significant retrofits. NYC indicated that it was found to be more cost-effective to tear-down and rebuild, using modular structures. NYC also indicated that a challenge in elevating homes was the requirement to obtain a valid certificate of occupancy, and that this contributed to the rate of participation in the program.

Given this understanding of the conditions in Broad Channel, the non-structural plan was eliminated from consideration. The USACE does not support non-structural plans that consist of

a tear-down and rebuild, without additional cost-sharing from the homeowner. The USACE also requires that the homeowner is responsible for any costs necessary for a structure to obtain a valid certificate of occupancy, unless directly related to the elevation. Given that the Build it Back program was offered to a large percentage of the Broad Channel Community, and given that the costs that would be borne by the homeowner are greater in the Corps Project than in the NYC program, the PDT determined that a USACE non-structural alternative for Broad Channel would be unlikely to garner sufficient voluntary participation to recommend it for inclusion in the Recommended Plan, given its likely added cost to homeowners. If the full costs for retrofits were considered in the evaluation, it is also likely that this would eliminate the plan from consideration.

5.18 Final HFFRRF Screening Results

The second phase of the screening included an analysis of existing drainage infrastructure and an analysis of the Minimum Facility, which is intended to ensure that the existing drainage system performs the same with and without the project put in place as to avoid induced flood damages. Project Cost was calculated and included estimates to account for modifications to the existing drainage infrastructure and construction of new drainage infrastructure as part of the HFFRRF projects. In addition a more detailed analysis of the potential impacts to wetland habitat was completed and the project NNBF designs were further refined and planned in co-location with the flood risk reduction features in order to take advantage of their capacity to improve the function and resilience of the structural features. Along with the refinement of the project designs, the benefits modeling was updated and refined to accurately capture the changes in the project design. The inclusion of interior drainage features and pump stations resulted in changes in residual damages and thus changes in project benefits.

After completion of the benefits modeling and interior drainage optimization (see Sub-Appendix E) the Benefit Cost Ratio (BCR) was calculated. Screening results for the Phase 2 projects are presented in Table 5-28.

The results of the Phase 2 screening results, based on BCR, presented in Table 5-28 indicate that three (3) out of the four (4) projects are cost effective. Benefit estimates include the reduced damages as result of coastal flooding as well as a reduction in damages as a result of all interior flooding. The Canarsie project has a BCR below unity and is not selected to move forward. The other three project alternatives will be included in the Recommended Plan.

Cedarhurst-Lawrence passed the final screening with the highest BCR: 8.5. Mid-Rockaway is the largest plan in terms of the extent of risk reduction and also the cost, with an estimated cost of approximately $194 million. Cedarhurst-Lawrence is expected to cost approximately $13.6 million, while Motts Basin, the smallest of the HFFRRFs, is estimated to cost roughly $2.6 million.

Table 5-28: Phase 2 Economic Screening Results of the Jamaica Bay HFFRRFs

		Mid-Rockaway Bayside with NNBFs	Canarsie	Cedarhurst - Lawrence	Motts Basin North (no Pumps)
Damages					
Without Project					
Annual Damage		$44,304,000	$4,424,000	$12,655,000	$710,000
With Project					
	Line of Risk Reduction Damages	$30,585,000	$3,557,000	$6,858,000	$484,000
	Interior Drainage Damages	$1,845,000	$692,000	$643,000	$86,000
Annual Damages		$32,430,000	$4,249,000	$7,501,000	$570,000
Benefits					
Annual Benefits		$11,874,000	$175,000	$5,154,000	$140,000
Costs					
	Total with Project Cost	$194,009,000	$27,675,000	$13,573,000	$ 2,596,000
Annual Cost		$8,507,000	$1,262,000	$607,000	$111,000
Net Benefits					
Net Annual Benefits		$3,367,080	($1,087,000)	$4,547,000	$29,000
BCR		1.4	0.1	8.5	1.3

Note: Benefits were calculated using April 2018 price levels, with a discount rate of 2.75%. Price cost estimates were based on first quarter 2018 for screening level costs (when the screening occurred).

During the final cost analysis conducted to obtain cost certification for the Recommended Plan, the initial project costs for Motts Basin North increased by roughly 20% to over $3,991,000 with a total annualized cost of $170,000, bringing the BCR from 1.3 to 0.8, with net negative annual benefits of $30,000. Therefore the Motts Basin North HFFRRF was removed from the Recommended Plan. Reasons for the cost increase include increases in the cost of steel, the main component of the low floodwall, and increases in the amount of steel used in the design, as well as higher contractor overhead rates assumed to better match local average overhead rates. Because the Motts Basin North cost estimate was the lowest to begin with and mainly included the cost of the low floodwall, the BCR was highly sensitive to cost increases. The Final HFFRRF Recommendation includes Mid-Rockaway and Cedarhurst-Lawrence HFFRRFs.

5.19 Consideration of Planning Objectives & Constraints

This section analyzes whether or not the Recommended Plan makes significant contributions to the planning objectives and sufficiently avoids planning constraints. Table 5-29 shows a summary of to what degree each alternative meets the planning objectives and avoids planning constraints on a subjective scale of Low-Medium-High. Those alternatives that met objectives and avoided constraints very well were rated "high." Because of this, the coloring scheme for objectives and constraints is "opposite" to best reflect these ratings.

Table 5-29: Consideration of Planning Objectives and Constraints

Evaluation Factor	Ranking	Discussion
Objective 1: Reduce vulnerability to coastal storm impacts	Medium	The Recommended Plan significantly reduces vulnerability to shorefront communities and reduces vulnerability to smaller coastal storms for Arverne, Hammels, Edgemere, the Village of Cedarhurst, and parts of the Town of Hempstead. Objective 1 is ranked as medium and not high because there is significant residual risk remaining, particularly in the Bayside communities. A comprehensive solution to address remaining residual risk by constructing a storm surge barrier in Jamaica Bay is being further investigated in the New York and New Jersey Harbor and Tributaries Study currently underway.
Objective 2: Reduce future coastal storm risk in ways that will support the long-term sustainability of the coastal ecosystem and communities	High	Risk management is managed in a way that supports the long-term sustainability of the coastal ecosystem and communities by enhancing or restoring natural resiliency to the shorelines in four areas along the Bayside and by recommending a plan which is self-mitigating for its impacts to the environment and does not negatively impact communities.
Objective 3: Reduce the economic costs and risks associated with large-scale flood and storm events	Medium	While the Recommended Plan significantly reduces the economic costs and risk associated with large-scale flood and storm events for the Atlantic Shorefront communities, communities along the Bayside remain vulnerable to large-scale flood and storm events without a storm surge barrier to protect the communities in and around Jamaica Bay. The feasibility of constructing a storm surge barrier is currently being studied and potentially recommended under the New York and New Jersey Harbor and Tributaries Study which is looking at regional coastal storm risk.
Objective 4: Improve community resiliency, including infrastructure and service recovery from storm effects	Medium	The interior drainage improvements and NNBFs included in the HFFRRFs and the risk reduction provided by the Shorefront plan will greatly improve community resiliency. Efforts by others to raise evacuation routes above the floodplain, storm proof the NYC subway system and raise and/or relocate homes have also significantly contributed to this objective since Hurricane Sandy hit this region. The Objective 4 ranking is medium and not high due to the residual risk that will remain without the storm surge barrier measure which would provide a comprehensive solution and is being further investigated under the New York and New Jersey Harbor and Tributaries Study.

Evaluation Factor	Ranking	Discussion
Objective 5: Improve coastal resilience and reduce the risk caused by frequent flooding	High	This study is recommending multiple HFFRRFs, including NNBFs, wherever feasible and justified, which will help improve coastal resilience and manage the risk of frequent flooding in a cost effective manner. The NNBFs will also enhance natural storm surge buffers.
Constraint 1: Do not negatively impact ongoing recovery, ecosystem restoration, and risk management efforts by others	Low	Coordination with other local, state, and federal agencies is ongoing to ensure that this project does not negatively impact efforts by others.
Constraint 2: Mutual Acceptability to DOI	Low	USACE has been coordinating with DOI and expects to achieve Mutual Acceptability.
Constraint 3: Do not negatively impact navigation	Low	The plan is not expected to negatively impact navigation.
Constraint 4: Do not induce flooding	Low	Analysis shows that the Recommended Plan will not induce any flooding.
Constraint 5: Do not reduce community access and egress during emergencies	Low	The plan is not expected to impact access nor evacuation, but may improve egress if streets are able to drain quicker when pump stations are utilized.
Constraint 6: Do not impact operations at John F. Kennedy International Airport	Low	NNBFs will be designed such that they will only provide foraging habitat to avian species which pose a flight hazard to planes traveling in and out of JFK Airport.
Constraint 7: Do not negatively affect plants, animals, or critical habitat of species that are listed under the Federal Endangered Species Act or a New York State Endangered Species Act.	Low	As discussed in the EIS and Environmental Compliance Appendix, this project is not expected to adversely affect any plants, animals, or critical habitat of listed species.

5.20 Consideration of the P&G Criteria

The 1983 P&G requires that alternative plans are formulated and compared in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability. Plans that require substantial activity by others, that is not likely to be forthcoming, in order to reach a "go" appraisal for critical objectives are not complete. Plans that are not appraised as a "go" for planning objectives are not effective. Plans that achieve contributions to objectives at higher costs, whether objectively or subjectively measured, are not efficient. Plans with effects that result in infeasibility are not acceptable. Minimum standards for these four criteria must be established in order to determine whether a plan is worthy of additional consideration.

Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planned efforts, including actions by other federal and non-federal entities.

In order to fully address large-scale storm and flood risk, the storm surge barrier which was included in the TSP, would need to be constructed. The agency decision was made to study this component of the Rockaway TSP under a separate study analyzing a suite of storm surge barriers across the region, including one which would obviate the need for the Rockaway Inlet Barrier. However, this action does not need to be taken in order for the Recommended Plan to function independently and address many of the problems and objectives of this study, even if it is not to the full extent that would be achieved if the barrier were built.

Effectiveness is the extent to which the alternative plans alleviate the specified problems and achieves the opportunities. The Recommended Plan achieves the study opportunities to:

- Enhance human health and safety by improving the performance of critical infrastructure and natural features during and after storm surge events.
- Prevent or reduce many future coastal storm impacts and related damages. Reduce the risk of coastal storm damage to buildings and infrastructure, which are subject to damages due to storm surge, waves and erosion from the ocean and storm surge in Jamaica Bay.
- Improve the community's ability to recover from damages caused by storm surges.

Efficiency is the extent to which an alternative plan is the most cost effective means of achieving the objectives. Efficiency was measured through a comparison of benefit-to-cost ratios, reduced damages, and benefits from the project. This comparison showed that of the HFFRRF alternatives, only Mid-Rockaway, Cedarhurst-Lawrence, and Motts Basin North sites provide positive net benefits and thus were deemed economically efficient. The Shorefront Plan is also economically efficient with maximized net benefits.

Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies. The alternatives were formulated in accordance with applicable laws and regulations. The recommended plan meets applicable laws, regulations and public policies and is considered to be implementable.

Table 5-30: Summary of Contribution of Alternatives to the P&G Criteria

	Completeness	Effectiveness	Efficiency	Acceptability
Recommended Plan	High	Medium	High	High

The Recommended Plan meets three of the four P&G criteria very well. The effectiveness could be greatly improved with the construction of the storm surge barrier if recommended under the NYNJHAT Study.

5.20.1 Consideration of P&G Accounts

The 1983 P&G requires that alternative plans are formulated and compared in consideration of four accounts:

- NED (National Economic Development): changes in the economic value of the National output of goods and services
- EQ (Environmental Quality): non-monetary effects on significant natural and cultural resources
- RED (Regional Economic Development): changes in the distribution of regional economic activity that result from each alternative plan
- OSE (Other Social Effects): effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts

The accounts were the basis for the plan formulation strategy, as described in Chapter 4. Table 5-31 shows a summary of to what degree each alternative meets the P&G accounts on a subjective scale of Low-Medium-High, which is also discussed in Section 6.7.

Table 5-31: Recommended Plan Performance on P&G Accounts

	NED	RED	OSE	EQ
Recommended Plan	High	High	High	High
No Action Plan / Future Without Project Condition	Low	Low	Low	Medium

The Recommended Plan will contribute the NED as described in the Economic Appendix. It will also contribute positively to RED, OSE and EQ as summarized in Section 6.7.

5.21 Decision to be Made

A Tentatively Selected Plan (TSP) was identified in the Summer of 2016 and presented in the 2016 Draft HSGRR/EIS which was released for agency and public comment. As a result of the significant input received during this comment period, the USACE, along with the non-federal sponsors, decided to defer the recommendation of a key component of the TSP—namely the proposed storm surge barrier— in order to allow for further consideration. This decision was an outcome of the Agency Decision Milestone (ADM). Since the ADM, the study team has refined the Recommended Plan and updated this HSGRR/EIS in order to incorporate the changes coming out of the ADM and fully analyze any potential impacts. Once all comments were received on the Recommended Plan, the decision to be made was whether or not to move forward to finalize the Recommended Plan in this HSGRR/EIS, or whether additional analysis would be required.

6 RECOMMENDED PLAN

The Recommended Plan integrates CSRM structures for the two planning reaches that provide system-wide benefits to the vulnerable communities within the study area. The major components of the Recommended Plan include:

- Beach restoration with renourishment, groin extension, construction of new groins, and a composite seawall along the Atlantic Ocean Shorefront Planning Reach;
- Two separate high frequency flooding risk reduction features (HFFRRFs) within the Jamaica Bay Planning Reach. The HFFRRFs are small scale CSRM features to reduce risks for communities vulnerable to high frequency events and to provide CSRM in the short-term prior to construction of a comprehensive solution developed as part of the NYNJHATs feasibility study. Each HFFRRF ties into adjacent high ground (see the HFFRRF Engineering Appendix, Sub-Appendix B for maps of inundation extents and elevation information). HFFRRFs would be located at the following locations:
    - Cedarhurst-Lawrence; and
    - Mid-Rockaway.

An overview of the project locations is provided in Figure 6-1 in order to provide a geographic reference for each of the project components.

6.1 Atlantic Shorefront Component

The Atlantic Shorefront component of the Recommended Plan calls for the following features:

- A composite seawall with a structure crest elevation of +17 feet NAVD88, the dune elevation is +18 feet NAVD88[37], and the design berm width is 60 feet;
- A beach berm elevation of +8 ft NAVD88 and a depth of closure of -25 ft NAVD88;
- A total beach fill quantity of 1,596,000 cy for the initial placement, including tolerance, overfill and advanced nourishment with a 4-year renourishment cycle of 1,111,000 cy, resulting in a minimum berm width of 60 feet;
- Extension of 5 existing groins; and
- Construction of 13 new groins.

The general approach to developing CSRM along Rockaway Beach (between Beach 9th Street and Beach 169th Street) was to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective renourishment approach prior to the evaluation of alternatives for coastal storm risk management. The most cost effective erosion control alternative is beach restoration with increased erosion control. This constitutes a beach berm width of 60 ft at an elevation of +8 ft NAVD88 constructed by a beach fill quantity of 1,596,000 CY for the initial placement and with a 4-year 1,111,000 renourishment cycle.

[37] As described in Section 1.9.3, emergency repair and restoration of Rockaway Beach in response to Hurricane Sandy was performed in 2014. Repair and restoration consisted of 3.5 million cubic yards of sand placement from Beach 19th Street to Beach 149th Street, and a dune at elevation +16 ft. NAVD88.

Figure 6-1: Recommended Plan Geographic Overview

In addition, a screening analysis was performed to evaluate the level of protection provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with the beach restoration with increased erosion control to optimize CSRM for the Atlantic Ocean Shorefront Planning Reach. A composite seawall was selected as the best coastal storm risk management alternative. The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding. The Recommended Plan spans from Beach 20th Street to Beach 149th Street (Reach 3 through Reach 6b) and combines beach restoration and Erosion Control and two tapered beach sections at both the east and west end of the project, which are described below.

The east beachfill taper is approximately 3,000 ft in shorefront length from Beach 19th Street east to Beach 9th Street. The taper comprises approximately 1,000 ft of dune and beach taper including reinforced dune feature and approximately 2,000 ft of dune and beach fill without reinforced dune feature. In addition to the tapering of berm width, the dune elevation also tapers from an elevation of +18 ft NAVD88 at 19th Street down to approximately +12 ft NAVD88 at Beach 9th Street which will be tied into the existing grade. The west beachfill taper is approximately 5,000 ft in shorefront length from Beach 149th Street west to Beach 169th Street fronting Riis Park. The beachfill taper will be beach fill only with a berm width tapered from the design width at 149th Street to the existing width and height at 169th Street. In addition to the beachfill taper, a tapered groin system comprised of three rock groins is included for this section.

Additional details on the reinforced dune with composite seawall, the shorefront beach restoration and the groins are provided below.

6.1.1 Reinforced Dune – Composite Seawall

A composite Seawall is proposed for Rockaway Beach from Beach 149th Street up to Beach 20th Street. The composite seawall alignment follows the existing boardwalk alignment. The composite seawall would consist of an impermeable core (i.e. sheet pile wall with concrete cap) and rubble mound structure on the seaward side of the wall. The composite seawall is covered with sand and only the top and concrete cap are exposed on the land side of the dune (see Figure 6-2). The structure crest elevation is +17 feet NAVD88, the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet at an elevation of +8 feet NAVD88. The armor stone feature of the composite seawall design significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls to be used in the design if the face of the wall is completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding 1-layer of armor stone and extending the concrete cap up to the elevation of the armor stone. Due to spatial constraints within Reach 3 between Beach 149th Street and Beach 126th Street, a modified version of the composite seawall that includes a splash apron on the leeward side of the sheet pile wall is proposed for this section (see Figure 6-3). Detailed plans and sections are provided in the Engineering Appendix.

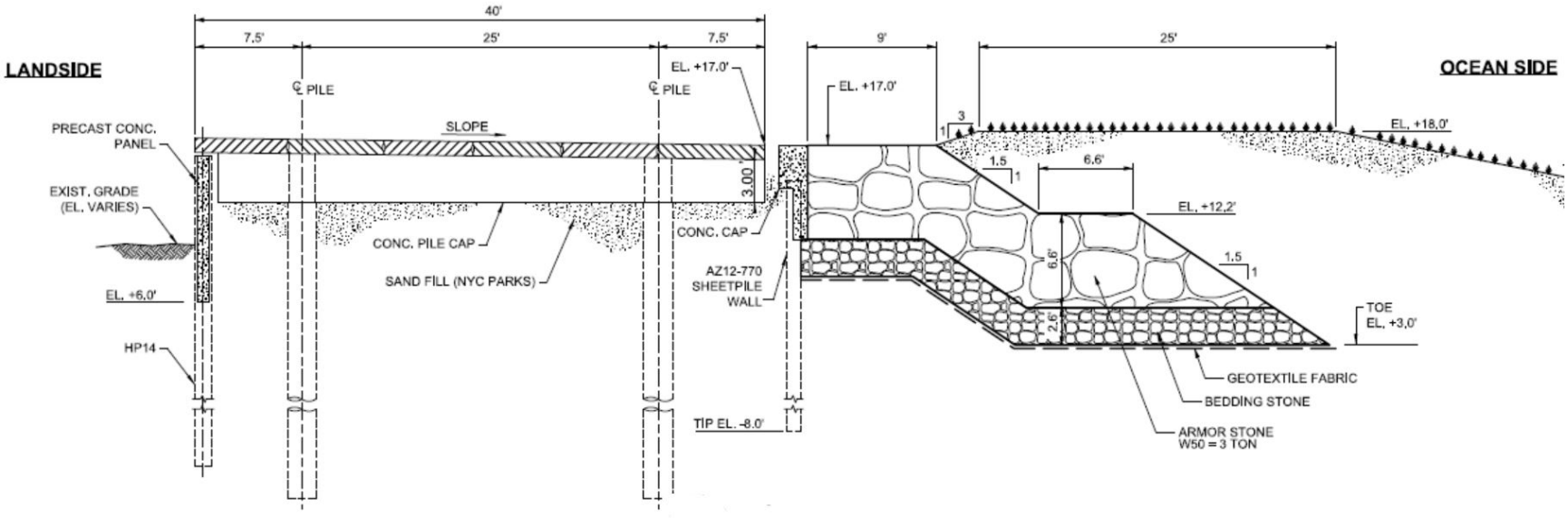


Figure 6-2: Atlantic Shorefront – Composite Seawall

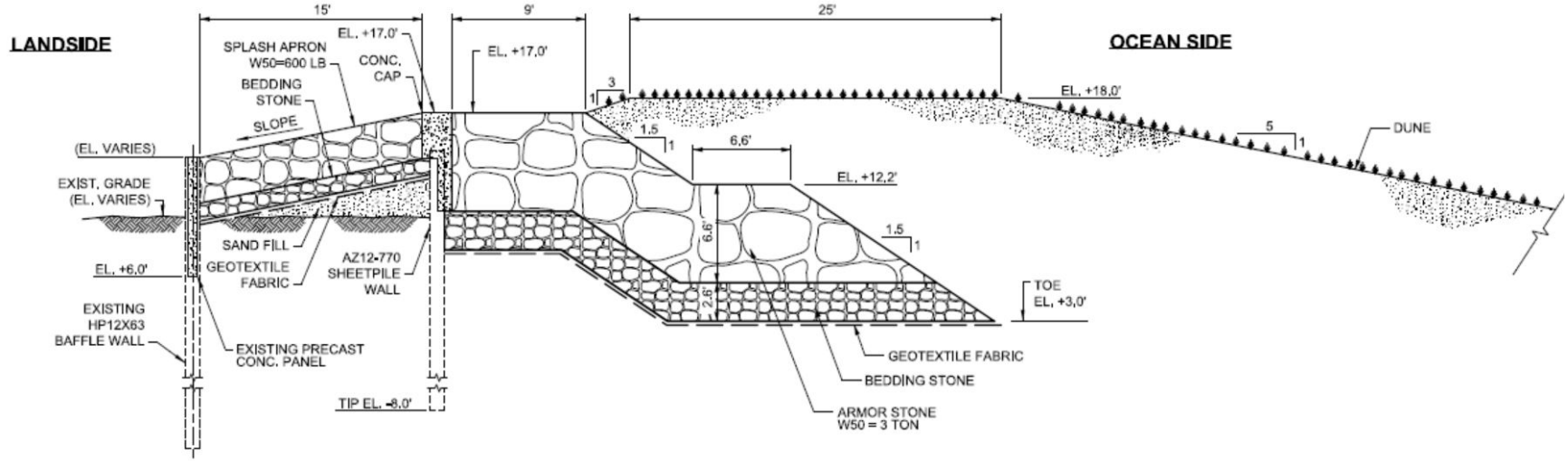


Figure 6-3: Atlantic Shorefront – Composite Seawall (Beach 126th St. to Beach 149th St.)

6.1.2 Beach Restoration

Beach restoration for the Atlantic Shorefront component consists of beach restoration for Reaches 3 through 6. A design profile is proposed that includes a dune with a 25 ft wide crest at elevation +18 ft NAVD88 and a back slope of 1V:3H and a front slope of 1V:5H. The design includes a berm with a minimum width of 60 ft at an elevation of +8 ft NAVD88. The width of the design berm is controlled by the alignment of the baseline. The baseline is aligned with the natural shoreline and the distance from the baseline to the design shoreline is always 243 ft. The alignment of the dune follows the unnatural alignment of the boardwalk and as a result the distance between the toe of the dune and the seaward crest of the berm varies (Figure 6-4). Detailed plans and sections are provided in the Engineering Appendix. Initial beachfill and renourishment quantities are provided in Table 6-1 below.

Table 6-1: Beachfill and Renourishment Quantities (cubic yards)

Sub-Reach	Beachfill	Renourishment per Cycle
West Taper	306,000	
Sub-Reach 3	356,000	475,000
Sub-Reach 4	294,000	149,000
Sub-Reach 5	321,000	476,000
Sub-Reach 6a	250,000	11,000
Sub-Reach 6b	20,000	0
East Taper	49,000	0
Totals	**1,596,000**	**1,111,000**

Note: Renourishment would occur on a four-year cycle

6.1.3 Groins

New groins are proposed for the Recommended Plan and include new groin construction and existing groin extension. Existing groins are extended in Reaches 5 and 6 and one new groin is constructed in Reach 6. In Reach 4 seven new groins are to be constructed, and in Reach 3 five new groins are to be constructed. Table 6-2 provides an overview of the groin length, type and location. The groins that are recommended for NPS property are to eliminate or offset any impacts on Riis Park resulting from the project and ensure that the Recommended Plan does not negatively impact the NPS beaches. Final design will be developed in PED phase, in coordination with NPS. Detailed plans and sections are provided in the Engineering Appendix.

Table 6-2: Summary of Groin Lengths for the Recommended Plan

Reach	Groin ID	Street	HSS (ft)	ISS (ft)	OS (ft)	Total (ft)	Status
6a	63	34th	62	108	328	498	new
6a	62	37th	55	108	328	491	extension
6a	61	40th	90	108	328	526	extension
5	53	43rd	90	108	228	426	extension
5	52	46th	90	108	228	426	extension
5	51	49th	90	108	228	426	extension
4	47	92nd	66	108	128	302	new
4	46	95th	62	108	128	298	new
4	45	98th	63	108	128	299	new
4	44	101st	62	108	128	298	new
4	43	104th	66	108	128	302	new
4	42	106th	67	108	128	303	new
4	41	108th	66	108	128	302	new
3	35	110th	90	108	153	351	new
3	34	113th	90	108	178	376	new
3	33	115th	90	108	178	376	new
3	32	118th	90	108	178	376	new
3	31	121st	63	108	128	299	new

HSS: horizontal shore section extending along the design berm
ISS: intermediate sloping section extending from the berm to the design shoreline
OS: outer section extending from the shoreline to offshore.

An overview of the Atlantic Shorefront component is shown on Figure 6-5, with additional detail shown on Figures 6-6a through 6-6d.

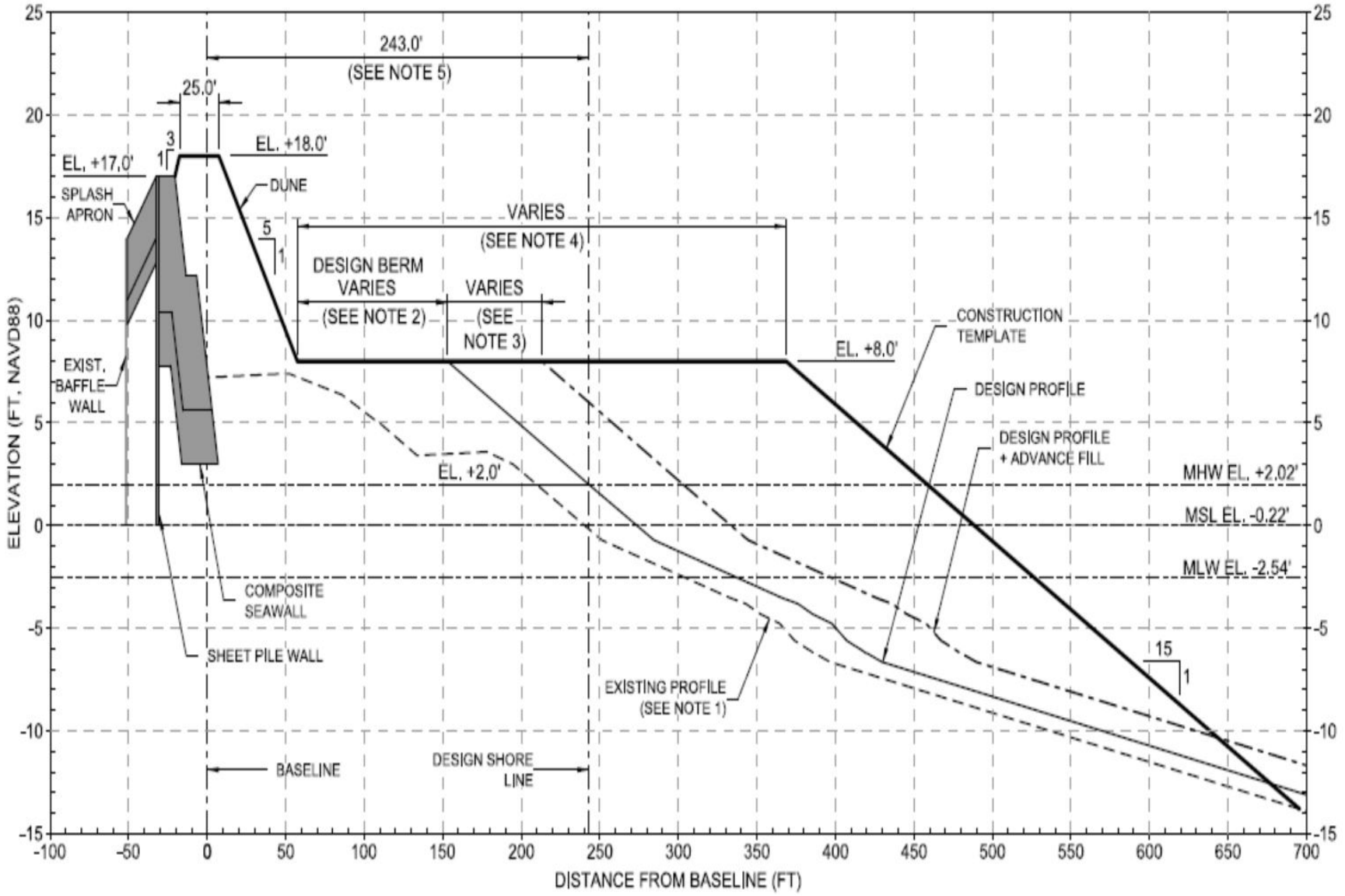


Figure 6-4: Design Beach Profile (note: existing profile varies)

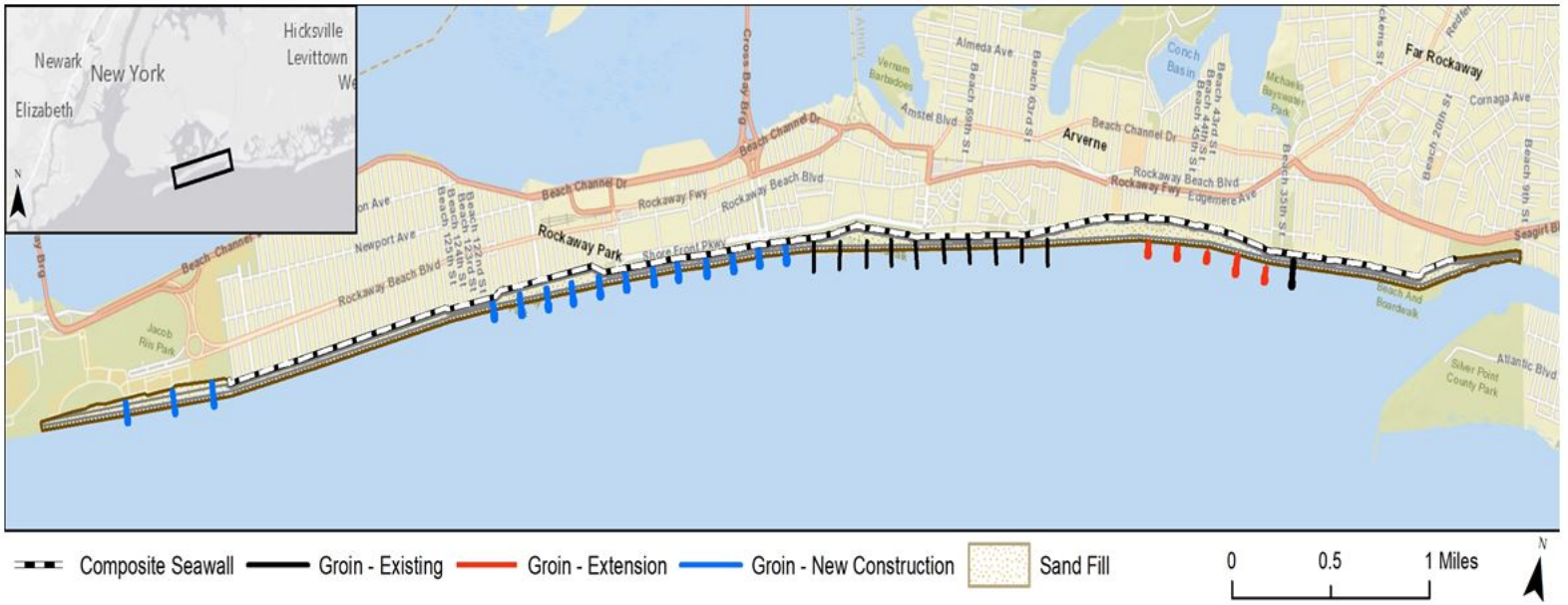


Figure 6-5: Atlantic Shorefront Component of the Recommended Plan - Overview

Figure 6-6a: Atlantic Shorefront Component of Recommended Plan (1 of 4)

Figure 6-6b: Atlantic Shorefront Component of Recommended Plan (2 of 4)

Figure 6-6c: Atlantic Shorefront Component of Recommended Plan (3 of 4)

Figure 6-6d: Atlantic Shorefront Component of Recommended Plan (4 of 4)

6.2 HFFRRF Component

The Recommended Plan includes solutions to address high frequency flooding risks for communities vulnerable to high frequency events. A wide range of high frequency flooding risk reduction measures (HFFRRFs) were evaluated, and are included in the project costs, with two separate projects identified for the Recommended Plan:

- Cedarhurst-Lawrence; and
- Mid-Rockaway.

6.2.1 Cedarhurst-Lawrence

The Cedarhurst-Lawrence project (Figure 6-7) begins on the east side of the channel near the driveway to Lawrence High School. It consists of approximately 1000 feet of deep bulkhead that follows the existing bulkhead line around the southern end of the channel at Johnny Jack Park, and continues north along the west side before being connected to high-ground behind the Five Towns Mini Golf & Batting Facility with a 23 foot segment of medium floodwall. The project is located in Nassau County and crosses the border between the Village of Cedarhurst and the town of Hempstead. Project design elevations have preliminarily been established based on expected wave exposure, and have been set at an elevation of +10.0ft NAVD88.

There are three existing outfalls in the area where the bulkhead will be raised. Each of the outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch or drainage collection pipe, with inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station capacity is estimated to be approximately 40 cfs, which will be refined during the design phase.

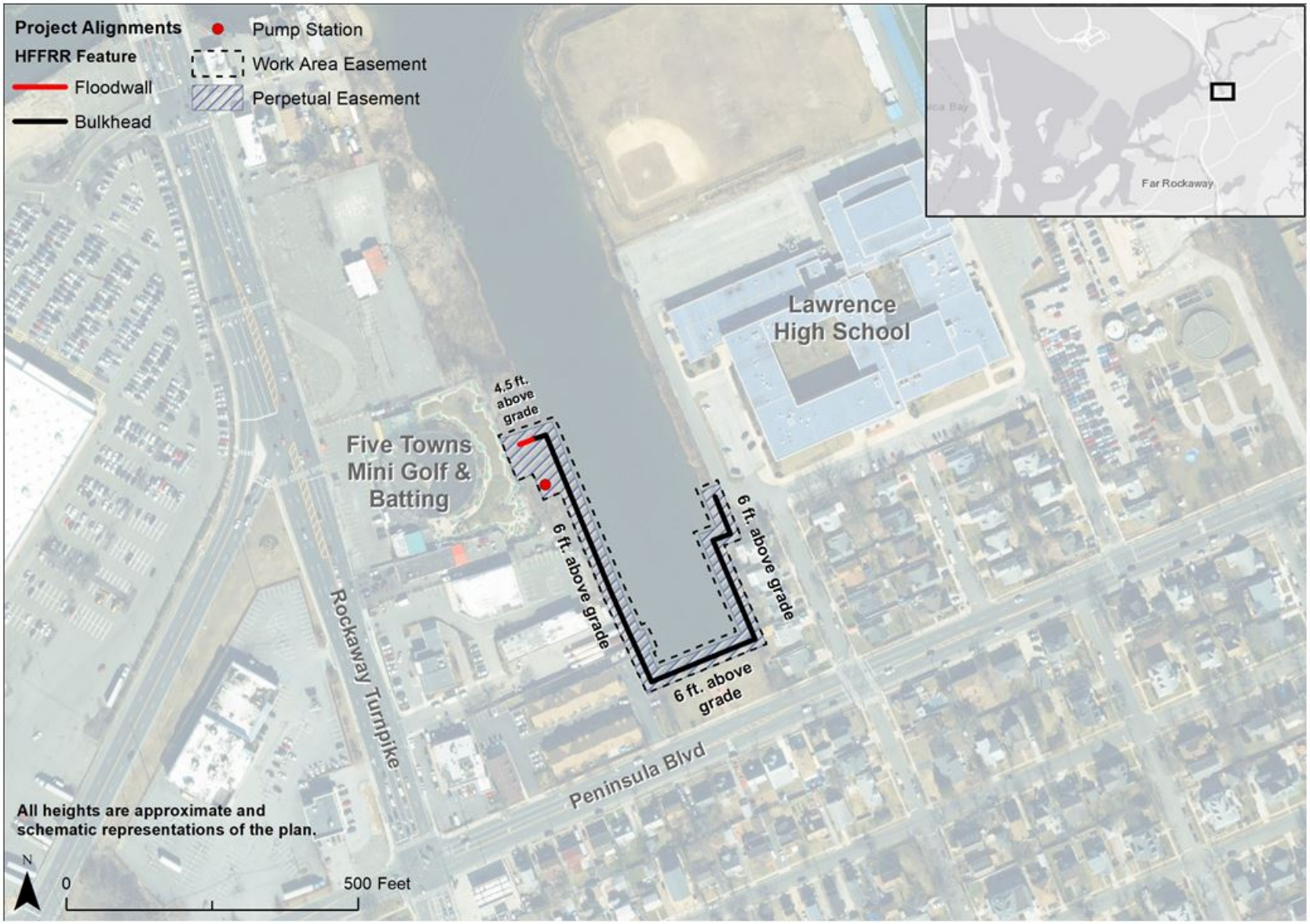


Figure 6-7: Cedarhurst-Lawrence HFFRRF Project Plan

6.2.2 Mid-Rockaway

Mid-Rockaway is the largest HFFRRF. It operates as a system and is broken up into three adjacent reaches.

6.2.2.1 Edgemere Area

The eastern end of the project area (Figure 6-8) begins at high ground near the intersection of Beach Channel Drive and Beach 35th Street. The project alignment proceeds north and then west following and parallel to Beach 35th Street before jogging to the north and crossing the abandoned portion of Beach 38th Street and continuing west. The project turns north and runs along the peninsula between Beach 43rd Street and the coastal edge. This approximately 3,200 foot section of hybrid berm has been placed as far landward as possible and weaves in and out between properties with the goal of providing structural protection to all occupied properties while minimizing impacts to wetland habitats. Efforts will be made during the PED phase to verify occupied status and to align project features in order to protect the greatest number of Rockaway residents. The hybrid berm is strategically used at these locations to minimize and avoid impacts to existing healthy wetland habitats. It should be noted that the alignment of the HFFRRF for the Mid-Rockaway Edgemere Area extends into NYC Park's Bayswater Park. Additional coordination with NYC Parks and NYCDOT (currently redesigning Beach 35th Street) will take place during PED.

This area also has been identified as a suitable candidate for the use of Natural and Nature Based Features (NNBFs). The NNBF design includes placement of a stone toe protection and rock sill structure just off the existing shoreline to attenuate wave action and allow tidal marsh to establish between the rock sill and the berm. In some locations the eroded/degraded shoreline (subtidal) will be regraded to allow for the development of low marsh (smooth cordgrass) to provide productive nursery habitats behind the sill structures. The shore slope behind the structure will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for establishment of a high tidal marsh, designated as scrub shrub areas in the figure. In addition, the graded habitat behind the structure will be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems.

On the north east of the Edgemere peninsula the project transitions into 200 feet of shallow bulkhead, which continues north along existing water front properties and bulkheads. Approximately 200 feet of medium elevation floodwall then turns west across, at the tip of the Edgemere peninsula. A road ramp on Beach 43rd Street has been included to maintain both pedestrian, and vehicle access to the coastal edge at north end of Beach 43rd street.

The floodwall continues in southwest direction along the coastline after which it transitions into a 750 foot section of high berm. The berm continues west from Beach 43rd Street before turning south just to the east of the unpaved extension of Beach 44th Street. The project then transitions into a 660 foot section of high floodwall which continues southwest staying as far landwards as possible to avoid an existing restoration project. Near the intersection of Norton Avenue and Beach 46th Street, north of Norton Avenue, the floodwall transitions back into a low berm which runs parallel to Norton Avenue southwest and then turns northwest along Conch Place. The area waterward of this berm has also been identified as a suitable location for the use of NNBFs and to restore high marsh habitat. Project design elevations vary and have preliminarily been

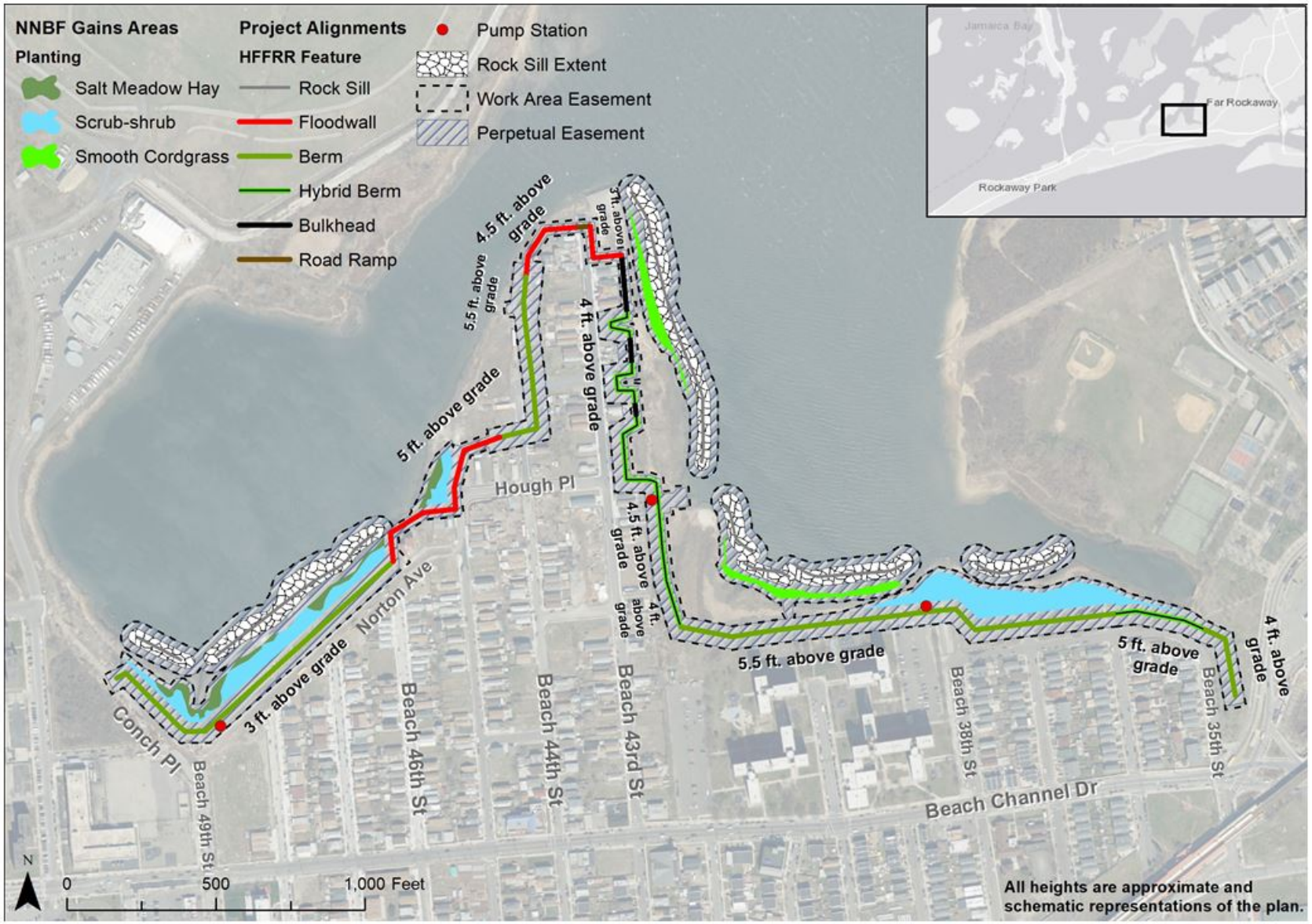


Figure 6-8: Mid-Rockaway - Edgemere Area HFFRRF Project Plan

established based on expected wave exposure. Project elevations range between +8.0ft and +9.5ft NAVD88.

The Edgemere interior drainage basin has two subbasins, E1 and E2 covering approximately 194 acres and 274 acres, respectively. The Edgemere drainage basin is almost fully developed and predominantly residential, except for a stretch of undeveloped, grassy area along the southern part of E1 and southwestern part of E2. Subbasin E1 was estimated to require nine outlets, which includes two existing outlets. Subbasin E2 was estimated to require six outlets, including one existing outlet (see Interior Drainage Appendix for additional information on Edgemere outlets). Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts.

Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations would be required in the Edgemere Area. Due to the length of the area and difficulties in draining all of the area to a single site, drainage subbasin E1 is proposed to have two pump stations. One pump station would be located near Norton Avenue and Beach 49th Street and the other near Beach 43rd Street and Hough Place with a combined capacity of approximately 210 cfs. Subbasin E2 is proposed to have one pump station located near Beach 38th Street with an estimated capacity of 120 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

6.2.2.2 Mid-Rockaway - Arverne Area

This area of the project (Figure 6-9) begins at high ground to the north of Almeda Avenue and Beach 58th Street. It should be noted that the alignment of the HFFRRF for the Mid-Rockaway Arverne Area extends into NYC Park's Rockaway Community Park. Additional coordination with NYC Parks will take place during PED.

An approximately 1,100 foot section of low berm runs south along Beach 58th Street. The alignment of the berm has been placed as far landward as possible to avoid healthy habitat. This segment has been identified as a candidate for the use of NNBFs. Much of the area is identified as existing quality wetlands, but a portion of fill area has been identified where intermediate marsh (Saltmeadow cordgrass) would be restored.

The project then transitions to an approximately 1,200 foot long low floodwall which, for feasibility level analysis, is purposefully sited along property boundaries at the southern end of the channel to minimize impacts to existing waterfront businesses. A road ramp has been included to maintain access to the marina. At the southwest corner of the channel the project transitions to run along the coastal edge north for approximately 1,700 feet. This segment transitions between revetments and bulkheads to match the existing coastline conditions and uses. The portion between Thursby Avenue and Elizabeth Road has been aligned such that it can be integrated into the planned NYC DPR Thursby Basin Park project.

Figure 6-9: Mid-Rockaway - Arverne Area HFFRRF Project Plan

Just north of De Costa Avenue, the project transitions to low berm for approximately 1,400 feet and runs west along De Costa Avenue and around the edges of healthy habitat while also creating an area for stormwater storage and a pump station just north of Beach Street. At the corner of De Costa Avenue and Beach 65th Street the low berm transitions into a hybrid berm to minimize habitat impacts.

The hybrid berm continues west and then north for 300 feet to the corner of Beach 65th Street and Bayfield Avenue. The project then transitions to a 2,400 foot long shallow bulkhead which travels west along the line of existing bulkheads and parallel with Bayfield Avenue in areas without existing bulkhead. The bulkhead section ends just west of the corner of Bayfield Avenue and Beach 72nd Street.

The area east of Beach 69th Street and the eastern end of De Costa Ave has been identified as a suitable candidate for NNBF. Based on existing elevations and profiles, a combination of either fill or excavation would be used to provide the appropriate elevations shoreward of the rock sills to maximize healthy subtidal habitats, with restoration of a transition area for low to high intertidal marsh. Eroded shorelines would be replaced with low intertidal (smooth cordgrass) habitats, and transition to either intermediate (saltmeadow cordgrass) and/or high marsh (scrub-shrub) habitats.

From the end of the bulkhead section, the project continues south with a 120 foot section of medium floodwall connecting the bulkhead to a 1,140 foot section of medium berm. The berm runs south along Beach 72nd Street and turns west at Hillmeyer Avenue and continues west past the corner of Barbadoes Drive and Hillmeyer Avenue, where it turns north and transitions to a flood wall to minimize the project footprint. The berm section has been positioned close to the roads to minimize impacts on habitat.

The berm section transitions into a high floodwall which runs west, and then runs parallel to the coast southwest for 440 feet, ending at a bulkhead section just west of the end of Hillmeyer Avenue.

The Brant Point area includes the creation of wetlands between the berm and the rock sills that are placed just off the coastal edge. The rock sill will protect the shoreline where eroded areas will be restored to low marsh habitats protecting the existing high quality habitats shoreward. The areas behind the existing wetlands areas will be graded to provide a transition area to high marsh and then uplands where practical. The existing uplands areas will be replanted as necessary to provide for a high quality maritime forest habitat, with plantings of appropriate tree species.

South of Hillmeyer Avenue the alignment follows the bulkheaded coastal edge. The project proposes a high frequency flood risk reduction bulkhead feature that follows an existing bulkhead along the coastal edge for approximately 270 feet ending just south of Almeda Avenue. From this point a low floodwall runs parallel with the coastal edge southeast for 500 feet, and then transitions into a deep bulkhead. This section of bulkhead continues southeast along the line of existing bulkhead for approximately 500 feet to the end of Thursby Avenue.

The project continues as a low floodwall for approximately 1,300 feet, traveling east along Thursby Avenue and then south, parallel with Beach 72nd Street turning west and running along Amstel Boulevard, ending just past Beach 74th street. Two road ramps and one vehicular gate are included to maintain access to the waterfront. The final segment is approximately 250 feet of medium floodwall which runs along the coastal edge and connects the low floodwall to high ground in the west. Project design elevations vary and have preliminarily been established based

on the expected wave exposure. Project elevations range between +8.0ft NAVD88 and +11.5ft NAVD88.

The Arverne drainage basin has three subbasins A1, A2, and A3, covering 76 acres, 139 acres, and 209 acres, respectively. The Arverne drainage basin is almost fully developed and predominantly residential, with a few, scattered undeveloped areas. Subbasin A1 was estimated to require eight outfalls, including five existing outfalls. Subbasin A2 was estimated to require three outlets. Subbasin A3 was estimated to require five outlets, including three existing outlets.

Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts (see Interior Drainage Appendix for additional information on Arverne outlets). Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations are desired in the Arverne Area. Drainage subbasin A1 is proposed to have a pump station located adjacent to De Costa Avenue near Beach 72nd Street with an estimated capacity of 70cfs. Subbasin A2 is proposed to have one pump station located on De Costa Avenue near Beach 63rd Street with an estimated capacity of 180 cfs. Subbasin A3 is proposed to have one pump station located south of Thursby Avenue with an estimated capacity of 300 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

6.2.2.3 Mid-Rockaway – Hammels Area

Two separate segments compose the Hammels area of the Mid-Rockaway project (Figure 6-10). The east segment begins approximately 320 feet west of the intersection of Beach 75th Street and Beach Channel Drive. It is composed of approximately 1,400 feet of low floodwall, running west along the north side of Beach Channel Drive, and parallel with the Rockaway Line elevated subway track. Three road ramps have been included to maintain access to the water front properties. The west segment consists of 1,400 feet of low floodwall beginning to the west of the MTA facility Hammels Wye adjacent to the Rockaway Line. The alignment heads west and south in a stair-step fashion to avoid impacts to existing structures, ending on the north side of Beach Channel Drive just west of Beach 87th Street. Three road ramps have been included to maintain access to the waterfront. Project design elevations have preliminarily been established based on the expected wave exposure, which is expected to be low, and are set at +8.0ft NAVD88.

The Hammels drainage basin includes two subbasins, H1 and H2, approximately 105 acres and 139 acres respectively. The Hammels drainage basin is almost fully developed, except for a few scattered grassy areas and is predominantly residential, with some commercial development. Subbasin H1 was estimated to require three outlets, which include two existing outlets. Subbasin H2 was estimated to require 3 outlets, including 1 existing outlet.

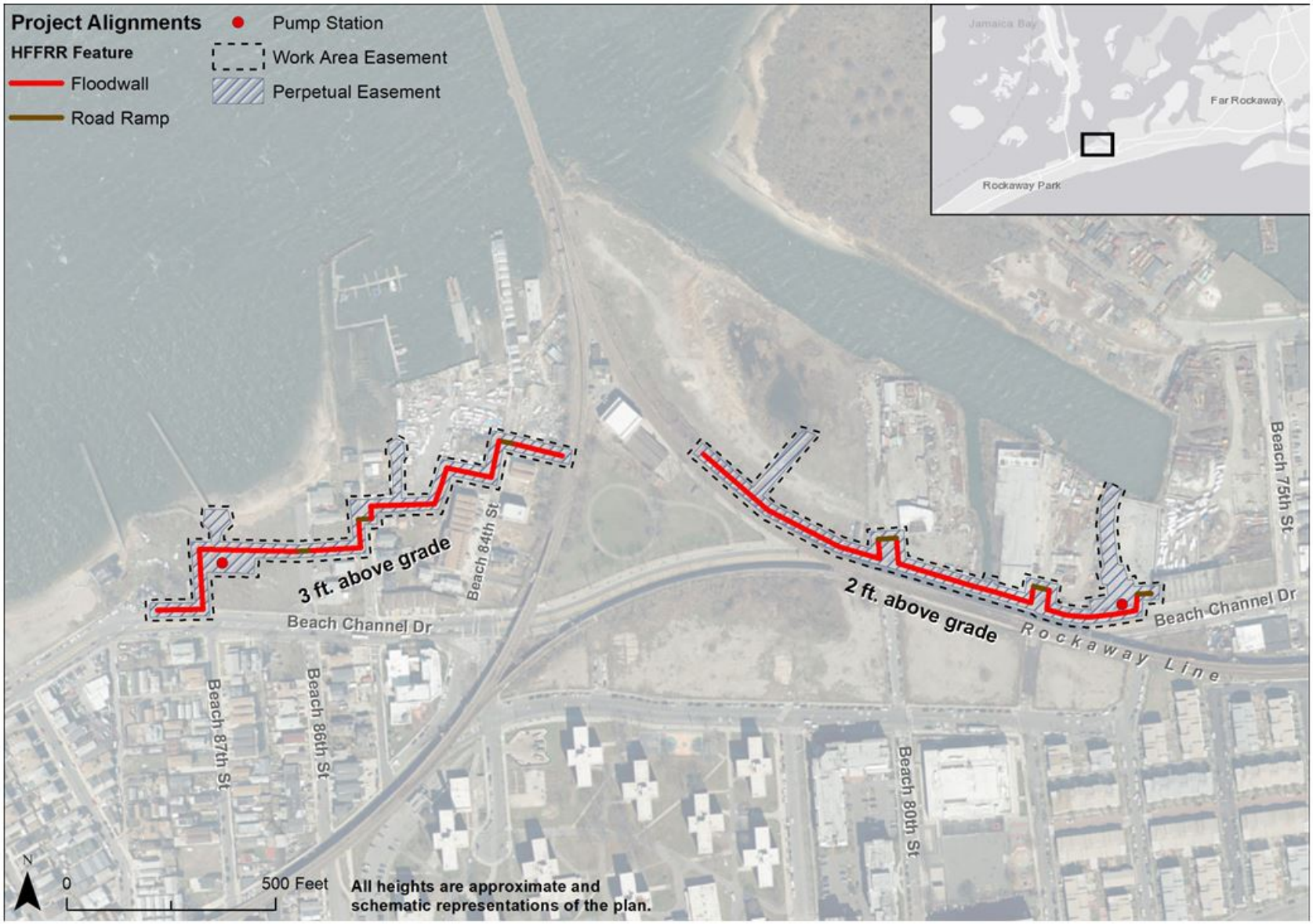


Figure 6-10: Mid-Rockaway - Hammels Area HFFRRF Project Plan

Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system (See Hammels Outlet Table). The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that two pump stations are desired in the Hammels Area. Drainage subbasin H1 is proposed to have a pump station located at the southern end of Hammels near Beach 87th Street with a capacity estimated at 100cfs. Subbasin H2 is also proposed to have one pump station which is located at the northern end of Hammels near Beach Channel Drive with an estimated capacity of 180 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlets will be refined during the project design phase.

6.3 Recommended Plan Cost Estimate

This section presents a summary of the detailed cost estimate (See Appendix C – Cost Engineering) developed for the Recommended Plan. Project first costs, annual operation, maintenance, repair, replacement and rehabilitation (OMRR&R – a 100% non-federal cost), monitoring and renourishment costs developed for the Recommended Plan are presented below.

6.3.1 Project First Costs

Project first costs for the entire Recommended Plan are provided in Table 6-3 below. Project first costs for the separable elements of the recommended plan are provided in Tables 6-4a through 6-4c. Please note that numbers may not add to totals due to rounding.

Table 6-3: Recommended Plan Project First Costs

Acct	Description	Cost ($)	Contingency ($)	Total ($)
01	Lands & Damages	**30,516,000**	**6,103,000**	**36,619,000**
02	Relocations	**4,419,000**	**1,253,000**	**5,673,000**
10	Breakwaters & Seawalls	**191,556,000**	**54,325,000**	**245,881,000**
11	Levees & Floodwalls	**99,944,000**	**28,344,000**	**128,288,000**
13	Pumping Plants	**37,327,000**	**10,586,000**	**47,913,000**
17	Beach Replenishment	**27,519,000**	**7,804,000**	**35,324,000**
18	Cultural Resources Preservation	**12,246,000**	**3,473,000**	**15,719,000**
30	Planning, Engineering, & Design	**36,219,000**	**10,272,000**	**46,491,000**
31	Construction Management	**22,470,000**	**6,373,000**	**28,843,000**
	Total	**462,217,000**	**128,534,000**	**590,750,000**

FY19 Q1 effective price level

Table 6-4a: Shorefront Element Project First Costs

Acct	Description	Cost ($)	Contingency ($)	Total ($)
01	Lands & Damages	**539,000**	**108,000**	**647,000**
10	Breakwaters & Seawalls	**191,556,000**	**54,325,000**	**245,881,000**
17	Beach Replenishment	**27,519,000**	**7,804,000**	**35,324,000**
18	Cultural Resources Preservation	**10,205,000**	**2,894,000**	**13,099,000**
30	Planning, Engineering, & Design	**18,667,000**	**5,294,000**	**23,960,000**
31	Construction Management	**13,533,000**	**3,838,000**	**17,371,000**
	Total	**262,019,000**	**74,264,000**	**336,282,000**

FY19 Q1 effective price level

Table 6-4b: Mid-Rockaway HFFRRF Project First Costs

Acct	Description	Cost ($)	Contingency ($)	Total ($)
01	Lands & Damages	**29,237,000**	**5,847,000**	**35,084,000**
02	Relocations	**4,240,000**	**1,203,000**	**5,443,000**
11	Levees & Floodwalls	**93,113,000**	**26,407,000**	**119,519,000**
13	Pumping Plants	**34,518,000**	**9,789,000**	**44,307,000**
18	Cultural Resources Preservation	**1,276,000**	**362,000**	**1,637,000**
30	Planning, Engineering, & Design	**16,260,000**	**4,611,000**	**20,871,000**
31	Construction Management	**8,279,000**	**2,348,000**	**10,627,000**
	Total	**186,922,000**	**50,567,000**	**237,489,000**

FY19 Q1 effective price level

Table 6-4c: Cedarhurst-Lawrence HFFRRF Project First Costs

Acct	Description	Cost ($)	Contingency ($)	Total ($)
01	Lands & Damages	**740,000**	**148,000**	**888,000**
02	Relocations	**179,000**	**51,000**	**230,000**
11	Levees & Floodwalls	**6,831,000**	**1,937,000**	**8,768,000**
13	Pumping Plants	**2,809,000**	**797,000**	**3,606,000**
18	Cultural Resources Preservation	**765,000**	**217,000**	**982,000**
30	Planning, Engineering, & Design	**1,293,000**	**367,000**	**1,659,000**
31	Construction Management	**658,000**	**187,000**	**845,000**
	Total	**13,276,000**	**3,703,000**	**16,979,000**

FY19 Q1 effective price level

6.3.2 Project Schedule and Interest During Construction

The project construction schedule begins in December of 2019, and continues through August of 2023, a period of 44 months. Schedules for the separable elements of the Recommended Plan are provided in Table 6-5 below.

Table 6-5: Recommended Plan Component Schedules

Recommended Plan Component	Construction Initiation	Construction Completion	Duration (months)
Shorefront Element	Dec 2019	July 2023	44
Mid-Rockaway HFFRRF	Jan 2020	May 2023	41
Cedarhurst-Lawrence HFFRRF	Jan 2020	Dec 2020	12

Interest during construction (Table 6-6) was calculated to account for the cost of capital during the construction period prior to the realization of project benefits. Costs were separated into two categories for the IDC analysis: initial costs (PED, Real Estate, and Utility Relocations), which will be incurred at the inception of each construction phase, and construction costs, which will be distributed evenly across each construction period of each phase. Project costs were amortized over the expected period of project construction for each of the Recommended Plan components at the FY19 discount rate of $2^{7/8}$ percent. Total interest during construction for the entire project equals $33,688,000.

Table 6-6: Interest During Construction

Recommended Plan Component	Project First Costs	Duration (months)	Interest During Construction
Shorefront Element	336,282,000	44	20,147,000
Mid-Rockaway HFFRRF	219,414,000	41	15,055,000
Cedarhurst-Lawrence HFFRRF	16,979,000	12	293,000
TOTAL			**35,495,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

6.3.3 Operations and Maintenance

Annual OMRR&R and monitoring costs for maintaining the Recommended Plan are presented below in Table 6-7. Charges attributed to the OMRR&R of the project consist of annualized replacement costs, repair, anticipated energy charges, and labor charges for the care and cleaning of project facilities. Project components requiring routine care include levees and floodwalls, interior drainage closures, road closure gates, pump stations, beach dune grass and sand fence.

Major mechanical equipment within the pump stations have anticipated life expectancies of 20-25 years. The cost of periodic equipment replacement has been estimated, annualized over the 50-year period of analysis, and incorporated into the OMRR&R charge. In addition, electric power requirements based on the anticipated frequency of pump station and storm gate operation have been added to the project's annual operation charge.

Table 6-7: Recommended Plan Annual OMRR&R and Monitoring[38] Costs

Annual Cost Item	Shorefront ($)	HFFRRFs ($)	TOTAL ($)
Estimated Renourishment (planned/emergency)	6,886,000		6,886,000
Coastal Monitoring Cost	380,000		380,000
Major Rehabilitation	332,000		332,000
Subtotal Monitoring & Rehabilitation	**7,598,000**	**0**	**7,598,000**
Groin & Seawall Maintenance	433,000		433,000
Sea Level Rise Adaptions	1,453,000		1,453,000
Levee, Floodwall, Interior Drainage, and Pumping Plant		1,235,000	1,235,000
Subtotal Operations & Maintenance	**1,886,000**	**1,235,000**	**3,121,000**
Total OMRR&R and Monitoring Annual Costs	**9,484,000**	**1,235,000**	**10,719,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

[38] OMRR&R is a 100% non-federal cost that is calculated to determine the overall annual cost of the project for BCR determination. Monitoring and renourishment are project costs, cost-shared in accordance with cost-sharing requirements for coastal storm risk management construction.

6.3.4 Annual Project Costs

Annualized project costs for the entire Recommended Plan are provided in Table 6-8 below. Tables 6-9a through 6-9c provide annual costs for each of the project components. Project first costs and interest during construction were annualized at the FY19 discount rate of $2^{7/8}$ percent.

Table 6-8: Recommended Plan Annual Project Costs

Item	Cost ($)
Project First Cost	590,750,000
Interest During Construction	35,495,000
Total Investment Cost	626,245,000
Annual Costs	
Annualized Investment Cost	23,765,000
Annual Shorefront OMRR&R Costs	9,484,000
Annual HFFRRF OMRR&R Costs	1,235,000
Annual Project Cost (50 years)	**34,484,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

Table 6-9a: Shorefront Element Annual Project Costs

Item	Cost ($)
Project First Cost	336,282,000
Interest During Construction	20,147,000
Total Investment Cost	356,429,000
Annual Costs	
Annualized Investment Cost	13,526,000
Annual Shorefront OMRR&R Costs	9,484,000
Annual Project Cost (50 years)	**23,010,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

Table 6-9b: Mid-Rockaway HFFRRF Annual Project Costs

Item	Cost ($)
Project First Cost	237,489,000
Interest During Construction	15,055,000
Total Investment Cost	252,544,000
Annual Costs	
Annualized Investment Cost	9,584,000
Annual HFFRRF OMRR&R Costs	1,153,000
Annual Project Cost (50 years)	**10,737,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

Table 6-9c: Cedarhurst-Lawrence HFFRRF Annual Project Costs

Item	Cost ($)
Project First Cost	16,979,000
Interest During Construction	293,000
Total Investment Cost	17,272,000
Annual Costs	
Annualized Investment Cost	655,000
Annual HFFRRF OMRR&R Costs	89,000
Annual Project Cost (50 years)	**744,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

6.3.5 Economic Performance

Table 6-10 provides economic performance metrics for the entire Recommended Plan. As shown in the table, the overall plan is economically justified with a benefit-to-cost ratio of 1.4 and annual net benefits of $13,846,000 excluding recreation benefits. When recreation benefits are added, the entire recommended plan is economically justified with a benefit-to-cost ratio of 2.3 and annual net benefits of $43,188,000.

Table 6-10: Recommended Plan Economic Performance Metrics

Without-Project Expected Annual Damages	
Shorefront (Flooding, Erosion, Waves)	18,363,000
Bayside (Cross-Shore Flooding)	30,234,000
Bayside (Jamaica Bay Flooding)	64,137,000
Bayside Mainland and Broad Channel HFFRRF Areas (Jamaica Bay Flooding)	61,918,000
With-Project Expected Annual Damages	
Shorefront (Flooding, Erosion, Waves)	2,555,000
Bayside (Cross-Shore Flooding)	15,651,000
Bayside (Jamaica Bay Flooding)	64,137,000
Bayside Mainland and Broad Channel HFFRRF Areas (Jamaica Bay Flooding)	44,920,860
Benefits: Reduced Damage to Structures	
Shorefront (Flooding, Erosion, Waves)	15,808,000
Bayside (Cross-Shore Flooding)	14,583,000
Bayside (Jamaica Bay Flooding)	0
Bayside Mainland and Broad Channel HFFRRF Areas (Jamaica Bay Flooding)	16,997,000
Total Annual Damage Reduction Benefits	47,388,000
Ancillary Benefits: Reduced Maintenance	942,000
Ancillary Benefits: Recreation	29,342,000
TOTAL ANNUAL PROJECT BENEFITS	**77,672,000**
TOTAL ANNUAL PROJECT COSTS	**34,484,000**
BENEFIT TO COST RATIO (excluding recreation benefits)	**1.4**
NET EXCESS ANNUAL BENEFITS (excluding recreation benefits)	**13,846,000**
BENEFIT TO COST RATIO	**2.3**
NET EXCESS ANNUAL BENEFITS	**43,188,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

Tables 6-11a through 6-11c provide economic performance metrics for each of the separable elements of the Recommended Plan. The tables show that each of the elements is economically justified on an individual basis.

Table 6-11a: Shorefront Element Economic Performance Metrics

Without-Project Expected Annual Damages	
Shorefront (Flooding, Erosion, Waves)	18,363,000
Bayside (Cross-Shore Flooding)	30,234,000
With-Project Expected Annual Damages	
Shorefront (Flooding, Erosion, Waves)	2,555,000
Bayside (Cross-Shore Flooding)	15,651,000
Benefits: Reduced Damage to Structures	
Shorefront (Flooding, Erosion, Waves)	15,808,000
Bayside (Cross-Shore Flooding)	14,583,000
Total Annual Damage Reduction Benefits	30,391,000
Ancillary Benefits: Reduced Maintenance	942,000
Ancillary Benefits: Recreation	29,342,000
TOTAL ANNUAL PROJECT BENEFITS	**60,675,000**
TOTAL ANNUAL PROJECT COSTS	**23,010,000**
BENEFIT TO COST RATIO (excluding recreation benefits)	**1.4**
NET EXCESS ANNUAL BENEFITS (excluding recreation benefits)	**8,323,000**
BENEFIT TO COST RATIO	**2.6**
NET EXCESS ANNUAL BENEFITS	**37,665,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

Table 6-11b: Mid-Rockaway HFFRRF Economic Performance Metrics

Without-Project Expected Annual Damages	
Bayside Mainland Mid-Rockaway HFFRRF Area	44,171,000
With-Project Expected Annual Damages	
Bayside Mainland Mid-Rockaway HFFRRF Area	32,320,000
Benefits: Reduced Damage to Structures	
Bayside Mainland Mid-Rockaway HFFRRF Area	11,851,000
TOTAL ANNUAL PROJECT BENEFITS	**11,851,000**
TOTAL ANNUAL PROJECT COSTS	**10,737,000**
BENEFIT TO COST RATIO	**1.1**
NET EXCESS ANNUAL BENEFITS	**1,114,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

Table 6-11c: Cedarhurst-Lawrence HFFRRF Economic Performance Metrics

Without-Project Expected Annual Damages	
Bayside Mainland Cedarhurst-Lawrence HFFRRF Area	12,625,000
With-Project Expected Annual Damages	
Bayside Mainland Cedarhurst-Lawrence HFFRRF Area	7,479,000
Benefits: Reduced Damage to Structures	
Bayside Mainland Cedarhurst-Lawrence HFFRRF Area	5,146,000
TOTAL ANNUAL PROJECT BENEFITS	**5,146,000**
TOTAL ANNUAL PROJECT COSTS	**744,000**
BENEFIT TO COST RATIO	**6.9**
NET EXCESS ANNUAL BENEFITS	**4,402,000**

FY19 Q1 effective price level, FY19 discount rate of $2^{7/8}$ %

6.4 Real Estate Considerations

The non-federal sponsors will be responsible for acquiring and furnishing all lands, easements, rights-of-way, relocations (i.e., P.L. 91-646 relocations and utility/facility relocations), borrow material, and dredged or excavated material disposal areas (LERRD) for the project areas, as required. All lands needed for this project will be acquired as an easement interest, with the exception of the land needed for the pump stations. It is estimated that the Recommended Plan requires a total of 783.95 acres and impacts 468 parcels:

- 696.66 acres in Perpetual Beach Storm Damage Reduction Easements,
- 54.14 acres in Flood Protection Levee Easements,
- 20.37 acres in Bank Protection Easements,
- 10.73 acres in Temporary Work Area Easements and;
- 2.05 acres in Fee; excluding minerals.

Real estate impacts and costs are discussed and presented in the Real Estate Plan, which is an appendix to this HSGRR/EIS. Table 6-12 below presents real estate impacts for the Recommended Plan. Real estate costs are included in Project First Costs under Account 01 – Lands and Damages.

Table 6-12: Recommended Plan Real Estate Impacts

Required Interest	Required Acres	Acres Below the MHWL	Number of Parcels		Number of Owners	
			Private	Public	Private	Public
Perpetual Beach Storm Damage Reduction Easement	696.66	380.78	0	20	0	2
Flood Protection Levee Easement	54.14	26.37	157	117	109	4
Bank Protection Easement	20.37	5.11	23	72	15	1
Temporary Construction Easement	10.73	2.79	37	23	34	3
Fee excluding minerals	2.05	N/A	9	10	6	2

6.5 Habitat Impacts and Mitigation Requirements

Environmental impacts associated with the Recommended Plan were addressed by two complimentary evaluations:

- Permanent and temporary impacts using acreage as a metric. This provides a traditional measure to evaluate mitigation requirements, and does not account for the level of ecological service and/or functions provided by wetland habitats; and
- Evaluation for Planned Wetlands (EPW) to evaluate impacts to ecological functioning within coastal intertidal wetlands. The EPW habitat model obtained Regional Certification by USACE in July 2016. A USACE-certified model was not available to evaluate functional impacts to adjacent habitats including open water and uplands.

To facilitate an assessment of impact for both planning reaches, a comprehensive habitat mapping was completed for all lands within the anticipated project areas. Existing data sources were relied upon as a foundation for this mapping, and which include:

- Existing habitat mapping for select ecological restoration projects throughout Jamaica Bay as provided by USACE, NY District;
- New York state tidal wetlands for NYC and Long Island (New York Department of Environmental Conservation ([NYDEC] as provided at New York State Geographic Information System [GIS] Clearinghouse);
- MapPLUTO – Brooklyn & Queens as provided by New York City Department of City Planning. Includes extensive land use and geographic data at the tax-lot level.
- NOAA Coastal Change Analysis Program (C-CAP) Land Use data – 2010.

Ecological field work in both 2016 and 2018 was relied upon to complete the habitat mapping based upon revisions to existing data sources. Site-specific field maps were created at each of the visited field sites, and which were utilized to refine the habitat mapping. For those sites that were not visited during field work, best professional judgment was used while evaluating available aerial photography.

The limits of disturbance were assumed to be the "work area easement" as illustrated in project plans included above in Section 6.2. Temporary impacts were assumed to be those areas within the work area easement but not within a defined "perpetual easement" required by USACE to maintain the CSRM feature. These areas will be restored in kind within 1 year following construction of the project. Permanent impacts were assumed to be those areas that occur within the perpetual easement, and which will not be restored in kind following construction of the project. Further habitat modeling assumptions are included in Section 6.5.2.

6.5.1 Habitat Impacts Using Acreage as a Metric

Tables 6-13 and 6-14 present permanent and temporary habitat impacts using acreage as a metric. Habitat types are consistent with those described in Section 2.6. It is important to note that Waters / Wetlands are assumed to include all freshwater wetlands and intertidal habitats; inclusive of freshwater wetlands, beach and unvegetated shoreline, intertidal wetlands (i.e., both high and low marsh), mudflats, and subtidal bottom.

Table 6-13: Permanent Habitat Impacts – Acreage

Habitat Type	CL	MRE	MRA	MRH	TOTAL
Beach / Unvegetated Shoreline	0.000	0.036	0.773	0.000	0.809
Freshwater Wetland	0.000	0.000	0.000	0.056	0.056
Intertidal Wetlands	0.108	0.875	1.675	0.115	2.773
Mudflats	0.046	0.000	0.015	0.000	0.061
Subtidal Bottom	0.000	0.000	0.000	0.000	0.000
Maritime Forest	0.318	0.000	1.487	0.000	1.805
Upland Ruderal	0.000	0.000	0.000	0.000	0.000
Urban	0.000	0.000	0.000	0.000	0.000
Total	**0.472**	**0.911**	**3.950**	**0.171**	**5.504**
Total Waters/Wetlands	**0.154**	**0.911**	**2.463**	**0.171**	**3.699**

CL: Cedarhurst-Lawrence
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

Table 6-14: Temporary Habitat Impacts - Acreage

Habitat Type	CL	MRE	MRA	MRH	TOTAL
Beach / Unvegetated Shoreline	0.000	0.000	0.273	0.114	0.387
Freshwater Wetland	0.000	0.000	0.000	0.000	0.000
Intertidal Wetlands	0.005	0.051	0.013	0.000	0.069
Mudflats	0.440	0.000	1.917	0.015	2.372
Subtidal Bottom	0.058	3.985	7.191	0.000	11.234
Maritime Forest	0.000	0.000	0.000	0.000	0.000
Upland Ruderal	0.218	8.457	6.746	0.922	16.343
Urban	0.018	1.726	4.641	3.038	9.423
Total	**0.739**	**14.219**	**20.781**	**4.089**	**93.828**
Total Waters/Wetlands	**0.503**	**4.036**	**9.394**	**0.129**	**14.062**

CL: Cedarhurst-Lawrence
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

The following assumptions were made as part of accounting for permanent and temporary impacts:

- Shallow intertidal and subtidal bottom habitats will be restored "in-kind" on the waterward side of CSRM features, but within permanent easement – resulting in temporary impacts. This is inclusive of rock sills, which were assumed to occur uniformly in subtidal bottom and are included herein as a component of NNBFs to stabilize eroding shorelines and provide ecological benefits to coastal shoreline ecosystems.[39]
- Beach/shoreline habitats will be restored in-kind on the waterward side of features, but within the perpetual easement – resulting in temporary impacts.
- Intertidal wetlands will be permanently impacted within the temporary work area easement. This was a conservative assumption that allows for further refinement of impacts in final design that would include a formal waters and wetland delineation.
- Maritime forest will be permanently impacted within the temporary easement. This was a conservative assumption that allows for further refinement of impacts in final design. Reforestation will be performed on-site and in-kind where possible.

[39] It is recognized that there is a trade-off when converting intertidal habitats (i.e., mudflats or subtidal bottom to rock sill or intertidal vegetated wetland). The introduction of rock sills are intended to not only provide coastal storm risk management to vulnerable shorelines and communities, but also are intended to preserve and enhance/restore existing intertidal vegetated wetlands that are a critical, yet diminishing, natural habitat within Jamaica Bay. The restored intertidal wetlands will then further reduce wave energy, minimize erosion, improve water quality, as well as provide additional habitat to species of conservation concern that utilize the bay. To minimize impacts, the final design will include hydraulic and hydrologic analysis based upon site conditions and to ensure minimization of impacts immediate to the rock sill as well as along the adjacent shoreline. This recognizes that each HFFRRF will require additional design consideration to account for specific site conditions, shoreline types, erosion rate, fetch, tide range and bank height and slope.

- Temporary impacts to intertidal wetlands will be restored on-site and in-kind. It is recognized that compliance monitoring, and associated adaptive management, would be required under federal and state wetland permitting. This would specifically address successful establishment of native plantings, and control of invasive species.

6.5.2 NNBFs

A series of NNBFs were developed as part of the Recommended Plan HFFRRFs to not only control erosion and help manage coastal storm risk, but also to provide opportunities for habitat restoration and enhancement which would offset unavoidable permanent impacts to federal and state regulated areas. The four different types of proposed NNBFs are depicted in Figures 6-9 and 6-10 above. Specifically, these NNBFs provide the following ecological benefits and were incorporated in the feasibility design to also recognize future federal, state, and city permitting requirements.

6.5.2.1 Restoration / Creation of Low and High Marsh Habitats

For purposes of habitat accounting and recognizing the difficulty in differentiating between low and high marsh habitats during mapping, these habitats have been categorized as "intertidal wetlands" as described in Section 2.6.5. Specifically, these NNBF efforts target the following:

- Restoration of low marsh habitat in existing mudflat areas proximate to highly erosional shorelines; and
- Restoration and/or creation of high marsh habitat in adjacent uplands that are dominated by common reed (*Phragmites australis*) and other invasive species.

6.5.2.2 Creation of Rock Sill Features

Creation of rock sill features provides protection for the subtidal and intertidal habitats, as well as provide a hard bottom habitat for increased ecological production. These features provide additional opportunities for shellfish habitat creation.

6.5.2.1 Restoration of Maritime Forest (upland)

Restoration of maritime forest (upland) within upland ruderal and urban habitats would take place in areas that have been significantly impacted by historic and current anthropogenic disturbance. While this feature would be in upland habitats, these restoration efforts account for anticipated state and city level permitting requirements.

Table 6-15 shows proposed restoration / creation, as well as enhancement efforts using acreage as a metric. While Table 6-13 above shows that the project will result in unavoidable impacts to 3.7 acres of federal and state regulated waters and wetlands[40], Table 6-15 shows that the project includes 7.65 (3.042 + 4.606) acres of wetland restoration or creation, and 0.468 acres of wetland enhancement. Regarding maritime forest, the project will result in unavoidable impacts to 1.81 acres (Table 6-13 above). Table 6-15 shows that the Recommended Plan offsets these loses through restoration of 1.35 acres.

[40] Conservatively assumed to include the following habitat types: beach/shoreline, freshwater wetlands, intertidal wetlands, mudflats, and subtidal bottom.

Table 6-15: Restoration, Creation, & Enhancements – Acreage

Habitat Type	Restoration / Creation		Enhancement	
	Mid-Rockaway Edgemere Area	Mid-Rockaway Arverne Area	Mid-Rockaway Edgemere Area	Mid-Rockaway Arverne Area
Intertidal Wetland	3.042	4.606	0.468	0.000
Maritime Forest	0.000	1.348	0.000	0.000

6.5.3 Evaluation for Planned Wetlands Analysis

EPW also was used to characterize the functional impacts and benefits within intertidal wetlands associated with each HFFRRF project. The assessment provides estimates of current resource value loss, and the potential increase in resource value through implementation of NNBFs. EPW provides a quantitative measure for capacity of an intertidal wetland to perform the following five functions:

- Shoreline bank erosion control – capacity to provide erosion control and dissipate erosive forces at the shoreline bank
- Sediment stabilization – capacity to stabilize and retain previously deposited sediments
- Water quality – capacity to retain and process dissolved or particulate materials to the benefit of downstream surface water quality
- Fish (tidal) – degree to which a wetland habitat meets the food/cover, reproductive, and water quality requirements for fish
- Wildlife – presence of characteristics that distinguish a wetland as unique, rare, or valuable.

Within each function, numerous elements (i.e., physical, chemical, and biological characteristics) are evaluated in order to identify a wetland's capacity to perform a given function. Element scores (unitless numbers ranging from 0.0 to 1.0, where 1.0 represents the optimal score) were assessed for the existing condition and proposed NNBFs. The scores were combined to produce a Functional Capacity Index (FCI) value from 0.0 to 1.0, which provides a relative index of a reference site's capacity to perform a given function. Total acreage of proposed intertidal wetland restoration, creation, or enhancement at the site is then multiplied by the FCI value to produce a wetland functional capacity unit (FCU), which represents the site's capacity to perform each wetland function (Bartoldus *et al.* 1994). Although no specific values are given to maritime or coastal buffer habitats with EPW, the wetland numbers are enhanced by having the adjacent buffer.

A summary of the analysis and the numerical results of the EPW functional assessment is provided in Tables 6-16 and 6-17. In summary, Table 6-16 shows that the project will result in the loss of 8.45 FCU's across the five functions. However, Table 6-17 shows that the NNBFs will result in the gain of 34.51 FCUs across the five functions. Similar to the acreage metric evaluation, the EPW functional assessment shows significant gains to the shoreline ecosystem through the incorporation of NNBFs.

Table 6-16: EPW Functional Assessment – FCU Losses

Function	CL	MRE	MRA	MRH	TOTAL
Shoreline Bank Erosion	0.000	-0.420	-1.014	0.000	-1.434
Sediment Stabilization	-0.108	-0.643	-1.255	-0.129	-2.135
Water Quality	-0.100	-0.776	-1.415	-0.101	-2.392
Fish (tidal)	-0.075	-0.444	-0.890	-0.065	-1.474
Wildlife	-0.048	-0.365	-0.558	-0.045	-1.016
Total	**-0.330**	**-2.648**	**-5.132**	**-0.340**	**-8.451**

CL: Cedarhurst-Lawrence
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

Table 6-17: EPW Functional Assessment – FCU Gains

Function	CL	MRE	MRA	MRH	TOTAL
Shoreline Bank Erosion	0.000	3.542	4.606	0.000	8.148
Sediment Stabilization	0.000	3.513	4.606	0.000	8.119
Water Quality	0.000	3.443	4.606	0.000	8.049
Fish (tidal)	0.000	2.470	3.224	0.000	5.694
Wildlife	0.000	1.965	2.533	0.000	4.498
Total	**0.000**	**14.933**	**19.574**	**0.000**	**34.507**

CL: Cedarhurst-Lawrence
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

6.6 Design and Construction Considerations

The planning level design used to identify the Recommended Plan gave significant consideration to existing infrastructure and habitats that are in close prominently to the work areas and CSRM structures. Construction activities would be closely monitored to ensure that there is not any damage to existing infrastructure. Coordination with numerous different stakeholders along with the project local sponsors will be required during the design phase.

6.6.1 Value Engineering

A Value Engineering Study will be performed on the plan carried forward during the design phase.

6.6.2 Design Adaptability to Relative Sea Level Change

Design and construction considerations for how the project would perform under relative sea level change focused on addressing the potential impacts of relative rise of sea level change in the study area. The design of the Atlantic shorefront features are based upon water surface elevations adjusted to 2015 sea level rise conditions and conservatively assume a low sea level change

projection in the initial construction, with the ability to adapt to faster rates of sea level change in the future. The HFFRRFs designs are based on the intermediate USACE sea level change projections for the project life of 50 years. Sensitivity analysis was performed for the historic (low) rates, intermediate and the high sea level change rates in order to understand how the project would perform under varying future conditions and also how the project could be adapted in the future based on actual future conditions.

6.6.2.1 Dune and Beach Restoration

Dune and beach restoration features can be adapted to sea level change. Additional sediment can be included in each renourishment operation to offset losses from sea level rise. The natural berm elevation will rise in concert with the rising sea surface, so the design berm of +8 feet NAVD88 would be adjusted accordingly by adding up to 2 feet of berm elevation consistent with the USACE high SLR projection in 1-foot increments in the future. The dune crest elevation will also need to be raised in response to sea level rise to maintain the design performance when the seawall is adapted for sea level rise as discussed in section 6.6.2.2.

6.6.2.2 Seawalls

The buried seawall and composite seawall both may be adapted to rising sea levels in the future by adding an additional layer of armor stone as shown in Figure 6-11, which amounts to approximately 3.3 additional feet in height, bringing the adapted seawall height to +20 feet NAVD88 and the adapted dune to a height of +21 feet NAVD88. The composite seawall would also require extending the concrete cap up to the elevation of the armor stone. Since the size of the median diameter of armor stone is fixed, the height of the seawalls following adaptation may actually increase more than the sea level rise – increasing the height of the seawalls by exactly 1 or 2 feet by adding smaller armor stone is not feasible because the smaller stone would not be stable under design storm conditions. Raising only the concrete cap in the composite seawall is also not feasible because wave forces on the cap and steel pile would increase dramatically without the protection of the armor stone on the storm-side of the structure. Consequently, there is considerably less flexibility in the adaptation of the seawalls in comparison to the dunes.

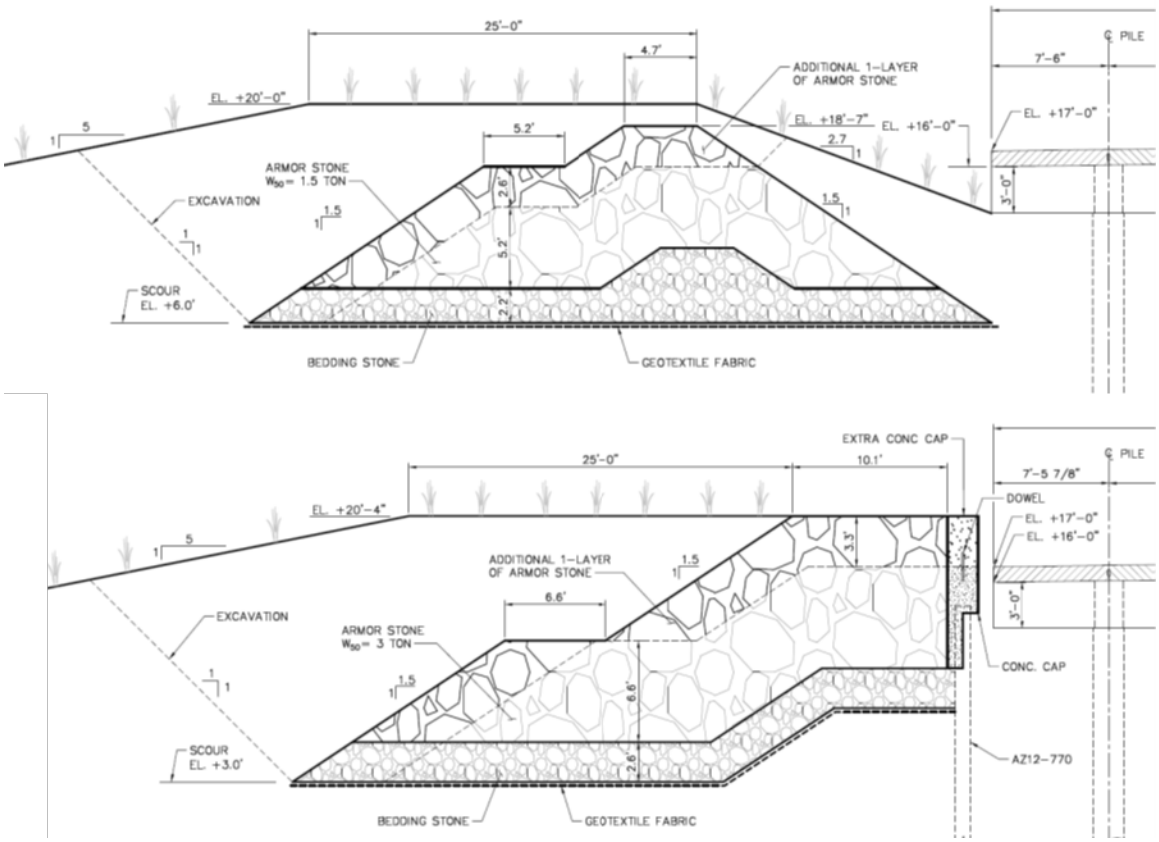


Figure 6-11: Atlantic Shorefront Component: Seawall Adaptability Measures

6.6.2.3 Groins

Due to the uncertainty in sea level change as well as the design/performance of the groin system, groins may be adapted in the future by adjusting renourishment quantities and placement locations. Even without considering sea level changes there will be some differences in the actual performance of the groins and the expected or modeled performance that will need to be adapted to by adjusting fill placement.

6.6.2.4 HFFRRFs

Of special note is also the analysis of the adaptability of the HFFRRF projects in the face of changing sea levels. Feature heights will be finalized during the PED phase and additional analysis is recommended to document the adaptability of the projects under the consideration of sea level rise scenarios. The HFFRRFs have been designed for future 20% AEP water levels with consideration of the intermediate SLC scenario. If the realized SLC exceeds the design SLC and closely resembles the USACE high SLC scenario, then adaptation is expected to be required in the year 2044 for those feature that provide the flood risk reduction function. In general, there are two adaptability options: 1) With a storm surge barrier for Jamaica Bay in place; operate the storm surge barrier more frequently and 2) Without a storm surge barrier in place; address larger wave overtopping volumes with collection systems and/or pumps and retrofit HFFRRF features to allow for an increase in elevation.

In addition, rock sills and the NNBFs are considered to be adaptable. The placement of additional stone over time allows for an increase in crest elevation of rock sills with sea level rise in the event that realized RSLC exceeds the projection. The designs also include an expectation that the protected habitats behind the sill features would migrate shoreward and the fill/cut elevations chosen in most cases are designed to allow for that migration. Thus, the NNBFs proposed herein are intrinsically adaptive features and consist of improved wetland habitats and a more natural shoreline that can migrate with rising sea levels in the future.

Finally, albeit that the HFFRRF elevations exceed the year 2018 10% AEP water levels, over time, and with rising sea levels is not expected that all HFFRRF elevations will be above future 10% AEP water levels. Finally, in all instances the 1% AEP water level is expected to exceed the lowest HFFRR-Feature elevation and therefore the project elevation. Since the appropriate adaptive features for the HFFRRFs depend so intrinsically on the yet to be determined Recommended Plan of the NYNJHATs study, the adaptation of the HFFRRFs is not part of the Recommended Plan, nor the cost estimate for the Recommended Plan. Adaptation for SLC greater than the intermediate USACE predictions will need to be included as part of the NYNJHATs final recommendation, or future consideration under this project, based upon the NYNJHATs findings.

6.7 Summary of Accounts

6.7.1 National Economic Development (NED)

The average annual equivalent net benefits for the Recommended Plan are $77,338,000. The average annual equivalent net benefits for the Atlantic Ocean shorefront separable element are $10,687,000 excluding recreation benefits and $40,117,000 including recreation benefits.

6.7.2 Environmental Quality (EQ)

The Recommended Plan design has taken care to avoid environmental impacts and incorporate *natural and nature-based features* (NNBFs) which should improve environmental quality, where feasible and appropriate. Five NNBFs are included for the Bayside HFFRRFs and a net gain of 25.9 FCUs of functional habitat across all five functions are expected as a result. The Shorefront design is also nature-based, with some hard structures incorporated such as the composite seawall and groins to improve system resiliency and reduce the overall fill volumes required compared to other alternatives. This avoids and minimizes potential impacts from dredging and placement activities. On the Bayside, hard structures were not proposed for existing living shorelines and natural areas. Impacts to the environment were carefully avoided by pulling alignments away from the coastal edge as much as possible. Unavoidable impacts are fully mitigated. Potential impacts of the Recommended Plan on human and environmental resources have been identified and presented in Section 7 of this document, though the analysis of habitat impacts and mitigation requirements for the Recommended Plan are provided above in Section 6.5.

All factors that may be relevant to the Recommended Plan were considered, including direct and indirect impacts on intertidal and freshwater wetlands, effects on essential fish habitat and listed species, air quality, water and sediment quality, hazardous materials, historic properties, socioeconomic, and environmental justice impacts. Environmental impacts to intertidal wetlands are the primary environmental effect.

6.7.3 Regional Economic Development Benefits (RED)

Construction of the Recommended Plan would reduce probabilities of direct damage to property which are captured as part of the NED benefits. In addition to these direct benefits, the regional economy will benefit from decreases in the occurrence of secondary impacts, such as potential disruptions to commercial, industrial, and retail productivity. Other RED benefits of note are related avoiding missed days at work and associated lost income as residents deal with flood evacuation response and cleanup and the increase in business activity associated with the construction activities. Maintaining beaches and avoiding loss of the recreation use in the area will also provide a benefit to businesses near the boardwalk. Differences in RED benefits between the different plans considered are typically closely correlated with the NED benefits. Therefore plans with high NED benefits will also have high RED benefits.

6.7.4 Other Social Effects

The Recommended Plan will contribute to improving life-safety and mental health for residents of the study area. Hurricane Sandy resulted in 10 fatalities in the project area, and 109 fatalities in the New York City metropolitan area (Daniel, 2012). The majority of deaths occurred as a result of drowning in homes and cars (37 percent), followed by trees falling (19 percent), and falls (11 percent). Deaths attributed to falls occurred mostly to senior citizens and were associated with lack of light due to power outages. Nine deaths were due to carbon monoxide poisoning after people left their generators running indoors (8 percent). The remaining deaths (25 percent) resulted from fire, illness, electrocution, debris crashing into people, and not receiving medical aid fast enough to prevent loss of blood or oxygen. Data for injuries that are the direct or indirect result of flooding are more difficult to track than fatalities. In addition to injuries that are directly related to a flood event, indirect injuries can occur when the affected population is dealing with the aftermaths of a storm event, such as debris removal, clean up, and repairs.

Significant factors impacting the likelihood of death or injury are the warning times and evacuation response, the frequency of flooding, the depth of flooding, the rate of rise and the flood velocity. Construction of the Recommended Plan would substantially reduce the risk of waves with high velocities impacting development along the Rockaway Beach shoreline, which would have a positive effect on reducing threats to life and safety. The reduction in the frequency and depth of cross shore flooding will also provide a clear reduction in risk to life and safety. For residents located in areas near the HFFRRF floodwalls, berms and bulkheads the recommended plan will reduce the frequency of flooding, but when the structures do overtop the rate of rise for floodwaters will increase. It is important that residents in all areas are frequently reminded of the need to evacuate in response to coastal flood warnings.

Another significant social effect of flooding is decreased mental health. This may be a result of mental stress and post-traumatic stress disorder (PTSD) associated with exposure to the disaster, including stress associated with evacuations, losing a home and possessions, physical injuries, and illnesses of family and friends. Mental stress can also be a secondary response to other direct impacts, such as being displaced from home and community, loss of electricity and heat in the home for extended periods of time, inability to receive regular counseling or treatment as a result of closure or lack of transportation, or inability to obtain needed medication. Mental health issues can lead to sleep disorders, drug/alcohol abuse, and inability to work and can last for months or years following a flood event. Productivity losses can occur from lost labor and production due to flood-related mental health issues and lost labor and production by those who provide care to

affected family members. While the Recommended Plan will not eliminate all of these sources of stress, the plan will reduce the number of people directly exposed to flooding and will reduce the stress of being displaced while homes are repaired.

6.8 Risk and Uncertainty

In conducting Feasibility Phase analysis for how to manage coastal storm risk, the study team develops and analyzes alternatives in order to arrive at a Recommended Plan. The goal of the Feasibility level design and analysis is to reduce the level of risk and uncertainty around the Recommended Plan such that decision makers are comfortable deciding whether or not to move forward with design and construction of the Recommended Plan. The agency must feel that the costs and impacts are well enough understood to minimize the risk that as design proceeds and is further developed, the costs and impacts will greatly exceed what was estimated and projected during the Feasibility Phase. During Pre-Construction Engineering and Design Phase, any changes that more than a twenty percent increase in cost will require a Post-Authorization Change Report. Risk and uncertainty are managed throughout the project phases and generally decrease as a project is further refined.

6.8.1 Residual Risks

The Recommended Plan for the Atlantic Shorefront Reach has very low residual risk, with an annual chance of exceedance of .0067%. If a storm occurs that exceeds the design of the shorefront, the composite seawall will still reduce damages by reducing cross shore flooding despite overtopping and reducing wave action. In the event of overtopping there would still be damages, but greatly reduced from the Future Without Project Condition. Unless a storm surge barrier is recommended and constructed as part of the NYNJHAT study, a large overtopping event would likely cause high storm surge elevations in Jamaica Bay which could potentially inundate the entire Rockaway peninsula from the Bayside. The risk of this size event occurring is low, though not impossible and sea level rise will increase the likelihood of this occurring over time.

The Recommended Plan will greatly reduce the frequency of flooding in Hammels, Arverne, Edgemere, Cedarhurst and parts of the Town of Hempstead adjacent to the Village of Cedarhurst from flooding which likely occurs at least once a month currently. This frequent flooding is due to tidal flooding and heavy rains. With a project in place the risk of a flood in a given year for these areas drops to a 10% chance in 2018 and 20% chance in 2058. However, it is important to communicate the remaining risk to residents even with the project in place, or residual risks.

The Recommended Plan has high residual risk for Bayside communities in the Jamaica Bay Planning Reach and for communities like Breezy Point and Coney Island who would have had their risk managed under the TSP with the storm surge barrier and tie-ins, which are now part of the NYNJHAT study. The communities where HFFRRFs are recommended will experience less frequent flooding, but still have residual risk for larger storms and hurricanes (anything exceeding the current 10% AEP storm), which are the types of events that can cause catastrophic loss of life and damages. Communities without HFFRRFs such as Old Howard Beach/Hamilton Beach, Canarsie, Broad Channel, Meadowmere, Rosedale, etc., also have residual risk for large storms and will continue to experience frequent flooding as well. The communities east of Beach 9th Street are outside the Rockaway project area and are currently included in another ongoing USACE study called the Nassau County Back-Bay (NCBB) Coastal Storm Risk Management Study, which is

evaluating the feasibility of managing flood risk for this area. For more information on residual risk for the Bayside, please see Section 7 of Appendix A2E on Interior.

It should be noted that this study evaluated the feasibility of implementing HFFRRF plans for the communities with high residual risk, but no feasible plans were identified which would meet the policies and guidelines of USACE. There is still an opportunity to manage coastal storm risk for Jamaica Bay communities with high residual risk through the proposed storm surge barrier across Rockaway Inlet and measures under evaluation in the NCBB study.

The NYNJHAT study will conclude when a Chief's Report is sent to Congress in the Summer of 2022, contingent upon available funding, continued non-federal sponsor support, and concurrence by the USACE higher-authority offices. The Recommended Plan should be identified in the Spring of 2021 with the Final Feasibility Report and Tier 1 EIS. If the NYNJHAT study does not recommend an alternative that includes the Jamaica Bay Reach in the area of protection (Alternatives 2, 3A, 3B, and 4), then residual risk will remain high for this area. If the storm surge barrier across Rockaway Inlet is recommended as part of the NYNJHAT study, the recommendation will need to be approved by the Assistant Secretary for the Army (Civil Works) and Congress will need to pass an appropriations bill authorizing and funding the implementation. Once authorized and funded, the implementation will need to be cost-shared with the non-federal sponsor(s). Construction for the NYNJHAT study is expected to have a longer-than-typical duration due to the scale and complexity of the concept alternatives.

While moving the storm surge barrier to the NYNJHAT study may result in delays to when a Rockaway Inlet storm surge barrier could feasibly be implemented, if recommended, it is important to note that those delays may not be significant. This is because even if the Rockaway barrier had not been transferred to NYNJHATs, it would not have been implemented without additional appropriations and authority from Congress of roughly 2.5 billion dollars, which is not a certainty. Furthermore, Congress would have likely chosen to wait until the NYNJHAT study made a determination that Alternative 2 is either screened out or the TSP before funding a redundant CSRM feature, since you would not need a Rockaway storm surge barrier if Alternative 2 is the NYNJHATS TSP. Finally, keeping the storm surge barrier in the Rockaway Study would have delayed the Chief's Report for the Rockaway Reformulation until all further analysis on the storm surge barrier could have been completed and could have potentially risked the availability of funding for implementation of the whole Rockaway Reformulation Recommended Plan.

6.8.2 Ecological Uncertainty

The evaluation of habitat impacts and mitigation requirements is founded upon a comprehensive mapping as detailed in Section 6.5. However, given stage of project planning, a formal delineation of waters and wetlands has not been completed at this time. As such, there is uncertainty relative to the total habitat impacts to federal and state regulated areas associated with the Clean Water Act, as well as State of New York laws pertaining to both tidal and freshwater wetlands. A field review of sites was performed as part of this phase of planning, and best professional judgment was used to estimate these regulatory boundaries.

6.8.3 Risk and Uncertainty in Economics

Uncertainty in the expected benefits and overall economic performance of the recommended plan was also evaluated. Table 6-18 presents a summary of the benefits by category and estimated uncertainty bands. The shorefront benefit uncertainty was calculated by post processing the Beach-

fx results to identify the lifecycle iterations associated with the 75th percentile and 25th percentile of benefits. The HFFRRF line of protection benefits, including adjustments for residual interior drainage, were computed by HEC-FDA. For cross shore flood analysis there are multiple HEC-FDA models reflecting different sources of flooding. For consistency, the uncertainty in reduced cross shore flood damages for a selected year of the lifecycle analysis was calculated. The 75th percentile and 25th percentile of benefits, including adjustments for residual bayside flooding, were estimated based on the percent increase or decrease in benefits calculated for the cross shore flood reduction. The greatest uncertainty in the recreation benefits was identified as the potential that some of the decreased beach usage predicted in the future without project conditions could be transferred to another location. Based on review of the recreation survey results it was estimated that visitation transfers could reduce the overall recreation benefits by 31%. Uncertainty in the benefits as presented in Table 6-18 indicates that the project BCR ranges between 1.5 and 2.8 for all project benefits, and between 0.9 and 2.0 for damage reduction benefits only.

Table 6-18: Range of Economic Benefits and Economic Metrics

Description	25th Percentile	Expected Value	75th Percentile
Shorefront Damage Reduced	9,303,000	15,808,000	21,323,000
Costs Avoided (Emergency Renourishment)	554,000	942,000	1,271,000
Cross-Shore Flood Damage Reduced	5,667,000	14,581,000	25,020,000
HFFRRF Damage Reduced	14,255,000	16,997,000	20,609,000
Total Storm Reduction Benefits	29,779,000	48,328,000	68,223,000
Recreation Benefits	20,246,000	29,342,000	29,342,000
TOTAL ANNUAL BENEFITS	**50,025,000**	**77,670,000**	**97,565,000**
ANNUAL COST	**34,484,000**	**34,484,000**	**34,484,000**
Net Benefits (damage reduction only)	**-4,705,000**	**13,844,000**	**33,739,000**
Net Benefits	**15,541,000**	**43,186,000**	**63,081,000**
BCR (damage reduction only)	**0.9**	**1.4**	**2.0**
BCR	**1.5**	**2.3**	**2.8**

6.8.4 Risk and Uncertainty for Project Costs

In early plan formulation, rough costs are estimated to aid in screening and are refined after the TSP milestone and again for the Final Report. In order to account for uncertainties in the final project costs, which could result from a variety of factors, all costs include an appropriate contingency on top of the actual estimated cost. The contingencies are based on a Cost Schedule Risk Assessment (CSRA), which is included in Appendix C. For this project, a contingency of 28.36% is being utilized for initial construction and renourishments.

6.8.5 Risk and Uncertainty in Borrow Area Availability

A minimum of 13,000,000 and a maximum of 18,000,000 cubic yards were identified for use as borrow material for the East Rockaway Inlet to Rockaway Inlet project. The project will require an estimated 14,372,500 cubic yards, including initial fill and renourishments over 50 years under the intermediate sea level rise scenario The identified borrow area likely has sufficient sand to supply the initial construction and periodic renourishment of the project through 43 years of the 50-year project life under minimum borrow area capacities, and for the full 50-year project life under maximum borrow area capacities. The borrow area will be permitted for use once the Water Quality Certificate is obtained. There is a low risk of running out of material for the last two renourishments (estimated as a deficit of 817,000 cubic yards of the total 1,111,000 cubic yards in Year 2064 and a deficit of 555,500 cubic yards in Year 2068), which may occur if the available material at the borrow sites more closely matches the minimum capacity estimate of 13,000,000 cubic yards stated above. In this worst case scenario, the identified borrow area would be short 1,372,000 cubic yards of sand.

Rockaway Inlet is a potential source for borrow area material should the identified borrow area not have a sufficient supply of sand. The borrow areas for the East Rockaway Inlet to Rockaway Inlet Atlantic Shorefront are exclusively for use of this project. If during PED or over the life of the project, it is determined that the borrow area will need to be expanded or a new borrow area identified, then a supplemental environmental compliance document will be prepared. The risk associated with this worst case scenario is relatively low, given that the shortage would be small (shortage would be 9.5% of total needs) and could potentially be met using O&M dredged material from Rockaway Inlet. Further, any capacity deficits under the worst case scenario would be realized at the earliest in year 2064, which gives the USACE and the NFSs time to plan and prepare. In the best case and expected scenarios (18 million cubic yards and 15.5 million cubic yards available, respectively), material in the borrow area would exceed initial construction and periodic renourishment sand needs of 14,372,500 cubic yards over the 50-year project life.

6.8.6 Risk and Uncertainty in Water Level and Sea Level Rise Assumptions

The expected value (mean) of model result data was used to determine the design water levels and wave characteristics for the design AEP event. I.e. for the HFFRRF the 20% AEP in 2068 was used. The design elevation of the HFFRRF is not merely dependent on the water elevation. The design elevation has been established using an overtopping criterion to establish a freeboard (see section 3.2.2 of Appendix A2). If water levels and waves deviate from the expected value additional overtopping could be expected for the design AEP event. Site specific design and engineering analyses and refinement of HFFRRFs (including refinements to the elevations) is recommended for PED.

The NED Plan for this project was identified using the intermediate SLR curve projections. However, in order to account for the uncertainty of these predictions, a sensitivity analysis on the economics of the Recommended Plan was performed using low and high accelerated sea level rise rates (per EC 1165-2-212). Section 6.6.2 and Section 7.6 of Appendix A1 discuss potential adaptive measures should sea levels rise faster than the intermediate curve predictions. The timing of potential future need for adaptation is also discussed in Section 7.4 of Appendix A2.

6.8.7 Risk and Uncertainty in Future Beach Placement Activities

Periodic renourishment is subject to Operations and Maintenance funding appropriations, which are passed by Congress and signed by the President. This project assumes that O&M will be fully funded at the authorized levels. However, there is a risk that O&M appropriations are not received at the fully funded level and frequency. If the project is not maintained to the design profile, the level of risk reduction would decrease. If the beach is allowed to erode significantly, the integrity of the buried seawall dune could eventually be compromised, which is the most significant factor for maintaining the design level of risk management.

6.8.8 Risk and Uncertainty in Coastal Storms

Uncertainty regarding the number and intensity of future storms in the area is handled through the Beach-fx Monte Carlo simulation, whereby each lifecycle randomly selects (based on actual probabilities of storm occurrence) a suite of storms that will hit the project area over a given lifecycle. The storm suite is selected from a group of 456 plausible storms. However, while the storms are randomly selected, the effect of any given storm on a given shore profile is determined by the SBEACH software, and is fixed. While the coastal storm modeling is a useful tool for planning and design of coastal storm risk management projects, it is based on the historical record of storms for the project area and nature can always produce a storm which exceeds the historical record storms to date. A storm can always come which would overtop manmade CSRM structures and cause damages. Evacuation warnings should always be heeded and citizens should exercise caution and err on the side of safety when assessing how to respond to flood risk, regardless of whether a USACE coastal storm risk project is in place or not.

6.8.9 Risk-Informed Decision Making

The study team has worked to reduce the risk and uncertainty throughout the Feasibility Phase of the Rockaway Reformulation and laid out a path to further reduce it in PED Phase. The study team is confident in the results of the evaluation and the feasibility determination for the Recommended Plan. It is very unlikely that the uncertainties discussed above would result in a substantively different Recommended Plan.

6.9 Recommendations for PED

Based on the data gathered during the feasibility study and engineering analyses, preliminary designs for the Shorefront Element and HFFRRF projects have been completed.

6.9.1 HFFRRF Designs

It should be noted that HFFRRF designs are prototypical in nature and are not complete site-specific designs. The dimensions and sizing of the individual features described in this HSGRR/EIS are preliminary – based on the study area conditions and sufficient for feasibility level study. It is fully expected that HFFRRF designs would be further refined to the appropriate design level in PED. Significant additional engineering analysis is required to substantiate the designs of the flood risk reduction features, habitat impacts, the drainage infrastructure and the pump stations including, but not limited to, a full evaluation of topographical and bathymetric elevations, subsurface soil conditions, inventory and investigation of existing structures and utilities.

A preliminary, non-exhaustive listing of potential future engineering analyses and design refinements for PED include the following:

- Geotechnical data collection (site specific borings and geotechnical data collection),
- Bathymetric and topographic data collection,
- Utility survey and an inventory and condition assessment of existing structures and utilities for the project area,
- Continued analysis of the impacts of design refinements to existing habitat,
- Site specific design for all HFFRRF including detailed structural, geotechnical and civil engineering analyses and design,
- Design and engineering analysis regarding HFFRRF site integration, notably roadway design for road ramps and all features in close proximity to DOT right-of-way,
- Given the close proximity to private property, additional refinement and site-specific details will need to be worked out to establish the permanent and temporary easements,
- Refinement of project elevations and design of the HFFRRF transitions between different feature types,
- For the AEP stage elevations relevant to the HFFRRF design it can be noted that the underlying tides play a more dominant role and it is recommended to further communicate this concept with the public to increase awareness of risk. For example, the 20% AEP water level can be a result of high tides with a relative small storm surge or a low tide with a relatively large storm surge. For extreme events, i.e. lower AEP events, the storm surge component is the dominant contributor to the total stage elevation regardless of whether the event coincides with high or low tides. This is important from a risk communication perspective since smaller meteorological events may not deserve the same attention but can result in flooding if they coincide with high tides.
- Bayswater Park and Beach 35th St are currently being redesigned by DOT and Parks. The design of the proposed berm will be further coordinated with both agencies.
- Refined engineering analyses and design for the pump stations, pump capacities and new drainage infrastructure,
- Refined design and engineering analyses of modifications and connections to existing drainage infrastructure,
- NNBF designs include the preliminary identification of locations where these elements will likely fit, but final design and NNBF siting will depend on final feature alignments and detailed delineation of existing grades and elevations,
- Detailed 2D wave modeling to optimize rock sill designs and freeboard requirements of HFFRRF, and
- Analysis of temporary construction features.

6.9.2 Atlantic Shorefront Element Design

For the Atlantic Shorefront Element, the feasibility level design was based on data gathered during the feasibility study and engineering analysis. The dimensions and sizing of the specific project features such as the composite seawall, the groins and splash apron are preliminary but of sufficient detail for feasibility study. Project feature designs and the composite seawall design will be further developed in PED.

Initial beach fill quantities will need to be updated based on current survey data. The preliminary designs shall not be construed as requirements for actual dimensions for implementation and significant additional engineering and design is required to substantiate the designs including, but not limited to, a full evaluation of topographical and bathymetric elevations, subsurface soil conditions and an inventory and condition assessment of existing structures and utilities for the project area.

A preliminary list of potential future engineering analyses and design refinements include the following:

- Bathymetric and topographic survey to establish beachfill quantities and inform detailed designs for the groins and buried seawall,
- Geotechnical data collection (site specific borings, samples and geotechnical data collection),
- Morphological modeling analysis to assess the performance of the tapered groin field in Reach 2 and beyond the terminal groin at 149th street and incorporate recent survey data on the performance of the FCCE project post Hurricane Sandy,
- Borrow area analysis, including, but not limited to surveys, grain size compatibility and site capacity analyses,
- Refined engineering analyses for the armor rock sizing (both for the coastal groins and the composite seawall) and geometry of the coastal groin structures,
- Refined engineering analyses for the beach tapers, dune transitions and tie-ins to higher ground at the project ends,
- Engineering analyses and detailed design to integrate the existing baffle wall into the design of the composite seawall between Beach 126th and Beach 49th Street, and
- Detailed design to account for the existing boardwalk, beach access (stairs and ramps) and modifications needed during construction of the composite seawall

7 ENVIRONMENTAL CONSEQUENCES*

In accordance with CEQ regulations (40 CFR 1502.16), direct and indirect impacts are described in this section and cumulative impacts are described Section 7.21. The significance of potential impacts from implementation of the Proposed Action (referred to herein as the Recommended Plan) and the No Action Alternative were analyzed for each resource area identified in Section 2 Existing Conditions. Potential effects on environmental resources are described qualitatively rather than quantitatively; however, for some resource areas, preliminary qualitative analyses are provided. Note that the terms "effect" and "impact" are used synonymously in the CEQ regulations (40 CFR §1508.8) and those terms are used interchangeably in this HSGRR/EIS.

7.1 Geologic Setting

If an alternative would result in an increased geologic hazard or a change in the availability of a geologic resource, it could have an adverse significant impact. Such geologic and soil hazards would include, but not be limited to, seismic vibration, land subsidence, slope instability, or a reduction in the productive agricultural use of soils.

7.1.1 No Action Alternative

Under the No Action Alternative, no short- or long-term direct or indirect impacts to geology are anticipated in both planning reaches. However, adverse significant long-term direct impacts to area topography and soils would likely continue due to shoreline loss. Specifically, not implementing the Recommended Plan would allow continued shoreline erosion from continued coastal wave action and future extreme weather events.

7.1.2 Recommended Plan (Atlantic Shorefront & Jamaica Bay Combined)

7.1.2.1 Geology

An adverse geologic impact could occur if Recommended Plan elements alter bedrock conditions such that bedrock aquifer quality would be compromised; bedrock competency to support existing or future building foundations would be decreased; or would cause an increase in seismic activity at levels capable of damaging buildings and at a frequency above predicted levels.

No impacts on geology are anticipated from implementation of the Recommended Plan. The Atlantic Shorefront component and HFFRRFs would have a negligible impact on bedrock, and all other construction activities would occur above bedrock elevation.

7.1.2.2 Topography

Adverse minor long-term direct impacts to topography are anticipated from construction or extension of temporary and permanent near-shore and on-shore features in both planning reaches.

With respect to the Atlantic Shoreline Planning Reach, direct impacts to topography are anticipated from the construction of groins and beach fill placement elements of the Recommended Plan. The impacts on topography would exist for as long as built structures remain in place. However, the built structures are intended to provide both CSRM benefits as well as reduce long-term maintenance requirements associated with this eroding shoreline. Following proposed project activities, the topography in beach fill areas would be characteristically like natural beach/dune

communities found along the Atlantic in the vicinity of the Project Area. The groins represent long-term structures but are intended as the most cost efficient approach to sediment control and reduction of long-term maintenance (i.e., additional placement of beach fill).

With respect to the Jamaica Bay Planning Reach, minor impacts to topography are anticipated from the construction of rock sills, restored intertidal wetlands, floodwalls, bulkheads, and berms. It is recognized that bulkheads can have minor long-term adverse impacts on bathymetry, as scouring at toe of the structural measure may result from amplified wave energy and increased erosion and sediment transport associated with these hardened structures. However, these features are generally recommended where a similar structure is already present and as such only minor impacts are anticipated. It is recognized that rock sills represent long-term in-water structures, but the construction of these features is intended to preserve existing shoreline topography throughout the planning reach by protecting against future shoreline erosion and flooding. These rock sills also provide long-term ecological benefits by preservation or restoration of intertidal wetlands along the affected shorelines (discussed further below).

7.1.2.3 Soils

Adverse minor direct short-term impacts to soils would occur due to such construction activities as clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project areas. Impacts include soil compaction and disturbance to and mixing of discrete soil strata. To reduce the impacts of construction on beach soils, Best Management Practices (BMPs) would be implemented to control erosion and sedimentation during construction (e.g., installation of silt fences). Areas disturbed to support construction activities (e.g., temporary access roads) would be restored at the end of project execution. Contamination from spills or leaks of fuels, lubricants, and coolant from construction equipment could adversely affect soils. The effects of contamination are typically minor because of the low frequency and volumes of spills and leaks. Spill prevention and countermeasures BMPs would be implemented to minimize the potential for impacts associated with an inadvertent spill of hazardous materials.

Specific to the Atlantic Shoreline Planning Reach, beneficial long-term direct and indirect impacts on soils would occur from built structures (e.g., groins, dunes and buried seawall) that retain and capture littoral materials native to the beach communities and/or limit the effects of wave and storm surge erosion. Construction and extension of groins and construction of buried seawalls would result in continued protection of upland soils from wave action and erosion that are anticipated from significant storms along project area shorelines and would reduce the amount of renourishment fill required in the future. The groin and seawall structures would help slow the long-term beach erosion rate in the project area. Construction of groins could have minor long-term effects by causing enhanced erosion on the down-current side due to the modified sand transport. In addition, some sand would be expected to be diverted offshore as longshore currents flow into deeper waters around the groins. However, it is anticipated that the Recommended Plan will meet the overall objectives to better retain existing beaches as well as protect from future erosion and flooding. Beneficial long-term direct impacts on soils would occur due to beach renourishment actions, where beach sands are replenished at prescribed intervals over the project life cycle. The texture of the nourishment material to be used would be compatible with native sand material.

It is recognized that USACE will continue to work with NPS at Jacob Riis Park to ensure any impacts to the sediment transport are offset. Specifically, NPS has concerns regarding a previously constructed groin at the eastern end of Jacob Riis Park that has produced a sand starved beach for much of the park site. It is recognized that an impact on sediment transport could have a direct impact on more inland soils. However, the objective of the beach nourishment and shore stabilization efforts at Rockaway Beach, adjacent to Jacob Riis Park are intended to ensure that infrastructure and lands associated with the Atlantic Shoreline communities remains intact in the face of future shoreline erosion from strong waves and storms. Unfortunately, longshore transport of sand to Rockaway Beach has been stopped in part by human activities related to the Rockaway Inlet. To the extent that the stabilization and beach nourishment projects offset the adverse effects of these actions, they are beneficial to restoring the natural coastal processes at Rockaway Beach and Jacob Riis Park.

Specific to the Jamaica Bay Planning Reach, all elements of the Recommended Plan would have a beneficial long-term direct and indirect impact by slowing shoreline erosion and protecting both wetland and upland native soils. Specifically, the NNBF components of the Recommend Plan includes placement of a stone toe protection and rock sill structure just off the existing shoreline to attenuate wave action and allow tidal marsh to establish between the rock sill and the berm. In some locations the eroded/degraded shoreline (subtidal) will be regraded to allow for the development of low marsh (smooth cordgrass) to provide productive nursery habitats behind the sill structures. The shore slope behind the structure will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for establishment of a high tidal marsh. In addition, the graded habitat behind the structure will be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems and preserving native soils.

7.2 Bathymetry and Sediments

7.2.1 No Action Alternative

Within the Atlantic Ocean Shorefront Planning Reach, long-term direct adverse impacts to sediment budgets are anticipated under the No Action Alternative. Beach-fill continues to be insufficient to offset the sediment deficit created by the overarching longshore sediment transport trend. The No Action alternative would leave the coast vulnerable to the strong waves and storm surges associated with extreme weather events, resulting in flooding, overwash, and loss of sand from dunes and some upland areas. The resulting loss of sand would increase adverse impacts on bathymetry and sediment budgets.

Within the Jamaica Bay Planning reach, the No Action Alternative would maintain exiting degraded conditions as it relates to bathymetry, sediment transport, and sediment quality. Specifically, the following processes would be expected to continue: (1) shoreline erosion from continued coastal wave action and future extreme weather events; (2) continual slowing of water that reduces sediment transport; and (3) continued presence of contaminated sediments.

7.2.2 Recommended Plan – Atlantic Shorefront

The Atlantic Ocean Shorefront Planning Reach components will have a direct long-term benefit on the shoreline bathymetry and associated sediment quantities by stabilizing erosion and minimizing the long-term requirements for beach renourishment. However, it is noted that

construction of groins could have minor long-term impacts by causing enhanced erosion on the down-current side due to the modified sand transport. In addition, some sand would be expected to be diverted offshore as longshore currents flow into deeper waters around the groins. However, it is anticipated that the Recommended Plan will meet the overall objectives to better retain existing beaches as well as protect from future erosion and flooding.

As noted in Section 7.2.1.3, it is recognized that USACE will continue to work with NPS at Jacob Riis Park to ensure any impacts to the sediment transport model are offset. As noted above, the objective of the beach nourishment and shore stabilization efforts at Rockaway Beach, adjacent to Jacob Riis Park are intended to ensure that infrastructure and lands associated with the Atlantic Shoreline communities remains intact in the face of future shoreline erosion from strong waves and storms. Unfortunately, longshore transport of sand to Rockaway Beach has been stopped in part by human activities related to the Rockaway Inlet. To the extent that the stabilization and beach nourishment projects offset the adverse effects of these actions, they are beneficial to restoring the natural coastal processes at Rockaway Beach and Jacob Riis Park.

Beachfill quantities required for initial construction were estimated based on the expected shoreline position in June of 2018, and are provided below in Table 7-1. It is impossible to predict the exact shoreline position in June 2018 since the wave conditions vary from year to year and affect shoreline change rates. The shoreline position in June of 2018 was estimated based on a 2.5 year GENESIS-T simulation representative of typical wave conditions.

Table 7-1: Recommended Plan Beachfill Quantities

Reach	Reach Length (ft)	Recommended Plan Fill Quantity (CY)
West Taper		306,000
Reach 3	10,320	356,000
Reach 4	5,380	294,000
Reach 5	10,650	321,000
Reach 6a	3,730	250,000
Reach 6b	2,000	20,000
East Taper		49,000
Total		**1,596,000**

No short- or long-term direct or indirect adverse impacts to sediment quality would occur from implementation of the Atlantic Shorefront element. Beach replenishment is not expected to have an adverse impact on sediment quality, as all imported sands will be brought from dredge areas that have been tested for grain size, compatibility, and potential toxicity.

7.2.3 Recommended Plan – Jamaica Bay

The Jamaica Bay HFFRRF components, with emphasis on the areas which include NNBFs, will have a net long-term benefit on the shoreline bathymetry and associated sediment quantities by stabilizing erosion and minimizing the loss of native shoreline habitats. In fact, the NNBFs strategically target restoration of native habitats where shoreline loss has historically occurred. As a result, the project will have a long-term benefit on both bathymetry and sediments.

Similar to discussion of groins above, construction of off-shore rock sills could have minor long-term effects by causing enhanced erosion on the down-current side due to the modified sand transport. However, the construction of rock sills will attenuate waves and allow intertidal wetlands to re-establish on existing mudflats to further protect the bathymetry and sediments over the long-term.

Construction of revetments and/or bulkheads would have minor long-term adverse impacts on bathymetry, as scouring at toe of the structural measure may result from amplified wave energy and increased erosion and sediment transport associated with these hardened structures. However, these features are generally recommended where a similar structure is already present.

No short- or long-term direct or indirect adverse impacts to sediment quality would occur from implementation of the Jamaica Bay Planning Reach components. Intertidal wetland restoration through placement of sand will require clean fill materials that have been tested for grain size, compatibility, and potential contamination.

7.3 Surface Water

7.3.1 No Action Alternative

Under the No Action Alternative, the Atlantic Shoreline Planning Reach will remain vulnerable to coastal storm hazards and SLR. As a result, the No Action Alternative will have long-term direct adverse impacts. In terms of tidal currents and wind and wave climate, the No Action Alternative will have no short- or long-term direct or indirect adverse impact. Baseline conditions would remain as described in Section 2.3 Surface Water.

7.3.2 Recommended Plan - Atlantic Shorefront & Jamaica Bay Combined

7.3.2.1 Coastal Storm Hazards

The Recommended Plan provides direct and in-direct benefits to both planning reaches in terms of vulnerability to flooding from coastal storm risks.

7.3.2.2 Tidal Currents

Proposed activities in the Atlantic Ocean Shorefront Planning Reach would have a direct impact on near shore tidal currents and associated shorelines. Specifically, to address CSRM objectives for the planning reach, the construction of groins will reduce the energy in tidal currents which currently occur, and affect, the project area. Consistent with discussion of sediment budgets in Section 7.2 Bathymetry and Sediments, the recommended plan is expected to provide long-term CSRM benefits to the shoreline within the Atlantic Shorefront Planning Reach by reducing shoreline erosion and in turn reducing long-term need for beach renourishment.

In terms of the Jamaica Bay Planning Reach, the project will also have a direct impact on near shore tidal currents in areas where rock sills are proposed as part of a larger NNBF. Like the discussion above for the Atlantic Shorefront, the rock sills are intended to reduce the energy of tidal currents and waves that currently occur, and affect, the project area.

The recommended plan is expected to provide long-term CSRM benefits, as well as ecological functional benefits, by reducing shoreline erosion and facilitating preservation and/or restoration of intertidal wetlands (which also are intended to reduce wave energies, provide wildlife habitat,

and improve water quality). During pre-construction engineering and design, hydraulic and hydrologic modeling will be conducted, taking into consideration anticipated sea level rise, to review the interaction of typical and storm tidal conditions on the NNBFs and associated shorelines. The final design of all NNBFs will include consideration of site specific conditions, shoreline type, erosion rate, fetch, tidal range, bank height and morphology, etc.

7.3.2.3 Wind and Wave Climate

Implementation of the recommended plan will have a long-term benefit by directly addressing anticipated wave climate and preventing future shoreline erosion in both planning reaches. Under implementation of the Atlantic Shorefront component of the Recommended Plan, tidal current flow speeds and directions within the Atlantic Ocean shorefront reach would not be measurably affected. Groins have the potential to alter wave climates but would have a long-term benefit by reducing future beach renourishment requirements.

Under implementation of the Jamaica Bay component of the Recommended Plan, wind and wave climate will be specifically addressed in certain locations through the construction of in-water rock sills. These features are specifically designed to attenuate wave climate and reduce long-term shoreline erosion. In fact, these rock sills are commonly part of a larger NNBF that strategically restores intertidal wetlands on the landward side of these rock sills to further attenuate waves.

7.4 Water Quality

7.4.1 No Action Alternative

With respect to both planning reaches, the No Action Alternative would maintain baseline conditions as described in Section 2.4 Water Quality, and therefore have a direct impact on long-term water quality due to continued shoreline erosion. Specifically, the No Action Alternative would have minor direct adverse effects on water quality through the continued, on-going impacts to nearshore and aquatic habitats from high energy storm events. Storms will temporarily increase water turbidity and changes in water chemistry from high energy wave action caused by storms. The loss of intertidal wetlands and mudflats could also impact water quality within Jamaica Bay.

With respect to the Jamaica Bay Planning Reach, the bay continues to be threatened by poor water quality. Almost the entire watershed is urbanized such that Jamaica Bay receives pollution from point and non-point sources around the bay, such as the CSOs, runoff from the roads and the airport, leachate from landfills, windblown trash, and other sources. However, it is recognized that NYCDEP is implementing a multiyear plan to address water quality in Jamaica Bay that will have a direct benefit to long-term water quality under the No Action Alternative.

7.4.2 Recommended Plan - Atlantic Shorefront & Jamaica Bay Combined

Minor short-term direct adverse impacts to ocean waters would occur from disturbance of subsurface sediments during construction of in water and shoreline components associated with both planning reaches. Water quality would quickly return to baseline conditions after construction activities are completed. It is anticipated that these adverse construction impacts would be minimized by implementation of BMPs.

Spills or leaks of fuels, lubricants, or coolant from construction equipment could adversely affect water quality; however, the effects of contamination are typically negligible because of the low

frequency and volumes of spills and the use of spill prevention standard construction BMPs. Leaks and spill effects would be minimized by immediate implementation of spill control and countermeasure BMPs (e.g. good housekeeping, adsorbents, storage containers).

Periodic renourishment activities over the project life-cycle would cause impacts similar to those generated during initial construction; however, because of tidal and current influences and the relatively quick settling velocity of subsurface sediments, turbidity is expected to dissipate rapidly, both spatially and temporally (Naqvi and Pullen 1982). Adherence to USACE and the New York State Section 404(b)(1) water-quality guidelines would further ensure minimal adverse water quality impacts.

Stormwater discharges to Jamaica Bay are proposed as part of the HFFRRFs, given the requirement for stormwater retention associated with these features. In terms of long-term impacts to water quality, the HFFRRFs will manage the transport of stormwater in these vulnerable locations that under the no action alternative would likely be impacted by high sediment loads and potential shoreline loss. In addition, adherence to USACE and the New York State Section 404(b)(1) water-quality guidelines would further ensure minimal adverse water quality impacts. The preservation and/or restoration of intertidal wetlands along the shoreline will also assist in mitigating water quality impacts of stormwater discharges.

Finally, the preservation, restoration and enhancement of intertidal wetlands along the Jamaica Bay shoreline associated with the HFFRRFs will provide potential long-term benefits to water quality. Specifically, wetlands provide a natural biogeochemical process that filters numerous constituents of concern within the bay and can improve water quality conditions.

To address potential water quality impacts on the landward side of the proposed rock sills as part of the HFFRRFs, the final design will include hydraulic and hydrologic analysis based upon site conditions and to ensure minimization of impacts immediate to the rock sill as well as along the adjacent shoreline. This recognizes that each HFFRRF will require additional design consideration to account for specific site conditions, shoreline types, erosion rate, fetch, tide range and bank morphology.

7.5 Air Quality Impacts

7.5.1 No Action Alternative

The No Action Alternative may result in greater pollutant emissions due to the repeated coastal management that would need to be conducted as individual projects or emergency actions (i.e., less efficient implementation). For example, additional mobilization and demobilization, emergency response conditions, and other elements associated with numerous individual projects would continue to be needed under the No Action Alternative, which may in turn lead to increases in pollutant emissions from multiple actions.

Further, from the pollutant perspective, there is the potential that not all of the individual or emergency actions would necessarily trigger General Conformity, resulting in no offsetting of construction emissions associated with 'de minimis' projects. In this scenario, the ongoing projects and activities associated with the No Action Alternative would continue to be reviewed with respect to General Conformity applicability and there is the potential that individual projects might not be subject to the requirements of General Conformity and therefore not be fully offset.

If this were the case, the No Action Alternative could actually result in higher levels of emissions than with implementation of the Recommended Plan.

7.5.2 Recommended Plan

7.5.2.1 General Conformity

The Recommended Plan will temporarily produce emissions associated with diesel-fueled equipment relating to dredging, beach sand placement, and related landside construction activities. For the purposes of the air quality impact analysis, a conservative construction duration of three years was used (impacts would be higher under a three year construction schedule rather than a schedule of longer duration). Localized emission increases from the diesel-fueled equipment will last only during the project's construction period (and primarily only locally to where work is actually taking place at any point in time), and then end when construction is completed. Therefore, any potential impacts would be temporary in nature.

Construction of the Recommended Plan will occur in Queens and Nassau Counties, New York and the General Conformity applicability trigger levels for 'moderate' ozone nonattainment areas are: 100 tons per year (any year of the project) for NO_x and 50 tons per year for VOC (40 CFR§93.153(b)(1)). For areas designated as 'maintenance' for $PM_{2.5}$, the applicability trigger levels are: 100 tons for direct $PM_{2.5}$, SO_2, and CO per year (40 CFR§93.153(b)(2)).

General Conformity-related emissions associated with the project are estimated as part of the General Conformity Review and are summarized below, by calendar year (assuming 5 year construction duration, regardless of start and end dates) below in Table 7-2. Emission calculations are provided in Attachment D7 of the Environmental Compliance Appendix.

Table 7-2: Recommended Plan Construction Emissions Estimate – Tons per Year

Pollutant	2020	2021	2022	2023	2024	2025-2028
NO_X	158.3	158.3	158.3	158.3	158.3	0.0
VOC	6.0	6.0	6.0	6.0	6.0	0.0
$PM_{2.5}$	8.2	8.2	8.2	8.2	8.2	0.0
SO_2	0.08	0.08	0.08	0.08	0.08	0.0
CO	17.7	17.7	17.7	17.7	17.7	0.0

The emission levels of NO_x exceed the ozone 'de minimis' trigger levels for General Conformity; therefore, applicable NO_x emissions will need to be fully offset as part of the project. Because NO_x will be fully offset, by rule, the net NO_x emissions increase will be zero and therefore will produce no significant impacts.

A Statement of Conformity (SOC) will be utilized to ensure that the project meets the General Conformity requirements. The associated mitigation and tracking over the life of the project will be coordinated through the Regional Air Team (RAT) that consists of EPA Region 2, NYSDEC, NJDEP, USACE New York District, and other agencies associated with the mitigation efforts associated with the Harbor Deepening Project and the Hurricane Sandy-related Authorized-But-

Unconstructed (ABU) projects. This approach was successfully used to fully offset emissions from the Harbor Deepening Project, which covered a construction period from 2005 through 2016.

The mitigation options for NO_x include: use of available Surplus NOx Emission Offsets (SNEOs) generated by the Harbor Deepening Project, establishment of a Marine Vessel Engine Replacement Program (MVERP; see Environmental Appendix), the purchase of EPA Cross-State Air Pollution Rule (CSAPR) ozone season NO_x allowances, statutory exemption, State Implementation Plan accommodation, or elongation of the construction schedule so as not to trigger GC. The final combination of the above options will be coordinated and tracked through the RAT.

In meeting the General Conformity requirements, the project, by definition will not incur significant impacts. Project emissions of VOC, $PM_{2.5}$, SO_2, and CO are all significantly below their respective trigger levels and therefore, by rule, are considered 'de minimis' and will have only temporary impacts around the construction activities with no significant impacts.

7.6 Shoreline Habitats

A summary of impacts to shoreline habitats, inclusive of both terrestrial and aquatic, as identified in Section 2.3.7 is included in Section 6 Habitat Impacts and Mitigation Requirements. The following provides additional discussion of impacts to these habitats.

7.6.1 No Action Alternative

Shoreline erosion in both planning reaches would be expected to continue, with a long-term direct impact on native habitats. The loss of shoreline habitat would in turn have significant impacts on both recreational uses as well as aquatic and terrestrial wildlife.

7.6.2 Recommended Plan – Atlantic Shorefront

Construction of buried seawalls and/or groins along the Atlantic Ocean Shorefront Planning Reach would have short-term minor adverse impacts on terrestrial and aquatic habitats within each nourishment area. With respect to the seawall, the feature will be buried with sand in an effort to restore the existing habitat type. With respect to the groins, habitats will be preserved outside the footprint of these features and benthic aquatic habitats are expected to-establish to a similar community within a 1 to 2-year period (USACE 1995, USACE 2001). Overall, the intention for the Recommended Plan is to have a net long-term benefit on these beach and dune habitats by stabilizing the shoreline, increasing sediment the sediment budget, and minimizing future renourishment activities necessary to support a healthy North Atlantic Upper Ocean Beach community.

7.6.3 Recommended Plan – Jamaica Bay

The design of the HFFRRFs has been refined to minimize impact to sensitive shoreline habitats, and primarily occur in mapped upland ruderal or urban habitats. Within these degraded habitats, the condition will primarily be restored as a temporary impact.

The project would have direct adverse impacts on native habitats that include beach and unvegetated shoreline, freshwater wetland, intertidal wetland, mudflats, subtidal bottom, and maritime forest. Specifically, as detailed in Section 6.5 Habitat Impacts and Mitigation Requirements, the project will result in 14.1 acres of temporary impacts and 5.5 acres of permanent impacts to these habitats (See Section 6.5, Tables 6-13 and 6-14 above). Specific to federal and

state regulated waters and wetlands, the project will temporarily impact 14.1 acres and permanently impact 3.7 acres (See Section 6.5, Tables 6-13 and 6-14 above). Temporary impacts assume that habitat will be replaced on-site and in-kind. The majority of temporary impacts to federal and state regulated waters and wetlands will occur in open water habitats (i.e., subtidal bottom, mudflat), or beach and unvegetated shorelines where subsequent planting will not be required and the time to full restoration of ecological services will be relatively quick compared to habitats that require development of native plant community.

To account for permanent impacts, NNBFs associated with the HFFRRFs will result in the restoration and/or creation of 7.6 acres of intertidal wetlands, enhancement to 0.5 acres of intertidal wetlands, and restoration of 1.3 acres of maritime forest (See Section 6.5, Table 6-15 above). Overall, the Recommended Plan that includes NNBFs will attenuate waves, stabilize shorelines, and facilitate the restoration or enhancement of native shoreline habitats. As such, the long-term benefit realized by this plan will likely exceed the NNBF acreage noted above. For example, shore slopes behind the rock sill structures will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for future establishment of tidal marsh plants. As such, the total restoration of intertidal marsh habitats will likely exceed the proposed planting area of 7.6 acres. The graded habitat behind the structure will also be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems. Finally, the rock sills will provide opportunities for shellfish habitat creation and will provide habitat complexity to near shore open water habitats (that is currently absent in project areas) which will support a diversity of both aquatic and terrestrial wildlife (discussed below), as well as improve near shore water quality.

As discussed in Section 6.5 above, EPW also was used to characterize the functional impacts and benefits within intertidal wetlands associated with each HFFRRF. The assessment results estimate current resource value loss, and the potential increase in resource value through implementation of NNBFs. A summary of the analysis and the numerical results of the EPW functional assessment is provided in Section 6, Tables 6-16 and 6-17 above. The project will result in the loss of 8.5 FCUs across the five functions. However, the NNBFs will result in the gain of 34.5 FCUs across the five functions. Similar to the metric evaluation, the EPW functional assessment shows significant gains to the shoreline ecosystem through the incorporation of NNBFs.

7.7 Invertebrate and Benthic Resources

7.7.1 No Action Alternative

Baseline conditions would remain as described in Section 2.7 Invertebrate and Benthic Resources. The No Action Alternative would have minor indirect adverse effects on the benthic species in both project study areas through the continued, on-going impacts to aquatic habitats from high energy storm events. Intertidal wetlands and mudflats that function as habitat for many invertebrate species would continue to experience significant erosion. Storms will also temporary increase water turbidity and changes in water chemistry from high energy wave action caused by storms. These adverse impacts can reduce the quality and extent of subtidal bottom and shellfish reef habitats that are important for benthic invertebrates.

7.7.2 Recommended Plan – Atlantic Shoreline Planning Reach

Beneficial long-term direct impacts to benthic shellfish species would be realized from implementation of the Atlantic Shorefront component. Constructed groins would create areas suitable for recruitment and protection for numerous shellfish species. Beneficial impacts to the benthic community include the increase in food source, spawning beds, and shelter in the project area (USACE 2015, [Jones Inlet EA]). Construction and extension of groins would provide living spaces for the floral and faunal communities on which benthic species rely. In addition to creating living spaces and increasing food availability, implementation of the Recommended Plan would provide shelter from wave attacks for the existing and surrounding benthic communities. Some species, such as rockweeds (*Fucus spp*.), and shellfish would flourish on the newly constructed groins (Carter 1989). Various floral species such as rockweed and spongomorpha (*Spongomorpha spp*.), and shellfish are expected to move into the area and colonize living space on groins (USACE 1995). Rockweeds are known to support numerous organisms, including both autotrophs and heterotrophs. In addition, rockweeds provide shelter, moisture at low tide, and food especially for the sessile epifaunal and epiphytic groups (Oswald et al. 1984). Gastropods, bivalves, and crustaceans are all common inhabitants of rockweeds.

It is noted that recent literature has shown direct adverse effects of shoreline armoring on mobile upper shore invertebrates (Dugan et al 2008, Dugan 2011). Specific to this project, the upper shore is heavily utilized and historically disturbed by continuous recreational activities. As such, research of natural shorelines may not be comparable to this heavily urbanized beach. It is recognized that while certain benthic invertebrate populations may be displaced by the proposed in water features (i.e., groins), it is expected that the habitat complexity will support a diverse assemblage of benthic species that would continue to function as prey for both aquatic and terrestrial wildlife that utilize this shoreline.

Minor short-term direct adverse impacts to benthic communities are anticipated from construction activities, including future periodic renourishment. Construction would cause increased sedimentation, resulting in the smothering of existing sessile benthic communities in the vicinity of construction areas. Some mortality of shellfish, and polychaetes is expected for individuals that cannot escape during the construction process. Mobile shellfish species would be able to relocate temporarily outside of the immediate project area. Benthic resources would begin to recolonize areas immediately following project completion. Infaunal organisms are likely to recolonize the area from nearby communities and re-establish to a similar community within a 2 to 6.5 month period (USACE 1995; USACE 2001). Short-term adverse impacts would occur because of short-term changes to water quality during construction, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates, as discussed in Section 7.2 Bathymetry and Sediments. Construction related increases in turbidity and suspended solids cause a short-term reduction in oxygen levels (Reilley, et al. 1978; Courtenay, et al. 1980). Impacts are expected to be minor, given the temporary nature of the disturbance and the availability of suitable adjacent habitat and given the large extent of the Atlantic Ocean compared to the project construction footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on benthic invertebrate species. It is possible that the species composition of the benthic community that reestablishes would be slightly different than the pre-construction composition given disturbance and potential change in substrate type.

Minor, but recurring, short-term, direct adverse impacts on nearshore benthic communities would occur as a result of dredging sand from the borrow areas and occur at each nourishment. Minor long-term direct impact on benthic invertebrates, particularly to the abundance and size structure of sand dollar (*Echinarachnius parma*) populations (USACE 2001), would be experienced due to displacement and/or mortality during dredging for borrow areas. Impacts to benthic communities in the borrow area are considered short-term and minor because benthic invertebrate species are expected to recolonize the borrow area within 2 to 2.5 years (USACE 2001). Consistent with final determinations associated with previously shoreline beach nourishment projects, borrow efforts have not shown significant direct adverse impacts to benthic and invertebrate populations (GMP/EIS 2014).

7.7.3 Recommended Plan – Jamaica Bay Planning Reach

Components of the Jamaica Bay Planning reach would have parallel effects on benthic and invertebrate populations. Overall, the construction of rock sills and restoration of shoreline intertidal wetlands would have minor short-term direct adverse impacts to benthic communities. Some mortality of shellfish, and polychaetes is expected for individuals that cannot escape during the construction process. Mobile shellfish species would be able to relocate temporarily outside of the immediate project area. Benthic resources would begin to recolonize areas immediately following project completion. In addition, construction related increases in turbidity and suspended solids would cause a short-term reduction in oxygen levels. However, implementation of BMPs to control sedimentation and erosion during construction would minimize these adverse impacts.

Overall, the NNBF portions of the HFFRRFs are intended to preserve and restore native shoreline habitats that are critical to support a diverse assemblage of benthic communities. The rock sills and adjacent shoreline habitats would provide living spaces for the floral and faunal communities on which benthic species rely. These benthic species would then provide a critical food source for aquatic and terrestrial wildlife that utilize these shorelines. As noted above, the rock sills would also provide opportunities for shellfish habitat creation.

Overall, the direct long-term benefits of the NNBFs outweigh the minor short-term effects that Recommended Plan will have on benthic communities.

7.8 Finfish

7.8.1 No Action Alternative

The No Action Alternative will potentially have minor indirect adverse effects on the fish species over the long-term as the result of continued, on-going impacts to aquatic habitats from high energy storm events. Intertidal wetlands along the Jamaica Bay shorelines that function as important nursery habitat for many fish species would experience continued erosion.

7.8.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

Beneficial long-term direct impacts to fish species are anticipated from implementation of both the Atlantic Shorefront and Jamaica Bay Planning Reaches. Constructed groins and rock sills would create in water habitat areas suitable for recruitment and protection for numerous fish species. Beneficial impacts to the fish community would include the increase in food source, spawning beds, and shelter in the project area (USACE 2015). Construction of groins and rock sills would also provide living spaces for the food resource on which fish species rely. In addition to creating

living spaces and increasing food availability of the project area, the proposed would potentially provide shelter for fish from wave attacks during large coastal storm events.

There would be minor short-term direct adverse impacts on adult and juvenile life stages of nearshore fish during construction activities, as mobile fish would be temporarily displaced from foraging habitat as they retreat from the area in response to construction activities. Construction related increases in turbidity and suspended solids will cause a short-term reduction in oxygen levels and reduce visibility for feeding (Reilley et al. 1978, Courtenay et al., 1980). Impacts are expected to be minor, given the temporary nature of the disturbance and the availability of suitable adjacent habitat. Adult and juvenile life stages and their prey species would quickly reestablish themselves after completion of construction.

Additional minor short-term direct adverse impacts on nearshore fish communities would occur as a result of dredging sand from the borrow areas. Additional minor short-term direct impact on benthic feeding fish species (e.g., windowpane, summer and winter flounder) would be experienced, due to temporary displacement during dredging for borrow areas. Impacts are considered minor because benthic feeding fish species are expected to avoid construction areas and feed in the surrounding area; therefore, would not be adversely affected by the temporary localized reduction in available benthic food sources. There are expected to be no impacts to fish assemblages of finfish foraging habits in offshore borrow areas consistent with conclusions of past regional beach renourishment projects (USACE 2001). The essential fish habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations are discussed below in Section 7.12.

Minor short-term direct adverse impacts on nearshore fish communities would be realized by less mobile life stages (eggs and larvae) of nearshore fish, e.g., Atlantic butterfish, red hake, windowpane flounder, winter flounder, summer flounder, and scup, if present at the time of construction activities. Impacts would occur because of short-term changes to water quality, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates, as discussed above in Section 7.2 Bathymetry and Sediments. Impacts to nearshore fish community assemblages are considered minor and not a threat to long-term sustainability of the identified species of concern given the large extent of the Atlantic Ocean and Jamaica Bay compared to the project construction footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on eggs and larvae of nearshore fish species.

With respect to the Jamaica Bay Planning Reach, the NNBFs are intended to preserve and restore native shoreline habitats that are critical to support a diverse assemblage of fish populations. The rock sills and adjacent shoreline habitats would provide living spaces for the floral and faunal communities on which benthic species rely and which provide a critical food source for fish.

7.9 Reptiles and Amphibians

7.9.1 No Action Alternative

The No Action Alternative will potentially have minor indirect long-term adverse effects on the amphibian and reptile species through the continued, on-going impacts to their habitats from high energy storm events. Beach/dune systems, uplands, intertidal wetlands, and mudflat habitats continue to experience significant erosion, and temporary increases in turbidity and changes in water chemistry from high energy wave action caused by storms. Erosion of buffer habitats like

intertidal wetlands may also have indirect adverse impacts on maritime and coastal shrub and forest habitats. These adverse impacts can reduce the quality and extent of these habitats in Jamaica Bay, negatively impacting the reptiles and amphibian species that use them.

7.9.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

Beneficial long-term direct impacts on herptiles (i.e., reptiles and amphibians) are anticipated from implementation of the recommended actions in both planning reaches. Construction of buried seawalls associated with the Atlantic Ocean Shorefront Planning Reach, as well as the HFFRRFs in the Jamaica Bay Planning Reach, would protect shoreline vegetation from physical degradation, thereby preserving both terrestrial and aquatic reptile and amphibian habitat.

Minor short-term direct adverse impacts on reptiles and amphibians are anticipated from construction activities. Native as well as disturbed and urban habitats would be temporarily impacted from construction activities such as clearing and grading to support construction. In addition, there will be permanent impacts to habitats within the Jamaica Bay Planning Reach as outlined in Section 6.5 above. However, NNBFs as part of the HFFRRFs will provide restoration, creation, and enhancement of native habitats to compensate for both the temporary and permanent impacts. Overall, the benefits of the enhanced ecological services associated with the shoreline ecosystem are expected to offset these minor-short term impacts associated with the project.

Effects of the project on federal and state listed reptiles is addressed in Section 7.12 below.

7.10 Birds

7.10.1 No Action Alternative

The No Action Alternative will potentially have minor indirect long-term adverse effects on the bird species through the continued, on-going impacts to their habitats from high energy storm events. Beach/dune systems, uplands, intertidal wetlands, and mudflat habitats continue to experience significant erosion, and temporary increases in turbidity and changes in water chemistry from high energy wave action caused by storms. Erosion of buffer habitats like intertidal wetlands may also have indirect adverse impacts on maritime and coastal shrub and forest habitats. These adverse impacts can reduce the quality and extent of these habitats in Jamaica Bay, negatively impacting the bird species that use them.

7.10.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

Beneficial long-term direct impacts on birds are anticipated from implementation of project elements in both planning reaches. Specific to the Atlantic Shoreline Planning Reach, proposed actions would support a healthy North Atlantic Upper Ocean Beach that in turn benefits many bird species of conservation concern. Specifically, beach nesting birds like piping plover and least terns that are known to nest at several locations within the study area. However, placement of beach fill and dune restoration is likely to increase overall habitat value for these species along the affected beachfront by expanding the area of suitable breeding, nesting and foraging habitat. In addition, stabilizing the eroding beaches and shorelines under the Recommended Plan would have a long term positive effect on maintaining or increasing suitable shoreline nesting or foraging habitat.

Potential short-term impacts to piping plover and other nesting shorebirds could result from proposed permanent hard structures such as seawalls and groins, as they would eliminate any suitable foraging or nesting areas directly within the footprint of these structures. However, the area of overall impact from these structures is expected to be minimal (< 1.0 ac within the Atlantic Shoreline Planning Reach), and most of the habitat that will be impacted is not of high habitat value to nesting and/or foraging birds. Specifically, these beaches are heavily utilized by humans (i.e., 5 million visitors in 2017) and most of the groins will be constructed in subtidal habitats (i.e., less favorable foraging habitat compared to intertidal areas). In addition, predator populations are not anticipated to increase due to human use of the project area. Overall impacts directly within the footprint of these structures would be permanent, but are not expected to significantly affect nesting shorebird, or other migratory birds, breeding or foraging activities for the long term. These impacts are assumed to be offset from the long-term benefits that will result from the project as beach fill and dune restoration is likely to increase overall habitat value for these species along the affected beachfront by expanding the area of suitable breeding, nesting and foraging habitat.

With respect to the Atlantic Shorefront Planning Reach, to minimize potential adverse impacts on the piping plover, the USACE will follow recommendations previously provided by the NYSDEC and USFWS as described below (USACE 1998; USFWS 1999). These measures are expected to minimize potential adverse impacts on numerous other avian species that may use coastal habitats in the Project Area, including several state-listed shorebird species. Time of year (TOY) no-dredge/work restriction recommendations are as follows: for piping plover from 1 April through 1 September when the presence of this species within an area of potential effect is confirmed. Conducting the beach fill operations outside of the piping plover nesting season is the easiest way to avoid adverse impacts. In addition, beach slope is also a critical factor for piping plover habitat selection and use. In order to maintain existing habitat conditions, the slope of the placement material will be consistent with adjacent existing beaches that contain successful brooding areas.

It is recognized that minor adverse short-term direct impacts on birds are anticipated from construction associated with components of both planning reaches. Native habitats would be temporarily and permanently impacted due to such construction activities. Terrestrial habitats could be impacted by vegetation clearing necessary to support construction, and degrading habitat structure important to birds. Aquatic habitats would be impacted by temporary changes in surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water, affecting freshwater-dependent and saltmarsh-dependent bird species. In addition, the project will result in some permanent habitat loss along these shorelines. However, it is recognized that these habitat losses would be offset through ecosystem restorations as part beach fill and dune restoration within the Atlantic Shorefront Planning Reach, as well as the NNBFs in the Jamaica Bay Planning Reach, specifically providing greater ecological services throughout the shoreline ecosystem.

7.11 Mammals

7.11.1 No Action Alternative

The No Action Alternative will potentially have minor indirect long-term adverse effects on mammal species within both planning reaches through the continued, on-going impacts to their habitats from high energy storm events. Erosion of buffer habitats like intertidal wetlands can have an indirect adverse impact on maritime and coastal shrub and forest habitats that are commonly

utilized by mammals. These adverse impacts can reduce the quality and extent of these habitats in Jamaica Bay, negatively impacting the mammals that use them.

7.11.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

Beneficial long-term direct impacts on mammals are anticipated from implementation of the common project elements in both planning reaches. Specific to the Atlantic Shoreline Planning Reach, proposed actions would support a healthy North Atlantic Upper Ocean Beach and near shore environment that in turn benefits many terrestrial and aquatic mammals that utilize these habitats. Overall habitat within the intertidal zone would increase as the beach is widened with beach fill, and groin structures would reduce the rate of beach loss. In terms of aquatic mammals, the increased shoreline diversity will likely increase fish usage and potentially provided enhanced foraging opportunities along the near shore. In terms of terrestrial mammals, the buried seawalls will protect adjacent upland habitats that provide critical habitat to a diversity of species.

Specific to the HFFRRFs in the Jamaica Bay Planning Reach, the proposed actions will support the preservation and restoration of native shoreline habitats through incorporation of NNBFs. These features will minimize shoreline loss, and in turn protect both aquatic and terrestrial habitats utilized by mammals. In term, the proposed actions will increase habitat diversity in both the aquatic and terrestrial environments to sustain healthy, and diverse mammal communities.

Minor short-term direct adverse impacts on mammals are anticipated from construction associated with components of both planning reaches. Native habitats would be temporarily and permanently impacted due to such construction activities and proposed features. However, species are expected to modify behaviors to utilize adjacent suitable habitats during construction and minimize these adverse impacts. It is recognized that these habitat losses would be offset through ecosystem restorations as part of the HFFRRFs and provide greater long-term ecological services along the targeted shorelines.

Effects of the project on federal and state listed mammals is addressed in Section 7.12 below.

7.12 Protected Species

7.12.1 No Action Alternative

Baseline conditions would remain as described in Section 2.12 Threatened and Endangered Species. However, as noted in Section 7.8 through 7.11, the No Action Alternative would have potentially minor indirect long-term adverse effects on federal and state protected species and associated habitats through the continued, on-going impacts to their habitats from high energy storm events. Continued loss of sensitive habitat that these species rely on will negatively impact the long-term survival of these populations within the study area.

7.12.2 Recommended Plan – Atlantic Shoreline and Jamaica Bay Combined

7.12.2.1 Federal Species

Through formal consultation with USFWS, as well as follow-up consultation with the New York State Department of Environmental Conservation (NYSDEC) and New York City Department of Parks and Recreation (DPR), three federally-listed species are likely to occur within the project area:

- Piping plover, federally threatened;
- Seabeach amaranth, federally threatened; and
- Rufa red knot, federally threatened

A Biological Assessment evaluating the potential impacts of the proposed action on the endangered and threatened species above was prepared and is provided in Attachment D2 of the Environmental Compliance Appendix. Formal consultation was initiated on September 27, 2018 to comply with requirements of Section 7 of the ESA. The Biological Assessment concluded that implementing the proposed action in accordance with the standards and guidelines (including mitigation measures that include protective and conservative best management practices) recommended by USFWS and NYSDEC, will not jeopardize the continued existence or contribute to the loss of viability of either piping plover or seabeach amaranth populations that occur or utilize the project area, and the proposed action would not significantly contribute to cumulative impacts associated with piping plover and seabeach amaranth. As such, the USACE concluded that the overall project results in a may affect, is likely to adversely affect (LAA) determination for piping plover, red knot, and seabeach amaranth. USFWS's Biological Opinion (BO) was received on April 4 and based on comments a revised version was received on June 25, 2019. Both BOs concluded that the proposed project is not likely to jeopardize the continued existence of the species covered in this Opinion. The Revised BO addresses comments provided by the USACE. Since there are no Critical Habitat designations, none will be affected by the proposed project. The BO concluded that there are Adverse Effects on all three species and provided an Incidental Take Statement for Piping plover (27 pairs, 24 individuals, 100 nests and 238 chicks over the 50 year life of the project) and for Red knot (263 over the 50 year life of the project). The revised BO also outlines the following reasonable and prudent measures to minimize take of piping plover and red knot (additional details of the Terms and Conditions for the Reasonable and Prudent Measures are detailed in the BO, Attachment D2c):

- Reduce adverse effects to piping plover and red knot from construction and maintenance of composite seawall/dune, dune grass planting, sand fence installation, artificial beach, groin construction, and HFFRRF and NNBF projects;
- Monitor pre-, concurrent, and post-habitat conditions in the action area;
- Monitor implementation of avoidance and minimization measures and report to our office. (50 CFR 402.14[i][3]) requires federal agency or applicant to report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.);
- Ensure that all project engineers, contractors, and construction staff are fully informed of and compliant with all conservation measures contained in the project description, RPMs, and terms and conditions; and
- Ensure that NYCDPR, state, and Service field staff have continued access to all portions of the project area necessary to carry out the endangered species management over the life of the project.

NOAA NMFS also completed the consultation under Section 7 of the ESA, and concluded that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat on their jurisdiction. The letter dated January 12, 2017 is included as Attached D2 of the Environmental Compliance Appendix). USACE also consulted with NOAA NMFS regarding

proposed actions that may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. An EFH Assessment Report with NOAA NMFS concurrence, dated October 31, 2018, is included as Attachment D3 of the Environmental Compliance Appendix.

As part of this consultation, minimally, the latest protective BMPs will be incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected aquatic species under NOAA NMFS jurisdiction (i.e., no-dredge windows on Atlantic Shorefront). The planned construction methods will incorporate BMPs, thereby reducing the temporary water quality impacts and general disturbances resulting from in-water construction activities. In addition, development of the projects' Plans and Specifications will consider pile driving activities in water or in near-shore environment and evaluate necessary BMPs to avoid reaching noise levels that may cause injury to protected aquatic species (i.e., sea turtles, sturgeon). Sediment curtains are not anticipated for the Atlantic Shoreline Project Reach due to the distance of anticipated sheet pile driving from the water's edge. For the Jamaica Bay Project Reach, sediment curtains will be considered on a site by site basis where shite pile driving is required in or proximate to open water. Finally, USACE recognizes that, transient listed species are expected to avoid the project area during construction activities.

As part of consultation, several seasonal restrictions were identified by NOAA NMFS to provide necessary protections to aquatic species. They are summarized below and in Table 7-3.

- *Sand Placement Effects on Fishes*. Winter flounder migrate into mid-Atlantic estuaries from mid-November through December. River herring enter these same estuaries on their spawning migrations from March through May. Because project plans include beach renourishment along Rockaway Beach to East Rockaway Inlet, sequencing of beach nourishment activities will be considered in order to avoid impacts to ingressing winter flounder and river herring. This may include seasonal in-water work restrictions for winter flounder from November 15 through December 21, and from March 1 to May 31 for river herring.
- *Impacts of NNBF Construction on EFH*. The construction of the NNBFs will result in a loss of winter flounder EFH associated with the footprints of the sills and in areas shoreward of the sills due to natural sediment accretion and tidal wetland creation. Seasonal in-water work restrictions within portions of the Jamaica Bay Planning Reach may include January 1 to May 31 to minimize impacts to winter flounder early life stages and their EFH during the construction activities.
- *Impacts to Prey Species*. Construction of the NNBFs may impede access by horseshoe crabs to spawning beaches. Horseshoe crab eggs are an important seasonal food source for summer flounder and winter flounder. Seasonal in-water work restrictions within portions of the Jamaica Bay Planning Reach that are suitable for horseshoe crab spawning may include April 15 to July 15 to minimize adverse effects to this prey species.

USACE recognizes the potential federal listing of additional species under the Endangered Species Act (ESA) before initiation of the project, or potentially while the project is ongoing. If a species is newly listed which has the potential to occur within the project area, then USACE will initiate further consultation with USFWS and/or NOAA NMFS.

Coordination with NPS is also ongoing to ensure protection of the distribution and productivity of threatened and endangered species that occur within lands protected and managed by NPS.

Table 7-3: Proposed Seasonal Work Restrictions – East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Project Reach	Species Protective Window	Notes and/or Comments	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Atlantic Shoreline														
	Shorebirds and Seabirds (Including Piping Plover and Red Knot)	**April 1 – Sept 1.** Includes activities associated with beach nourishment; berm, composite seawall, dune construction, and groin rehabilitation.												
	Saltmarsh Birds and Neotropical Songbirds	**March 15 – July 31** Avoid construction activities that include vegetation removal within saltmarsh, salt shrub, maritime dune, maritime grassland, and maritime shrubland habitat.												
Inlets and channels	Winter Flounder	**November 15 – December 31***												
Inlets and channels	River herring	**March 1 to May 31*.**												
Jacob Riis & Fort Tilden Parks	N/A	**March 15 to September 15** NPS no work window during peak recreational season.												
Jamaica Bay														
	Saltmarsh Birds and Neotropical Songbirds	**March 15 – July 31** Avoid construction activities that include vegetation removal within saltmarsh, salt shrub, maritime dune, maritime grassland, and maritime shrubland habitat.												
Mid-Rockaway NNBFs	Winter Flounder	**January 1 to May 31** Early life stages of flounder. Specifically address sills and tidal marsh restoration												
Brant Point and Dubos Point at Arverne portion of Mid-Rockaway HFFRRF	Horseshoe Crab	**May 1 to July 1** Specific to locations that spawning horseshoe crabs are identified. Report identifies Brant Point and Dubos Point.												

*Possible window pending further coordination in PED with NMFS. Purpose of these windows is to ensure ingress to estuarine and spawning waters is maintained.

7.12.2.2 Migratory Birds

A determination of direct and indirect effects to migratory birds is consistent with that discussed in Section 7.10. Beneficial long-term direct impacts on birds are anticipated from implementation of the common project elements in both planning reaches. Stabilizing the eroding beaches and shorelines under the Recommended Plan would have a long term positive effect on maintaining or increasing suitable shoreline nesting or foraging habitat.

Minor adverse short-term direct impacts on birds are anticipated from construction associated with components of both planning reaches. Native habitats would be temporarily and permanently impacted due to such construction activities. Terrestrial habitats could be impacted by vegetation clearing necessary to support construction, and degrading habitat structure important to birds. However, birds are expected to modify behavior to utilize adjacent more suitable habitats during construction. It is also recognized that these habitat losses would be offset over the long-term through ecosystem restorations as part of the NNBFs specifically providing greater ecological services throughout the shoreline ecosystem.

7.12.2.3 State Species of Concern

Minor adverse short-term direct impacts on New York State species of conservation concern are anticipated from construction associated with components of both planning reaches. Native habitats would be temporarily and permanently impacted due to such construction activities. Terrestrial habitats could be impacted by vegetation clearing necessary to support construction, and degrading habitat structure important to birds. However, mobile species (i.e., fish, birds, mammals, reptiles) are expected to modify behavior to utilize adjacent more suitable habitats during construction. It is also recognized that these habitat losses would be offset over the long-term through ecosystem restorations as part of the NNBFs specifically providing greater ecological services throughout the shoreline ecosystem.

As discussed above, it is also assumed that the latest protective BMPs will be incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected state listed species. The planned construction methods will incorporate BMPs, thereby reducing the temporary impacts and general disturbances resulting from proposed construction activities.

7.13 Special Management Areas

A significant impact could occur if elements of an alternative were not in compliance with development and management requirements established for a regulated Special Management Area. Additionally, impacts could be significant if the project resulted in the degradation of characteristic natural or man-made features of Special Management Areas.

7.13.1 No Action Alternative

No short- or long-term direct impacts on special management areas are anticipated under the No Action Alternative.

7.13.2 Recommended Plan

No long-term direct adverse impacts on special management areas are anticipated under the Recommended Plan. Special management areas that would realize protection from the common project elements include:

- Coastal Zone Boundary (portions of Rockaway Peninsula); and
- NYC Waterfront Revitalization Program (same areas as Coastal Zone Boundary).

Negligible short-term direct impacts during project construction are anticipated from disruption of access to the special management areas listed above. Negligible short-term indirect impacts are anticipated from construction noise and dust, slightly diminishing the visitor experience in the special management areas listed above. Construction BMPs would be implemented to reduce the severity of these impacts to negligible levels to the maximum extent possible. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, water tanker trucks for dust suppression, covering trucks with tarps to prevent airborne dust, etc.

7.14 Recreation

An alternative could have a significant impact on recreation resources if it reduced or prevented use of designated recreational areas. Additionally, an impact could be significant if actions associated with an alternative permanently degraded the characteristics of a recreation resource that make the resource appealing to the public.

7.14.1 No Action Alternative

Significant long-term direct impacts on recreation are anticipated under the No Action Alternative. The No Action alternative would leave Atlantic Ocean Shorefront Planning Reach vulnerable to coastal storm risks from waves, storm surge, and inundation. Extreme storms would be detrimental to recreational resources. Under the No Action Alternative, beaches would experience erosion and eventually be as much as half the width of existing beaches, limiting recreational land use. Rockaway Beach would continue to experience erosion at a rate of about 10 feet per year. Based on responses to beach surveys completed in the summer of 2015, it is estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by over 4.5 million visits. Beach visits per year were interpolated between these two points based on survey responses (Economics Appendix).

Additionally, the No Action Alternative could result in similar significant adverse impacts on recreational resources as occurred during Hurricane Sandy in October 2012, which devastated the area, sweeping away the majority of the Rockaway boardwalk, and many of the adjacent recreational areas on Rockaway. Following Hurricane Sandy, more than $140 million was invested to repair and restore Rockaway Beach. As part of this work, intact sections of the boardwalk were repaired, damaged beach buildings were renovated with new boardwalk islands constructed around them, public restrooms and lifeguard stations were installed to replace destroyed facilities and interim shoreline protection measures were created. The No Action Alternative would offer no protection to the recently constructed Rockaway Boardwalk (i.e. NYP Rockaway Boardwalk EA 2014).

7.14.2 Recommended Plan

Beneficial long-term direct impacts on recreation would be realized by implementation of the recommended plan. Construction of seawalls and groins, along with beach renourishment actions, would stabilize areas currently used for recreation, protecting recreational resources from the detrimental influence of winds, waves, currents, and sea-level changes. Long-term benefits to recreational resources generally result from:

- Additional areas available for sport fishing (i.e., additional groins);
- An increase in the size of recreational beach area (Rockaway);
- Improved access to comfort stations and lifeguard headquarters (Rockaway);
- Protection of beaches (Rockaway); and
- Protection of the newly constructed Rockaway Boardwalk (NYC Parks EA, 2014);

The shorefront component of the Recommended Plan is designed to maintain the beaches in the study area to a width of approximately 200 feet of beach (Economics Appendix). Maintaining the width of existing beaches would create an enhanced recreation experience relative to the future condition of the beach without maintenance, which would be reflected in an increase in visitation. The Rockaway Beach Attendance Study demonstrated that people would be more willing to visit Rockaway Beach if the beach restoration projects were implemented. Based on responses to beach surveys completed in the summer of 2015, it was estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by over 4.5 million visits (Economics Appendix). For example, the total annual Rockaway Beach project recreation benefits are $38.6 million dollars (Economics Appendix). CSRM provided by the Recommended Plan would also support future planning and implementation efforts for NYC's Rockaway Parks Conceptual Plan.

Negligible short-term direct impacts are anticipated from disruption of access to recreation resources during project construction (e.g., beaches, parks, historic sites). Additionally, negligible short-term indirect impacts are anticipated from construction noise and dust, slightly diminishing the recreational experience of visitors who visit recreation areas during active construction. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, water tanker trucks for dust suppression, and covering trucks with tarps to prevent airborne dust.

7.15 Navigation

An alternative could have a significant impact if it significantly reduced, impeded, or prevented the overwater navigation of commercial and recreational vessels.

7.15.1 No Action Alternative

No short- or long-term direct or indirect impacts on navigation are anticipated under the No Action Alternative.

7.15.2 Recommended Plan

No short- or long-term direct or indirect impacts on navigation are anticipated from implementation of the recommended plan. Jamaica Bay's navigation channels were viewed in

GIS along with the project alignments of the Recommended Plan. The navigation channels are in proximity to the Recommended Plan elements near the Mid-Rockaway HFFRRF project located at Arverne. The nearest point from the navigation channel to the Mid-Rockaway Arverne HFFRRF project is roughly 350 feet. With or without implementation of the recommended plan, commercial or recreational vessel usage of Jamaica Bay, including the Federal Navigation Channel, would be maintained to support baseline conditions or future projected conditions.

The rock sills as part of the HFFRRF will be located in the near shore environment and are not anticipated to have an adverse effect on recreational navigation. The rock sills are designed to be higher than the MHHW, and as such will be visible throughout an average tidal cycle; thus, minimizing risk to recreational boating traffic. Navigation markers will be considered during PED if further analysis indicates that the rock sills underwater components are a hazard to recreational boaters. In fact, the rock sills will enhance in water structure and potentially provide direct benefits to fish. As such, the rock sills could have direct benefits to recreational fishing. Further analysis and refinement of the rock sills will be undertaken during PED.

7.16 Infrastructure

An alternative could have a significant effect on infrastructure if it would increase demand on a given infrastructure beyond the infrastructure's capacity, requiring a substantial system expansion or upgrade. Additionally, an impact could be significant if it would result in substantial system deterioration over current infrastructure condition beyond normal "wear and tear".

7.16.1 No Action Alternative

No short- or long-term direct or indirect impacts on infrastructure are anticipated under the No Action Alternative, and the No Action Alternative would not prevent similar adverse significant impacts on waterfront infrastructure as occurred during Hurricane Sandy in October 2012.

7.16.2 Recommended Plan

No long-term direct or indirect adverse impacts on infrastructure are anticipated from implementation of the Recommended Plan, as no infrastructure components are in the construction foot print of Recommended Plan elements. It is important to note that borrow areas have been specifically selected to avoid pipeline and cable structures buried offshore.

Negligible short-term direct impacts on roads and traffic are anticipated from implementation of the Recommended Plan. Roadways used for the transportation of materials and equipment to access project construction sites would experience negligible short-term direct impacts from increased traffic congestion and wear. Temporary disruption of traffic on local roadways and thoroughfares in the area may occur during delivery of stone rubble and other construction-related materials and equipment.

The project area for the Shorefront and HFFRRF actions is geographically linked to surrounding neighborhoods and population centers through a network of local roads and highways. The majority of roads in the project area are identified as local streets or avenues, which primarily function to provide access to abutting residential and commercial properties and serve as easements for various public utilities.

7.16.2.1 Construction Schedule & Number of Truck Trips Required

The schedule for construction for the entire project under analysis is estimated to last three and a half years. During that period, construction on the shorefront element would only take place between 2 September and 31 March of each year, following the no work windows provided in the Biological Opinion and through coordination with NMFS and NPS (summarized in Table 7-3), which provides a total of 747 construction days for the shorefront element, based on our projected dates. NMFS recommends that construction of NNBF elements of the HFFRRFs be restricted from 15 April to 15 July each year to minimize impacts to horseshoe crab eggs. It is expected that construction on other, non-NNBF portions of HFFRRFs can take place during the restricted period, with no impact on the total number of days available for construction. As such, the total number of construction days for the HFFRRFs is equal to 1,236.

Underlying data from the MII cost estimate provided the number of truck trips required for construction, which are shown for the HFFRRFs combined, and the shorefront element. These data are summarized in Table 7-4 below.

Table 7-4: Truck Trips Required for Construction of the Recommended Plan

Commodity	Commodity Origin	HFFRRFs Truck Trips	Shorefront Truck Trips	Total Truck Trips
Stone	West via I95	762	31,294	32,056
Concrete	Flushing	1,408	1,195	2,603
Fill	Long Island	18,489		18,489
Landfill	Long Island	2,221	270	2,491
Sheet Pile	West via I95	341	239	580
Total		**23,221**	**32,998**	**56,219**

Given the 23,221 truck trips required for construction of the HFFRRFs over 1,236 construction days, the total truck trips per day for construction of the HFFRRFs amounts to 18.8, which was rounded up to 20 truck trips per day for this analysis. With 32,998 truck trips required for construction of the shorefront element over 747 construction days, the total truck trips per day for construction of the shorefront element is 44.2, which was rounded up to 45 truck trips per day for this analysis.

7.16.2.2 Truck Routing throughout New York City

The New York City Truck Route Network is a set of roads that commercial vehicles must use in New York City. This network is comprised of two distinct classes of roadways, Local Truck Routes and Through Truck Routes as defined in Section 4-13 of the New York City Traffic Rules.[41] According to the NYC truck routing rules, the truck route that must be utilized depends on the origin and destination of the trip. The *Local Truck Route Network* is designated for trucks

[41] http://www.nyc.gov/html/dot/downloads/pdf/trafrule.pdf#section4-13a

with an origin and destination within a borough (e.g., traveling to make a delivery or for loading). Trucks should only use non-designated routes for the purpose at the beginning or end of a trip, when traveling between their origin/destination and a truck route. As depicted in Figure 7-1, the *Through Truck Route Network* is primarily composed of major urban arterials and highways and must be used by trucks that have neither an origin nor a destination within the borough.

Figure 7-1: NYC Through Truck Route Network to Access Project Area

When there are destinations not located on the designated Truck Route Network, an operator is allowed to travel on a street that is not a designated truck route for the purpose of arriving at their destination. When accessing such a location, the operator must leave a designated truck route at the intersection that is nearest to his/her destination, proceed by the most direct route, and then return to the nearest designated truck route using the most direct route.[42]

Given the constraints imposed by the NYC DOT Truck Route Network of Local and Through Truck Routes, all materials to be delivered by truck to construct the Shorefront and HFFRRF project components are assumed to be delivered to the project area as depicted in Figure 7-2.

[42] http://www.nyc.gov/html/dot/html/motorist/truckrouting.shtml

These assumptions have been made for the purpose of analysis and do not represent a commitment to final design, vendors for materials, or formal decisions regarding how materials would be delivered or removed from the sites. Detailed design would occur at the plans and specifications stage of the planning process as designs are finalized and coordination/detailed planning was completed with local authorities and the NYC DOT. However, the assumptions herein provide a reasonable presentation of how the materials truck transportation could occur and therefore allows consideration of the potential environmental consequences.

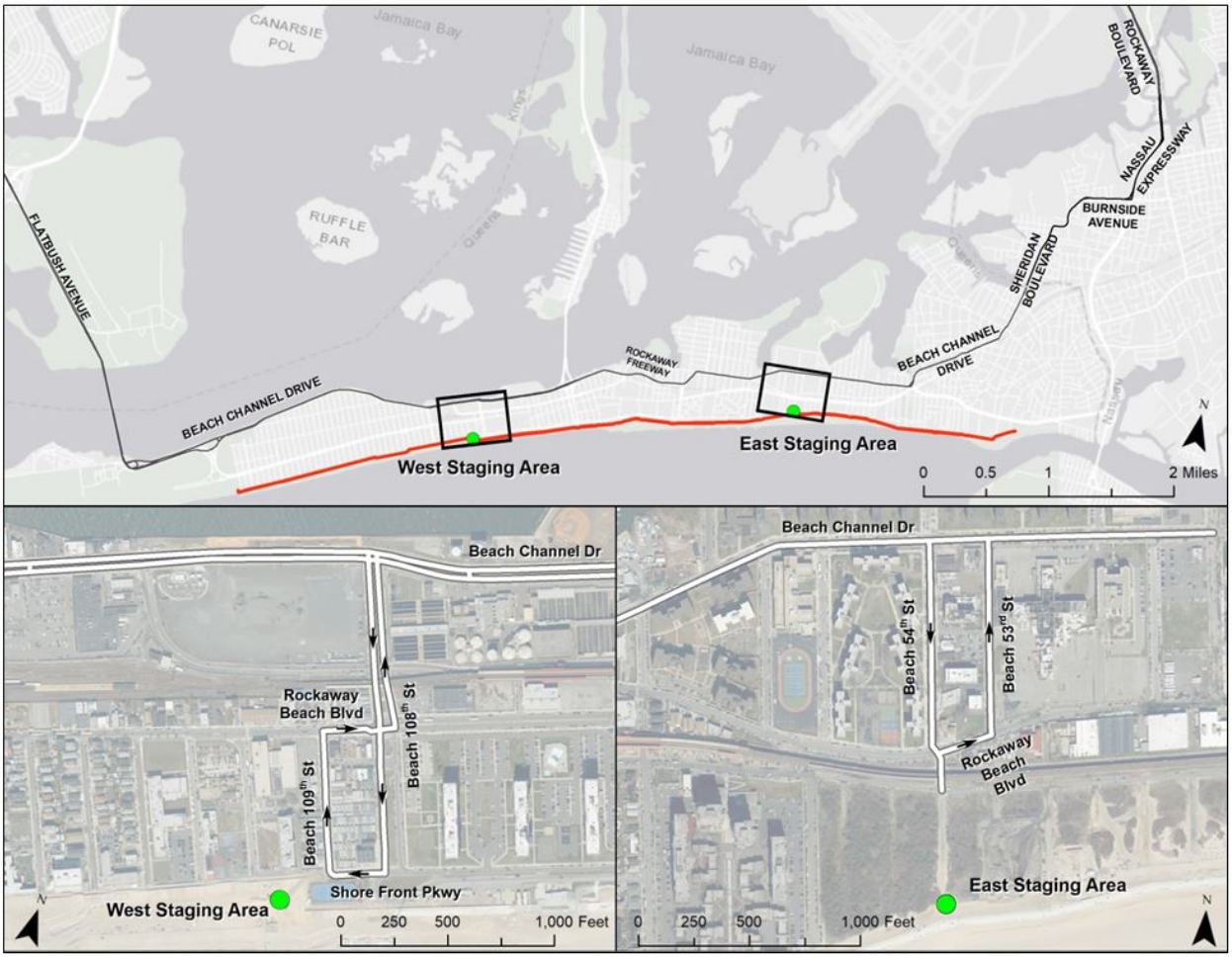


Figure 7-2: Local Truck Route Network Roadways to Access Project Area

The communities of the Rockaway Peninsula where construction material truck transportation would occur include Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammels, Arverne, Edgemere, Bayswater, and Far Rockaway. All transport within the local communities would be in accordance with the NYC DOT requirements for use of the Truck Route Network of Local and Through Truck Routes. As such, all east-west movement would occur on Beach Channel Drive and movement to specific locations would be on the nearest road perpendicular to Beach Channel Drive. For the purpose of analysis, all Shorefront materials are assumed to be delivered to the West and East Staging Areas in a 50:50 ratio. All HFFRRF materials are assumed to be delivered at various locations off Beach Channel Drive/Sheridan Boulevard on the eastern end of the project area.

Materials originating from the west would be assumed to originate from I-95 in New Jersey and would be trucked as follows:

- 95 North or South to US 278 East and the Goethals Bridge to Staten Island,
- US 278 East across Staten Island on the Staten Island Expressway,
- US 278 East across the Verrazano-Narrows Bridge to Brooklyn,
- US 278 East until exit onto State Highway 27 (Prospect Expressway),
- State Highway 27 (Prospect Expressway) south to Church Avenue Exit,
- East on Church Avenue and turn Right (south) onto Flatbush Avenue,
- Flatbush Avenue south to the Marine Parkway (Gil Hodges) Bridge to Rockaway,
- Turn east on Beach Channel Drive to Beach 108th Street/West Staging Area access or the Beach 54th Street/East Staging Area Access,
- Re-trace route across the Marine Parkway (Gil Hodges) Bridge, Flatbush Avenue, Church Avenue, State Highway 27 (Prospect Expressway), US 278 west, to US 95.

Materials originating from the north in Queens (e.g., Flushing vicinity) and east from Long Island would be assumed to be trucked as follows:

- US 687 South to Exit 1E S Conduit Ave (NY 27) east,
- Turn right (south) onto Rockaway Boulevard,
- Turn left (south) onto Nassau Expressway (NY 878) concurrent with Rockaway Boulevard/Turnpike,
- Exit right continuing on Nassau Expressway (NY878) toward Long Beach/Rockaways,
- Turn right (west) onto Burnside Ave as it changes to Sheridan Boulevard in Inwood,
- Continue south on Sheridan Boulevard as it changes to Beach Channel Drive in Far Rockaway,
- Proceed on Beach Channel Drive to the Beach 108th Street/West Staging Area access or the Beach 54th Street/East Staging Area Access.

7.16.2.3 Delivery to Staging Areas

In order to comply with the NYC DOT-designated Truck Route Network rules for trucks delivering materials,[43] trucks would be assumed to deliver materials to the Shorefront project at the Beach 108th Street (West Staging Area) and Beach 54th Street (East Staging Area) as depicted in Figure 2.

West Staging Area Deliver via Beach 108th Street would occur as assumed below:

- While traveling on Beach Channel Drive, turn south onto Beach 108th Street and take to Shore Front Parkway,
- Turn west onto Shore Front Parkway and deliver to the Western Staging Area,
- Exit construction site onto Beach 109th Street north (one-way street) to Rockaway Beach Boulevard,

[43]Delivery trucks would be allowed to travel on streets not designated as truck routes for the purpose of arriving at the Shorefront and HFFRRF construction areas. When accessing areas needing material delivery, trucks would be assumed to leave the designated truck route at the intersection that is nearest to the destination, proceed by the most direct route, and then return to the nearest designated truck route using the most direct route.

- Turn east onto Rockaway Beach Boulevard proceed to and turn north onto Beach 108th Street to Beach Channel Drive, and
- Turn east or west onto Beach Channel Drive (depending on the truck's origin) and return via the Truck Route Network approved roads.

East Staging Area deliver via Beach 54th Street would occur as assumed below:

- While traveling on Beach Channel Drive, turn south onto Beach 54th Street and take to the terminus south of Edgemere Avenue and the Eastern Staging Area,
- The return would head north on Beach 54th Street and turn west (right) onto Rockaway Beach Boulevard,
- Turn north (left) onto Beach 53rd Street and proceed to Beach Channel Drive, and

Turn east or west onto Beach Channel Drive (depending on the truck's origin) and return via the Truck Route Network approved roads.

7.16.2.4 Material Transport Assumptions and Effects Analysis

During construction of the Shorefront and HFFRRF elements, materials and equipment would be assumed to be delivered to and from the job sites seven days a week and 10 hours per day. Construction workers would also need to commute to and from work, but they would typically travel outside of peak commuting hours (i.e., arrival before 7:00 a.m. in the morning and departure after 4:00 p.m.). Peak personnel involved in construction would be conservatively assumed to be a maximum of 40 people for the Shorefront work and a maximum of 100 for the HFFRRF work.

Construction activities associated with the Shorefront and HFFRRF actions, which are located in a major metropolitan area, would result in limited, short-term increase in vehicles predicted on surface road transportation. As described above, constructing the Shorefront and HFFRRF project elements would require 45 truck round trips per day from the west and 20 truck round trips per day from the east to the project area, which is depicted in Table 7-5 below. Therefore, the number of daily trips associated with material and equipment deliveries would be small compared with the capacity and annual average daily traffic present on the NYC DOT-designated Truck Route Network with access to the areas where the Shorefront and HFFRRF actions would be implemented.

The congestion-related impacts associated with construction of the Shorefront and HFFRRF would be short term and localized on the routes where trucks would be routed. The movement of construction equipment and materials to each site would have a temporary impact on traffic (because of the slightly increased number of vehicles per day) but, once delivered, the equipment and material would remain on each site until construction was completed.

Workers would commute to and from each site during off-peak hours, and -- typical of local construction projects in New York City -- would reasonably expect some workers to carpool or utilize public transportation thereby minimizing the number of additional vehicles contributing to traffic congestion. The contractor(s) would coordinate with state and city officials to obtain any required permits for use of roads in order to comply with weight limitations and any other restrictions on area roadways.

Contractors would also be required to remove any materials (e.g., soils) that fall from equipment on to surface roads. As such, construction of the Shorefront and HFFRRF elements would not be

expected to have a discernible effect on levels of service on high-capacity road (arterial roadways). The increased truck traffic on Beach Channel Drive and the Beach 108th Street and Beach 54th Street project access would be a temporary and substantial increase in the number of trucks on the local roads and impact on road traffic or use.

Table 7-5: Baseline Traffic and Project-Related Traffic Increases

	Baseline Conditions		Project Traffic Increase		
	AADT*	Peak Hour Traffic*	Trucks Per Day	Additional Vehicles in Peak Hour	Peak Hour Increase
Flatbush Avenue (North of Rockaway Inlet)					
Northbound	12,580	1,644	45	4.5	0.27%
Southbound	12,455	1,245	45	4.5	0.36%
Beach Channel Drive					
Southbound from Marine Parkway Bridge	10,309	1,025	45	4.5	0.44%
Northbound to Marine Parkway Bridge	9,322	985	45	4.5	0.46%
Rockaway Freeway/Beach Channel Drive (Beach 84th St to Beach 79th St)					
Eastbound	997	91	45	4.5	4.95%
Westbound	943	78	45	4.5	5.77%
Beach Channel Drive from Beach 73rd St to Mott Ave					
Eastbound	5,077	411	45	4.5	1.09%
Westbound	5,585	483	45	4.5	0.93%
Beach Channel Drive at Nassau County Line					
Eastbound	10,105	720	45		
Westbound	10,475	733	45	4.5	0.61%
Beach 108th Street (Northbound)	1,150	137	45	4.5	3.28%
Nassau Expressway (878)					
Northbound	18,867	1,410	20	2	0.14%
Southbound	18,826	1,523	20	2	0.13%
Burnside Ave (Inwood)					
Eastbound	14,755	1,154	20	2	0.17%
Westbound	15,905	1,285	20	2	0.16%

7.17 Hazardous, Toxic, and Radioactive Waste (HTRW)

An alternative could have a significant effect if it would result in a substantial increase in the generation of hazardous substances, increase the exposure of persons to hazardous or toxic substances, increase the presence of hazardous or toxic materials in the environment, or place substantial restrictions on property use due to hazardous waste, materials, or site remediation.

7.17.1 No Action Alternative

No short- or long-term direct or indirect impacts related to HTRW are anticipated under the No Action Alternative. Following Hurricane Sandy, New York DEP undertook a study to understand the impact of the storm on sites that store hazardous substances, in accordance with Local Law 26 of 1988, more commonly known as the NYC Right-to-Know Law. Of 367 facilities that had filed reports under Local Law 26, 46 facilities were severely affected by Hurricane Sandy, but reported no spills and showed no evidence of spills. Only 11 facilities reported spills related to Hurricane Sandy, but the spills had been cleaned up by the facility prior to DEP inspection or spills were completely washed out by the storm. The DEP study concluded that though the lack of evidence of contamination may indicate that the impacted businesses had secured these chemicals sufficiently prior to Hurricane Sandy or adequately remediated their sites post-storm, it also may reflect the particular reality of Hurricane Sandy, as the high volume of water may have diluted and washed away any spills that occurred.[44]

7.17.2 Recommended Plan

No known HTRW sites are intersected by the alignments of the HFFRRFs or the Atlantic Shorefront element. There is a Brownfield Cleanup Program site (NYSDEC site C241207, located at Latitude: 40.591055556 / Longitude: -73.805044444 / 3-60 Beach 79th Street / 1.34 acres in size) located relatively close but not intersecting the alignment, namely 75 feet within the unprotected side of the Mid-Rockaway Hammels Area HFFRRF. This is noted so that as the HFFRRF design is refined in the PED Phase, the alignment should remain such that it does not intersect with the known Brownfield site. The site has no buildings but does have an asphalt parking lot and grassy open area. The site is zoned M1-1 (light industrial uses) and is currently inactive and contains no buildings. The grassy area of the site is used for storage of miscellaneous material. Historical industrial occupants of the site from include an ice factory, coal yard, bike corporation, and various manufacturing businesses. The site is underlain by historic fill that rests on natural clay and soil sand deposits. The historic fill contains elevated concentrations of various metals, semi-volatile compounds, PCB and pesticides, as is typical of historic fill encountered in the New York Metropolitan Area.

Adverse minor short term direct impacts could occur during construction of the Recommended Plan project elements. Operation of the construction vehicles would increase the likelihood for release of vehicle operating fluids (e.g., oil, diesel, gasoline, anti-freeze, etc.) in the work zones. However, releases are expected to be immediately addressed by site safety spill prevention and control measures to minimize potential impacts.

7.18 Cultural Resources

7.18.1 No Action Alternative

Adverse significant short- and long-term direct impacts on cultural resources are anticipated under the No Action Alternative. Not implementing the proposed coastal protective measures would leave cultural resources vulnerable to degradation and destruction by future extreme weather events.

[44] http://www.nyc.gov/html/sirr/downloads/pdf/final_report/Ch11.5_EnvironProtection_FINAL_singles.pdf

7.18.2 Recommended Plan

As described in Section 2 above, historic properties have been identified within the Area of Potential Effect (APE) for Rockaway and Jamaica Bay. This section analyzes the potential for the construction and operation of the project elements to adversely impact those historic properties identified within the respective APE. In cases where previous research investigations for cultural resources was inadequate or unknown within the APE, USACE will execute an Programmatic Agreement to continue to identify historic properties and determine the effect of project elements on historic properties, if identified (Attachment D6 of the Environmental Compliance Appendix).

7.18.2.1 Groin Construction and Extensions

These elements require excavating potentially undisturbed sediments up to 10 feet below the seafloor. Based on previous investigations, the potential for buried/submerged cultural resources in this area is low. Accordingly, the potential for this element to adversely impact cultural resources is low. However, USACE will consider utilizing a cultural monitor during excavation for the groin footings to document the discovery of potential cultural resources. The groins within the Jacob Riis Park Historic District may be contributing elements to the historic district and their modification may be considered an adverse effect. Additional research and documentation on the groins will be required by the Programmatic Agreement. No groins or groin extensions are proposed for the Jamaica Bay APE.

7.18.2.2 Renourishment

Panamerican conducted a remote sensing survey at Borrow Area A-West and A-East in 2005 (Panamerican, 2005). Sixty-seven magnetic anomalies were recorded within the project area. Based on signal characteristics, three anomalies have the potential to represent significant cultural resources. Panamerican recommended avoidance of all three targets. If avoidance is not an option, additional archaeological investigations are recommended to identify the source of the magnetic anomalies. Additional work should consist of remote-sensing target refinement and diver assessment of the refined target location. Diver assessment should consist of a visual and tactile investigation of the ocean bed at the center of highest gamma deviation for each. In the event that there is no source of magnetic deflection located directly on the ocean bed, sub-ocean bed investigations should be conducted with a probe or hydroprobe to a depth sufficient to either meet proposed project requirements or to locate and delineate the anomaly source. All targets should be assessed as to historical significance, relative to NRHP criteria. The remaining anomalies represent debris deposited for fish havens along and in the western edge of the project area, as well as a pipeline that parallels the southern project area boundary (Panamerican, 2005).

A remote sensing survey has not been conducted at Borrow Area B-West. If USACE plans to use this borrow area, a remote sensing survey will be conducted prior to dredging any material. USACE will share the results with the SHPO and provide recommendations for avoidance or additional investigation, as warranted (See Attachment D6 of the Environmental Compliance Appendix).

7.18.2.3 Borrow Area Dredging

Panamerican conducted a remote sensing survey at Borrow Area A-West and A-East in 2005 (Panamerican, 2005). Sixty-seven magnetic anomalies were recorded within the project area. Based on signal characteristics, three anomalies have the potential to represent significant cultural

resources. Panamerican recommended avoidance of all three targets. If avoidance is not an option, additional archaeological investigations are recommended to identify the source of the magnetic anomalies. Additional work should consist of remote-sensing target refinement and diver assessment of the refined target location. Diver assessment should consist of a visual and tactile investigation of the ocean bed at the center of highest gamma deviation for each. In the event that there is no source of magnetic deflection located directly on the ocean bed, sub-ocean bed investigations should be conducted with a probe or hydroprobe to a depth sufficient to either meet proposed project requirements or to locate and delineate the anomaly source. All targets should be assessed as to historical significance, relative to NRHP criteria. The remaining anomalies represent debris deposited for fish havens along and in the western edge of the project area, as well as a pipeline that parallels the southern project area boundary (Panamerican, 2005).

A remote sensing survey has not been conducted at Borrow Area B-West. If USACE plans to use this borrow area, a remote sensing survey will be conducted prior to dredging any material. USACE will share the results with the SHPO and provide recommendations for avoidance or additional investigation, as warranted (See Attachment D6 of the Environmental Compliance Appendix).

7.18.2.4 Buried Seawall, Beach and Dune Restoration

The buried seawall, with its beach and dune restoration, would not have an adverse effect on the Jacob Riis Historic District. However, this measure requires the installation of pilings up to 8 feet below NAVD88. Although the presence of buried cultural resources in the piling footprint is low, USACE will consider utilizing a cultural monitor during construction activities.

No buried seawall with beach and dune restoration is proposed for the Jamaica Bay APE.

7.18.2.5 Bulkheads, floodwalls, wetland creation and pump stations

The proposed high frequency flood risk reduction measures located within the APE consist of a combination of bulkheads, floodwalls, wetland creation and pump stations. All of these measures have the potential to cause ground disturbance. Although the areas around Jamaica Bay, in general, and in the Jamaica Bay APE in particular, consist of both original shorelines and filled land, there is a potential to encounter original ground surfaces and features. The alignment for the Hammels high-frequency flood risk reduction measure is immediately adjacent to two properties eligible for the National Register. Additional work may be required if the measure's alignments change. In accordance with the Programmatic Agreement, additional documentary research, field investigations and other activities will look to further identify and evaluate historic properties as features and elements are designed (See Attachment D6 of the Environmental Compliance Appendix). None of these features will be constructed within the Rockaway APE.

7.19 Socioeconomics and Environmental Justice

Environmental justice issues would arise if activities associated with an alternative caused a disproportionate impact to low-income or minority populations. Disproportionate impacts could be related to human health effects or environmental effects. As described in Section 2.17, the NYSDEC identifies "Potential Environmental Justice Areas" (PEJAs) as census block groups meeting one or more of the following NYSDEC criteria in the 2000 U.S. Census (NYSDEC, 2016):

- 51.1% or more of the population are members of minority groups in an urban area;
- 33.8% or more of the population are members of minority groups in a rural area, or;
- 23.59% or more of the population in an urban or rural area have incomes below the federal poverty level.

Figure 7-3 provides an overview of the Recommended Plan project areas with PEJAs highlighted throughout the study area. The NYSDEC publishes county maps identifying PEJAs, including Kings, Queens, and Nassau counties (NYSDEC, 2016).

7.19.1 No Action Alternative

Adverse significant long-term direct impacts on PEJAs are anticipated under the No Action Alternative. The No Action alternative would leave the Atlantic Ocean Shorefront Planning Reach and Jamaica Bay Planning Reach PEJAs vulnerable to property damage from strong waves and storm surges associated with extreme weather events (Figure 7-3). Adverse impacts are felt more deeply by communities with high levels of poverty.

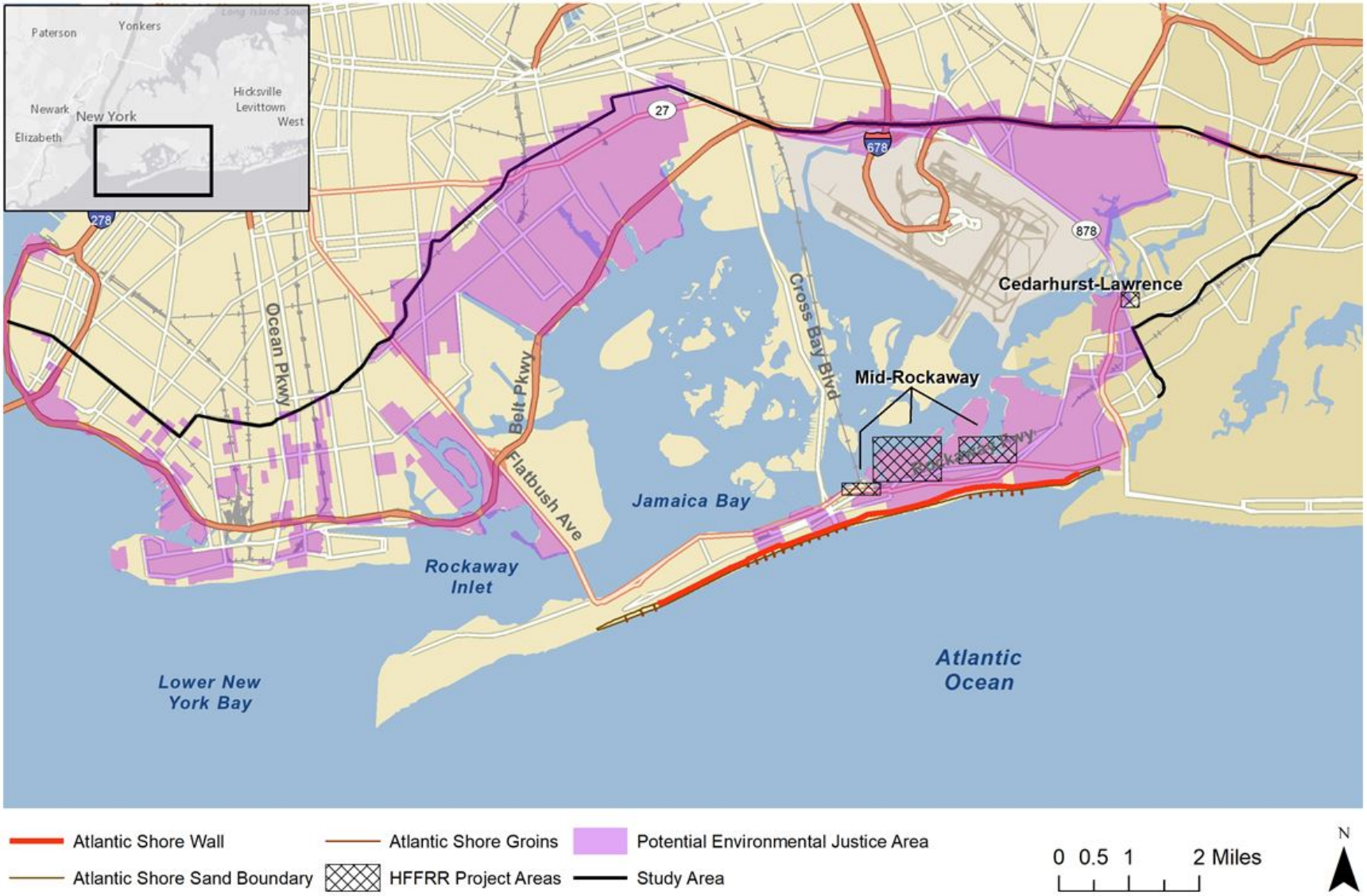


Figure 7-3: Potential Environmental Justice Areas and Project Locations

7.19.2 Recommended Plan

Beneficial long-term direct impacts on Potential Environmental Justice Areas (PEJAs) would be realized by implementation of the Recommended Plan. Construction of seawalls and groins, along with beach renourishment actions as part of the Atlantic Ocean Shorefront component, would provide coastal storm risk reduction to residential areas defined as PEJAs. Adverse impacts from storm damage are felt more deeply by communities with high levels of poverty, because community residents have limited financial resources available for rebuilding structures and replacing damaged possessions. In addition, benefits of the HFFRRFs of the Recommended Plan would be beneficial to areas with higher levels of poverty (e.g., PEJAs). As shown in Figure 7-3 above, PEJAs are located in or adjacent to all Recommended Plan elements – demonstrating that PEJA communities would directly benefit from Recommended Plan implementation.

In addition to the beneficial long-term impacts, PEJA communities would experience adverse effects from construction of the Recommended Plan. Demolition and construction work can cause an increase in sound that is well above the ambient level. A variety of sounds are emitted from loaders, trucks, saws, and other work equipment. Construction equipment usually exceeds the ambient sound levels by 20 to 25 dBA in an urban environment and up to 30 to 35 dBA in a quiet suburban area. PEJA communities also would experience increased traffic and traffic disruptions during construction of the Recommended Plan.

7.20 Aesthetics

An alternative could significantly affect visual resources if it resulted in abrupt changes to the complexity of the landscape and skyline (i.e., in terms of vegetation, topography, or structures) when viewed from points readily accessible by the public.

7.20.1 No Action Alternative

Adverse long-term direct impacts on aesthetics are anticipated under the No Action Alternative. The No Action alternative would leave land along the coast vulnerable to change and instability from strong waves and storm surge. Coastal storms would negatively alter the aesthetic landscape, including beaches, parks, and landmark structures. Negative impacts to aesthetics would contribute to the loss in recreational beach visits, as described in Section 7.14 Recreation.

7.20.2 Recommended Plan

Beneficial long-term direct impacts on aesthetics would be realized by implementation of the Recommended Plan. Construction of seawalls and groins, along with beach renourishment actions would stabilize areas currently frequented by residents and visitors seeking to connect with significant natural or built features, including area beaches, parks, and landmark structures. Implementation of protective features and beach renourishment would protect the project area's natural and culturally significant resources from the detrimental influence of winds, waves, currents, and sea-level changes. As discussed under impacts to recreation, based on responses to beach surveys completed in the summer of 2015, it was estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by more than 4.5 million (Economics Appendix).

Negligible short-term direct impacts to area aesthetics are anticipated from the presence in the viewshed of heavy equipment during project construction and from temporary increases in dust

and exhaust from construction activities. Construction BMPs would be implemented to reduce the severity of these impacts to negligible levels to the maximum extent possible. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, water tanker trucks for dust suppression, and covering trucks with tarps to prevent airborne dust.

7.21 Cumulative Impacts

As defined by CEQ Regulations at 40 CFR Part 1508.7, cumulative impacts are those that "result from the incremental impact of the Recommended Plan (for NEPA purposes the Proposed Action is the Recommended Plan) when added to other past, present, and reasonably foreseeable future actions, without regard to the agency (federal or non-federal) or individual who undertakes such other actions." Cumulative impact analysis captures the effects that result from the Recommended Plan in combination with the effects of other actions in the Recommended Plan's region of influence (ROI). A cumulative impacts analysis is intended to give a better picture of the additive or total impacts a given resource may experience when the impacts of unrelated actions or events are added to the predicted impacts of the alternative being evaluated. Analysis of cumulative impacts considers how the Recommended Plan affects sensitive resources directly or indirectly, and also what other effects have occurred, are occurring, or might occur to these resources from other, related or unrelated activities within the Recommended Plan's ROI. The analysis of cumulative effects is an extension of the impacts analysis performed to determine the significance of direct and indirect, project-specific effects.

The first step in cumulative impacts analysis is identification of resources that could be impacted by the Recommended Plan, as presented in Sections 7.1 through 7.24 above. Resources deemed to have no impacts from the Recommended Plan were eliminated from the cumulative impacts analysis; resource areas that would not experience impacts could not contribute cumulatively to regional effects. Based on the impacts analysis, resources with minor adverse impacts from the Recommended Plan were considered for inclusion in the cumulative impacts analysis. The following resources were included in the cumulative impacts analysis, based on the conclusion that the Recommended Plan would have a minor adverse impact on the resource and could contribute to cumulative regional impacts.

- Soils
- Sediments (bathymetry and sediment budgets)
- Water Quality (surface and ocean)
- Vegetation (including invasive species and terrestrial habitat)
- Wetlands (including aquatic habitat)
- Fish
- Benthic Community
- Wildlife
- Protected Species and Critical Habitat

Secondly, the ROI for each resource under each alternative scenario was defined in order to evaluate cumulative impacts resulting from projects that are proposed or anticipated within the foreseeable future. The ROI for all resources considered for the cumulative impacts analysis is defined as the "greater New York Metropolitan area" coastal and estuarine regions.

Thirdly, the relevant past, present, and reasonably foreseeable future actions in the ROI were researched. Regional projects were evaluated for inclusion in the analysis that could cumulatively affect each identified resource, considering both the magnitude and significance of the potential cumulative effects.

Representative projects were researched and considered in broad categories of regional projects. Dozens of regional projects were identified, and those with a potential to introduce cumulative impacts in conjunction with potential effects of the Recommended Plan were included in the analysis.

Recent, on-going, and proposed actions planned over the next several years with the potential for cumulative interaction or effects related to the Recommended Plan are described below in Sections 7.21.1 through 7.21.6. Cumulative impacts for the potentially-affected resource areas identified, which encapsulates resources for all the known or projected cumulative actions, are summarized in Table 7-6 below. The past, present, and reasonably foreseeable future actions, as presented in Sections 7.21.7.1 through 7.21.7.9, leads to a determination that all adverse cumulative impacts are insignificant-adverse or insignificant-beneficial, as summarized in Table 7.6.

Table 7-6: Region of Influence for Cumulative Impact Analysis

Resource Area	Region of Influence (ROI)	Impact
Aquatic	The Atlantic Coast in Rhode Island, Connecticut, New York, and New Jersey	Insignificant-Adverse
Threatened and Endangered Species and Critical Habitat	The extent of each species' known range of critical habitat	Insignificant-Adverse
Erosion and Larger Scale Coastal Zone Management	The Atlantic Coast in Rhode Island, Connecticut, New York, and New Jersey	Insignificant-Beneficial
Water Quality	The greater New York metropolitan area	Insignificant-Adverse
Terrestrial	The Atlantic Coast in Rhode Island, Connecticut, New York, and New Jersey	Insignificant-Adverse

7.21.1 Special Aquatic Habitat Programs Including Wetlands

Regional programs are being implemented to restore degraded or diminished aquatic habitat, including wetlands. Regional projects are described in the following subsections.

7.21.1.1 Yellow Bar, Black Wall and Rulers Bar Marsh Island Restoration 2012

The Marsh Islands Complex is an integral part of Jamaica Bay, targeted for restoration by the USACE, PANYNJ, National Park Service (Gateway), NYSDEC, NYCDEP, the National Resources Conservation Service and the New York/New Jersey Harbor Estuary Program. Restoring intertidal wetlands in Jamaica Bay are a critical component of the Comprehensive Restoration Plan for the Hudson Raritan Estuary. Since 2007, more than 160 acres (0.68

kilometers2) of marsh island habitat have been restored at Elders Point East and West, Yellow Bar Hassock, Black Wall, and Rulers Bar. Additional marsh islands, including Pumpkin Patch, Duck Point, Elders East/West, and Stoney Point are being designed as part of the HRE Ecosystem Restoration Feasibility Study.

The NYSDEC, NYCDEP with the local non-profit organizations EcoWatchers, Jamaica Bay Guardian and the American Littoral Society, completed a community-based planting effort to vegetate 30 new acres created at Black Wall and Rulers Bar. Plantings in June 2013 included a mixture of smooth cord grass or salt marsh cord grass (*Spartina alterniflora*), salt marsh cord grass, salt meadow cord grass or salt hay (*Spartina patens*), and spike grass (*Distichis spicata*).

The marsh island restoration efforts are being monitored by a project team that is providing valuable data on the cause of problems and assisting to identify optimum effective future restoration options. This program also has significant implications for the future success of restoration activities from beneficially using sand from the Operations and Maintenance (OMRR&R) Program

7.21.1.2 Broad Channel's Sunset Cove Salt Marsh Restoration Project

In 2009, NYCDPR acquired a former marina at Sunset Cove located in the center of Jamaica Bay. The site is adjacent to Big Egg Marsh, a large wetland complex owned and managed by the NPS. The restoration plan for Sunset Cove Park was created by a partnership of NYCDPR, NPS, NY-HEP, New England Interstate Water Pollution Control Commission (NEIWPCC), Jamaica Bay EcoWatchers, Broad Channel Civic Association, and the American Littoral Society. The plan incorporates approximately 4 acres (0.02 kilometers2) of salt marsh restoration and preservation, 500 feet (152.4 meters) of shoreline restoration, and approximately 7 acres (0.03 kilometers2) of upland habitat restoration. Together, these restoration efforts will establish a sustainable salt marsh, remove concrete tailings, debris, and construction fill, expand the existing wetland complex at Big Egg Marsh, and create an upland walking path through a coastal shrubland. In addition, Phase 2 of the plan, in partnership with the Governor's Office of Storm Recovery, proposes enhancements to amenities for public waterfront access, including a boardwalk and access to the water for educational programs. The plan also includes berms along the upland perimeter to provide shoreline protection, enhancing resiliency to climate change and laying the foundation for regional economic growth. The project is currently under construction.

7.21.2 Beach Front Measures

Regional projects affecting beach fronts include the beach renourishment and replenishment projects identified in Section 7.25.4 USACE Overall Program. Additional regional projects are described in the following subsections.

7.21.2.1 Rockaway Boardwalk Reconstruction Project

The NYC Department of Parks and Recreation and the NYC Economic Development Corporation have funded this project, which is designed to reconstruct the boardwalk between Beach 20th and Beach 126th Streets in a similar footprint. The existing constructed project at Rockaway includes precast concrete panels shown on the landside of the boardwalk. This wall consists of precast concrete panels, extending to +6 ft NAVD88 supported by H piles, and is not considered a significant CSRM feature. The primary function of the panels is to 1) limit access underneath the boardwalk and 2) contain wind-blown sand.

Existing concrete foundations in the way of new construction are to be removed and new steel foundations would be spaced approximately 30 feet apart. The reconstructed boardwalk will not intrude on the seaward side of the mean high water spring elevation. The typical boardwalk surface would be designed to be 3.0 feet above the 100-year storm surge elevation. This new elevation would result in raising the new boardwalk sections from approximately 1.4 feet at the eastern portion of the site to approximately 8.0 feet to the west. The reconstruction would also incorporate a sand-retaining wall underneath the boardwalk that would prevent sand migration and help to protect the adjacent beach vegetation community. Between Beach 126th and Beach 149th Streets, the project includes providing structured access to the beach with stairs and ramps across the new dunes currently being constructed as part of the USACE beach renourishment project. In addition, the project would maintain the five existing at-grade crossings through the existing dunes between Beach 9th and Beach 20th Streets.

7.21.3 Borrow Area Usage

Regional projects affecting beach fronts include the beach renourishment and replenishment projects identified in Section 7.25.4, USACE Overall Program and Coastal Zone Habitat Modifications. Each of these projects includes dredging borrow materials from off-shore sources. Regional projects requiring borrow material are discussed in this section. Some projects may have completed initial construction activities, but are considered for cumulative impacts because of plans for future, periodic replenishment. Sufficient sand has been identified for all of the listed beach nourishment projects in this section and the borrow areas for the East Rockaway Inlet to Rockaway Inlet Atlantic shoreline will be exclusively used for this project.

7.21.3.1 Coney Island

The project includes approximately 3 miles of public beachfront from Corbin Place to West 37th Street. The constructed beach has a minimum design berm elevation of +13 ft. NGVD (+11.9 ft. NAVD88), with a width of 100 feet measured from the Coney Island boardwalk seaward and an additional 50 feet of advanced nourishment fill. Approximately 2.3 million cubic yards were dredged from the borrow area offshore, south of the project shoreline within the East Bank Shoal and there is more available for future nourishments if necessary.

7.21.3.2 Long Beach

This USACE project entailed the construction of a beach berm, dune and groin system to reduce the potential for storm damage along approximately 35,000 linear feet of shoreline. Work began in the spring of 2016. Contract one included 4 new groins and 18 groin rehabilitations and was completed in 2018. Contract two, including a dune, sand replenishment of 4 million cubic yards, and the construction of 66 crossovers, was started in 2018. Beachfill placement was completed in early 2019, and all remaining crossover work will be completed by the end of 2019.

7.21.3.3 The Westhampton Beach Project

The project is designed to provide beach fill, taper an existing groin field, and fill the compartments of the groins in the villages of Westhampton Dunes, Westhampton Beach, and Southampton. Including re-nourishments, approximately 6.5 million cubic yards of sand were placed along 21,460 linear feet of beach. The project is reportedly performing better than expected.

7.21.3.4 West of Shinnecock Project

Starting in 2004, this project placed approximately 450,000 cubic yards of sand from the inlet channel on adjacent beaches. Approximately 40,000 to 60,000 cubic yards were placed just west of the inlet jetties to address severe erosion problems in front of the fishing cooperative. The remainder were placed further downdrift to accomplish sand bypassing around the inlet. The timing of future fill to address erosion west of the jetties is still uncertain.

7.21.3.5 Fire Island Inlet to Moriches Inlet Stabilization Project (FIMI)

The Fire Island to Moriches Inlet (FIMI) project includes one reach within the overall FIMP Project area. The USACE is currently constructing a project to reinforce the existing dune and berm system along the island. The stabilization effort was developed as a one-time, stand-alone construction project to repair damages caused by Hurricane Sandy and to stabilize the island. The offshore borrow areas used for construction is approximately 5,000,000 cy of sand to be removed from one borrow area and placed in the fill areas between Fire Island Inlet and Davis Park. Approximately 700,000 cy to be removed from another borrow area, and approximately 1,300,000 cy to be removed from a third borrow area for fill areas between Smith Point County Park and Moriches Inlet.

7.21.4 USACE Overall Program and Coastal Zone Habitat Modifications

The USACE New York District plans and executes an overall ecosystem restoration program to provide a comprehensive approach for addressing problems associated with disturbed and degraded ecological resources. Restoration techniques include wetland creation and restoration, streambank stabilization, reclamation and treatment of contaminated waterways, flood damage prevention, shoreline and coastal protection, and coastal zone habitat modification projects also involving beach renourishment and replenishment (similar to the Recommended Plan). Projects in USACE's overall program that were considered for potential cumulative impacts are described in the following subsections. USACE will adopt the conservation recommendation of the USFWS to dredge in thin layers and avoid digging deep pits during dredging, which results in quicker recovery of borrow areas according to research and monitoring performed by the USACE New York District.

7.21.4.1 Hurricane Sandy Coastal Restoration in New York

USACE is carrying out near-term coastal restoration work at previously completed coastal storm risk reduction projects throughout the northeast that were impacted by Hurricane Sandy in October 2012. This involves the placement of millions of cubic yards of sand along beaches impacted by Hurricane Sandy in order to restore them. The USACE New York District manages projects in New York and in New Jersey north of Manasquan Inlet. (Work south of Manasquan Inlet is managed by the USACE Philadelphia District.) Near-term coastal restoration work includes the following five projects in New York.

- Rockaway Beach – Placed approximately 3.5 million cubic yards of sand through two contracts to repair and restore this CSRM beach project.
- Coney Island - Placed approximately 600,000 cubic yards of sand to repair and restore this CSRM beach project.

- Gilgo Beach - Placed approximately 1.5 million cubic yards of sand to complete the repair of this CSRM beach that is part of dual-purpose navigation (Fire Island Inlet) and CSRM project and to bolster nearby municipal beaches using additional funds provided by the state of New York.
- West of Shinnecock Inlet - Placed approximately 450,000 cubic yards of sand to repair and restore this CSRM beach project.
- Westhampton – USACE awarded a construction contract for this work and expects to oversee the placement of roughly 1 million cubic yards of sand by the end of this year to repair and restore this CSRM beach project.

7.21.4.2 North Atlantic Coast Comprehensive Study

The North Atlantic Coast Comprehensive Study (NACCS) provides a step-by-step approach, with advancements in the state of the science and tools to conduct three levels of analysis (available at http://www.nad.usace.army.mil/CompStudy). Tier 1 is a regional scale analysis (completed as part of this study), Tier 2 would be conducted at a State or watershed scale (conceptual Tier 2 evaluations were completed in each State and the District of Columbia and can be found in State and District of Columbia Analyses Appendix), and Tier 3 would be a local-scale analysis that incorporates benefit-cost evaluations of CSRM plans.

Using the tiered analyses will enable communities to understand and manage their short-term and long-term coastal risk in a systems context. The NACCS addresses the coastal areas defined by the extent of Hurricane Sandy's storm surge in the District of Columbia and the States of New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, and Virginia. Maine was not included in the study because minimal impacts from storm surge were documented as part of the Federal Emergency Management Agency's (FEMA's) Modeling Task Force (MOTF) Hurricane Sandy Impact Analysis. Additionally, the USACE Hurricane Sandy Coastal Projects Performance Evaluation Study included an assessment of 13 USACE CSRM projects in northern Massachusetts and Maine, and noted that Hurricane Sandy was generally less than a 20 percent flood with negligible damages to project features. Based on minimal impacts and the authorization language that defined the study area as areas affected by Hurricane Sandy, Maine was not included as part of the NACCS study area. Regardless, as the Maine coastline is primarily affected by nor'easters and periodically by tropical storms and hurricanes, stakeholders and communities could apply the study results to address coastal storm risk as well as utilize the various products generated as part of the NACCS.

7.21.4.3 NY & NJ Harbor Deepening Contract Areas and Future OMRR&R Projections

The project area is the main navigation channels in the Port of New York and New Jersey that support the container terminals. The non-federal sponsor is The Port Authority of New York & New Jersey. The authorized project provides 50-foot water access to the four container terminals by deepening Ambrose Channel from deep water in the Atlantic Ocean to the Verrazano-Narrows Bridge, the Anchorage Channel (from the Verrazano-Narrows Bridge to its confluence with the Port Jersey Channel), the Kill Van Kull Channel, the main Newark Bay Channel to Pt. Elizabeth and the Port Elizabeth and South Elizabeth tributary channels, the Arthur Kill Channel adjacent to the New York Container Terminal), and the Port Jersey. Also authorized but deferred is the

deepening of the Bay Ridge channel to 50 ft to the South Brooklyn Marine Terminal. The project also facilitated the beneficial use of nearly all dredged material from the channel deepening project. Some of the beneficial uses include creating fishing reefs from blasted rock, creating marshes, capping the Historic Area Remediation Site (HARS), and capping existing impacted landfills and brownfields.

The project includes 21 dredging contracts and construction of four marsh restoration projects. Two marsh restoration projects at Woodbridge, NJ and Elders Point East, Jamaica Bay, NY (2006-2007, 40 acres of wetlands) were constructed as mitigation for the channel deepening. In 2009 through 2012, the project was modified to include the restoration of two additional Jamaica Bay marsh islands (Elders West and Yellow Bar Hassock) through the beneficial reuse of dredged material. In 2010 with 100 percent non-federal sponsor funding, 339,235 cubic yards of sand was beneficially used for the restoration of Lincoln Park, New Jersey. Twenty dredging contracts have been awarded with 19 physically complete and one underway. Two of the last three contracts removed accumulated shoals and debris (partially due to Hurricane Sandy) in previously deepened channel areas inside the Narrows to facilitate transition of the project from construction to operation. The last contract, which involves the removal of material in utility corridors and other shoals in the Anchorage and Port Jersey Channels, is underway and will be completed shortly following the abandonment of two existing water supply siphons within Anchorage Channel. This water siphon relocation construction work by the Port Authority of NY and NJ and the NYC Economic Development Corporation was severely impacted and delayed by Hurricane Sandy such that the utility corridor deepening contract is not expected to be completed until summer of 2016.

7.21.4.4 Hudson-Raritan Estuary (HRE) Comprehensive Restoration Plan

The Hudson Raritan Estuary (HRE) is within the boundaries of the Port District of New York and New Jersey, and is situated within a 25-mile radius of the Statue of Liberty National Monument. The HRE study area includes 8 Planning Regions: 1) Jamaica Bay; 2) Lower Bay; 3) Lower Raritan River; 4) Arthur Kill/Kill Van Kull; 5) Newark Bay, Hackensack River and Passaic River; 6) Lower Hudson River; 7) Harlem River, East River, and Western Long Island Sound; and 8) Upper Bay.

The study purpose is to identify the water resources problems, existing conditions and factors contributing to environmental degradation within the estuary in order to develop potential solutions aimed at ecosystem restoration, while building upon existing restoration efforts and management plans (e.g., Harbor Estuary Program's Comprehensive Conservation Management Plan).

The HRE Ecosystem Restoration Program will enable USACE, its non-federal cost-sharing sponsors, and other regional stakeholders to restore and protect lost or degraded aquatic, wetland and terrestrial habitats within the HRE study area. These activities will be accomplished by implementing various site-specific ecosystem restoration projects formulated within the context of an overall strategic plan.

As a first step, the USACE, with participation of the regional stakeholders, developed a Comprehensive Restoration Plan (CRP) that serves as a master plan and blueprint for future restoration in the HRE region. The CRP provides the framework for an estuary-wide ecological restoration program by utilizing restoration targets - Target Ecosystem Characteristics (TECs)

developed by the region's stakeholders. The CRP Program goal is to develop a mosaic of habitats that provide society with renewed and increased benefits from the estuary environment. Each TEC is an important ecosystem property or feature that is of ecological and/or societal value including restoration of intertidal wetlands, shellfish reefs, eelgrass beds, water bird islands, public access, maritime forest, tributary connections, shorelines and shallow habitat, fish crab and lobster habitat, reduction of contaminated sediments and improvement of enclosed and confined waters. The CRP provides a strategic plan to achieve the TEC goals, identify potential restoration opportunities and mechanisms for implementation.

The HRE Feasibility Study will recommend specific restoration projects throughout the HRE Study Area that advance the CRP goals and provide solutions for water resource problems. Projects will be recommended for near-term construction and future feasibility study spin-offs (per Civil Works Transformation). Recommendations from the HRE- Lower Passaic River, HRE-Hackensack Meadowlands, Flushing Creek and Bay, Bronx River Basin, and Jamaica Bay, Marine Park, Plumb Beach Feasibility Studies will be incorporated into the HRE Feasibility Report and Environmental Assessment. These recommendations may include benthic habitat restoration, tidal wetland restoration, vegetative buffer creation, shoreline stabilization, and aquatic habitat improvement.

7.21.4.5 Spring Creek North Restoration Project and Spring Creek South Hazard Mitigation Grant Program

The USACE), NYSDEC, NYCDPR, NYCDEP, NPS, the Federal Emergency Management Agency (FEMA), the Governor's Office of Storm Recovery (GOSR), and the U.S. Department of Housing and Urban Development (HUD), among others, have partnered to restore the Spring Creek area located along the north shore of Jamaica Bay. The site consists of two separately funded projects referred to as Spring Creek North and Spring Creek South. Spring Creek North is owned by NYCDPR and the restoration project is being funded by the USACE and NYCDPR pursuant to the Continuing Authorities Program (CAP). Spring Creek South is owned by NPS and the restoration project is funded by a grant provided to NYSDEC under the FEMA Hazard Mitigation Grant Program (HMGP). These projects are also being coordinated with the Governor's Office of Storm Recovery's Howard Beach New York Rising Community Reconstruction Plan (March 2014).

Spring Creek North is a tidal creek that has retained its meandering pattern and has several smaller side channels with exposed mudflats at low tide. The proposed ecosystem restoration project at this site consists of excavating and re-contouring uplands to achieve intertidal elevation, as well as removing invasive plant species and replanting the area with native plants. A total of approximately 8 acres (0.03 kilometers2) of low marsh, 5.5 acres (0.02 kilometers2) of high marsh, and almost 25 acres (0.1 kilometers2) of maritime upland habitat would be restored.

In addition, NYCDPR received and utilized a National Fish and Wildlife Foundation (NFWF) Grant to construct complementary actions to provide coastal storm risk management (CSRM) features and improve resiliency at the site.

Spring Creek South was originally recommended as a potential restoration opportunity for the USACE's Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study. As part of FEMA's HMGP, NYSDEC, USACE (as a planning and construction management contractor), and NPS have reevaluated the restoration plans to include Natural/Nature Based

Features (NNBFs) providing CSRM benefits and enhanced coastal resiliency to the Howard Beach Community. A protective berm, in conjunction with up to 178 acres (0.72 kilometers^2) of maritime upland habitat and 51 acres (0.21 kilometers^2) of wetlands, could be restored at Spring Creek South.

7.21.5 Long-Term Combined Sewer Overflow (CSO) Projects

Municipalities are concerned about CSOs because of their effect on water quality and recreational uses in local waterways. Water treatment plants are affected by heavy rain and snow storms when combined sewers receive higher than normal flows. Treatment plants are unable to handle flows that are more than twice design capacity and when this occurs, a mix of excess stormwater and untreated wastewater discharge directly into waterways at certain outfalls. The following subsections describe CSO projects evaluated for cumulative impacts.

7.21.5.1 Jamaica Bay CSO Upgrade Projects

NYC Department of Environmental Protection (DEP) prepared a 2014 update to the Jamaica Bay Watershed Protection Plan. The plan, first issued in 2007, focuses on water quality improvements, ecological restoration and enhancing valuable natural resources. The update outlines the numerous initiatives DEP has undertaken, along with state and federal partner agencies, environmental advocates, leading educational institutions and community groups, to protect one of the most bountiful wildlife habitats in the Northeastern Unites States.

Ongoing initiatives include wastewater treatment plant upgrades, shellfish pilot restoration projects, wetlands restoration, green infrastructure projects and mapping.

7.21.5.2 NYC CSO Control Plan

Recent NYCDEP construction projects have included upgrades in key wastewater treatment facilities, storm sewer expansions and the construction of several large CSO retention tanks to further mitigate this chronic source of pollution. Existing infrastructure developments have increased NYCDEP's standardized CSO capture rate from about 30% in 1980 to over 80% today. Some of the most recent increases can be attributed to the implementation of additional CSO control measures such as the Spring Creek and Flushing Bay CSO Retention Facilities that came online in 2007, and the Paerdegat Basin and Alley Creek CSO Retention Facilities, which came online in 2010.

7.21.6 Community Development Plans

Community development plans in the ROI can have direct cumulative effects, but such projects are also known to induce associated development. For example, improved recreational opportunities at area beaches often bring commercial development designed to serve increased visitor traffic. Regional projects are described in the following subsections.

7.21.6.1 Rehabilitation of the Gil Hodges Bridge

The Metropolitan Transportation Authority (MTA) rehabilitation of the Gil Hodges Marine Parkway Bridge underwater structures is currently underway via a Design Build project that also includes similar work at the Cross Bay Bridge. The contract was awarded in December 2018 and is projected for completion in 2021.

The long term planning study for rehabilitation or replacement of these bridges is now complete and recommended actions are undergoing further analysis for eventual incorporation in future capital programs.

7.21.6.2 The Arverne Urban Renewal Area

The 308-acre Arverne Urban Renewal Area is bounded by Beach 32nd Street, Beach 81st Street, Rockaway Freeway, and the Rockaway Boardwalk. The project is to be developed in phases. Phase I, Water's Edge, was completed in the Spring of 2001 and consisted of the construction of 40 two-family homes on four infill sites between Beach 59th Street and Beach 62nd Street, south of Rockaway Beach Boulevard. In 2006, construction began on Phase II, which consists of 130 condominiums in the same area as Phase I. The area also contains two other projects. Arverne by the Sea is intended to produce 2,300 units, half of which will be affordable to households making no more than $92,170 for a family of four. An area adjacent to Arverne by the Sea, Arverne East, has the goal of building 1,600 units of middle-income units. Forty-three percent of the units will be reserved for households with incomes no greater than $92,170 for a family of four.

7.21.7 Summary of Cumulative Impacts

The minor adverse impacts of Recommended Plan implementation on the aforementioned resource areas would not increase to significant adverse impact levels when combined with past, present, or reasonably foreseeable future impacts from other regional projects. These minor impacts are primarily associated with construction of the Recommended Plan. Cumulative adverse impacts on recreation, intertidal wetlands, water quality, sediment transport, fish and wildlife, and essential fish habitat would remain minor and short-term. This is due to the coastal storm risk reduction afforded by the Recommended Plan to regional projects that have or are planned to restore and/or protect coastal resources located within the study area. Accordingly, the minor adverse impacts associated primarily with construction of the Recommended Plan would be offset by the cumulative long-term beneficial impacts of the Recommended Plan on, and in combination with, restorative regional projects.

Implementation of the Recommended Plan is not expected to have a significant cumulative adverse impact on any of the resource areas evaluated in this HSGRR/EIS. Cumulative net positive impacts would be realized in the local socioeconomic environment and many resource areas where protection from coastal storm events is beneficial to the resource (e.g., vegetation, wildlife, recreation).

The Recommended Plan would not significantly, cumulatively increase regional impacts in the areas identified by the cumulative impact analysis methodology. Minor (insignificant) and beneficial cumulative impacts are discussed in the following sections.

7.21.7.1 Soils

The Recommended Plan would cumulatively contribute to beneficial long-term direct impacts that would occur from the resulting built structures (e.g., groins, seawalls, dunes) that retain and capture littoral materials native to the beach communities and/or limit the effects of wave and storm surge erosion. Construction and extension of groins and construction of seawalls and dunes under the Recommended Plan and similar regional projects would result in continued protection of beach

sands and upland soils from wave action and erosion that result from significant storm events. Cumulative beneficial long-term direct impacts on soils would occur as a result of the Recommended Plan and similar regional projects due to beach renourishment actions, where beach sands are replenished at prescribed intervals over project life cycles.

Cumulative minor adverse direct short-term impacts to soils would occur as a result of implementation of the Recommended Plan due to construction activities (e.g., clearing, grading, trench excavation, backfilling) and the movement of construction equipment within the project areas. Soil compaction and disturbance to and mixing of discrete soil strata cumulative impacts would be reduced through implementation of BMPs to control erosion and sedimentation during construction (e.g., installation of silt fences). Cumulative impacts would be reduced further because areas disturbed by construction activities (e.g., temporary access roads) would be restored at the end of project execution.

7.21.7.2 Sediments (bathymetry and sediment budgets)

Implementation of the Recommended Plan would cumulatively contribute to long term benefits to shoreline bathymetry and associated sediment quantities by stabilizing erosion and minimizing the long-term requirements for beach renourishment. Construction of the recommended shoreline protection measures would result in continued protection of beach and dune sands, shoreline wetland habitats, as well as upland soils from wave action and erosion that result from significant storm events. Cumulatively with the multiple regional shoreline restoration plans, the Recommended Plan is intended to have long term benefits by minimizing shoreline erosion.

It is recognized that the construction of groins and rock sills does have the potential to alter bathymetry and enhanced erosion on the down gradient side of the feature. However, these expected impacts are localized, and it is anticipated that project will have a net long-term benefit over a much larger area by stabilizing the shoreline and reducing the need for future beach renourishment projects. In addition, construction of revetments or bulkheads would increase scour at the toe of the structural feature as a result from amplified wave energy. However, these features are generally recommended where similar features are already present and the project has made an effort to incorporate NNBFs wherever possible.

7.21.7.3 Water Quality (surface and ocean)

Implementation of the Recommended Plan would cumulatively contribute to long term benefits by directly addressing anticipated wave climate, and preventing future shoreline erosion. Groins have the potential to alter wave climates, but would have a long-term benefit by reducing future beach renourishment requirements.

The Recommended Plan would cumulatively contribute to minor short-term direct adverse impacts to ocean waters due to disturbance of subsurface sediments during construction of groins, walkovers, bulkheads, seawalls, and dredging of sand from the offshore borrow area. Water quality would quickly return to baseline conditions after construction activities are completed. It is anticipated that these minor short-term direct adverse construction impacts would be further minimized by implementation of BMPs.

Minor direct short-term impacts to surface water quality would occur due to common construction activities such as clearing, grading, trench excavation, backfilling, and the movement of construction equipment used during execution of the common project elements. Water quality

impacts to surface water would primarily be related to increases in turbidity and suspended solids as a result of increased erosion and sedimentation, which would cause a short-term reduction in oxygen levels. These adverse construction impacts would be minimized by implementation of BMPs (e.g., silt curtains, work at low tide out of the water).

7.21.7.4 Vegetation (including invasive species and terrestrial habitat)

The Recommended Plan would contribute positive benefits to regional terrestrial habitats in conjunction with other similar projects listed in Sections 7.21.1 and 7.21.4 above. Projects initiated in the ROI would benefit from the shoreline and inlet CSRM features of the Recommended Plan, which would serve to impede extreme storm surges, such as those experienced during Hurricane Sandy, from destroying or impeding establishment of beach vegetation communities.

A summary of impacts associated with habitat type is included in Section 6.5.1 Habitat Impacts Using Acreage as a Metric. To address impacts to existing native vegetation, as well as federal and state regulated waters and wetlands, a series of NNBFs were developed as part of the HFFRRFs. In terms of vegetated intertidal wetlands, the Recommended Plan will result in a net gain (i.e., approximately 2:1 gain versus impact) based upon an acreage metric. In terms of vegetated Maritime Forest, the Recommend Plan will restore approximately 75 percent of the impacted area.

7.21.7.5 Wetlands (including aquatic habitat)

As described in Section in Section 6.5.1 Habitat Impacts Using Acreage as a Metric, federal and/or state regulated waters and wetlands are assumed to include all freshwater wetlands and intertidal habitats waterward of the MHWS; inclusive of freshwater wetlands, beach and unvegetated shoreline, intertidal wetlands, mudflats, and subtidal bottom. The Recommended Plan would contribute positive benefits to regional aquatic habitats in conjunction with other similar projects listed in Sections 7.21.1 and 7.21.4 above. Projects initiated in the ROI would benefit from the shoreline features and NNBFs of the Recommended Plan. As noted above, a series of NNBFs were developed as part of the HFFRRFs within the Jamaica Bay Planning Reach. In terms of intertidal wetlands, the Recommended Plan will result in a net gain (i.e., approximately 2:1 gain versus impact) based upon an acreage metric.

Construction of buried seawalls and/or groins along the Atlantic Ocean Shorefront Planning Reach, as well as portions of the HFFRRFs, would have short-term minor adverse impacts on beach habitats, aquatic habitat, and potentially associated dune habitats at each nourishment area. These aquatic and terrestrial habitats are likely to be recolonized from nearby communities and benthic aquatic habitats are expected to-establish to a similar community within a 1 to 2-year period (USACE 1995). No permanent impacts associated with habitat structure and/or vegetation are anticipated in this segment, as the seawall will be buried with sand in an effort to restore the existing habitat type. In fact, the project will have a net long-term benefit on these habitats by stabilizing the shoreline, increasing sediment the sediment budget, and minimizing future renourishment activities necessary to support a healthy North Atlantic Upper Ocean Beach community.

7.21.7.6 Fish

NOAA NMFS completed the consultation under Section 7 of the Endangered Species Act (ESA), and concluded that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat on their jurisdiction. The letter dated January 12, 2017 is included as Attachment D2b of the Environmental Compliance Appendix). However, USACE is currently consulting with NOAA NMFS regarding proposed actions that may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. An EFH Assessment Report is included as Attachment D3 of the Environmental Compliance Appendix. While the EFH Assessment Report provides a detailed analysis of direct and indirect impacts to fisheries, a summary is provided herein.

As noted in the EFH Assessment Report, the Recommended Plan would contribute positive benefits to regional fish species. Constructed groins and rock sills would create in water habitat areas suitable for recruitment and protection for numerous fish species. Beneficial impacts to the fish community would include the increase in food source, spawning beds, and shelter in the project area (USACE, 2015). Construction of groins and rock sills would also provide living spaces for the food resource on which fish species rely. In addition to creating living spaces and increasing food availability of the project area, the proposed would potentially provide shelter for fish from wave attacks during large coastal storm events.

The Recommended Plan would contribute to minor short-term direct adverse impacts on adult and juvenile life stages of nearshore fish during construction, as mobile fish would be temporarily displaced from foraging habitat as they retreat from the area in response to construction activities. Construction related increases in turbidity and suspended solids will cause a short-term reduction in oxygen levels and reduce visibility for feeding (Reilley et al. 1978, Courtenay et al., 1980). Impacts are expected to be minor, given the temporary nature of the disturbance and the availability of suitable adjacent habitat. Adult and juvenile life stages and their prey species would quickly reestablish themselves after completion of construction.

Additional minor short-term direct adverse impacts on nearshore fish communities would occur as a result of dredging sand from the borrow areas. According to the NPS environmental documents prepared for borrow efforts indicate the adverse impacts are not significant (GMP/EIS, 2014). Additional minor short-term direct impact on benthic feeding fish species (e.g., windowpane, summer and winter flounder) would be experienced, due to temporary displacement during dredging for borrow areas. Impacts are considered minor because benthic feeding fish species are expected to avoid construction areas and feed in the surrounding area; therefore, would not be adversely affected by the temporary localized reduction in available benthic food sources. Because adverse effects to essential fish habitat would be minor, the essential fish habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations would be satisfied.

Minor short-term direct adverse impacts on nearshore fish communities would be realized by less mobile life stages (eggs and larvae) of nearshore fish, e.g., Atlantic butterfish, red hake, windowpane flounder, winter flounder, summer flounder, and scup, if present at the time of construction activities. Impacts would occur because of short-term changes to water quality, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates, as discussed in Section 7.2 Bathymetry and Sediments. Impacts are considered minor, given the large extent of the Atlantic Ocean compared to the project construction

footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on eggs and larvae of nearshore fish species.

7.21.7.7 Benthic Community

The Recommended Plan would contribute positive benefits to regional benthic shellfish species. Constructed groins would create areas suitable for recruitment and protection for numerous shellfish species. Construction and extension of groins would provide living spaces for the floral and faunal communities on which benthic species rely and would provide shelter from wave attacks for the existing and surrounding benthic communities. Some species, such as rockweeds (*Fucus spp*.), and barnacles (*Balanus spp*.) would flourish on the newly constructed groins (Carter 1989). Various floral species such as rockweed and spongomorpha (*Spongomorpha spp*.), and faunal species such as barnacle, and blue mussel are expected to move into the area and colonize living space on groins (USACE 1995). Rockweeds are known to support numerous organisms, including both autotrophs and heterotrophs. In addition, rockweeds provide shelter, moisture at low tide, and food especially for the sessile epifaunal and epiphytic groups (Oswald et al. 1984). Gastropods, bivalves, and crustaceans are all common inhabitants of rockweeds.

Minor short-term direct adverse impacts to benthic communities are anticipated from construction activities associated with future periodic renourishment. Construction would cause increased sedimentation, resulting in the smothering of existing sessile benthic communities in the vicinity of construction areas. Some mortality of shellfish, and polychaetes is expected for individuals that cannot escape during the construction process. Motile shellfish species would be able to relocate temporarily outside of the immediate project area.

7.21.7.8 Wildlife

The Recommended Plan would cumulatively contribute to the beneficial long-term direct and indirect impacts on protected species populations, as discussed in Section 7.9 through 7.12. Beach renourishment of Rockaway beaches associated with the Recommended Plan would support healthy North Atlantic Upper Ocean Beach communities; therefore, species that rely on these habitat types would benefit from the Recommended Plan and similar regional projects. In addition, the project is intended to have a long-term benefit by reducing maintenance activities (i.e., additional beach renourishment).

Within both planning reaches, the Recommended Plan and similar regional actions may cause minor adverse impacts associated with short-term construction activities that may cause direct mortality of individuals or contribute indirectly to mortality of individuals due to temporary destruction of habitat on which a species relies.

It is recognized that USFWS prepared a Planning Aid Letter (PAL) dated August 18, 2016 to assure equal consideration and coordination of fish and wildlife resources. The PAL recognized the potential for direct and indirect adverse impacts to fish and wildlife resources within the project area. However, USACE will continue to work with USFWS to incorporate recommended actions to avoid, minimize, and mitigate project impacts. Many of the recommendations are already included herein, and include but potentially are not limited to:

- Observation of protective time-of-year restrictions.

- Incorporation of NNBFs where possible to reduce shoreline hardening, and promote restoration of native habitats (i.e., both wetlands and uplands).
- Incorporation of construction BMPs to minimize sedimentation and turbidity

7.21.7.9 Protected Species and Critical Habitat

A Biological Assessment has been prepared specific to three species (i.e., piping plover, seabeach amaranth, and Rufa red knot) to support continuation of a formal consultation process with USFWS (Attachment D2 of the Environmental Compliance Appendix). The Biological Assessment, which includes a Cumulative Impact assessment, concludes that implementing the proposed action in accordance with the standards and guidelines (including mitigation measures that include protective and conservative best management practices) recommended by USFWS and NYSDEC, will not jeopardize the continued existence or contribute to the loss of viability of either piping plover or seabeach amaranth populations that occur or utilize the project area, and the proposed action would not significantly contribute to cumulative impacts associated with piping plover and seabeach amaranth. As such, the USACE concludes that the overall project results in a May Affect is Likely to Adversely Affect (LAA) determination for piping plover and seabeach amaranth, and a May Affect, but Not Likely to Adversely Affect (NLAA) determination for red knot.

NOAA NMFS completed the consultation under Section 7 of the Endangered Species Act (ESA), and concluded that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat on their jurisdiction. The letter dated January 12, 2017 is included as Attached D2 of the Environmental Compliance Appendix). However, USACE is currently consulting with NOAA NMFS regarding proposed actions that may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. An EFH Assessment Report is included as Attachment D3 of the Environmental Compliance Appendix.

Potential short-term impacts to piping plover and other nesting shorebirds, as well as seabeach amaranth, could result from proposed permanent hard structures such as buried seawalls and groins, as they would eliminate any suitable foraging or nesting areas directly within the footprint of these structures. However, the area of overall impact from these structures is expected to be minimal (< 1.0 ac within the Atlantic Shoreline Planning Reach), and most of the habitat that will be impacted is not of high habitat value to nesting and/or foraging birds. Specifically, these beaches are heavily utilized by humans (i.e., 5 million visitors in 2017) and most of the groins will be constructed in subtidal habitats (i.e., less favorable foraging habitat compared to intertidal areas). In addition, predator populations are not anticipated to increase due to human use of the project area. Overall impacts directly within the footprint of these structures would be permanent, but are not expected to significantly affect nesting shorebird, or other migratory birds, breeding or foraging activities for the long term. These impacts are assumed to be offset from the long-term benefits that will result from the project as beach fill and dune restoration is likely to increase overall habitat value for these species along the affected beachfront by expanding the area of suitable breeding, nesting and foraging habitat.

In summary, the Recommended Plan would cumulatively contribute to minor short-term direct impacts to threatened and endangered species. Construction of seawalls associated with the Atlantic Ocean Shorefront Planning Reach would protect shoreline vegetation from physical

degradation, likewise preserving habitat for these species. Overall supporting habitats for nesting and breeding of identified shorebirds of concern, as well as seabeach amaranth, would increase as the beach is widened with beach fill and groin structures would reduce the rate of beach loss; as well as reduce long-term maintenance activities. The physical characteristics of the intertidal habitat will not be altered because the grain size of fill material will be the same as that of project footprint native sand.

Shoreline intertidal, subtidal, upper beach and dune, and intertidal wetland habitats would be impacted due to such construction activities as clearing and grading for temporary access road construction, or construction of proposed CSRM measures. However as described in Section in Section 6.5.1 Habitat Impacts Using Acreage as a Metric, the Recommended Plan would contribute positive benefits to terrestrial and aquatic habitats that support federal and state protected species. In addition, USACE will continue to consult with USFWS and NMFS to ensure the latest reasonable and prudent measures for protected species and standard BMPs are incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected species under their jurisdiction. Many of the recommendations are already included herein, and include but potentially are not limited to:

- Observation of protective time-of-year restrictions;
- Incorporation of NNBFs where possible to reduce shoreline hardening, and promote restoration of native habitats (i.e., both wetlands and uplands); and
- Incorporation of construction BMPs to minimize sedimentation and turbidity.

7.22 Summary of Environmental Effects

7.22.1 Unavoidable Adverse Environmental Impacts

Implementation of the Recommended Plan would have direct adverse impacts on native habitats that include beach and unvegetated shoreline, freshwater wetland, intertidal wetland, mudflats, subtidal bottom, and maritime forest. Specifically, as detailed in Section 6.6 Habitat Impacts and Mitigation Requirements, the project will result in 14.1 acres of temporary impacts and 5.5 acres of permanent impacts to these habitats (See Section 6.5, Table 6-14 above). Specific to federal and state regulated waters and wetlands, the project will temporarily impact 14.1 acres and permanently impact 3.7 acres (Table 6-13 above).

Temporary impacts assume that habitat will be replaced on-site and in-kind. The majority of temporary impacts to federal and state regulated waters and wetlands will occur in open water habitats (i.e., subtidal bottom, mudflat), or beach and unvegetated shorelines where subsequent planting will not be required and the time to full restoration of ecological services will be relatively quick compared to habitats that require development of native plant community.

To account for permanent impacts, NNBFs associated with the HFFRRFs will result in the restoration and/or creation of 7.6 acres of intertidal wetlands, enhancement to 0.5 acres of intertidal wetlands, and restoration of 1.3 acres of maritime forest (See Section 6.5, Table 6-15 above). Overall, the Recommended Plan that includes NNBFs will attenuate waves, stabilize shorelines, and facilitate the restoration or enhancement of native shoreline habitats. As such, the long-term benefit realized by this plan will likely exceed the NNBF acreage noted above. For example, shore slopes behind the rock sill structures will be regraded to reduce risk of erosion further and create

suitable elevation gradients and substrates for future establishment of tidal marsh plants. As such, the total restoration of intertidal marsh habitats will likely exceed the proposed planting area of 7.6 acres. The graded habitat behind the structure will also be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems. Finally, the rock sills will provide opportunities for shellfish habitat creation and will provide habitat complexity to near shore open water habitats that will support a diversity of both aquatic and terrestrial wildlife (discussed below), as well as improve near shore water quality.

As discussed in Section 6.5 above, EPW also was used to characterize the functional impacts and benefits within intertidal wetlands associated with each HFFRRF. The assessment results estimate current resource value loss, and the potential increase in resource value through implementation of NNBFs. A summary of the analysis and the numerical results of the EPW functional assessment is provided in Section 6, Tables 6-12 and 6-13 above. The project will result in the loss of 8.6 FCUs across the five functions. However, the NNBFs will result in the gain of 34.5 FCUs across the five functions. Similar to the metric evaluation, the EPW functional assessment shows significant gains to the shoreline ecosystem through the incorporation of NNBFs.

No other long-term environmental impacts are expected to occur as a result of Recommended Plan implementation.

7.22.2 Irreversible and Irretrievable Commitments of Resources

The labor, capital, and material resources expended in the planning and construction of this project are irreversible and irretrievable commitments of human, economic, and natural resources. Careful attention was paid to selecting and placing CSRM structures to minimize environmental impacts, nonetheless implementation of the Recommended Plan would cause permanent habitat impacts (see discussion above). No other long-term environmental impacts are expected to occur as a result of Recommended Plan implementation.

7.23 Short-Term Use and Long-Term Productivity of the Environment

Implementation of the Recommended Plan would result in the loss of habitat types as indicated in Section 6, and as restated above.

7.24 Energy and Natural or Depletable Resource Requirements and Conservation Potential of Various Alternatives and Mitigation Measures

NEPA regulations in 40 CFR 1502.16 (e) and (f) require a discussion of project energy requirements and natural or depletable resource requirements, along with conservation potential of alternatives and mitigation measures in an EIS. Energy (fuel) will be required to construct the new levee system and reconstruct existing systems, but this is a short-term impact. Construction of the Recommended Plan would not result in a significant depletion of depletable energy or natural resources.

8 COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS

This HSGRR/EIS has been prepared to satisfy the requirements of all applicable environmental laws and regulations and has been prepared using the Council on Environmental Quality (CEQ) NEPA regulations (40 CFR Part 1500–1508) and the USACE's regulation ER 200-2-2-Environmental Quality: Policy and Procedures for Implementing NEPA, 33 CFR 230. In implementing the Recommended Plan, USACE would follow provisions of all applicable laws, regulations, and policies related to the Recommended Plan, including agreement from the NPS on plans affecting GNRA. The following sections present brief summaries of federal environmental laws, regulations, and coordination requirements applicable to this HSGRR/EIS.

Clean Air Act as amended, 42 U.S.C. §§ 7401-7671q.

In compliance

Temporary air emission impacts resulting from construction of the Recommended Plan have been calculated; the analysis is presented in Attachment D7 of the Environmental Compliance Appendix. The USACE is committed to fully offsetting the emissions generated as a result of the disaster relief and coastal protection work associated with this project. USACE has demonstrated conformity with the New York State Implementation Plan by utilizing the emission offset options listed below. The demonstration can consist of any combination of options, and is not required to include all or any single options to meet conformity. The options for meeting general conformity requirements include the following:

a. Emission reductions from project and/or non-project related sources in an appropriately close vicinity to the project location. In assessing the potential impact of this offset option, USACE recognizes the possibility of lengthening the time period in which offsets can be generated as appropriate and allowable under the general conformity rule (40CFR§93.163 and §93.165).

b. Use of Surplus NOx Emission Offsets (SNEOs) generated under the Harbor Deepening Project (HDP). As part of the mitigation of the HDP, USACE and the Port Authority of New York & New Jersey developed emission reduction programs coordinated through the Regional Air Team (RAT). The RAT is comprised of the USACE, NYSDEC, New Jersey Department of Environmental Protection, United States Environmental Protection Agency (EPA) Region 2, and other stakeholders. SNEOs will be applied in concurrence with the agreed upon SNEO Protocols to ensure the offsets are real, surplus, and not double counted.

c. Development of a Marine Vessel Engine Repower Program (MVERP) which replaces older, more polluting marine engines with cleaner engines, the delta in emissions being used to offset project emissions. The MVERP approach worked successfully for offsetting the HDP's construction emissions. The details of the MVERP, its implementation, and tracking would be coordinated with the RAT.

d. Use of Cross-State Air Pollution Rule (CSAPR) ozone season NO_x Allowances with a distance ratio applied to allowances, similar to the one used by stationary sources.

e. Rescheduling the project by elongating the construction schedule so as not to exceed the 100 tons per year threshold for NOx in any one calendar year.

Clean Water Act, as amended, (Federal Water Pollution Control Act) 33 U.S.C. §§ 1251-1388.

In compliance

Clean Water Act Section 404 of the CWA regulates dredge-and/or-fill activities in waters of the U.S. In New York, Section 401 of the CWA (State Water Quality Certification Program) is regulated by the NYSDEC. Compliance will be achieved through coordination of this HSGRR/EIS with NYSDEC to obtain water quality certification for the Recommended Plan. Coordination includes an evaluation of the Recommended Plan based on the Section 404(b)(1) Guidelines as presented in Attachment D4 of the Environmental Compliance Appendix.

Submittal of this HSGRR/EIS to NYSDEC initiates USACE's requested Section 401 State Water Quality Certification for the Recommended Plan. USACE has determined that construction and operation of the Recommended Plan will not violate water quality standards. The proposed alignment of the Rockaway Atlantic Ocean CSRM, and borrow area has been located to minimize, to the greatest extent practicable, impacts on the Rockaway shoreline and to avoid and minimize impacts on the aquatic ecosystem in the Atlantic Ocean. The Recommended Plan is the least environmentally damaging practicable alternative; overall, the Recommended Plan provides protection from coastal storms that would otherwise damage the environment to a far greater degree than the No Action Alternative.

Endangered Species Act, as amended. 16 U.S.C. §§ 1531-1544.

In Compliance

USACE prepared a Biological Assessment (BA) (included as Attachment D2a in the Environmental Compliance Appendix) to describe the potential effects of Recommended Plan implementation on the piping plover, seabeach amaranth, and rufa red knot. It is the USACE's determination that implementing the proposed action, in accordance with the standards and guidelines (including mitigation measures that include protective and conservative best management practices) recommended by USFWS and NYSDEC, will not jeopardize the continued existence or contribute to the loss of viability of either piping plover, seabeach amaranth, nor red knot populations that occur or utilize the project area, and the proposed action would not significantly contribute to cumulative impacts associated with piping plover, red knot, and seabeach amaranth. The USACE concludes that the overall project results in a may affect is likely to adversely affect (LAA) determination for piping plover, red knot, and seabeach amaranth.

USFWS issued their Biological Opinion (BO) on April 4, 2019 and a Revised BO on June 25, 2019 based on District comments. The Revised BO is included as Attachment D2c within the Environmental Compliance Appendix. The BO includes an Incidental Take Statement (ITS), based upon the analyses provided in this Biological Assessment, according to and in compliance with our joint Section 7 obligations. The RPMs provided in the Revised BO are discussed in Section 7.12.2.1. The USACE responses to the April 4, 2019 and June 25, 2019 BOs are included within the Pertinent Correspondence Appendix I (pages 56 to 66 and page 85).

In regards, to potentially affected species under the jurisdiction of NMFS and also to be proactive within the NY/NJ Harbor Estuary, USACE has agreed to include East Rockaway in its ongoing 'batch' BA (for multiple coastal projects) to ensure that consultation is sufficiently covered under Section 7 for all possible outcomes. The trigger to reinitiate consultation might not occur (no

predetermination will be made), but, if it does, USACE will be in compliance under the ongoing Consultation, which will result in the BO containing the ITS for all affected projects.

Given the best possible and latest information with no predetermination, East Rockaway is in total compliance with Section 7 per USACE's documented NLAA/Concurrence for this project from NMFS.

The NMFS Assistant Regional Administrator for Protected Resources' letter dated 12 January 2017 to the USACE New York District Environmental Analysis Branch Chief states "*Based on our knowledge, expertise, and the action agency's materials, we concur with the action agency's conclusion that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat under our jurisdiction. Therefore, no further consultation pursuant to Section 7 of the ESA is required.*" This letter is included as Attachment D2b of the Environmental Compliance Appendix.

Magnuson-Stevens Fishery Conservation and Management Act of 1976

In compliance

The Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265), as amended, establishes procedures for identifying Essential Fish Habitat (EFH) and required interagency coordination to further the conservation of federally-managed fisheries. Its implementing regulations specify that any federal agency that authorizes, funds, or undertakes, or proposes to authorize, fund, or undertake, an activity that could adversely affect EFH is subject to the consultation provisions of the Act and identifies consultation requirements. EFH consists of those habitats necessary for spawning, breeding, feeding, or growth to maturity of species managed by Regional Fishery Management Councils in a series of Fishery Management Plans.

Submittal of the Revised Draft HSGRR/EIS to National Marine Fisheries Service (NMFS) initiated EFH consultation between USACE and NMFS for the Recommended Plan. An assessment of impacts on EFH was included in the Revised Draft HSGRR/EIS. NMFS provided input on the EFH Assessment which has been incorporated into the final EFH Assessment (Attachment 3 of Appendix D—Environmental Compliance). Direct and indirect impacts associated with the Atlantic Shoreline Planning Reach would result from dredging offshore in the borrow site; construction of groins, seawalls, and beach fill placement in the intertidal zone and nearshore. Due to the mobility of larger fish, direct impacts from dredging and near shore construction activities (i.e., sand placement, and groin construction) would be limited to eggs, larvae, small fish, and benthic invertebrates or shellfish which would be removed, buried, or displaced. Specifically, dredging activities could have direct impacts to eggs, larvae, and potential juvenile EFH due to impingement or entrainment. They would also have an indirect impact through the loss of benthic invertebrate prey species within the footprint of the proposed project. Small motile and sedentary epifaunal species (*e.g.*, small crabs, snails, tube- dwelling amphipods), and all infaunal species (*e.g.*, polychaetes), would be most vulnerable to suction dredging and/or burial. However, they are expected to recolonize quickly following construction.

Direct and indirect impacts associated with the Jamaica Bay Planning Reach would result from construction of bulkheads, revetments, and rock sills in the intertidal zone and nearshore. Similarly, the placement of material would have an immediate direct effect on eggs, larvae, small fish, and benthic invertebrates or shellfish that would be buried or displaced. In addition, there would be indirect impacts through the loss of benthic invertebrate species within the footprint of

the project. However, impacted areas are expected to be recolonized quickly following construction. Therefore, implementation of the Recommended Plan may adversely affect EFH, but likely would result in minimal adverse effects as the resulting changes to EFH and its ecological functions would be relatively small and insignificant. In addition, it is anticipated that ecosystem restoration efforts as part of this Recommended Plan would result in long-term, net benefits to managed species (all life stages), associated species, and EFH.

In summary, USACE has concluded that the federal project will not cause significant adverse effects to EFH or EFH species. USACE and NMFS have coordinated EFH conservation recommendations (Attachment 3—EFH Assessment—of Appendix D and Appendix I—Pertinent Correspondence) and NMFS concurred with the EFH assessment on December 4, 2018. Additional coordination on the EFH conservation recommendations will be undertaken during the PED phase.

Coastal Zone Management Act

In compliance

Under the New York State Coastal Management Program (NYCMP), enacted under the Coastal Zone Management Act in 1972, the NY Department of State (NYDOS) reviews federal activities to determine whether they are consistent with the policies of the NYCMP. The waterward boundary extends 3 miles into open ocean, to shared state lines in Long Island Sound and the New York Bight and to the International boundary in the Great Lakes, Niagara and St. Lawrence Rivers. Generally, the inland boundary is approximately 1,000 feet from the shoreline following well-defined features such as roads, railroads or shorelines. In urbanized and other developed locations along the coast, the landward boundary is approximately 500 feet from the shoreline or less than 500 feet at locations where a major roadway or railway line runs parallel to the shoreline. The seaward boundary of New York State's coastal area includes all coastal waters within its territorial jurisdiction.

USACE has prepared a Consistency Determination that evaluates the Recommended Plan for consistency with the NYCMP; it is provided as Attachment D5 of the Environmental Compliance Appendix. USACE has concluded that the Recommended Plan is consistent to the maximum extent practicable with the enforceable policies of the NYSDOS program. NYSDOS, in coordination with NYC Planning, concurred with the Federal Consistency Determination on December 6, 2018 (Appendix I—Pertinent Correspondence).

Fish and Wildlife Coordination Act, as amended, 16 U.S.C. §§ 661-665, 665a, 666, 666a-666c.

In compliance

The Fish and Wildlife Coordination Act requires governmental agencies, including the USACE, to coordinate activities so that adverse effects on fish and wildlife would be minimized when water bodies are proposed for modification.

The HSGRR/EIS contains information regarding impacts associated with implementing the Recommended Plan. The USFWS updated the Coordination Act Report (CAR), which is included as Attachment D1 of the Environmental Compliance Appendix.

Marine Mammal Protection Act of 1972

In compliance

The Marine Mammal Protection Act was passed in 1972 and amended through 1997. It is intended to conserve and protect marine mammals and establish the Marine Mammal Commission, the International Dolphin Conservation Program, and a Marine Mammal Health and Stranding Response Program.

NOAA NMFS completed the consultation under Section 7 of the Endangered Species Act (ESA), and concluded that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat on their jurisdiction. The letter dated January 12, 2017 is included as Attachment D2b of the Environmental Compliance Appendix).

National Historic Preservation Act, as amended, 54 U.S.C. §§ 300101-307108

Compliance in progress

Compliance with the National Historic Preservation Act of 1966, as amended, requires the consideration of effects of the undertaking on all historic properties in the project area and development of mitigation measures for those adversely affected properties in coordination with the NY SHPO and the Advisory Council on Historic Preservation.

USACE has initiated Section 106 consultation with the NY SHPO and selected Native American Tribes. Copies of Section 106 consultation letters are provided in the Environmental Compliance Appendix D6 and the Pertinent Correspondence Appendix I. Additionally, USACE anticipates executing a Programmatic Agreement among USACE, the NY SHPO, and non-federal implementation sponsors to address the identification and discovery of cultural resources that may occur during the construction and maintenance of proposed or existing facilities. USACE will also invite the NPS, and the ACHP to participate as signatories to the anticipated Programmatic Agreement.

Federal Water Project Recreation Act

In compliance

This 1995 Act requires consideration of opportunities for outdoor recreation and fish and wildlife enhancement in planning water-resource projects. The Recommended Plan is expected to have substantial and positive long- term effects on outdoor recreation opportunities in the Project Area.

Farmland Protection Policy Act of 1981 and the CEQ Memorandum Prime and Unique Farmlands

Not applicable

In 1980, the CEQ issued an Environmental Statement Memorandum "Prime and Unique Agricultural Lands" as a supplement to the NEPA procedures. Additionally, the Farmland Protection Policy Act, passed in 1981, requires federal agencies to evaluate the impacts of federally funded projects that may convert farmlands to nonagricultural uses and to consider alternative actions that would reduce adverse effects of the conversion. The Recommended Plan will not impact prime or unique farmlands identified by the Natural Resource Conservation Service or NYSDEC.

Executive Order 11988, Floodplain Management

In compliance

Executive Order 11988 directs federal agencies to evaluate the potential effects of proposed actions on floodplains. Such actions should not be undertaken that directly or indirectly induce growth in the floodplain unless there is no practicable alternative. The Water Resources Council Floodplain Management Guidelines for implementation of Executive Order 11988, as referenced in USACE ER 1165-2-26, requires an eight-step process that agencies should carry out as part of their decision making on projects that have potential impacts on or within the floodplain. The eight step assessment, presented in the Section 9.1 below, concludes that all practicable alternatives have been considered in developing the Recommended Plan, and that the main federal objective of reducing coastal flood risk cannot be achieved by alternatives outside the floodplain. Additionally, USACE has determined that the Recommended Plan does not induce direct or indirect floodplain development within the base floodplain.

Executive Order 11990, Protection of Wetlands

In compliance

Executive Order 11990 directs federal agencies to avoid undertaking or assisting in new construction located in wetlands, unless no practicable alternative is available. While the project will result in unavoidable permanent impacts to 3.74 acres of federal and state regulated waters and wetlands, the project includes 7.65 acres of wetland restoration or creation, and 0.472 acres of wetland enhancement. All practicable measures have been taken to minimize the loss of wetlands. Alternatives to avoid the loss of wetlands were evaluated, and the CSRM elements were carefully located to minimize the loss.

Coastal Barrier Improvement Act of 1990

In compliance

This act is intended to protect fish and wildlife resources and habitat, prevent loss of human life, and preclude the expenditure of federal funds that may induce development on coastal barrier islands and adjacent nearshore areas. The Coastal Barrier Improvement Act of 1990 expanded the CBRS and created a new category of lands known as otherwise protected areas (OPAs). The only federal funding prohibition within OPAs is federal flood insurance. Other restrictions to federal funding that apply to CBRS units do not apply to OPA's. The western portion of Rockaway Peninsula and all of Jamaica Bay are located within the designated CBRA OPA (Unit NY-60P) and has determined that the National Park Service has local jurisdiction of the CBRA Unit. Accordingly, no further coordination under the CBIA or CBRA is necessary.

Executive Order 12898, Environmental Justice

In compliance

This EO directs federal agencies to determine whether the Preferred Alternative would have a disproportionate adverse impact on minority or low-income population groups within the project area. Based on a demographic analysis of the study area (presented in Section 7.19 Socioeconomics and Environmental Justice), implementation of the Recommended Plan would not have a disproportionately high and adverse impact on any low-income or minority population.

Rather, USACE has determined that implementation of the Recommended Plan will provide long-term benefits to PEJA communities by protecting infrastructure resources (e.g. housing, transportation, commercial, retail, and recreational facilities) from damage caused by coastal storms.

Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds and the Migratory Bird Treaty Act

In compliance

The Migratory Birds and the Migratory Bird Treaty Act (MBTA) of 1918 (as amended) is the domestic law that affirms, or implements, the United States' commitment to four international conventions with Canada, Japan, Mexico and Russia for the protection of shared migratory bird resources. The MBTA governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent over utilization. Executive Order 13186 (2001) directs executive agencies to take certain actions to implement the act. USACE has consulted with the USFWS with regard to this activity's potential effects on migratory birds as part of the Fish and Wildlife Coordination Act coordination. USACE has incorporated recommendations from consultation into this HSGRR/EIS.

Executive Order 13045, Protection of Children from Environmental and Safety Risks

In compliance

Executive Order 13045 states that every federal agency, to the extent permitted by law and appropriate, should make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children, and to ensure that its policies, programs, activities, and standards address these risks. Analysis and disclosure of these potential effects under NEPA is necessary because some physiological and behavioral traits of children render them more susceptible and vulnerable than adults to environmental health and safety risks. Children may have higher exposure levels to contaminants (through pathways such as degraded water quality or contaminants exposed during construction) because they generally eat more food, drink more water, and have higher inhalation rates relative to their body size. Also, children's normal activities, such as putting their hands in their mouths or playing on the ground, can result in higher exposures to contaminants as compared with adults. In addition, a child's neurological, immunological, digestive, and other bodily systems are also potentially more susceptible to exposure-related health effects. It has been well established that lower levels of exposure can have negative toxicological effects in children as compared to adults, and childhood exposure to contaminants can have long-term negative health effects.

Following the direction of this Executive Order, USACE conducted an analysis of the proximity of locations associated with children to the project area. For the purpose of this analysis the project area includes both permanent and temporary easements proposed for the Rockaway project in this HSGRR/EIS. The project area is shown as orange polygons in Figure 8-1. Next, data representing public elementary schools, private elementary schools, day care facilites, and playgrounds were obtained. The data on public and private schools was obtained from ESRI as the U.S. MapData Schools layer, which was published in 2004. The day care facilites data was compiled by the U.S.

Department of Homeland Security (DHS) and includes all state-licensed childcare centers that care for 10 or more children during the workday. This data was last updated by the DHS in 2008. The playgrounds data came from the New York City Department of Information Technology and Telecommunications as the Brooklyn and Queens NYC Parks layer, which was published in 2016. The playgrounds data was part of a larger NYC parks dataset that contained several different types of parks, including playgrounds, community parks, nature areas, green streets, etc. Playgrounds were broken out of the rest of the data as a location associated with children.

Figure 8-1: Locations Associated with Children within 200 feet of the Project Area

Displaying these data on a map, it was clear that there were many locations associated with children on the Rockaway Penninsula. Not all of these locations would be affected by the construction associated with the proposed Rockaway project though. Analysis was done to identify locations 200 feet or less from the project area where children frequent and which could potentially therefore be a hazardous area for children during construction of the Recommended Plan. Two hundred feet was choosen as a precautionary distance, following the "New York City 200 Foot Rule". The '200 foot rule' is a New York City zoning rule that prohibits the sale of alcohol (a dangerous substance) within 200 feet of a school or church. The reasoning with our application of the 200 foot rule here is that construction is also a dangerous thing for children to be close to, and that there needs to be a buffer between children and construction. For the purpose of our analysis here, any locations associated with children that are within 200 feet of our project area will need to receive special treatment to keep kids safe during the construction period.

The locations associated with children within 200 feet of the project area were found by running a "select by location" application in ArcMap. This search found that there were four playgrounds within 200 feet of the project area (Figure 8-1). In other words, there were no schools (either public or private) or day care facilities within 200 feet of the project area. These four parks include: the Conch Playground, the Beach 9 Playground, the Beach 17 Playground, and the Beach 59th St. Playground.

Knowing that these locations are present, USACE will take special precautions in these areas during construction. During construction staging areas will be placed as far away from the playgrounds as possible, construction traffic will be directed as far away as possible, and safety signage and notices of when work will occur will be posted. Appropriate barriers will be constructed and signage installed to prevent accidental incursion of children into dangerous work sites. Assuming the project as proposed meets the required federal, state and local permitting requirements outlined in the EIS, required mitigation measures should minimize the amount of criteria pollutants emitted to the environment, thereby reducing the potential for sensitive populations, such as children, to be exposed to unhealthy levels of environmental contaminants.

9 EXECUTIVE ORDER 11988 AND PUBLIC LAW 113-2 CONSIDERATIONS

This study has considered the requirements of Executive Order 11988, Flood Plain Management and PL 113-2, the Disaster Relief Appropriations Act of 2013. Specifically, this section of the report addresses:

- The Water Resources Council Floodplain Management implementing guidelines for EO 11988;
- The specific requirements necessary to demonstrate that the project is economically justified, technically feasible, and environmentally acceptable, per PL 113-2; and
- The specific requirements necessary to demonstrate resiliency, sustainability, and consistency with the North Atlantic Coast Comprehensive Study (NACCS), per PL 113-2.

9.1 Executive Order 11988

Executive Order 11988 requires federal agencies avoid, to the extent possible, the long and short term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of Executive Order 11988, as referenced in USACE ER 1165-2-26, requires an eight step process that agencies should carry out as part of their decision making on projects that have potential impacts to, or are within the floodplain. The eight steps and project-specific responses to them are summarized below.

1. Determine if a proposed action (Recommended Plan) is in the base floodplain (that area which has a one percent of greater chance of flooding in any given year). The proposed action is within the base floodplain. However, the project is designed to reduce damages to existing infrastructure located landward of the proposed project.
2. If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain. Section 5 of this document presents an analysis of potential alternatives. Practicable measures and alternatives were formulated and evaluated against USACE guidance, including nonstructural measures such as retreat, demolition and land acquisition.
3. If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments. There has been extensive coordination with pertinent federal, state and local agencies. Multiple public meetings were held in the study area during the public review periods for the 2016 Draft and 2018 Revised Draft HSGRR/EISs.
4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified. The anticipated impacts associated with the proposed action are summarized

in Section 7 of this report. The project would not alter or impact the natural or beneficial flood plain values.

5. If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists. The project provides benefits solely for existing and previously approved development, and is not likely to induce development. Real estate requirements required for construction of the project will reduce the level of development that is at risk.
6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the No Action Alternative. There is no mitigation to be expected for the proposed action. The project would not induce development in the flood plain and the project will not impact the natural or beneficial flood plain values. Section 5 of this report summarizes the alternative identification, screening and selection process. The No Action Alternative was evaluated as part of the plan formulation phase.
7. If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings. The Revised Draft HSGRR/EIS was provided for public review and public meetings were held during the public review period. Each comment received was addressed and, if appropriate, incorporated into the HSGRR/EIS. A record of all comments received also is included in the Public Engagement Appendix. The Pertinent Correspondence Appendix includes correspondence with environmental resource agencies, the National Parks Service, and the non-federal sponsors.
8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order. The Recommended Plan is the most responsive to all of the study objectives and the most consistent with the executive order.

9.2 Resiliency, Sustainability, and Consistency with the NACCS

This section has been prepared to address how the Recommended Plan contributes to the resiliency of the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area; how it affects the sustainability of environmental conditions in the affected area; and how it will be consistent with the findings and recommendations of the North Atlantic Coast Comprehensive Study (NACCS).

Resiliency is defined in the February 2013 USACE-NOAA Infrastructures Systems Rebuilding Principles white paper as the ability to adapt to changing conditions and withstand, and rapidly recover from disruption due to emergencies. Sustainability is defined as the ability to continue (in existence or a certain state, or in force or intensity), without interruption or diminution.

9.2.1 Resiliency

One of the planning objectives of this General Reevaluation is to "restore coastal processes and nature based measures to the maximum extent possible to provide resiliency and reduce storm damages". The Recommended Plan features have all been designed with enhancing the resiliency of the coastal system, particularly with regard to future Sea Level change.

CSRM projects are engineered beaches that are designed, constructed, and periodically renourished to reduce the risk of economic losses arising from coastal storms, primarily along communities with high-value public and private infrastructure immediately landward of the beach. The intent is to replicate the function of beaches in areas that were once part of natural, undeveloped systems that have subsequently experienced significant human development and utilization. Storms reduce the degree of storm risk management provided by the beach fill project; elevated water levels and larger-than-normal waves displace sand from the berm and dune portions of the engineered beach profile and transport it principally in the offshore direction. After the storm, normal tide and wave conditions return, typically resulting in onshore-directed sand transport that rebuilds at least a portion of the berm (i.e., beach). This natural recovery of the beach berm occurs over a period that may range from days to months. Natural rebuilding of the dune is a process that requires years to decades, given its dependence on wind transport and an adequate sand supply on the beach. In the period between the storm and the partial natural recovery, an increased level of storm damage risk exists due to the eroded condition of the project berm and dune relative to the level of risk associated with a constructed, fully maintained project. Consequently, repair of an engineered beach to its design dimensions is usually accomplished as a planned renourishment, which is included in the authorized period of analysis cycle, or as an emergency activity under the USACE Flood Control and Coastal Emergencies authority (PL 84-99), to restore the storm damage risk reduction function for which the project was authorized. This post-storm repair is necessary because the engineered beach may not otherwise fully recover to its authorized dimensions naturally, or at least not in a time frame that would minimize risks due to the deteriorated condition. In this regard, it is apparent that storm risk management projects involving beach replenishment possess intrinsic "resilience", in light of the large volume of sediment that remains within the system after a major disturbance and the associated repair or replenishment that is included to restore the project design dimensions.

9.2.2 Sustainability/Adaptability

As described in this HSGRR/EIS, the Recommended Plan meets the economic, environmental, and community sustainability goals for the fifty year length of the project. Economic principals are used in benefit calculations, plan formulation ranking, and project justification by their contributions to the National Economic Development account. Environmental concerns are evaluated in this document and through coordination and review by the resource agencies including the US Environmental Protection Agency, the US Department of Interior, and the New York State Department of Environmental Conservation as part of the feasibility study process. Social accounts are intrinsic in beach nourishment projects since they maintain habitat for beach patrons. The nexus of these three pillars indicates that a project is sustainable.

9.2.3 Consistency with the North Atlantic Coast Comprehensive Study

The North Atlantic Coast Comprehensive Study (NACCS, 2015) was released in January 2015 and provides a risk management framework designed to help local communities better understand changing flood risks associated with climate change and to provide tools to help those communities better prepare for future flood risks. In particular, it encourages planning for resilient coastal communities that incorporates wherever possible sustainable coastal landscape systems that takes into account, future sea level and climate change scenarios. The process used to identify the Recommended Plan utilized the NACCS Risk Management framework that included evaluating alternative solutions and also considering future sea level change and climate change. The

Recommended Plan echoes many of the principles of the NACCS, in that it considers the entire area as a system, the formulation considered multiple plan components to address the multiple risks, the plan considered non-structural components, would reestablish coastal processes, and has been developed in recognition of balancing the needs for coastal storm risk management with the requirements of the partner agencies.

10 IMPLEMENTATION REQUIREMENTS

This section provides a summary of the preliminary implementation requirements for Recommended Plan.

10.1 Division of Plan Responsibilities and Cost-Sharing Requirements

The Project Partnership Agreement (PPA) is a good faith agreement between the federal government and the non-federal sponsor, which must be approved and executed prior to the start of construction. The PPA sets forth the obligations of each party. The non-federal sponsors must agree to meet the requirements for non-federal responsibilities, which will be identified in future legal documents. Construction of this project is authorized and funded at 100% federal expense, subject to the available funds in P.L. 113-2, except for the renourishment which will need authorization by Congress. A Chief's Report is required to seek authorization for the renourishment included in the Recommended Plan. 'Items of local cooperation' in standard Coastal Storm Risk Management PPAs are listed below to indicate likely responsibilities were P.L. 113-2 funds to be fully depleted. Items not related to cost-sharing are likely responsibilities for the PPA:

- Provide a minimum of 35 percent of initial project costs assigned to coastal and storm damage reduction, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits, and 50 percent of periodic nourishment costs assigned to coastal and storm damage reduction, plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do provide public benefits, and as further defined below:
- Provide, during design, 35 percent of design costs allocated to coastal and storm damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
- Provide all lands, easements, rights-of-way, including suitable borrow areas, and perform or assure performance of all relocations, including utility relocations, as determined by the federal government to be necessary for the initial construction, periodic nourishment or operation and maintenance of the project;
- Provide, during construction, any additional amounts necessary to make its total contribution equal to 35 percent of initial project costs assigned to coastal and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;
- Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;
- Inform affected interests, at least yearly, of the extent of protection afforded by the flood risk management features; participate in and comply with applicable federal floodplain management and flood insurance programs; comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12); and publicize

floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

- Operate, maintain, repair, replace, and rehabilitate the completed project, or function portion of the project, at no cost to the federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal and state laws and regulations and any specific directions prescribed by the federal government;
- For so long as the project remains authorized, ensure continued conditions of public ownership and use of the shore upon which the amount of federal participation is based;
- Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;
- At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the federal government;
- Give the federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
- Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors;
- Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;
- Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the initial construction, periodic nourishment, operation and maintenance of the project;
- Assume, as between the federal government and the non-federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way required for the initial construction, periodic nourishment, or operation and maintenance of the project;
- Agree, as between the federal government and the non-federal sponsor, that the non-federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability,

and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

- Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;
- Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601- 4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;
- Comply with all applicable federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis- Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c); and
- Not use funds from other federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-federal sponsor's obligations for the project unless the federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

10.2 Costs for the Recommended Plan

The cost estimate included in this document is intended to provide an estimate of total costs of the Recommended Plan. The Recommended Plan project first cost is shown above in Table 6-3. The fully funded cost escalated to the midpoint of construction is shown in Table 10-1. Note that the total fully funded cost estimate of $ 626,369,163 differs from the estimate of project first costs of $ 590,750,280 shown above in Table 6-3 and in Table 10-1 below. This difference is due to the addition of roughly $35.6 million in escalation costs, which reflect expected cost increases between the FY 2019 quarter 1 price level and the varying midpoints of construction.

Table 10-1: Recommended Plan Fully Funded Costs

	Initial Construction		Project First Cost** ($)			Total Project Cost (Fully Funded) ($)	
Acct	Description	Cost* ($)	Contingency* ($)	Total First Cost ($)	Cost ($)	Contingency* ($)	Total Project Cost ($)
01	Lands & Damages	**30,515,993**	**6,103,199**	**36,619,192**	**31,579,217**	**6,315,843**	**37,895,061**
02	Relocations	**4,419,294**	**1,253,312**	**5,672,605**	**4,575,827**	**$1,297,704**	**5,873,531**
10	Breakwaters & Seawalls	**191,555,639**	**54,325,179**	**245,880,819**	**203,280,803**	**$57,650,436**	**260,931,239**
11	Levees & Floodwalls	**99,943,553**	**28,343,992**	**128,287,545**	**106,487,233**	**$30,199,779**	**136,687,012**
13	Pumping Plants	**37,327,343**	**10,586,035**	**47,913,378**	**39,782,541**	**$11,282,329**	**51,064,870**
17	Beach Replenishment	**27,519,179**	**7,804,439**	**35,323,618**	**28,352,553**	**$8,040,784**	**36,393,337**
18	Cultural Resources Preservation	**12,246,169**	**3,473,013**	**15,719,182**	**12,889,332**	**$3,655,415**	**16,544,746**
30	Planning, Engineering, & Design	**36,219,134**	**10,271,746**	**46,490,880**	**37,635,987**	**$10,673,566**	**48,309,552**
31	Construction Management	**22,470,443**	**6,372,618**	**28,843,061**	**25,451,710**	**$7,218,105**	**32,669,814**
	Total Initial First Cost	**462,216,748**	**128,533,533**	**590,750,280**	**490,035,202**	**136,333,961**	**626,369,163**

	Renourishment		Project First Cost** ($)		Total Project Cost (Fully Funded) ($)		
Acct	**Description**	**Cost* ($)**	**Contingency ($)**	**Total First Cost ($)**	**Cost ($)**	**Contingency* ($)**	**Total Project Cost ($)**
06	Fish & Wildlife Facilities	**15,124,165**	**4,289,213**	**19,413,378**	**27,061,089**	**7,674,525**	**34,735,614**
17	Beach Replenishment	**235,994,678**	**66,928,091**	**302,922,769**	**422,257,145**	**119,752,126**	**542,009,272**
30	Planning, Engineering, & Design	**24,016,689**	**6,811,133**	**30,827,822**	**103,665,968**	**29,399,669**	**133,065,637**
31	Construction Management	**13,929,680**	**3,950,457**	**17,880,137**	**63,214,205**	**17,927,549**	**81,141,754**
	Total Renourishment Cost	**289,065,211**	**81,978,894**	**371,044,105**	**616,198,408**	**174,753,868**	**790,952,276**
Total Project Cost (Initial + Renourishement)		**751,281,959**	**210,512,426**	**961,794,385**	**1,106,233,610**	**311,087,829**	**1,417,321,439**

* FY19 Q1 effective price level ** Project First Cost = Cost + Contingency

10.3 Cost Sharing Apportionment

Table 10-2 provides the cost sharing for initial construction and lifecycle activities.

Table 10-2 Cost Apportionment

Cost Description	Cost ($)	Federal Cost Share (%)	Non-Federal Cost Share (%)
Project Total First Cost*	**590,750,000**	**100**	**0**
LERRDs (Non-Federal Project Cost)**	**38,924,000**	**100**	**reimbursed**
Total SLR Adaptation***	**38,285,000**	**50**	**50**
Total Monitoring & Renourishment Cost	**371,044,000**	**50**	**50**
Operations & Maintenance Annual Cost	**1,668,000**	**0**	**100**

* FY19 Q1 effective price level

**Non-federal Lands, Easements, Relocations, Right-of-ways, and Disposal Areas (LERRDs) value from Real Estate Plan in FY19 Q1 price levels added to the Total Project Cost Summary (TPCS) Relocations account value

***2.875% interest rate

Cost sharing is based on Public Law 113-2 (29Jan13), The Disaster Relief Appropriations Act of 2013, which provides 100% federal funding, as long as the appropriated funds remain available for initial construction. Renourishment costs will be cost-shared as 50% federal and 50% non-federal, as future renourishment would be constructed under a new construction authority, given that the existing construction authority, including the provisions of Section 934 of WRDA 1986, will expire in 2026.

10.4 Views of the Non-Federal Sponsors and Others

The New York State Department of Environmental Conservation, acting as the non-federal sponsor, supports the Recommended Plan. The NYC Mayor's Office of Recovery and Resiliency, the local sponsor to New York State, also supports the Recommended Plan, as do the Village of Cedarhurst and the Town of Hempstead, additional local sponsors to New York State. Other project partners, including NYC Department of Parks and Recreation, NYC Department of Environmental Protection, and the National Park Service also support the Recommended Plan. Letters of Support for the project by the non-federal sponsors can be found in Appendix H.

Based upon the review of the proposed project during the feasibility phase, the NYSDEC will require during the PED Phase further justification or component revisions to ensure the protection of water quality, habitat quality, and public access.

10.5 Recommended Plan and Recent USACE Initiatives

10.5.1 USACE Campaign Plan

The Recommended Plan addresses the Chief of Engineers Campaign Plan Goal 2: Deliver enduring and essential water resource solutions using effective transformation strategies.

Objective 2a: Modernize the Civil Works project planning program and process. This HSGRR/EIS contributes to the objective defined within Goal 2. This report recommends specific solutions to water resource problems and opportunities based on risk-informed decisions. It was developed in close collaboration with stakeholders and partners.

Objective 2c: Deliver quality solutions and services. This objective is measured by successfully meeting or exceeding established commitments for schedule, cost, and quality to ensure consistent, high-quality performance. A Cost and Schedule Risk Analysis and a Risk Management Plan will be developed to ensure the authorized cost limits are set and cost risks are managed.

10.5.2 Environmental Operating Principles

Environmental consequences of construction and operation of the Recommended Plan have been considered in avoiding and minimizing impacts; remaining unavoidable impacts would be fully mitigated. Sustainability was an integral consideration in the development of coastal storm risk reduction recommendations. A risk management and systems approach was developed with input from the USACE Risk Management Center and the Flood Risk Management Planning Center of Expertise; operation of the projects will also employ a risk management approach. Coordination with stakeholders and the general public began with four public scoping meetings, continued with stakeholder updates, and extensive resource agency input during impact modeling. Resource agency knowledge and evaluation methods developed for similar projects were applied in the impact analysis. A thorough NEPA and engineering analysis has ensured that the USACE will meet its corporate responsibility and accountability for actions that may impact human and natural environments. This analysis will be transparent and communicated to all individuals and groups interested in USACE activities.

11 PUBLIC INVOLVEMENT

11.1 Public Involvement Activities

A series of public scoping meetings were held in the study area after the Alternatives Milestone meeting, but prior to the TSP Milestone Meeting. A Notice of Intent (NOI) to prepare an Environmental Impact Statement for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study was issued on April 2, 2015 in the Federal Register. The NOI also invited public comment on the scope of the issues and alternatives to be addressed in the draft EIS. Input was received through public meetings with both oral and written comments being provided and written comments were also submitted and considered throughout the study process. The meeting format included a presentation of the study purpose, alternatives considered and analyses of performance and cost of alternative plans. Posters highlighting pertinent analyses and findings of the study were available before and after the presentation to allow the attendees to circulate from area to area and pose questions and express concerns to technical staff.

Common concerns expressed included the sense of urgency to move to construction of a risk management feature. Other concerns included maintaining access to the water, preserving views, and balancing risk management with environmental impacts (see Appendix G—Public Engagement—for more information). Consistent with the USACE planning paradigm, the features were presented at this early stage in the study were shown as lines only, and no renderings were available.

The post-Hurricane Sandy environment afforded USACE an unusual opportunity to coordinate the reformulation effort with many Agencies and stakeholders. A Public Agency Council convened regularly to address Jamaica Bay issues of flooding, environmental quality and sustainability, and USACE. Reformulation goals and objectives were jointly identified. Without project conditions reflected careful consideration of ongoing efforts of partner agencies, and impacts of the Reformulation effort considered all proposals for future efforts of other agencies within the study area.

Following public release of the document, additional public meeting were held to solicit comments on the TSP. The study team met with stakeholders and members of the public and received over one thousand comments on the Tentatively Selected Plan (Appendix G). These comments were summarized and presented to the decision makers prior to the agency decision on whether or not to finalize the recommendation. The Rockaway study team held additional public meetings throughout the Feasibility Study. Local elected officials also facilitated a number of public meetings where they requested and obtained participation from the Rockaway study team members in order to further the public engagement on this study.

A second public and agency comment period was held for the Revised Draft GRR/EIS from August 31, 2018 to October 22, 2018. Two public meetings were held as a part of the public engagement during the second comment period. The meetings were held firstly in the Mid-Rockaway HFFRRF project area, and in the Village of Cedarhurst where the second HFFRRF is located. Comments and feedback received was incorporated into the preparation of the Final GRR/EIS. Comments and their responses are included in the Public Engagement Appendix (Appendix G).

11.2 Distribution List

Elected Officials

Senators

Steve_Barton@schumer.senate.gov

robert_hickman@schumer.senate.gov

Leeann_Sinpatanasakul@schumer.senate.gov

Deborah_Tinnirello@gillibrand.senate.gov

Jordan_Baugh@gillibrand.senate.gov

janneke_house@gillibrand.senate.gov

House of Representatives

Joseph.Edwards@mail.house.gov

Tasia.Jackson@mail.house.gov

Matt.Wiesenthal@mail.house.gov

Anita.Taylor@mail.house.gov

Charles.Jackson@mail.house.gov

Frieda.Menos@mail.house.gov

Asi.Ofosu@mail.house.gov

State Government

New York State Assembly

titusm@assembly.state.ny.us

amatos@nyassembly.gov

New York State Senate

addabbo@nysenate.gov

sanders@nysenate.gov

MillerML@nyassembly.gov

kaminsky@nysenate.gov

City Government

New York City Council

drichards@council.nyc.gov

eulrich@council.nyc.gov

msanders@council.nyc.gov

County Government

Nassau County

bschneider@nassaucountyny.gov

ssallie@nassaucountyny.gov

Federal Agencies

U.S. Environmental Protection Agency

moltzen.michael@epa.gov

Poetzsch.Michael@epa.gov

nyman.robert@epa.gov

Knutson.Lingard@epa.gov

U.S. Department of the Interior

andrew_raddant@ios.doi.gov

U.S. National Park Service

mary_foley@partner.nps.gov

patricia_rafferty@nps.gov

jen_nersesian@nps.gov

Doug_Adamo@nps.gov

joshua_laird@nps.gov

barbara_repeta@nps.gov

U.S. Geological Survey

chapke@usgs.gov

National Oceanic and Atmospheric Administration

Karen.Greene@NOAA.gov

christopher.boelke@noaa.gov

daniel.marrone@noaa.gov

NMFS.GAR.ESA.Section7@Noaa.gov

U.S. Fish and Wildlife Service

steve_papa@fws.gov

david_stilwell@fws.gov

kerri_dikun@fws.gov

steve_sinkevich@fws.gov

Federal Emergency Management Agency

John.McKee@fema.dhs.gov

michael.audin@fema.dhs.gov

irene.changcimino@fema.dhs.gov

patrick.tuohy@fema.dhs.gov

U.S. Department of Housing and Urban Development

Lynn.Rakos@hud.gov

Therese.J.Fretwell@hud.gov

State Agencies

New York State Department of Environmental Conservation

alan.fuchs@dec.ny.gov

arvind.goswami@dec.ny.gov

eric.star@dec.ny.gov

sue.ackerman@dec.ny.gov

andrew.walker@dec.ny.gov

dawn.mcreynolds@dec.ny.gov

michael.sheehan@dec.ny.gov

matthew.chlebus@dec.ny.gov

jean.occidental@dec.ny.gov

steve.zahn@dec.ny.gov

joanna.field@dec.ny.gov

Caitlyn.Nichols@dec.ny.gov

stephen.watts@dec.ny.gov

james.tierney@dec.ny.gov

New York State Department of State

Carolyn.LaBarbiera@dos.ny.gov

Jennifer.Street@dos.ny.gov

Jeff.Herter@dos.ny.gov

Matthew.Maraglio@dos.ny.gov

New York State Governor's Office of Storm Recovery

DBerkovits@stormrecovery.ny.gov

CGorman@stormrecovery.ny.gov

cfilomena@stormrecovery.ny.gov

Dormitory Authority of the State of New York

JSmitsAn@dasny.org

New York State Department of Transportation

ASilvestri@dot.nyc.gov

Ian.Francis@dot.ny.gov

Local Agencies and Government

New York City Planning

MMarrel@planning.nyc.gov

New York City Hall

JBavishi@cityhall.nyc.gov

RFischman@cityhall.nyc.gov

New York City Parks

alyssa.cobb@parks.nyc.gov

Marit.Larson@parks.nyc.gov

liam.kavanagh@parks.nyc.gov

Mitchell.Loring@parks.nyc.gov

elizabeth.jordan@parks.nyc.gov

alyssa.cobb@parks.nyc.gov

New York City Department of Environmental Protection

kmahoney@dep.nyc.gov

AngelaL@dep.nyc.gov

JohnM@dep.nyc.gov

OlsonC@dep.nyc.gov

GarinJ@dep.nyc.gov

klam@dep.nyc.gov

JMcColgan@dep.nyc.gov

New York City Department of Transportation

LShelby@dot.nyc.gov

New York City Department of Housing Preservation and Development

morrisd@hpd.nyc.gov

StraughP@hpd.nyc.gov

New York City Mayor's Office of Environmental Coordination

EBrunner@cityhall.nyc.gov

HSemel@cityhall.nyc.gov

Port Authority of New York and New Jersey

cweydig@panynj.gov

Village of Cedarhurst

village@cedarhurst.gov

Town of Hempstead

jdavenport@tohmail.org

thomdoh@tohmail.org

rsinclair@tohmail.org

12 RECOMMENDATIONS

12.1 Overview

In making the following recommendations, I have given consideration to all significant aspects of this study as well as the overall public interest in coastal storm risk management within the East Rockaway to Rockaway Inlet and Jamaica Bay Study Area. The aspects considered include engineering feasibility, economic effects, environmental impacts, social concerns, and compatibility of the project with the policies, desires, and capabilities of the local government, State, federal government, and other interested parties.

12.2 Recommendation

A number of alternatives have been examined as part of the study and a National Economic Development Plan has been identified and considered. In accordance with current Planning Guidance and the guidance outlined in P.L. 113-2, the NED plan described in this report is acceptable to the non-federal partner, agencies, and stakeholders as a Coastal Storm Risk Management Project.

I make this recommendation based on findings that the selected plan constitute engineering feasibility, economic justification, and environmental acceptability. This recommended project, which is subject to modifications by the ASA(CW), has a project first cost of $590,750,280 for initial construction, and a first cost of $371,044,105 for continuing construction (cumulative renourishment) at September 2019 price levels; and for purposes of the PPA, a fully funded cost of $626,369,163 and an estimated fully funded continuing construction (cumulative renourishment) cost of $790,952,276. My recommendation is subject to the non-federal interests agreeing to execute and comply with the terms of a Project Partnership Agreement following approval of this report.

The recommendations contained herein reflect the information available at this time and current USACE policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of the national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to higher authority as proposals for authorization and/or implementation funding.

Thomas D. Asbery
Colonel, U.S. Army
Commander

13 References

Baltimore Sun, 2000. Barren Island's harsh past brought to life. By Kirk Johnson. December 3, 2000. http://articles.baltimoresun.com/2000-12-03/news/0012030148_1_barren-island-garbage-new-york

Barnes, J.D., N.M. Laymon, E.W. 1977. *Power Plant Construction Noise Guide*. Prepared for the Empire State Electric Energy Research Corporation, Report No. 3321, 1977. Wood.Bolt, Beranek and Newman, Inc.

Black, F.R. 1981. Jamaica Bay: A History, Gateway National Recreation Area, New York--New Jersey. Cultural Resources Management Study No. 3. Division of Cultural Resources, North Atlantic Regional Office, National Park Service, U.S. Dept. of Interior, Washington, D.C.

Buxton, H.T. and P.K. Shernoff. 1999. Ground-water Resources of Kings and Queens Counties, Long Island, New York. U.S. Geological Survey Water Supply Paper 2498. Prepared in cooperation with New York City Department of Environmental Protection and New York State Department of Environmental Conservation. Available online at http://pubs.er.usgs.gov/publication/wsp2498.

Cadwell, D. H. 1986. Surficial Geologic Map of New York. New York State Museum – Geological Survey, NY.

Camp, Dresser, and McKee, 1983. Study Overview.

Cartwright, Richard A. 2002. History and Hydrologic Effects of Ground-Water Use in Kings, Queens, and Western Nassau Counties, Long Island, New York, 1800s through 1997. United States Geological Survey Water-Resources Investigations Report 01-4096. In cooperation with New York City Department of Environmental Protection, New York 2002.

Cialone, Mary A., T. Chris Massey, Mary E. Anderson, Alison S Grzegorzewski, Robert E. Jensen, Alan Cialone, David J. Mark, Kimberly C. Pevey, Brittany L. Gunkel, Tate O. McAlpin, Norberto N. Nadal-Caraballo, Jeffrey A. Melby, and Jay J. Ratcliff. 2015. North Atlantic Coastal Comprehensive Study (NACCS) Coastal Storm Model Simulations: Waves and Water Levels.

City of New York Environmental Quality Review (CEQR), 2014. Chapter 19 – Noise. Issued by the NYC Mayor's Office of Sustainability. Available online at: http://www.nyc.gov/html/oec/downloads/pdf/2014_ceqr_tm/19_Noise_2014.pdf

Columbia University, 2008. Bedrock Geology In and Around the Jamaica Bay Estuary. Center for International Earth Science Information Network: Jamaica Bay Research and Management Information Network. http://www.ciesin.columbia.edu/jamaicabay/photogallery/jb_bed_geology.pdf

Cowan, J.P., 1994. *Handbook of Environmental Acoustics.* New York, New York: John Wiley & Sons.

Dugan JE, Airoldi L, Chapman MG, Walker SJ, and Schlacher T (2011) Estuarine and Coastal Structures: Environmental Effects, A Focus on Shore and Nearshore Structures. In: Wolanski E and McLusky DS (eds.) Treatise on Estuarine and Coastal Science, Vol 8, pp. 17–41. Waltham: Academic Press.

Dugan, J.E., Hubbard, D.M., 2006. Ecological responses to coastal armoring on exposed sandy beaches. Shore and Beach 74 (1), 10–16.

Ehrler, M.—NPS, Gateway National Recreation Area, 2013. Personal communication from Marilou Ehrler re: Uses of Fort Hancock's Officers' Row, Hurricane Sandy damage at Breezy Point Surf Club, National Register nominations and Determinations of Eligibility, etc.

Engebretsen, Jan, 1982. New York Harbor and Adjacent Channels Study Shipwreck Inventory. Submitted to the U.S. Army Corps of Engineers, New York District.

Federal Energy Regulatory Commission (FERC), 2013. 2013 Report of Enforcement, Docket No. AD07-13-006.

Federal Energy Regulatory Commission (FERC), 2014. Rockaway Delivery Lateral Project, Northeast Connector Project, Final Environmental Impact Statement. February, 2014.

Federal Interagency Committee on Noise (FICON). 1992. Federal Agency Review of Selected Airport Noise Analysis Issues. August 1992. Available online at: http://airportnoiselaw.org/65dnl.html

Federal Transit Authority (FTA), 2006. Transit Noise and Vibration Impact Assessment. FTA-VA-90-1003-06. May, 2006. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Noise_and_Vibration_Manual.pdf

FEMA, 2013. Flood Insurance Study, City of New York, New York. Flood Insurance Study number 360497V000B. Preliminary: December 5, 2013.

Fugro, 2016. Lafayette River Tidal Protection Alternatives Evaluation, City of Norfolk, City-wide Coastal Flooding Project, Work Order No. 7, January 2016.

Freshkills Park Alliance, 2011. New York City Landfills, Past and Present. Presentation dated November 29, 2011. Accessed 2016. http://freshkillspark.org/wp-content/uploads/2011/12/marty-bellew-lecture-112911_lowrez.pdf

Gittman et al. 2014 Ocean & Coastal Management

Google, 2016. Search results for "Marinas near Jamaica Bay, NY" and "Marinas near Rockaway, NY". Search performed by Mabbett & Associates, Inc. Available online at: www.google.com

Hess, L., and W. H. Harris. 1987. Morphology and sediment budget during recent evolution of a barrier beach, Rockaway, New York. Northeastern Geology 9:94-109.

Hunter, Richard and Damon, Tvaryanas, 2002. Phase 1A Cultural Resource Documentary Study For Gerritsen's Creek Ecosystem Restoration, Borough of Brooklyn, Kings County, New York. Report on file with the U.S. Army Corps of Engineers, New York, New York. Included in: "USACE – New York District: Final Ecosystem Restoration Report and Environmental Assessment, Gerritsen Creek Ecosystem Restoration Section 1135, Brooklyn, NY, October 2003".

Incident Management Team (IMT), 2012h. "Jacob Riis Park, Preliminary Damage Assessment." In NPS Response to Effects of Hurricane Sandy, November 11, 2012. Incident Management Team, National Park Service, Gateway National Recreation Area.

Incident Management Team (IMT), 2012i. "Breezy Point Surf Club and Silver Gull Beach Club, Preliminary Damage Assessment." In NPS Response to Effects of Hurricane Sandy, November 11, 2012. Incident Management Team, National Park Service, Gateway National Recreation Area.

Kopper, Steven, 1979. Cultural Resources Reconnaissance Dredging Project, East Rockaway Inlet, New York. Report to the New York District, U.S. Army Corps of Engineers.

Lane, Frenchman, and Associates, 1992. Jacob Riis Park Cultural Landscape Report, Gateway National Recreation Area. Prepared for the Denver Service Center, National Park Service.

Liboiron, Max, 2013. Detritus from Historic Deadhorse Bay: Trash Meant to be Left Behind. Published at Discard Studies. https://discardstudies.com/2013/07/11/detritus-from-historic-deadhorse-bay-trash-meant-to-be-left-behind/

Long Island American Water, 2016. Typical Water Quality Information. http://www.amwater.com/files/NY_2902835_TWQ.pdf

Louis Berger Associates, Inc., 1990. The VanDeventer-Fountain House Site Ca. 1786 to 1901 Staten Island, New York. Report prepared for the U.S. Department of the Navy, Northern Division. Louis Berger Associates, Inc.

Mabbett, 2016. Telephone communication with the US National Park Service regarding visitor statistics. April 11, 2016.

Misut, Paul E. and Jack Monti, Jr., 1999. Simulation of Ground-Water Flow and Pumpage in Kings and Queens Counties, Long Island, New York, United States Geological Survey Water-Resources Investigations Report 98-4071. 1999.

Nassau County, 2016. Building and Zoning Permits. https://www.nassaucountyny.gov/3482/Building-and-Zoning-Permits

National Park Service, n.d.i. Cultural Resource Index with Hurricane Sandy Assessments, Gateway National Recreation Area, provided by Helen Mahan March 6, 2013.

National Park Service, 1978. National Register of Historic Places Nomination Form, Floyd Bennett Field, Jamaica Bay Unit, Gateway National Recreation Area.

National Park Service, 1979b. National Register of Historic Places Nomination Form, Jacob Riis Park, Jamaica Bay Unit, Gateway National Recreation Area.

National Park Service, 1980b. Historic Structure Report, Historical Data Section, Fort Tilden, Gateway National Recreation Area, New York, Denver Service Center.

National Park Service (NPS), 2002. Olmstead Center for Landscape Preservation. https://www.nps.gov/oclp/index.htm

National Park Service, 2004e. National Register Nomination Form: U.S. Coast Guard Station Far Rockaway, Queens, Gateway National Recreation Area.

National Park Service, 2009a. Archeological Overview and Assessment, Sandy Hook Unit, Gateway National Recreation Area. United States Department of the Interior, National Park Service.

National Park Service, 2010c. National Register of Historic Places Nomination Form, Floyd Bennett Field (expanded), Jamaica Bay Unit, Gateway National Recreation Area.

National Park Service, 2011a. Archeological Overview and Assessment, Gateway National Recreation Area, Great Kills Park, Staten Island Unit, Richmond County, New York. United States Department of the Interior, National Park Service.

National Park Service, 2011b. Archeological Overview and Assessment, Gateway National Recreation Area, Fort Wadsworth, Staten Island Unit, Richmond County, New York. United States Department of the Interior, National Park Service.

National Park Service, 2011c. Archeological Overview and Assessment, Gateway National Recreation Area, Jamaica Bay Unit, Kings and Queens Counties, New York. United States Department of the Interior, National Park Service.

National Park Service (NPS), 2013. Gateway National Recreation Area – Draft General Management Plan/Environmental Impact Statement. July, 2013.

National Park Service (NPS), 2013b. National Register of Historic Places, Registration Form, Far Rockaway Beach Bungalow Historic District. May 31, 2013. Available online at: https://www.nps.gov/nr/feature/places/pdfs/13000499.pdf

National Park Service (NPS), 2014. Gateway National Recreation Area, Final General Management Plan, Environmental Impact Statement. April 2014.

National Park Service (NPS), 2014a. A New Vision for a Great Urban National Park Gateway National Recreation Area Final General Management Plan / Environmental Impact Statement. April.

National Park Service (NPS), 2015. https://www.nps.gov/gate/planyourvisit/thingstodojamaicabay.htm

National Park Service (NPS), 2016.
https://www.nps.gov/gate/learn/historyculture/detailedforttilden.htm

NED, 2015. NED Recreation Benefit for Rockaway Beach, NY.

Nersesian, G. K., 1977. Beach fill design and placement at Rockaway Beach, New York, using offshore ocean borrow sources. Coastal Sediments '77, ASCE: 228-247.

New York City Comprehensive Waterfront Plan (NYCCWP, 1992. Reclaiming the City's Edge: Chapter on Visual Corridors. NYC Department of City Planning. Summer, 1992. Available online at: http://www1.nyc.gov/assets/planning/download/pdf/about/publications/cwp.pdf

New York City Department of City Planning (NYCDCP), 1999b. Waterfront Revitalization Program.
http://www.nyc.gov/html/oec/downloads/pdf/dme_projects/07DME025M/DEIS/07DME025M_%20DEIS_12_Waterfront_Revitalization.pdf

New York City Department of City Planning (NYCDCP), 2016. Article VI, Special Regulations Applicable to Certain Areas; Chapter 2 – Special Regulations Applying in the Waterfront Area, Effective March 22, 2016. Available online at:
http://www1.nyc.gov/assets/planning/download/pdf/zoning/zoning-text/art06c02.pdf

New York City Department of Environmental Protection (NYCDEP). 2007. Notice of Adoption of Rules for Citywide Construction Noise Mitigation.

New York City Department of Environmental Protection (NYSDEP), 2011. Jamaica Bay Waterbody/Watershed Facility Plan Report, October 2011. Available online at:
http://www.hydroqual.com/projects/ltcp/wbws/jamaica_bay.htm

New York City Department of Parks and Recreation, 2016. Forever Wild; Dubos Point Wildlife Sanctuary. http://www.nycgovparks.org/greening/nature-preserves/site?FWID=29

New York City Department of Parks and Recreation, 2016. Jamaica Bay and the Rockaways. http://www.nycgovparks.org/parks/jamaica-bay-and-the-rockaways

New York City Health, 2007. Proposed Adulticiding of the Rockaways.
http://www.nyc.gov/html/doh/images/public/press05/pr093-05.jpg

New York City Local Laws (NYCLL), 2005. New York City Noise Code §24-232. Available online at: http://www.nyc.gov/html/dep/html/noise/index.shtml.

New York City Natural Hazard Mitigation Plan (NYCNHMP), 2009. Section III: Natural Hazard Risk Assessment. March 2009.
http://www.nyc.gov/html/oem/downloads/pdf/hazard_mitigation/section_3h_earthquake_hazard_analysis.pdf

New York City Planning Commission (NYCPC), 2012. *Hudson Square Rezoning Final EIS.* Prepared by AKRF, Inc. January 2013. New York City Planning Commission (NYCPC), 2012a.

625 West 57th Street Final EIS, New York City Planning Commission. Prepared by AKRF, Inc., and Philip Habib & Associates. December 2012.

New York City Planning Commission (NYCPC), 2013. *Hudson Square Rezoning Final EIS.* Prepared by AKRF, Inc. January 2013.

New York Department of State, Office of Planning and Development, 2016. NYS Coastal Boundary Map. https://appext20.dos.ny.gov/coastal_map_public/map.aspx

New York Harbor Parks, 2016. http://nyharborparks.org/podcasts/rs-hawks.html

New York State Department of Environmental Conservation (NYSDEC), 1990. Jamaica Bay Critical Environmental Area (CEA). http://www.dec.ny.gov/docs/permits_ej_operations_pdf/jamaicabay.pdf

New York State Department of Environmental Conservation (NYSDEC), 2001. Assessing and Mitigating Noise Impacts Program Policy. Issued 6 October 2000; Revised February 2, 2001.

New York State Department of Environmental Conservation (NYSDEC), 2018. Spring Creek Park Information on Radium Contamination. January 2018.

New York State Department of Transportation (NYSDOT), 2013. Traffic Data Viewer Shapefiles 2013: TDV_AADT_2013.shp. Available at: https://www.dot.ny.gov/tdv

New York State Office of the State Comptroller (NYSOSC), 2011. An Economic Snapshot of Coney Island and Brighton Beach. July, 2011. Available online at: http://www.osc.state.ny.us/osdc/rpt8-2012.pdf

New York State Office of the State Comptroller (NYSOSC), 2014. An Economic Snapshot of Brooklyn. May, 2014. Available online at: http://www.osc.state.ny.us/osdc/rpt4-2015.pdf

New York Times, 1984. A cooperative on the beach loves privacy. By Elaine Sciolino. http://www.nytimes.com/1984/09/10/nyregion/a-cooperative-on-the-beach-loves-privacy.html

New York Times, 1999. Defunct Equine Esturary. By Daniel B. Schneider. http://www.nytimes.com/1999/07/18/nyregion/fyi-634484.html

New York Times, 2009. A Wooded Prairie Springs From a Site Once Piled High With Garbage, by Kenneth Chang. September 6, 2009. http://www.nytimes.com/2009/09/07/science/earth/07landfill.html?_r=0

New York-New Jersey Harbor & Estuary Program (HEP), 2001. 2001 Status Report: A Regional Model for Estuary and Multiple Watershed Management – Report by the Habitat Workgroup of the HEP. April 2001. Available online at: http://mss3.libraries.rutgers.edu/dlr/outputds.php?pid=rutgers-lib:34653&ds=PDF-1

NOAA, 2013. NOAA Water Level and Meteorological Data Report: Hurricane Sandy. https://www.tidesandcurrents.noaa.gov/publications/Hurricane_Sandy_2012_Water_Level_and_Meteorological_Data_Report.pdf

NOAA, 2016. FEMA Flood Zones. From NOAA Coastal Flood Exposure Mapper. Available online at: http://go.usa.gov/cuj9Y.

NOAA, 2016. United States – East Coast, New York, Jamaica Bay and Rockaway Inlet, Map 12350, 1:20,000 scale. Last corrected February 25, 2016. Available online at: http://www.charts.noaa.gov/InteractiveCatalog/nrnc.shtml?rnc=12350

Northeast Regional Climate Center, 2016. Accessed in 2016. Available at: http://www.nrcc.cornell.edu/wxstation/comparative/comparative.html#

NPS, 2012. *Gateway General Management Plan/Environmental Impact Statement Newsletter No.3.* United States Department of the Interior, National Park Service, Gateway National Recreation Area. August 2012.

NYC Planning, 2016. Special Use Districts. Available online at: http://maps.nyc.gov/doitt/nycitymap/template?z=4&p=991423,157389&a=ZOLA&c=ZOLA&f=DCP_SPEC_PURPOSE_DISTRICT

NYCDEP, 2016. Jamaica Bay Tidal Barrier Water Quality Modeling Analysis, New York City Department of Environmental Protection, draft in preparation.

NYCDCP, 2016b. Community Portal – District Descriptions. Available online at: http://www1.nyc.gov/site/planning/community/community-portal.page

NYCDEP, 2010. Restoring Brooklyn's Pennsylvania and Fountain Landfills. Presentation dated January 26, 2010. https://freshkillspark.files.wordpress.com/2010/01/012610-fkp-talks_mclaughlin.pdf

NYS Comptroller, 2012. Accessed April 2016. Available Online at:

NYSDEC, 1990. Critical Environmental Areas, Jamaica Bay (Kings and Queens Counties). Available online at: http://www.dec.ny.gov/permits/25123.html

NYSDEC, 2003. Commissioner Policy 29, DEC Environmental Justice Policy. Issued on March 19, 2003. Available at: http://www.dec.ny.gov/docs/permits_ej_operations_pdf/cp29a.pdf

NYSDEC, 2016. County Maps Showing Potential Environmental Justice Areas. Accessed April 2016. Available online at: http://www.dec.ny.gov/public/899.html

NYSDEP, 2007. Chapter 28, Citywide Construction Noise Mitigation, in Title 15 of the Rule of the City of New York. Available online at: http://www.nyc.gov/html/dep/pdf/noise_constr_rule.pdf

NYC Metropolitan Transportation Authority (NYCMTA), 2016. Marine Parkway-Gil Hodges Memorial Bridge. Available online at: http://web.mta.info/bandt/html/marine.html.

Panamerican Consultants, 2003. Cultural Resources Baseline Study, Jamaica Bay Ecosystems Restoration Project, Kings, Queens and Nassau Counties, New York. July, 2003. Included as the Cultural Resources Phase 1A Report in USACE, June 2010: Volume 2: Jamaica Bay, Marine Park and Plumb Beach, New York, Environmental Restoration Project, Draft Interim Feasibility Report, Kings and Queens Counties, New York.

Panamerican Consultants, 2003. Final Report, Underwater Inspection of Targets Borrow Area 2, Atlantic Coast of Long Island, East Rockaway Inlet to Rockaway Inlet, Queens County New York, Storm Damage Reduction Project. September 2003.

Panamerican Consultants, 2005. Remote Sensing Survey of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York. Submitted to the U.S. Army Corps of Engineers, New York District. Final Report dated November, 2005.

Panamerican Consultants, 2006. Remote Sensing Survey of the Swinburne Beneficial Use Site In Connection With The New York and New Jersey Harbor Navigation Study Of The Upper and Lower Bay Port of New York and New Jersey, Richmond County, New York. Submitted to the U.S. Army Corps of Engineers, New York District. Draft Report dated May, 2006.

PBS&J, 2009. Marine Archeological Assessment for the Rockaway Delivery Point Project, Queens County, New York. Prepared for Gateway National Recreation Area.

Port Authority of NJ and NY, 2016. AirTrain JFK. http://www.panynj.gov/airports/jfk-airtrain.html

Riess, Warren C., 1994. *East Rockaway Inlet To Rockaway Inlet And Jamaica Bay, New York -- Section 934 Study Remote Sensing Survey Of Borrow Area* 2 1993. Prepared by WCH Industries, Waltham, Massachusetts in association with Boston Affiliates, Inc., Boston, Massachusetts. Submitted to the U.S. Army Corps of Engineers, New York District.

Ruijs, M., 2011. The Effects of the "Ike Dike" Barriers on Galveston Bay, Delft University of Technology, June 2011.

Selvek, C., 2005. Draft Cultural Landscape Report for Fort Tilden, Gateway National Recreation Area (95% Draft), September 2005. Olmsted Center for Landscape Preservation, National Park Service, Boston, Massachusetts.

Skanska, 2014. Rockaway Boardwalk, Project Informational Session, Phase 4B Construction Logistics, October 28, 2014. Available online at: https://www.nycgovparks.org/pagefiles/79/Rockaway-Boardwalk-Phase-4B-Construction-Logistics.pdf

Structures of Coastal Resilience (SCR), 2014. Phase 1, Context, Site, and Vulnerability Analysis. Section 07, Shifting Sands: Sedimentary Cycles for Jamaica Bay, New York.

Available online at: http://dev.structuresofcoastalresilience.org/wp-content/uploads/2014/10/Phase_1_JB.pdf

Student Conservation Association, 2016. http://sandy.thesca.org/jamaica-bay-ny

Sykes L. R., Armbruster J.G, Kim W. and Seeber L. 2008. Observations and Tectonic Setting of Historic and Instrumentally Located Earthquakes in the Greater New York – Philadelphia Area. Bulletin of the Seismological Society of America, Vol. 98, No. 4, pp. 1696 – 1719, August 2008.

Tunstead, R. 1999. Telephone Communication on July 1, 1999, between R. Tunstead, Geologist, U.S. Department of Agriculture, National Resources Conservation Service, Staten Island, New York, and M. Van Brocklin, Northern Ecological Associates, Inc., Canton, NY.

USACE, 1979. Rockaway B-149th Street Groin, General Design Memorandum Supplement and EIS Supplement. February, 1979.

USACE, 1993. Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York. Final Reevaluation Report (Section 934 of WRDA 1986). May, 1993.

USACE, 2001. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury Park to Manasquan Section Beach Erosion Control Project. Final Report". U.S. Army Engineer District, New York and U.S. Army Engineer Research and Development Center, Waterways Experiment Station http://www.nan.usace.army.mil/Missions/CivilWorks/ProjectsinNewJersey/SandyHooktoBarnegatInlet/BiologicalMonitoringProgram.aspx

USACE, 2005. Jamaica Bay March Islands, Jamaica Bay, New York, Integrated Ecosystem Restoration Report, Environmental Assessment and Finding of No Significant Impact. December 2005.

USACE, 2013. Waterborne Commerce of the United States. Data for Jamaica Bay. Available online at: http://www.navigationdatacenter.us/wcsc/pdf/wcusatl13.pdf

USACE, 2015. 2015 Strategic Sustainability Performance Plan. June 30, 2015. Available online at: http://www.usace.army.mil/Portals/2/docs/Sustainability/Performance_Plans/2015_USACE_Sustainability_Plan.pdf

USACE. 2015a. Raritan Bay and Sandy Hook Bay, New Jersey, Combined Erosion Control and Coastal Storm Risk Management Project. Borough of Highlands Feasibility Study. Appendix B2: Coastal Engineering.

USACE, 2016. East Rockaway Inlet to Rockaway Inlet, NY Reformulation Study, Appendix B – Borrow Source Investigation. April 7, 2016.

U.S. Bureau of Labor Statistics, 2016. Civilian Labor Force in Nassau County, NY [NYNASS9LFN], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/NYNASS9LFN, April 2016.

U.S. Bureau of Labor Statistics, 2016. Unemployment Rate in Nassau County, NY [NYNASS9URN], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/NYNASS9URN, April 2016.

U.S. Census Bureau Economics, 2012. Accessed April 2016. Available Online at:

U.S. Census Bureau Housing, 2012. Accessed April 2016. Available Online at:

U.S. Census Bureau Quick Facts, 2016. Accessed April 2016. Available Online at:

U.S. Census Bureau. 2015. Income and Poverty in the United States: 2014. Current Population Reports. P60-252. Issued September 2015. https://www.census.gov/content/dam/Census/library/publications/2015/demo/p60-252.pdf

U.S. Census Bureau. 2014. 2014 American Community Survey 1-Year Estimates. On-line at: http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_1YR_S1701&prodType=table (accessed April 2016).

U.S. Census Bureau. 2014a. U.S. Poverty Thresholds in 2014. On-line at: https://www.census.gov/hhes/www/poverty/about/overview/measure.html (accessed April 2016).

U.S. Code of Federal Regulations, 1982. CBRA; 16 U.S.C. § 3505.

U.S. Code of Federal Regulations. 36 CFR Part 60.4.

U.S. Code of Federal Regulations. 36 CFR Part 800.

U.S. Department of Housing and Urban Development (HUD, 1991. Noise Abatement and Control (24 CFR Part 51B). Available online at: http://portal.hud.gov/hudportal/documents/huddoc?id=noiseabatement.pdf

U.S. Department of Agriculture (USDA), 2001. Soil Survey of Gateway National Recreation Area, New York and New Jersey.

U.S. Department of the Interior, National Park Service (NPS), 2015. Jamaica Bay Wildlife Refuge West Pond Trail Breach Repair Environmental Assessment. October, 2015.

U.S. EPA, 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. Prepared by Bolt, Beranek and Newman under contract 68-04-0047 for the U.S. Environmental Protection Agency Office of Noise Abatement and Control, Washington, D.C. 20460. December 31, 1971.

U.S. EPA, 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. Publication No. 550/9-74-004. Washington D.C. March 1974.

U.S. EPA, 1978. Protective Noise Levels. A Supplement to the USEPA Report: Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate

Margin of Safety, EPA/ONAC 550/9-74-004, March, 1974, Office of Noise Abatement and Control, Washington, D.C.).

U.S. EPA, 1981. Noise Effects Handbook. A Desk Reference to Health and Welfare Effects of Noise. Office of Noise Abatement and Control. October 1979, Revised July 1981.

U.S. EPA, 1983a. Region 2 Brooklyn - Queens Aquifer System: Support Document Kings and Queens Counties New York December 1983. Available on the Internet at:

U.S. EPA, 1983b. Region 2 Nassau-Suffolk Aquifer System: Support Document Nassau and Suffolk Counties, New York December May 1975. Available on the Internet at:

U.S. EPA. 1983. Brooklyn-Queens Aquifer System, Support Document. Available online at http://www.epa.gov/region2/water/aquifer/brooklyn/brooklyn.htm.

USDA, 2016a. Custom Soil Resource Report for Kings County, New York, Nassau County, New York, and Queens County, New York. Rockaway API. Web Soil Survey. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

USDA, 2016b. Custom Soil Resource Report for Kings County, New York, Nassau County, New York, and Queens County, New York. Jamaica Bay API. Web Soil Survey. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

USFWS, 1997. Significant habitats and habitat complexes of the New York Bight watershed. U.S. Fish & Wildlife service, Southern New England, New York Bight Coastal Ecosystems Program, Charlestown, RI.

USFWS, 2016. Coastal Barrier Resources System. Available online at: http://www.fws.gov/ecological-services/habitat-conservation/coastal.html

USGS, 2013. Geology of the New York City Region, A Preliminary Regional Field-Trip Guidebook. Available online at: http://3dparks.wr.usgs.gov/nyc/index.html

USGS, 2014. Quaternary fault and fold database for the United States, accessed 2016, from USGS web site: http://earthquake.usgs.gov/hazards/qfaults/map/hazfault2014.html

USGS, 2015. Geology of National Parks, 3D and Photographic Tours. Plumb Beach, Coney Island. Modified January 20, 2015. Available online at: http://3dparks.wr.usgs.gov/nyc/parks/loc71.htm

USGS, 2016. Earthquake Hazards Program. http://earthquake.usgs.gov/, http://earthquake.usgs.gov/earthquakes/shakemap/background.php

USGS, 2016. Topographic maps for Lynbrook, Brooklyn, Coney Island, Far Rockaway, Lawrence, Jamaica Bay, and The Narrows Quadrangles. 7.5 Minute Topographic maps, New York 2013.

USNDC, 2016. Port Facility Data Layer, Accessed April 2016. Available online at: http://www.navigationdatacenter.us/gis/arcexplorsteps.htm, http://www.navigationdatacenter.us/db/gisviewer/port_facility.kmz

Yasso, W. E. and E. M. Hartman, Jr. 1976. Beach Forms and Coastal Processes. MESA New York Bight Atlas, Monograph 11. New York Sea Grant Institute, Stony Brook, NY.

Yue, C., Mahoney, E., and Herbowicz, T., 2013. Economic Benefits to Local Communities from National Park Visitation, 2011. National Park Service, U.S. Department of the Interior, Natural Resource Report NPS/NRSS/ARD/NRR–2013/632. Available online at: https://www.nature.nps.gov/socialscience/docs/NPSSystemEstimates2011.pdf

USACE, 2001. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury Park to Manasquan Section Beach Erosion Control Project. Final Report". U.S. Army Engineer District, New York and U.S. Army Engineer Research and Development Center, Waterways Experiment Station http://www.nan.usace.army.mil/Missions/CivilWorks/ProjectsinNewJersey/SandyHooktoBarnegatInlet/BiologicalMonitoringProgram.aspx

14 INDEX*

Air Quality, 25, 183, 198, 199

Arverne, viii, xx, xxi, xxii, xxiii, xxvi, xxix, 5, 13, 16, 31, 53, 118, 120, 122, 126, 127, 128, 129, 134, 135, 138, 141, 161, 162, 164, 176, 177, 179, 180, 185, 210, 214, 218, 237

Atlantic Shorefront, v, vi, vii, x, xi, xii, xiii, xiv, xv, xxvi, xxvii, xxx, xxxi, 5, 6, 9, 14, 15, 18, 22, 23, 25, 28, 30, 31, 32, 35, 40, 41, 45, 47, 59, 61, 66, 67, 68, 69, 70, 72, 73, 79, 85, 86, 87, 88, 91, 93, 95, 100, 102, 104, 107, 109, 141, 145, 147, 148, 149, 150,152, 153, 154, 155, 156, 182, 185, 188, 190, 192, 194, 195, 196, 197, 198, 200, 202, 204, 205, 206, 207, 209, 212, 222, 225, 227, 239, 243

Benefits, vi, vii, x, xvi, xxv, xxxi, 11, 27, 65, 76, 80, 86, 89, 90, 92, 96, 97, 98, 99, 100, 102, 105, 107, 108, 109, 110, 112, 113, 114, 118, 122, 123, 125, 126, 128, 130, 131, 132, 133, 135, 138, 139, 140, 143, 145, 168, 171, 172, 173, 174, 177, 178, 179, 183,186, 187, 192, 193, 196, 197, 198, 201, 203, 205, 206, 207, 213, 214, 227, 235, 236, 238, 239, 240, 241, 242, 243, 244, 249, 251, 256, 259, 261, 284

Berm, vii, x, xviii, xx, xxii, xxiii, xxvii, xxviii, xxix, 11, 12, 21, 22, 64, 65, 86, 93, 94, 95, 96, 97, 98, 99, 100, 118, 136, 138, 145, 147, 149, 150, 159, 161, 163, 164, 166, 181, 190, 194, 210, 231, 232, 236, 257

Borrow Area, vi, x, xxv, 17, 25, 28, 30, 52, 57, 58, 92, 93, 188, 203, 204, 214, 223, 224, 231, 232, 238, 240, 247, 259, 280

Bulkhead, xvi, xviii, xx, xxii, xxvii, xxviii, xxix, 63, 88, 89, 121, 132, 157, 159, 163

Cedarhurst-Lawrence, viii, xvi, xvii, xxvii, xxx, xxxi, 62, 87, 120, 121, 122, 132, 133, 134, 135, 139, 140, 143, 145, 157, 158, 167, 168, 171, 174, 176, 177, 180

Coastal Storm Risk Management, i, iv, v, vii, viii, xxv, xxvii, 1, 2, 3, 5, 13, 14, 41, 66, 73, 76, 80, 81, 82, 83, 85, 86, 87, 88, 89, 90, 91, 95, 96, 98, 99, 100, 101, 102, 104, 109, 114, 115, 116, 117, 119, 120, 122, 123, 124, 125, 138, 142, 145, 147, 176, 177, 180, 185, 186, 189, 192, 196, 197, 213, 230, 232, 233, 235, 236, 239, 243, 244, 247, 251, 257, 259, 272, 281, 288

Coastal Zone, 36, 37, 39, 212, 229, 231, 232, 249

Cost, ii, iv, vi, vii, x, xvi, xxv, xxviii, xxxi, 1, 11, 12, 20, 38, 62, 80, 86, 91, 92, 93, 94, 95, 97, 98, 99, 100, 105, 106, 107, 108, 109, 110, 112, 113, 114, 115, 118, 119, 120, 121, 122, 124, 126, 128, 130, 131, 132, 134, 135, 137, 138, 139, 140, 143, 145, 166, 167, 168, 169, 170, 171, 185, 186, 187, 193, 215, 233, 234, 259, 260, 261, 262, 263, 264

Cumulative Effects, 228, 229, 236

Edgemere, viii, xviii, xix, xx, xxvi, xxviii, 5, 16, 53, 118, 120, 122, 126, 129, 130, 131, 134, 135, 138, 141, 159, 160, 161, 176, 177, 179, 180, 185, 218, 219

Endangered Species, 29, 31, 34, 83, 142, 208, 209, 229, 240, 242, 243, 247, 249, 288

Environmental Consequences, 192, 217, 263

Environmental Justice, 59, 183, 224, 226, 227, 251, 279, 290

Fish, 18, 24, 25, 26, 28, 29, 32, 37, 39, 40, 41, 42, 58, 65, 179, 180, 183, 204, 205, 207, 208, 211, 214, 223, 224, 228, 235, 237, 240, 241, 242, 248, 249, 250, 251, 268, 272, 283, 288, 290

Fish and Wildlife, 32, 37, 39, 40, 41, 42, 65, 235, 237, 241, 249, 250, 251, 268, 272, 290

Floodwall, xvi, xviii, xx, xxii, xxiii, xxvii, xxviii, xxix, 89, 118, 121, 137, 138, 140, 157, 159, 161, 163, 164, 166, 169

General Conformity, 199, 200

Groin, vi, vii, x, xxvii, 11, 68, 86, 87, 88, 91, 92, 93, 94, 95, 145, 147, 149, 150, 169, 182, 191, 193, 194, 207, 210, 223, 231, 243, 248, 281

Habitats, ii, iv, xviii, xx, xxii, xxv, 17, 22, 25, 26, 27, 28, 29, 30, 31, 32, 34, 37, 38, 39, 40, 41, 42, 43, 44, 65, 79, 83, 86, 97, 104, 105, 106, 107, 111, 117, 118, 119, 120, 121, 122, 124, 136, 139, 142, 159, 161, 163, 175, 176, 177, 178, 179, 180, 183, 186, 189, 194, 196, 197, 200, 201, 202, 203, 204, 205, 206, 207, 208, 210, 211, 228, 229, 230, 231, 232, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 248, 249, 251, 257, 263, 278, 283, 288

Hammels, viii, xxiii, xxiv, xxv, xxvi, xxix, 5, 16, 53, 120, 122, 126, 127, 134, 135, 141, 164, 165, 166, 176, 177, 180, 185, 218, 222

HFFRRF, ii, vi, viii, xvi, xvii, xix, xxi, xxiv, xxvi, xxix, xxxi, 62, 67, 87, 114, 115, 118, 119, 120, 121, 122, 123, 124, 126, 131, 132, 133, 134, 136, 137, 139, 140, 143, 145, 157, 158, 159, 160, 161, 162, 165, 167, 168, 170, 171, 172, 173, 174, 177, 179, 182, 183, 184, 186, 187, 188, 189, 190, 196, 198, 201, 210, 214, 215, 217, 218, 219, 220, 222, 244, 264, 289

Hurricane Sandy, i, ii, iv, v, x, 1, 2, 9, 12, 13, 14, 20, 21, 22, 54, 55, 62, 63, 64, 65, 70, 71, 73, 77, 81, 83, 107, 136, 141, 145, 184, 191, 200, 212, 214, 221, 232, 233, 234, 239, 264, 274, 275, 279, 289

Mid-Rockaway, viii, xvi, xviii, xix, xx, xxi, xxiii, xxiv, xxviii, xxix, xxx, xxxi, 53, 120, 122, 123, 126, 127, 128, 134, 135, 137, 139, 140, 143, 145, 157, 159, 160, 161, 162, 164, 165, 167, 168, 171, 173, 176, 177, 179, 180, 210, 214, 222, 264

Mitigation, 47, 63, 64, 106, 112, 175, 200, 201, 235, 243, 245, 277, 279

Motts Basin North, 118, 120, 122, 123, 133, 134, 135, 140, 143

Nassau County, ii, viii, xvi, 3, 5, 7, 14, 19, 23, 37, 56, 60, 62, 77, 87, 116, 121, 122, 157, 185, 221, 275, 281, 282, 283

NNBF, xviii, xxii, xxviii, xxix, 79, 80, 89, 90, 115, 117, 118, 119, 122, 123, 124, 136, 137, 138, 139, 159, 163, 178, 190, 194, 197, 201, 203, 209, 215, 244, 289

NYSDEC, ii, vi, 2, 12, 21, 23, 24, 28, 32, 34, 42, 46, 47, 59, 60, 85, 200, 206, 208, 222, 224, 225, 229, 230, 235, 236, 242, 246, 247, 250, 257, 262, 263, 268, 273, 278, 279, 290

Perimeter Plan, vii, 13, 85, 101, 104, 105, 107, 109, 114, 116, 119

Public Involvement, 264

Recommended Plan, i, ii, viii, ix, x, xi, xii, xiii, xiv, xv, xvi, xxv, xxvi, xxvii, xxxi, 1, 2, 59, 62, 68, 86, 87, 101, 106, 113, 114, 133, 134, 139, 140, 141, 142, 143, 144, 145, 146, 147, 149, 150, 152, 153, 154, 155, 156, 157, 166, 168, 169, 170, 171, 172, 174, 175, 178, 179, 180, 183, 184, 185, 186, 188, 189, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 211, 212, 213, 214, 215, 222, 225, 227, 228, 229, 232, 237, 238, 239, 240, 241, 243, 244, 245, 246, 247, 248, 249, 250, 251, 253, 255, 256, 257, 259, 261, 262, 263, 272

Recreation, ii, v, vi, xxxi, 3, 5, 11, 17, 24, 25, 31, 35, 36, 41, 43, 44, 46, 50, 51, 52, 53, 54, 56, 60, 64, 66, 83, 86, 89, 90, 97, 98, 99, 107, 108, 171, 172, 173, 183, 184, 187, 208, 212, 213, 227, 230, 237, 250, 262, 273, 274, 275, 276, 277, 279, 280, 282, 288, 289

Rock Sill, xxviii, xxix, 80, 178

Rockaway peninsula, vi, 1, 3, 5, 15, 16, 25, 38, 39, 42, 45, 46, 52, 58, 59, 85, 86, 87, 91, 92, 100, 109, 185

Sea Level Change, 19, 23, 24, 68, 71, 72, 73, 93, 98, 99, 169, 181, 182, 188, 196, 290

Seawall, vii, x, xxvi, xxvii, 86, 89, 95, 96, 97, 98, 99, 100, 107, 145, 147, 148, 169, 181, 182, 183, 185, 188, 190, 191, 193, 200, 210, 224, 239

Storm Surge Barrier Plan, vii, 13, 85, 101, 102, 109, 114

Tentatively Selected Plan, i, vii, 14, 86, 87, 101, 103, 107, 108, 109, 110, 113, 114, 142, 144, 185, 186, 187, 264, 290

Vegetation, 21, 25, 26, 27, 32, 42, 64, 65, 86, 97, 119, 136, 205, 207, 210, 211, 227, 228, 231, 237, 239, 243

Water Quality, 23, 180, 197, 228, 229, 238, 247, 275, 279

Wetlands, xviii, xx, xxii, 2, 5, 21, 22, 26, 27, 37, 38, 42, 61, 64, 65, 67, 69, 70, 75, 78, 79, 87, 89, 106, 112, 115, 116, 117, 118, 124, 136, 139, 143, 159, 161, 163, 175, 176, 177, 178, 179, 183, 186, 193, 194, 196, 197, 198, 201, 202, 203, 204, 205, 207, 209,224, 228, 229, 230, 232, 234, 235, 236, 237, 238, 239, 242, 243, 244, 251, 288

15 LIST OF ACRONYMS

AAEQ	Average Annual Equivalent
ABU	Authorized-But-Unconstructed
ADM	Agency Decision Milestone
AEP	Annual Exceedance Probability
APE	Area of Potential Effect
ATR	Agency Technical Review
BA	Biological Assessment
BFE	Base Flood Elevation
BMP	Best Management Practice
CAR	Coordination Act Report
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CDP	Census-Designated Place
CEA	Critical Environmental Area
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	Cubic Feet Per Second
CSO	Combined Sewer Overflow
CSRM	Coastal Storm Risk Management
DASNY	Dormitory Authority of the State of New York
DCP	New York City Department of City Planning
DPR	New York City Department of Recreation
EAD	Equivalent Annual Damages
EFH	Essential Fish Habitat
EPW	Evaluation for Planned Wetlands
ER	Engineer Regulation
ESA	Endangered Species Act
FCI	Functional Capacity Index
FCU	Functional Capacity Unit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission

FIRM	Flood Insurance Rate Map
FWOP	Future Without Project
GHG	Greenhouse Gas
GNRA	Gateway National Recreation Area
GOSR	Governor's Office of Storm Recovery
GRR	General Reevaluation Report
HEP	New York/New Jersey Harbor Estuary Plan
HFFRRF	High Frequency Flooding Risk Reduction Feature
HQUSACE	U.S. Army Corps of Engineers Headquarters
HRE CRP	Hudson-Raritan Estuary Comprehensive Restoration Plan
HSGRR/EIS	Hurricane Sandy General Reevaluation Report & Environmental Impact Statement
HTRW	Hazardous, Toxic, and Radiological Waste
IEPR	Independent External Peer Review
LAA	Likely to Adversely Affect
LF	Linear Feet
LERRDs	Lands, Easements, Relocations, Right-of-ways, and Disposal Areas
MHHS	Mean High Water Springs
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lower Low Water
MVERP	Marine Vessel Engine Replacement Program
NACCS	North Atlantic Coast Comprehensive Study
NAVD88	North American Vertical Datum of 1988
NED	National Economic Development
NEPA	National Environmental Policy Act
NLAA	Not Likely to Adversely Affect
NMFS	National Marine Fisheries Service
NNBF	Natural and Nature Based Feature
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRC	National Research Council
NYC	New York City

NYCLPC	New York City Landmarks Preservation Commission
NYNJHATS	New York / New Jersey Harbor and Tributaries Study
NYSDEC	State of New York Department of Environmental Conservation
NYSDOS	New York State Department of State
O&M	Operations and Maintenance
OMRR&R	Operation, Maintenance, Repair, Replacement & Rehabilitation
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PAL	Planning Assistance Letter
PDT	Project Delivery Team
PED	Preconstruction, Engineering, and Design
PEJA	Potential Environmental Justice Area
PPA	Project Partnership Agreement
ROI	Region of Influence
RSLR	Relative Sea Level Rise
SLC	Sea Level Change
TPCS	Total Project Cost Summary
TSP	Tentatively Selected Plan
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WWTP	Wastewater Treatment Plant

US Army Corps of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix A1

Shorefront Engineering and Design Appendix

December 2018

TABLE OF CONTENTS

LIST OF ACRONYMS VIII
1 PROJECT DESCRIPTION 2
1.1 Overview of Engineering & Design Appendix 2
1.2 Reach Delineation 3
1.3 Overview of Engineering and Design and Numerical Models 4
1.3.1 Numerical Models 4
1.3.2 Vertical and Horizontal Datum 4
2 PROJECT AREA HISTORY 5
2.1 Storm History 5
2.1.1 Hurricane of 21 September 1938 5
2.1.2 Hurricane (Donna) of 12 September 1960 5
2.1.3 Storm of 6-8 March 1962 6
2.1.4 Storm of 28-30 March 1984 6
2.1.5 Hurricane Gloria of 27 September 1985 7
2.1.6 Halloween Northeaster of 30 October, 1991 7
2.1.7 Northeaster of December 1992 7
2.1.8 Hurricane Irene of 27 August 2011 7
2.1.9 Hurricane Sandy of 29 October 2012 7
2.2 Shoreline History 10
2.2.1 Data Sources 10
2.2.2 Analysis of Shorelines 10
2.3 Engineering Activities 13
2.3.1 Coastal Structures 13
2.3.2 Beach Restoration 15
2.3.3 Inlet Maintenance Dredging 17
2.3.4 East Rockaway Inlet Channel 19
2.3.5 Rockaway Inlet Channel 21
3 PERFORMANCE OF PRIOR PROJECTS 24
3.1 WRDA 1974 Beach Erosion Control Project (1978-1988) 24
3.2 Section 934 Beach Erosion Control Project (1996-2004) 26
3.3 Section 934 Beach Profile Surveys 28
3.3.1 Data Availability 28
3.3.2 Volumetric Changes 30
3.4 Summary 33
4 EXISTING CONDITIONS 35

4.1 General 35
4.2 Astronomical Tides 35
4.3 Storm Tides 35
4.4 Sea Level Rise 38
4.5 Waves 39
4.6 Wave Setup 41
4.7 Structural Condition 42
5 BORROW SOURCE 45
5.1 Historical Borrow Areas 45
5.2 Native Beach Model 46
5.2.1 Native Beach Sediment Data 46
5.2.2 Native Beach Model Development 46
5.3 Potential Upland Source 48
5.4 Potential Nearshore Source 49
5.5 Potential Offshore Borrow Areas 49
5.6 Borrow Area A-West 50
5.7 Borrow Area A-East 50
5.8 Borrow Area B-West 50
5.9 Recommended Borrow Source for Further Investigation 51
5.10 Impacts of Borrow Area Dredging 51
6 SEDIMENT BUDGET 53
6.1 Formulating a Sediment Budget 53
6.2 Historical Sediment Budget 53
6.3 Without Project Sediment Budget 59
6.3.1 GENESIS-T Modeling 59
6.3.2 Without Project Future Conditions Sediment Budget 61
6.3.3 Sea Level Rise (SLR) 62
6.3.4 Two-Cell Sediment Budget 62
6.3.5 Seven-Cell Sediment Budget 63
6.4 With Project Sediment Budget 67
7 ALTERNATIVE DEVELOPMENT 71
7.1 Overview 71
7.2 Erosion Control Alternatives 71
7.2.1 Screening Level Design 73
7.2.2 Preliminary Design Profile 74
7.2.3 Project Baseline & Alignment 75

7.2.4 Initial Construction Beachfill Quantities 75
7.2.5 Renourishment Operations 76
7.2.6 Boardwalk Relocation 78
7.2.7 Groin Design 78
7.2.8 Cost Estimates 86
7.3 Coastal Storm Risk Management Alternatives 90
7.3.1 Prior Projects 90
7.3.2 Performance 93
7.3.3 Beach Restoration and Dune Alternatives 93
7.4 Buried Seawall 99
7.5 Composite Seawall 100
7.5.1 Range of Proposed Seawall Configurations 101
7.5.2 Screening Criteria 101
7.5.3 Screening Methodology 101
7.5.4 Results 101
7.5.5 Screening Level Design 102
7.6 Plan Adaptations to SLC 105
7.6.1 Dune and Beach Restoration 106
7.6.2 Seawalls 107
7.6.3 Groins 110
7.6.4 CSRM Alternatives Comparison 110
8 THE RECOMMENDED PLAN 115
8.1 The Recommended Plan for the Atlantic Ocean Shorefront 115
8.1.1 Reinforced Dune – Composite Seawall 116
8.1.2 Beach Restoration 117
8.1.3 Groins 119
8.2 Quantities & Costs 120
8.3 Construction Schedule 121
8.4 Recommendations for PED 122
REFERENCES 124
A. SUB-APPENDIX A1.A: ENGINEERING MODELING APPENDIX 2
B. SUB-APPENDIX A1.B: SCREENING LEVEL COST ESTIMATES SUPPORTING DATA 2
C. SUB-APPENDIX A1.C: PLANS AND SECTIONS FOR THE RECOMMENDED PLAN FOR ATLANTIC OCEAN SHOREFRONT 2

LIST OF TABLES

Table 2-1: Groin and Bulkhead Construction by Decade 13
Table 2-2: List of Coastal Structures....14
Table 2-3: Historical Beach Fill Placement (Cubic Yards) by Reach....16
Table 2-4: Historical Beach Fill Placement Summary (Cubic Yards) 17
Table 2-5: East Rockaway Inlet Channel Dredging History....20
Table 2-6: Rockaway Inlet Channel Dredging History....23
Table 3-1: WRDA 1974 Beachfill Events....26
Table 3-2: Section 934 Beachfill Events....28
Table 3-3: Profile Survey Availability 30
Table 3-4: Volumetric Changes (cy/ft)....31
Table 3-5: Summary of Shoreline Changes (ft/yr) 33
Table 3-6: Comparison of WRDA 1974 and Section 934 Renourishment Operations....34
Table 4-1: Tidal Datum Relationships 35
Table 4-2: Ocean Stage Frequency Elevations (ft, NAVD88) 38
Table 4-3: Bay Stage Frequency Elevations (ft, NAVD88)....38
Table 4-4: Offshore and Nearshore Wave Conditions 40
Table 4-5: Wave Setup 41
Table 4-6: Coastal Structures Condition Survey Summary 43
Table 5-1: Average Values of the Rockaway Beach Sediment Samples by Beach Area ...47
Table 5-2: Native Beach Model Characteristics....47
Table 5-3: Characteristics of Upland Sand Sources for Rockaway 49
Table 5-4: Potential Borrow Area Coordinates....51
Table 6-1: Sea Level Rise Impacts on Shoreline Changes and Sediment Budget 62
Table 6-2: Two-Cell WOPFC Shoreline Changes 63
Table 6-3: Seven-Cell WOPFC Shoreline Changes....64
Table 7-1: Initial Construction Beachfill Quantities 76
Table 7-2: Renourishment Quantities per Operation....78
Table 7-3: Summary of Groin Lengths 80
Table 7-4: Typical Groin Quantities for New Construction Reaches 3 & 4 (Alt 3) 81
Table 7-5: Typical Groin Quantities for New Construction Reach 6a (Alt 3) 81
Table 7-6: Typical Groin Quantities for Extensions Reach 6a (Alt 3)....81
Table 7-7: Unit Prices....87
Table 7-8: Erosion Control - Initial Construction Cost Estimates 88
Table 7-9: Erosion Control - Renourishment Cost Estimates 89
Table 7-10: Erosion Control Life-Cycle Cost Estimates – Atlantic Ocean Shorefront Formulation Summary....89

Table 7-11: Adjusted Beach Berm Width for Prior Projects (Including Advance Fill) 91
Table 7-12: Design Beach Profiles 96
Table 7-13: Wave Transmission Coefficients 100
Table 7-14: Recommended Level of Risk Reduction of Reinforced Dunes 102
Table 7-15: Recommended Level of Risk Reduction for Design Beachfill Profiles 103
Table 7-16: Recommended Level of Risk Reduction of Reinforced Dunes 104
Table 7-17: Low SLR CSRM Benefits 112
Table 7-18: Intermediate SLR CSRM Benefits 113
Table 7-19: High SLR CSRM Benefits 114
Table 8-1: Initial Construction Beachfill Quantities (CY) 118
Table 8-2: Renourishment Quantities per Operation[1] 119
Table 8-3: Summary of Groin Lengths for the Recommended Plan 119
Table 8-4: MII Estimate Recommended Plan – Atlantic Ocean Shorefront Reach 121

LIST OF FIGURES

Figure 1-1: Rockaway Shorefront Engineering Reaches 3
Figure 2-1: Hurricane Sandy Flood Inundation 8
Figure 2-2: Pre- and Post-Storm Photo Comparison at Rockaway Beach 9
Figure 2-3: Shoreline Evolution: 1880-1934 10
Figure 2-4: Shoreline Evolution: 1934-1962 11
Figure 2-5: Shoreline Evolution: 1962-1970 11
Figure 2-6: Shoreline Evolution: 1970-2010 12
Figure 2-7: East Rockaway Inlet Channel 18
Figure 2-8: Rockaway Inlet Chanel 19
Figure 3-1: Authorized Construction Profile for Flood Control Act of 1965 24
Figure 3-2: Erosional Hot Spots 27
Figure 3-3: ACNYMP Locations 29
Figure 3-4: ACNYMP Data at Profile 30 31
Figure 3-5: ACNYMP Data at Profile 35 32
Figure 4-1: Components of Water Surface Elevation 37
Figure 4-2: Location of Wave Stations 40
Figure 4-3: Cross-shore Location at which Wave Setup is extracted from SBEACH 42
Figure 5-1: Historical Offshore Borrow Areas for Rockaway Beach 45
Figure 5-2: Native Beach Model 48

Figure 5-3: Example of Nearshore Wave Changes from Dredging....52
Figure 6-1: Historical Shoreline Changes (1975-2010)....54
Figure 6-2: 2-Cell Historical Sediment Budget (1975-2010)....57
Figure 6-3: 7-Cell Historical Sediment Budget (1975-2010)....58
Figure 6-4: WOPFC Shoreline Changes....60
Figure 6-5: WOPFC Sediment Transport & Gross Volume Changes.....61
Figure 6-6: WOPFC Sediment Transport Pathways at Rockaway Beach....64
Figure 6-7: 2-Cell WOPFC Sediment Budget....65
Figure 6-8: 7-Cell WOPFC Sediment Budget....66
Figure 6-9: 7-Cell Alternative 1 Sediment Budget....68
Figure 6-10: 7-Cell Alternative 2 Sediment Budget....69
Figure 6-11: 7-Cell Alternative 3 Sediment Budget....70
Figure 7-1: Short-Listed Alternatives....73
Figure 7-2: Preliminary Design Profile (Applied in Erosion Control Evaluation)....74
Figure 7-3: Typical Groin in Reaches 3 & 4 – Profile View....82
Figure 7-4: Typical Groin in Reaches 3 & 4 – Section View....83
Figure 7-5: Typical Groin in Reach 6a – Profile View....84
Figure 7-6: Typical Groin in Reach 6a – Section View....85
Figure 7-7: Typical Groin Shortening in Reach 5 – Profile View....86
Figure 7-8: WRDA 1974 Construction Template and Design Profile (Reach 4)....91
Figure 7-9: Section 934 Construction Template and Design Profile (Reach 4)....92
Figure 7-10: FCCE Construction Template and Design Profile (Reach 4)....93
Figure 7-11: Medium Design Profile....97
Figure 7-12: Buried Seawall Example at Dam Neck, Virginia (USACE, 1999)....98
Figure 7-13: Seawall/Breakwater Structure Types (from Takahashi, 2002)....99
Figure 7-14: CIRIA Relationship for Wave Transmission at Low-Crested Structures....100
Figure 7-15: Beach Restoration and Dune Alternatives....103
Figure 7-16: Reinforced Dune Alternatives (Buried Seawall in top panel, composite seawall in lower panel)....105
Figure 7-17: Seawall Adaptability Measures....108
Figure 7-18: Graphic Representation of Adaptability of Atlantic Ocean Shorefront Measures (red markers indicate the years at which adaptation measures are expected to occur).....109
Figure 8-1: Schematic overview of the Beach Restoration and Groin features of the Recommended Plan for the Atlantic Ocean Shorefront Reach....116
Figure 8-2: Composite Seawall....117

Figure 8-3: Composite Seawall (Beach 126th Street to Beach 149th Street).....117
Figure 8-4: Design Beach Profile (note: Baseline location varies) 118
Figure 8-5: Schematic overview of the construction schedule for the Atlantic Ocean Shorefront Reach of the Recommended Plan.....121

LIST OF ACRONYMS

AASHTO	American Association of State Highway Transportation Officials
ACES	Automated Coastal Engineering System
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BOD	Basis of Design
CPT	Cone Penetration Test
CY	Cubic Yards
DDR	Design Documentation Report
E&D	Engineering & Design
EL.	Elevation
EM	Engineering Manual
ETL	Engineering Technical Letter
ER	Engineering Regulation
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
FS	Factor of Safety
FWOP	Future Without Project
FWP	Future With Project
FWS	Fish and Wildlife Service
GIWW	Gulf Intracoastal Waterway
HAT	Highest Astronomical Tide
HSDRRS	Hurricane Storm Damage Risk Reduction System
ITR	Independent Technical Review
ISO	International Standards Organization
LAT	Lowest Astronomical Tide
MHHW	Mean Higher-High Water
MHW	Mean High Water
MSL	Mean Sea Level
MLW	Mean Low Water
MLLW	Mean Lower-Low Water
NACCS	North Atlantic Comprehensive Study
NAN	USACE New York District
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
O&M	Operation and Maintenance
PED	Pre-Construction Engineering and Design
QA	Quality Assurance

OSHA	US Department of Labor, Occupational Safety and Health Administration
RSLR	Relative Sea Level Rise
PVC	Polyvinyl chloride
Rev	Revision
RSLR	Relative Sea Level Rise
ROW	Right of Way
SLR	Sea Level Rise
SPT	Standard Penetration Test
TOW	Top of Wall
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Engineering Appendix A1

Shorefront Engineering and Design

1 PROJECT DESCRIPTION

1.1 Overview of Engineering & Design Appendix

This Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet Hurricane Sandy General Revaluation Report Engineering Appendix summarizes the multiple models and analyses applied to evaluate and compare alternative features for each planning reach within the study area. Since each planning reach is exposed to different risk mechanisms while they must collectively function as a system, the engineering appendices document the evaluation process in separate sub appendices which detail the specific analyses applied to confirm the recommended plan is engineeringly feasible, complete and economically justified.

The initial study was limited to the Atlantic Ocean Shorefront Planning Reach and was conducted as a legacy study. The Jamaica Bay Planning Reach analysis was added following Hurricane Sandy and was conducted to broaden the recommended plan to the entire authorized study area and was conducted under SMART planning guidelines. The USACE transition to SMART Planning is an additional reason which resulted in the inclusion of multiple sub-appendices.

SMART planning documents propose a 10% design, documentation of risks and efforts to mitigate risks, and decisions made to expedite the opportunity for public and agency comment on the recommendation. More detailed design decisions are generally deferred to the Planning, Engineering and Design phase.

This Engineering & Design Appendix provides an overview of the analyses supporting the Shorefront Erosion Control alternative analysis and Shorefront Coastal Storm Risk Management (CSRM) alternative analysis for the Atlantic Ocean Shorefront Planning Reach.

This appendix includes a description of the project area history (Chapter 2) and the performance of prior projects in Chapter 3. Existing conditions inclusive of the water level, storm surge and wave conditions for the Atlantic shorefront are described in Chapter 4. Borrow source areas and considerations are presented in Chapter 5. Chapter 6 presents the sediment budget for the planning reach prior to the description of the project alternatives in Chapter 6. Two categories of alternatives, 1) Erosion Control Alternatives and 2) Coastal Storm Risk Management (CSRM) alternatives are addressed within that chapter. The general approach to identifying a recommended plan is to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost-effective approach to reducing project renourishment. This analysis is a lifecycle cost comparison to ensure that the most cost effective renourishment approach has been identified prior to the evaluation of alternatives that address coastal storm risk management. Secondly, the Coastal Storm Risk Management (CSRM) alternatives consist of various beachfill, dune and seawall measures to reduce future storm damages for Rockaway Beach. Chapter 8 presents the recommended plan.

The Engineering Appendix for the Shorefront Planning Reach is organized into multiple sub-appendices, which are a compilation of engineering work products which summarize the design and performance specifications which informed the Recommended Plan.

1.2 Reach Delineation

The Project Area has been divided into smaller segments known as reaches for the purpose of engineering and economic analysis. As shown in Figure 1-1, the Project Area is an 11 mile long narrow peninsula with Rockaway Inlet at the western project limit near Breezy Point and East Rockaway Inlet at the eastern limit near Beach 19 Street. The engineering analyses include historical erosion rates, sediment budget, historic shoreline changes and alternatives design considerations. The economic analyses include damages, cost, and benefit estimates. The reaches are developed based on physical, economic, and institutional differences including sediment transport rate boundaries, shoreline orientation, coastal structures, topographic elevations, and existing economic developments. The engineering reaches do not have to coincide with the economic reaches; however, they must be interrelated. The Project Area has been divided into six major reaches based on both engineering and economic considerations as follows:

- Reach 1: Rockaway Point to Beach 193rd Street
- Reach 2: Beach 193rd Street to Beach 149th Street
- Reach 3: Beach 149th Street to Beach 109th Street
- Reach 4: Beach 109th Street to Beach 86th Street
- Reach 5: Beach 86th Street to Beach 42nd
- Reach 6a: Beach 42nd Street to Beach 28th Street
- Reach 6b: Beach 28th Street to Beach 19th Street

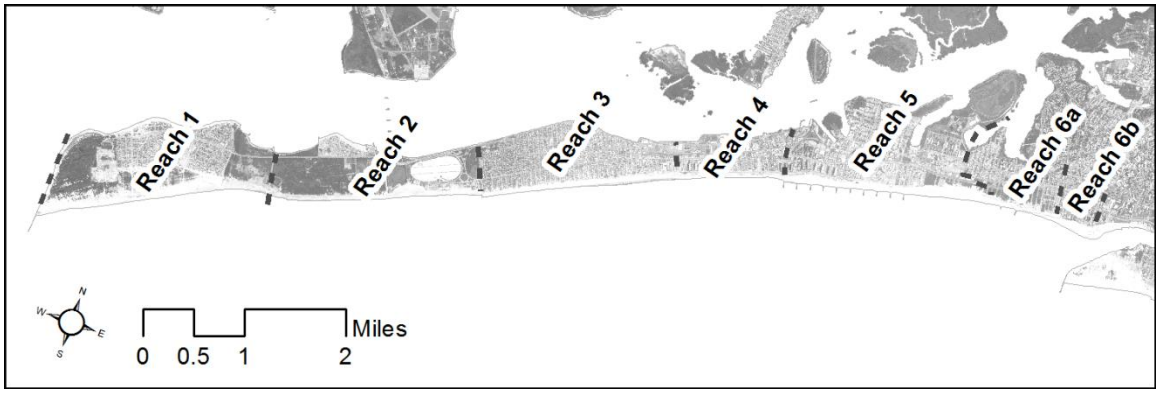


Figure 1-1: Rockaway Shorefront Engineering Reaches

1.3 Overview of Engineering and Design and Numerical Models

1.3.1 Numerical Models

The numerical modeling strategy for The Atlantic Ocean Shorefront addresses a comprehensive list of physical processes by utilizing a range of hydrodynamic, wave, sediment transport, and shoreline change models. The following numerical models were applied in the study:

- ADCIRC – storm surge propagation;
- WISWAVE – regional wave transformation;
- STWAVE – nearshore wave transformation;
- SWAN – nearshore wave transformation;
- GENESIS – long-term shoreline evolution;
- SBEACH – storm induced profile change;
- XBEACH – cross-island flooding.

A detailed description of these modeling efforts is provided in the Engineering Modeling Appendix (Sub-Appendix A). The results of these modeling analyses are used throughout this Engineering and Design Appendix.

1.3.2 Vertical and Horizontal Datum

Vertical elevations (EL.) of project components and features are referenced to the North American Datum of year 1988 (NAVD88), Geoid12A vertical reference system. All elevations throughout the report are referenced to NAVD88 Geoid12A and presented in feet unless otherwise stated.

The horizontal datum shall be the North American Datum of year 1983 (NAD83) Long Island, New York State Plane with units in feet, unless specifically noted otherwise.

2 PROJECT AREA HISTORY

2.1 Storm History

The study area is subject to damages from hurricanes and extra-tropical storms known as "northeasters". Hurricanes strike the study area more frequently in summer months from June to October while northeaster strike in winter months from January through March. Hurricanes that most severely affect the study area usually approach from the south-southwest direction after re-curving around eastern Florida and skirting the Middle Atlantic States. The most severe hurricane on record for the study area is Hurricane Sandy, which occurred on 29 October 2012.

Northeasters sometimes develop into more complex storms. Relative location of high and low pressure centers may cause wind speeds in excess of what could be expected from a single storm cell. Winds reaching almost hurricane strength may occur over many thousands of square miles. Northeasters may form with little or no advance warning and may persist for as long as a week to ten days. The most severe northeaster on record that struck the study area occurred on 6-8 March 1962 which caused serious tidal flooding and wide spread damage all along the Middle Atlantic Coast. The following paragraphs describe a few of the more notable hurricanes and northeasters that impacted the study area. A more detailed elaboration on storm suite used for modeling purposes is provided in Sub-Appendix A.

2.1.1 Hurricane of 21 September 1938

The center of this hurricane skirted the east coast of New Jersey and struck the south shore of Long Island near Moriches Inlet during a rising tide. The minimum barometric pressure at New York City was 28.72 inches. The U.S. Weather Bureau station near the Battery reported a gust velocity of 80 mph from the northwest. A maximum storm tide elevation of 4.3 ft NAVD88 was recorded at Sandy Hook, NJ. At Edgemere, about 500 summer cottages and 10 pleasure boats on Jamaica Bay were damaged. At Rockaway Beach, physical damage to waterfront private property and to pleasure boats was estimated at $25,000 and $56,000, respectively, as reported in 1938. A heavy sea swept away a large section of the breakwater near the Neponset Beach hospital east of Jacob Riis Park. It flooded the first floor, endangering approximately 130 children.

2.1.2 Hurricane (Donna) of 12 September 1960

Hurricane Donna made landfall approximately 100 miles east of Atlantic City, New Jersey at 11:00 am EST on September 12th. The hurricane eye passed near the study area and moved north during the high tide and became elongated and extended from New York City to Montauk Point. U. S. Air Force radar operators at Montauk Point indicated that the storm had separated into three eyes upon reaching this area. The weather bureau reported winds between 60 and 70 mph at 2:00 pm at New York City. The fastest speed recorded at LaGuardia Airport in Queens was 70 mph from northwest at 11:52 am with peak gust wind speed of 97 mph at 12:31 pm. The weather bureau at New York City reported a low barometric pressure of 28.65 inches at 1:40 pm. The near

coincidence of the storm's passage with the time of high tide in the study area resulted in the highest recorded storm water elevation (at the time) in the study area. Storm tide elevations peaked at +7.3 feet NAVD88 at Sandy Hook, NJ. High water marks in the study area were documented in the post-storm survey report (USACE, 1961). Based on Plate 4 of this report, the maximum ocean high water marks were approximately +10.2 feet NAVD88 and maximum bay high water marks were approximately +8.3 feet NAVD88.

Total damages in Rockaway reached $8,774,000 as reported in 1960. Ocean flooding and wave attack damages were chiefly residential and, to a lesser extent, commercial. About 6,000 homes and hundreds of commercial establishments were damaged. There was extensive damage to passenger cars, as well as public and private schools. Many streets of the low-lying Rockaway Peninsula were under 3 to 4 feet of water, which remained several feet deep in many areas for four days because of inadequate drainage facilities. In Arverne and Far Rockaway (Beach 74th to 32nd streets), there was a major breach, as bay and ocean waters met, causing physical damages of more than $2,500,000 to homes. Commercial losses were exceptionally severe near Edgemere Avenue and Beach 34th street in Far Rockaway, where ten stores were completely ruined and subsequently went out of business.

2.1.3 Storm of 6-8 March 1962

This extratropical storm resulted from the merging of two storms. One storm moved easterly from the Midwest, while the other storm moved northerly up the coast. The storms merged off the mid-Atlantic coast and remained nearly stationary. Strong offshore winds over a long fetch of ocean affected the entire Atlantic coast for three days. This storm has been described as one of the most destructive extra tropical cyclones ever to hit the United States coastline, and is one of the most destructive to hit the study area. A continuous storm surge height of 3 to 5 feet coupled with spring tides resulted in prolonged storm tides with a maximum elevation of 6.6 ft NAVD88 at Sandy Hook, NJ. High water marks in the study area were documented in a post-storm survey report (USACE, 1963). Based on Plate 2 of this report, the maximum ocean high water marks were approximately +9.2 feet NAVD88 and maximum bay high water marks were approximately +7.7 feet NAVD88.

The Rockaway Peninsula suffered total estimated damage of $8,450,400 as reported in 1962. Damaging high waters occurred on five successive high tides over a period of 48 hours. The storm tides combined with the high waves to carry flood waters to buildings which would ordinarily be beyond the reach of ocean water. The storm's long duration caused unprecedented beach erosion, damage to groins and jetties, and destruction of houses on sites which had been considered safe for 60 to 80 years.

2.1.4 Storm of 28-30 March 1984

This extra-tropical storm threatened the study area, but available data indicated that it caused no damages except for beach erosion, which was caused by high waves driven by storm winds up to

84 mph. A maximum storm tide elevation of +5.9 ft NAVD88 was recorded at Sandy Hook, New Jersey.

2.1.5 Hurricane Gloria of 27 September 1985

This hurricane made landfall at Fire Island, 50 miles east of the study area, at 11:00 am EST on September 27th. The forward velocity was reduced by the rotational velocity at the study area, resulting in moderate damage to the study area. A storm surge height of 7.3 feet was recorded at Sandy Hook, NJ but coincided with low tide resulting in maximum storm tide elevation of only 5.7 ft NAVD88. If the storm had occurred closer to high tide the flooding impacts could have been severe.

2.1.6 Halloween Northeaster of 30 October, 1991

Overwash from this extratropical storm resulted in beach sand deposits on residential streets 100 to 200 feet landward of the boardwalk/beach. Beach erosion in the area between Beach 31st and Beach 34th streets resulted in the high water line (+1.3 ft NAVD88) reaching the boardwalk. A maximum storm tide elevation of +5.7 ft NAVD88 was recorded at Sandy Hook, NJ.

2.1.7 Northeaster of December 1992

One of the fiercest extratropical storms this century battered the project area for 48 hours with fierce rain, hurricane force winds, and near records storm tides. Ambrose Light station just southeast of New York City recorded sustained winds of 80 mph and gust to 93 mph. A record tying storm tide of +7.3 ft NAVD88 was recorded at Sandy Hook, NJ. The storm caused flooding and beach sand to wash up on residential streets. As a result of the flooding most of the roads on the peninsula were impassable and subway service was shutdown.

2.1.8 Hurricane Irene of 27 August 2011

In August 2011, Hurricane Irene was downgraded to a tropical storm right before it made landfall in New York City. In preparation the City issued the first-ever mandatory evacuation of coastal areas, including the entire project area. A storm tide of +7.0 ft NAVD88 was recorded at Sandy Hook, NJ. Damage to the boardwalk, beach erosion, and overwash and sand deposits were reported in the project area. The impacts of the storm were less than anticipated as the storm weakened just prior to making landfall.

2.1.9 Hurricane Sandy of 29 October 2012

On 29 October 2012, Hurricane Sandy made landfall approximately five miles south of Atlantic City, NJ, where it collided with a blast of arctic air from the north, creating conditions for an extraordinary and historic storm along the East Coast with the worst coastal impacts centered on the northern New Jersey, New York City, and the Long Island coastline. Hurricane Sandy's unusual track and extraordinary size generated record storm surges and offshore wave heights in the New York Bight. The maximum water level at The Battery, NY peaked at +11.3 feet NAVD88,

exceeding the previous record by over 4 feet. The tide gauge at Sandy Hook, NJ reached +10.4 ft NAVD88 before failing. USGS deployed storm tide sensors and high water marks surveyed by the USGS after the storm indicate that the maximum water levels during Sandy varied between +12.9 ft NAVD88 and +10.3 ft NAVD88 within the Project Area (USGS, 2013).

Rockaway was one of the hardest hit areas by Hurricane Sandy. An overview of the extent of flooding in the project area is shown in Figure 2-1. As the storm surge rose the peninsula was flooded first with water from the ocean and then later with water from the bay. Strong ocean waves and currents carried water, sediment, and debris across the peninsula leaving behind a wake of destruction (Figure 2-2). Many homes and other buildings, including the boardwalk, were destroyed by waves or flooding and many more were severely damaged. At least four people are known to have died in this area. In addition to the direct effects of flooding, the storm caused the outbreak of multiple fires in Rockaway caused by the interaction electricity and sea water, including one in Breezy Point that destroyed over 100 homes. Critical services like electricity and water were knocked out leading to dangerous conditions, particularly in high-rise structures.

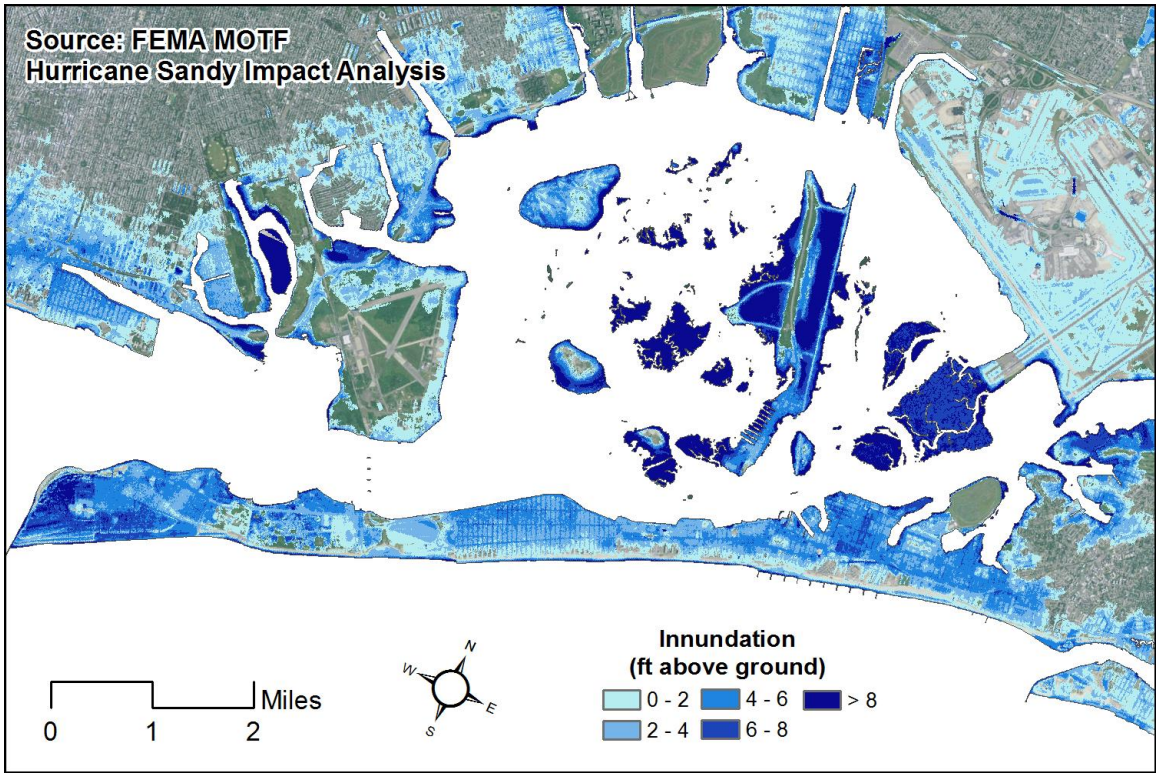


Figure 2-1: Hurricane Sandy Flood Inundation

Figure 2-2: Pre- and Post-Storm Photo Comparison at Rockaway Beach

2.2 Shoreline History

2.2.1 Data Sources

High water shoreline surveys for the Rockaway Peninsula were obtained from U.S. Coast and Geodetic Survey records, and digitized aerial photography. Shoreline surveys show significant reconfiguration of the landforms over the period of record, which extends from year 1880 to present.

2.2.2 Analysis of Shorelines

The evolution of the shoreline along the Rockaway Peninsula may be characterized by several distinct time periods based on inlet stabilization, beachfill activities, and construction of erosion control structures (e.g. stone and timber groins).

1835-1934: Pre-Inlet Stabilization

Prior to the stabilization of Rockaway and East Rockaway Inlets the shoreline experienced large morphological changes including the growth of the Rockaway Peninsula to the southwest by more than 4 miles (Figure 2-3), and westward migration of East Rockaway Inlet (not shown). This time period is also characterized by construction of numerous bulkheads and groins (constructed between 1914 and 1930) and placement of fill for land development purposes.

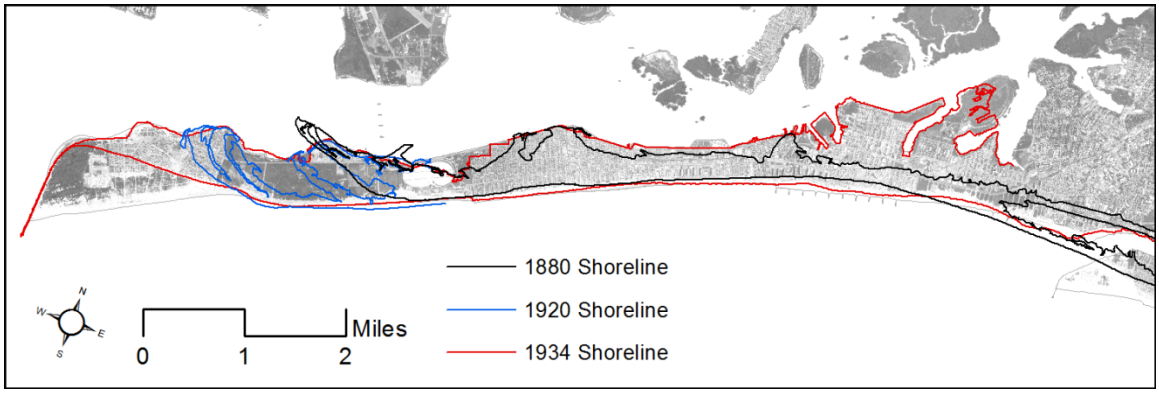


Figure 2-3: Shoreline Evolution: 1880-1934

1934-1961: Post-Inlet Stabilization

In 1933 an 8,400 ft long stone jetty was constructed on the updrift (eastern) side of Rockaway Inlet to stabilize the inlet. One year later, 1934, a 4,500 foot long stone jetty was constructed on the updrift (eastern) side of East Rockaway Inlet to stabilize the inlet. A second jetty was authorized for construction on the downdrift (eastern) side of East Rockaway Inlet but was never constructed. The construction of the jetties halted the westward migration of the inlets and stabilized their position. Shortly after the construction of the Rockaway Inlet jetty (1936) approximately 5 million cubic yards of fill was placed at the western end of Rockaway for land development. The fillet updrift of Rockaway Inlet continued to grow over this time period (Figure 2-4) creating the area

now called Breezy Point. From 1930-1976 no maintenance dredging was required at Rockaway Inlet as nearly all of the sediment was impounded updrift of the jetty. This time period is also characterized by construction of additional stone and timber groins and sporadic beachfill projects. Construction of five stone groins in Reach 6a (Beach 36th St. to Beach 49th St) was completed in 1956. The seven stone groins in Reach 5 were constructed from 1961-1962.

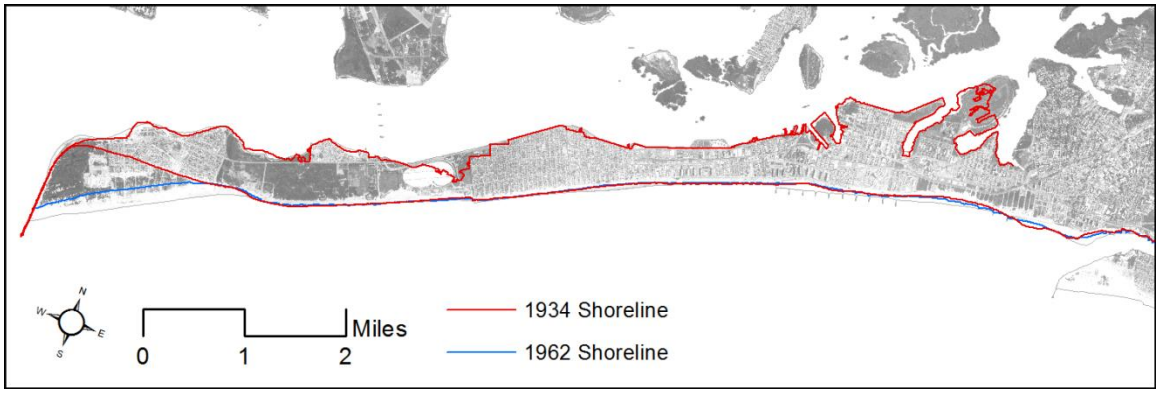


Figure 2-4: Shoreline Evolution: 1934-1962

1961-1973: No Engineering Activities

The Section 934 study (USACE 1993) examined shoreline changes between 1961 and 1973 based on profile surveys. This time period was chosen because no major beachfill operations occurred and all the shore stabilization groins were complete except the Beach 149th St. terminal groin, which was built in 1982. The only fill placement during this time period, 175,000 cubic yards, occurred in Reach 5 in 1962. Over this time period the shoreline was relatively stable, with shoreline change rates between +7.9 ft/yr and – 5.4 ft/yr. It is noted that in 1962 a very strong Nor'easter known as the "Ash Wednesday Storm of 1962" caused extensive coastal erosion as the storm persisted over 5 high tides. The 1962 shoreline is based on an aerial image taken on July of 1962, four months after the Ash Wednesday Storm.

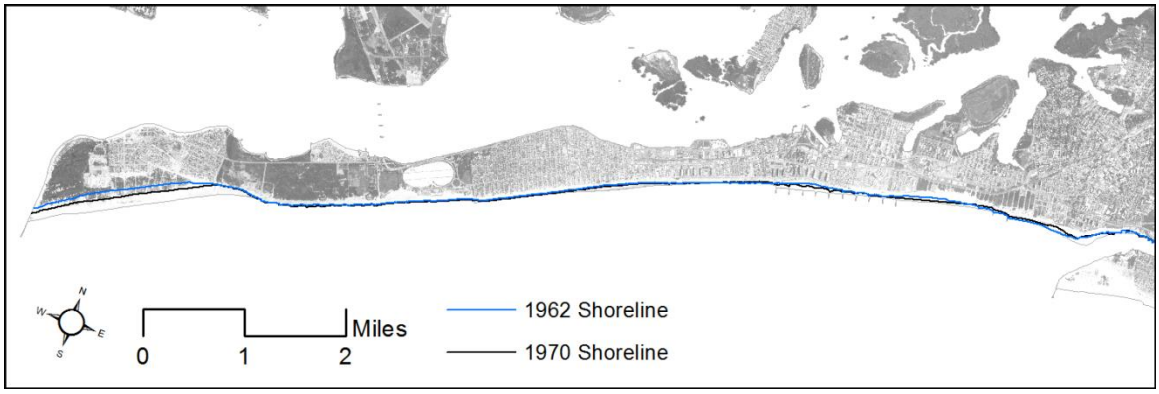


Figure 2-5: Shoreline Evolution: 1962-1970

1975-Present: WRDA 1974 & Section 934 WRDA 1986

This time period encompasses two major beach nourishment projects with intermittent renourishment and routine maintenance dredging of East Rockaway Inlet. An estimated 18.7 million cubic yards of beach fill was placed at Rockaway Beach during this time period. The shoreline positions fluctuated over this period in concert with the beach nourishment activities (Figure 2-6). The impact of 1975 beachfill project in Reach 4 and 5 is captured by the shoreward advance of the shoreline in these two reaches. Over this time period the net change in the shoreline position along the central portion of The Atlantic Ocean Shorefront (Reach 2 to Reach 5) is relatively small. The shoreline in Reach 1 and Reach 6b has advanced seaward by several hundred feet.

A detailed description of the performance of the two beach nourishment projects constructed during this period is provided in Section 3.

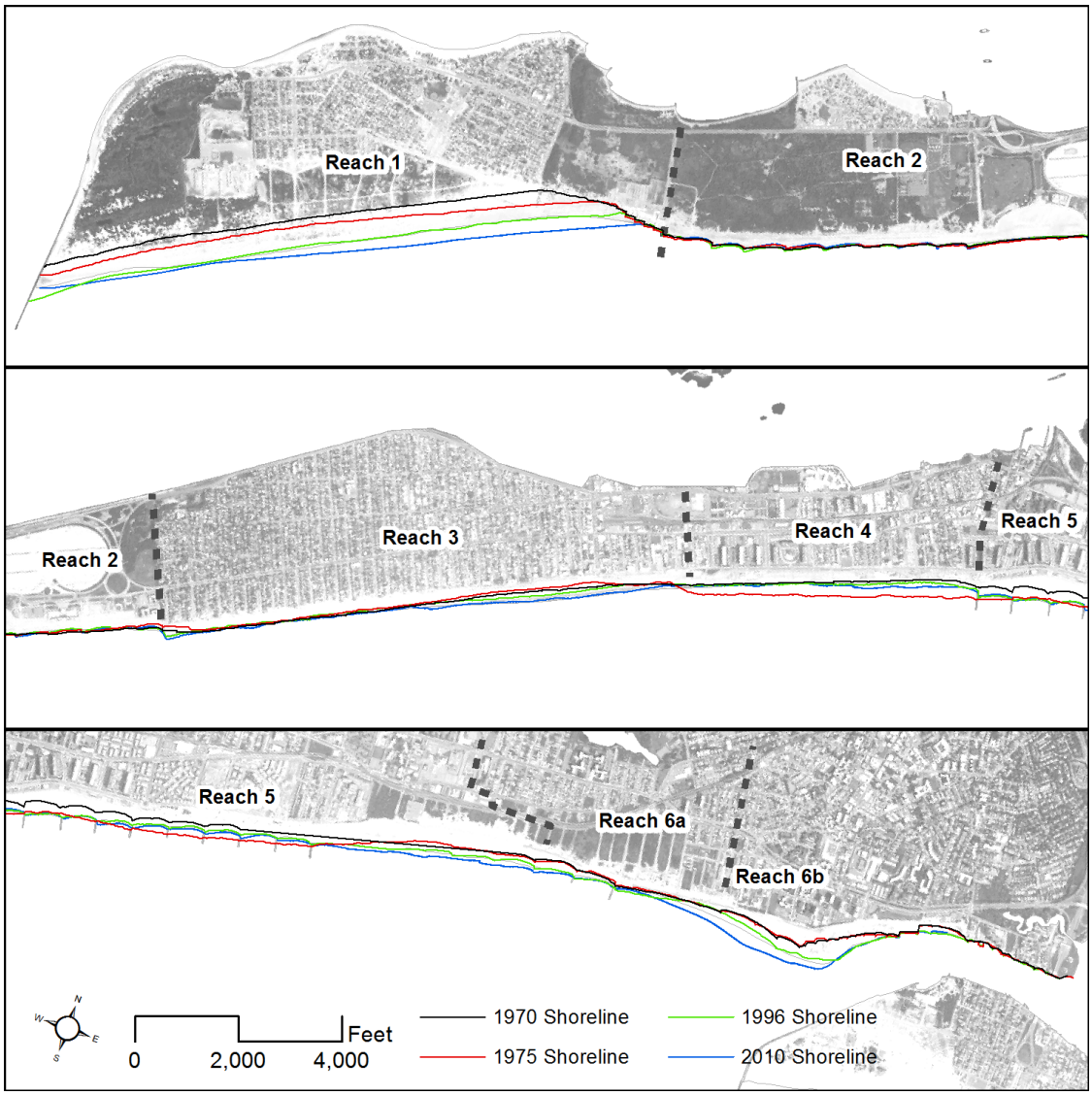


Figure 2-6: Shoreline Evolution: 1970-2010

2.3 Engineering Activities

2.3.1 Coastal Structures

Numerous shore protection structures were built along the Rockaway Peninsula during the 20th century. Table 2-1 summarizes the total number of groins and linear feet of bulkhead constructed during the 20th century. Table 2-2 lists coastal structures from west to east along the Peninsula as excerpted from the 1964 Survey Report, except structure #28, stone terminal groin at Beach 149th Street, built in 1982. As shown in the tables, the majority of the hard structures including over 200 groins and 25,300 linear feet of bulkhead were built prior to 1930. The next four decades saw the construction of additional 49 groins. The last ten stone groins were built in 1961-1962 until one final groin built in 1982 at the western end of the beach erosion control project (B149th St).

Based on a structure condition survey performed in spring of 2009, the majority of the timber groins are either buried or deteriorated and are no longer functioning effectively. The 24 stone groins constructed after 1943 are generally in fair to good condition.

Table 2-1: Groin and Bulkhead Construction by Decade

Time Period	# of Groins	Linear Feet of Bulkhead
Before 1930	207	25,300
1931-1940	14	0
1941-1950	20	0
1951-1960	5	0
1961-1970	10	0
1971-2015	1	0
TOTAL	257	25,300

Notes: Approximately 233 timber groins, all built on or before 1941, lengths range from 200 to 300 ft.

Table 2-2: List of Coastal Structures

Structure Number (West to East)	Type	Year Built
1	8,400 ft stone jetty at Rockaway Inlet	1933
2	7,600 ft bulkhead	1922
3	38 timber groins 200-300 ft long	1922
4	3 timber and stone groins 200 ft long	1922
5	8 stone groins 250-300'	1943
6	28 timber groins 200'	1922
7	25 timber groins 220'	1927
8	6 groins concrete& steel 300' inshore, timber offshore 300' long (500' total)	1940
9	6000 lf bulkhead	1930
10	20 timber groins 300'	1930
11	12 timber groins 200'	1941
28	1 terminal groin B149th St.	1982
12	39 timber groins 300'	1926
13	3 stone groins 500'	1962
14	1 timber groin 200'	1920
15	2 timber groins 160-220'	1919
16	4 stone groins 510'	1961
17	8 timber groins 400-600'	1938
18	7200 lf timber bulkhead	1928
19	21 timber groins 380'	1928
20	1 timber groin 300'	1917
21	5 stone groins 600'	1956
22	10 groins	1915
23	4,250 stone jetty E. Rock Inlet	1934
24	4,500 lf timber bulkhead	1930
25	17 timber groins	1930
26	3 stone groins 105'	1961
27	2 groins 60' timber inshore 150' stone offshore	1922

2.3.2 Beach Restoration

The Atlantic Ocean Shorefront has a long history of beachfill operations even before the start of the Federal Erosion Control Project in 1975. From 1926 to 2012 a total of approximately 27 million cubic yards of sand have been placed along Rockaway Beach. A tabulation of the historical beach fill volumes by reach and years is shown in Table 2-3. Historical beachfill operations have been either maintenance dredging of East Rockaway and Rockaway Inlets or larger beach restoration projects with sediment dredged from offshore borrow areas. A detailed account of inlet maintenance dredging is provided in the next section.

Since the Erosional Control Project began in 1975 approximately 19.5 million cubic yards of beach fill have been placed along Rockaway (Table 2-4). Nearly all of this beachfill over this time period has been placed east of Beach 149th Street in Reaches 3, 4, 5, and 6. However, Reach 4 and Reach 6 have received the greatest proportion of the beachfill volumes.

Table 2-3: Historical Beach Fill Placement (Cubic Yards) by Reach

Year	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
1926				1,250,000	1,250,000	
1928						1,450,000
1930			1,250,000			
1936	5,000,000					
1940		400,000				
1958						1,250,000
1962					175,000	
1975				1,834,500[1]	1,834,500[1]	
1976						1,490,000
1977			1,205,000			
1978				453,000		231,000
1980						466,000
1982			163,300	414,000		479,000
1984				828,000		631,000
1986				654,000		691,000
1988				501,000		819,000
1990						206,000
1991						157,000
1995						606,400
1996			582,800	742,900[1]	742,900[1]	
1998						218,000
2000				504,644[1]	504,644[1]	241,000
2002						140,000
2004			94,968	317,279[1]	317,279[1]	271,953
2005						221,002
2007						260,000
2009						285,000
2010				137,000		
2012						272,000

Notes: [1]Distribution of beachfill between Reaches 4 and 5 unknown. Volume equally split between reaches.

Table 2-4: Historical Beach Fill Placement Summary (Cubic Yards)

Year	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
1926-1974	5,000,000	400,000	1,250,000	1,250,000	1,425,000	2,700,000
1975-2012			2,046,000	6,386,000	3,400,000	7,685,000

2.3.3 Inlet Maintenance Dredging

Federal navigation channels are located at both inlets bracketing the Rockaway Peninsula. The East Rockaway Inlet channel is shown in Figure 2-7, and the Rockaway Inlet channel, known as the Jamaica Bay channel, is shown in Figure 2-8.

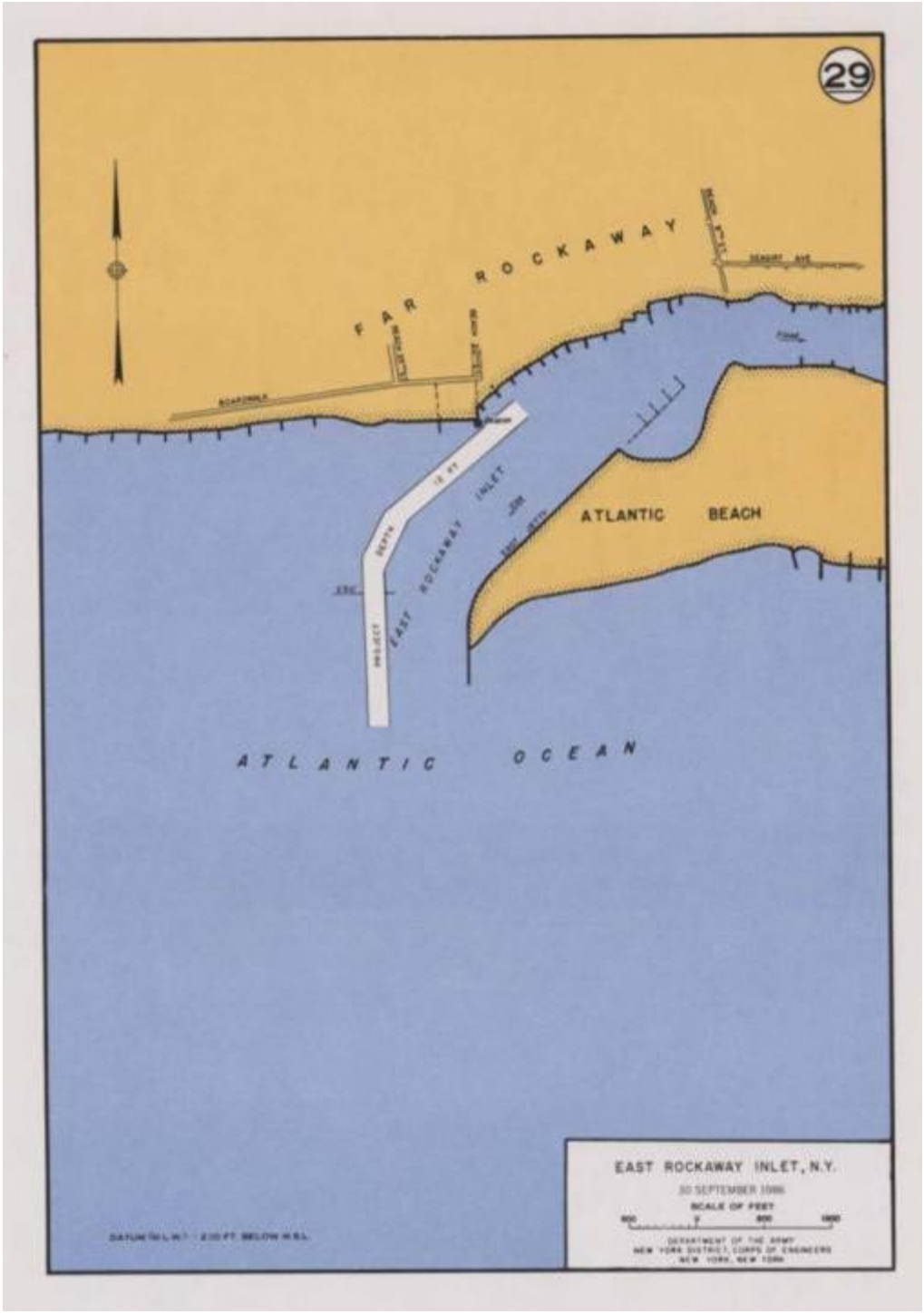


Figure 2-7: East Rockaway Inlet Channel

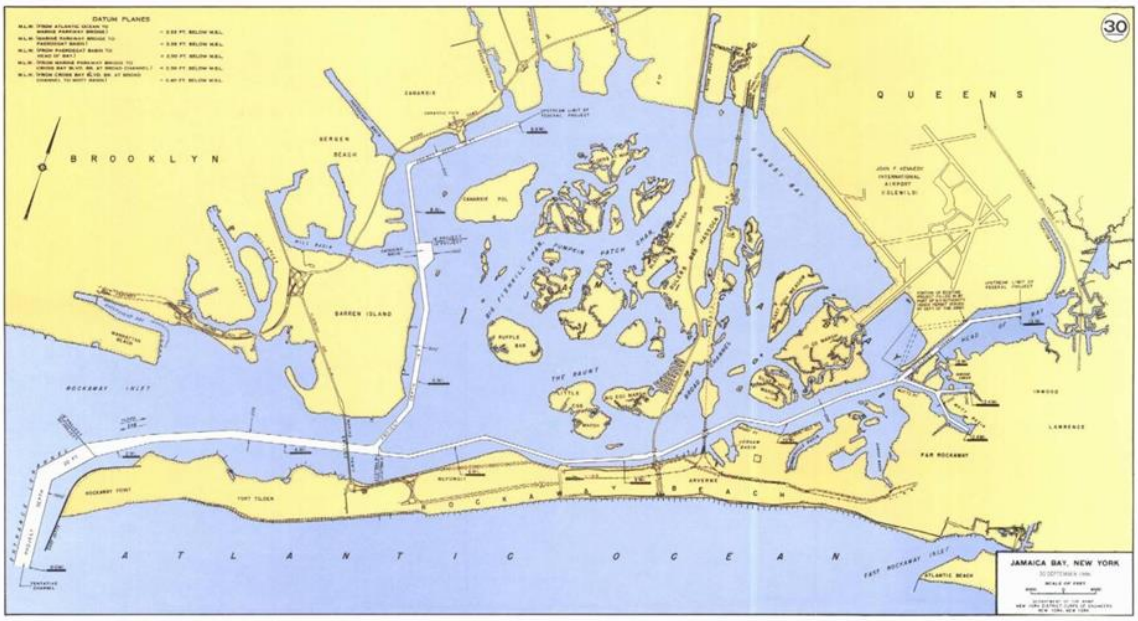


Figure 2-8: Rockaway Inlet Chanel

2.3.4 East Rockaway Inlet Channel

The East Rockaway Inlet Project was authorized by the Rivers and Harbors Act of 1930. The project allows navigation to proceed from the Atlantic Ocean into Reynolds Channel and the bays north of the Long Beach. The inlet provides for:

- A channel 12 ft. deep and approximately 250 ft. wide;
- One jetty constructed on the east side of the channel;
- One jetty (authorized but not constructed) on the west side of the channel.

Dredging records for East Rockaway channel show initial construction in 1935, maintenance dredging from 1938-1985, a channel realignment in 1988, and maintenance dredging from 1989 to present. Dredging intervals have historically varied from 1 year to 11 years, with recent dredging operations occurring 2 to 3 years apart. Table 2-5 gives the history of new work, defined as initial dredging to new authorized dimensions, and maintenance dredging. From 1938-1978 annual maintenance dredging volumes were approximately 32,500 cy/yr. A marked increase in the maintenance dredging volumes has occurred after 1979, with annual maintenance dredging volumes of 115,00 cy/yr. The increase in maintenance dredging volumes since 1979 is most likely due to the large amounts of beach fill placed on the Rockaway Peninsula since 1975, a portion of which migrates to the east into the channel.

Table 2-5: East Rockaway Inlet Channel Dredging History

FY	Depth (ft)	Reach	New Work (CY)	Maintenance (CY)
1935	12	Dredging Channel	171,230	
1938	12	Dredging Channel		75,963
1939	12	Dredging Channel		48,000
1941	12	Dredging Channel		42,967
1952	12	Dredging Channel		166,700
1954	12	Dredging Channel		56,600
1955	12	Dredging Realigned Channel		123,200
1956	12	Dredging Channel		48,700
1957	12	Dredging Channel		42,500
1958	12	Dredging Channel		20,300
1959	12	Dredging Channel		29,100
1960	12	Dredging Channel		4,868
1961	12	Dredging Channel		11,432
1962	12	Dredging Channel		7,900
1963	12	Dredging Channel		14,900
1964	14	Dredging Channel		26,298
1966	12	Channel		6,000
1967	12	Channel		8,650
1968	14	Channel		980
1968	12	Channel		24,880
1969	14	Channel		62,000
1970	12	Channel		53,485
1971	14	Channel		67,005
1972		Channel		52,024
1973	14	Channel		1,913
1973	14	Channel		22,952

FY	Depth (ft)	Reach	New Work (CY)	Maintenance (CY)
1974	12	Channel		46,714
1975	12	Channel		89,400
1976	12	Channel		71,930
1976	12	Channel		34,860
1977	14	Channel		23,482
1978	12	Channel Entrance		15,560
1979	12	Remove Shoals		241,100
1982	12	Offshore (12 +4) & Inshore Channels (18 +2)		197,743
1985	12	Channel		386,428
1988	12 (14+2)	Entire Channel, New Channel Alignment	1,006,000	
1989	12, 14	Inlet Channel		230,000
1990	12	East Rockaway Inlet		190,000
1991	14	Entrance		157,081
1993		Dredge		152,508
1996		Dredge		411,760
2002		Dredge		141,900
2004		Dredge		224,000
2007		Dredge		266,890
2009		Channel Maintenance		285,000
2010		Channel Maintenance		137,000
1938-1978 (CY/YR)				32,500
1979-2007 (CY/YR)				115,00
Total Maintenance 1938-2010 (CY)				4,323,000

2.3.5 Rockaway Inlet Channel

The Federal Navigation Maintenance Project of Jamaica Bay (Rockaway Inlet) was authorized by the Rivers and Harbor Acts of 1910 and subsequently modified by the Rivers and Harbors Acts of 1945 and 1950. Rockaway Inlet allows navigation to proceed from the Atlantic Ocean into Jamaica

Bay, splitting into access channels for both north and south sides of the Bay. The Project provides for:

- An entrance channel 20 ft. deep and approximately 1000 ft. wide extending from deep water in the Atlantic around Breezy Point;
- An 18-ft deep channel approximately 500 ft wide extending past the Marine Parkway Bridge;
- Northern and southern branch channels within Jamaica Bay;
- One rock jetty constructed on the east side of the entrance channel.

Dredging records for the Rockaway channel show initial construction in 1930. No maintenance dredging of the entrance channel occurred until 1976, after which records show regular maintenance of this portion of the channel. The lack of maintenance dredging until the 1976 is likely due to the impoundment capacity of the jetty at Rockaway Inlet. Once maintenance dredging began in 1976, dredging intervals varied from 1 year to 5 years. Table 2-6 provides a history of new work, defined as initial dredging to new authorized dimensions, and maintenance dredging for the channel. Maintenance dredge volumes have gradually increased over time and is likely due to the growth of the fillet and increasing bypassing around east jetty at Breezy Point. From 1976-2004 annual maintenance dredging volumes are 96,000 cy/yr.

Table 2-6: Rockaway Inlet Channel Dredging History

FY	Depth (ft)	Reach	New Work (CY)	Maintenance (CY)
1930	18	Inner Section of Entrance Channel	1,343,024	
1933		Filling in at Jetty	83,120	
1976		20 Foot Channel		89,696
1977		Entrance Channel		218,037
1979		20 Foot Channel		61,729
1981		Sea Leg of Channel - Vicinity Of Buoys		159,270
1985		Entrance Channel		181,685
1988		Entrance Channel		230,273
1991		Entrance		404,141
1992		Entrance		145,800
1994		Entrance		198,941
1996		Entrance		225,837
1998		Entrance		222,718
2002		Entrance		366,080
2004		Entrance		182,943
1976-2004 (CY/YR)				96,000
Total Maintenance 1930-2004 (CY)				2,687,000

3 PERFORMANCE OF PRIOR PROJECTS

3.1 WRDA 1974 Beach Erosion Control Project (1978-1988)

The multiple purpose beach erosion control and hurricane protection project was authorized by the Flood Control Act of 26 October 1965 in accordance with House Document No. 215, 89th Congress, First Session (USACE, 1993). It was then modified by Section 72 of the Water Resources Development Act of 6 March 1974, which authorized the separate construction of the beach erosion control portion. The project provided for the restoration of a protective beach along 6.2 miles of Rockaway Beach, between Beach 19th Street and Beach 149th Street (reaches 3, 4, 5 and 6). The project authorization also provided for Federal participation in the cost of periodic beach nourishment to stabilize the restored beach for a period not to exceed 10 years after the completion of the initial beach fill. A Post Authorization Change allowed the construction of 380-foot long quarry stone groin at the western limit of the project in the vicinity of Beach 149th Street in 1982.

The initial nourishment construction was completed in three contracts from 1975 to 1977. The authorized construction profile varied along Rockaway Beach and was comprised of a 100-foot berm between Beach 19th Street and Beach 126th Street, 150-foot berm between Beach 126th Street and Beach 110th Street, and 200-foot berm from Beach 110th Street to Beach 19th Street. The 150-foot and 200-foot berms were authorized based on separable recreation benefits. The storm damage reduction features of the authorized project consist only of a 100-foot berm width. The top of the berm elevation was constructed to +10 feet NGVD (+9 feet NAVD88). The constructed beach fill section was developed at a 1V:20H slope from +10 ft to -2 ft NGVD, and 1V:30H slope from -2 ft NGVD to closure. Figure 3-1 provides an overview of the authorized construction profile.

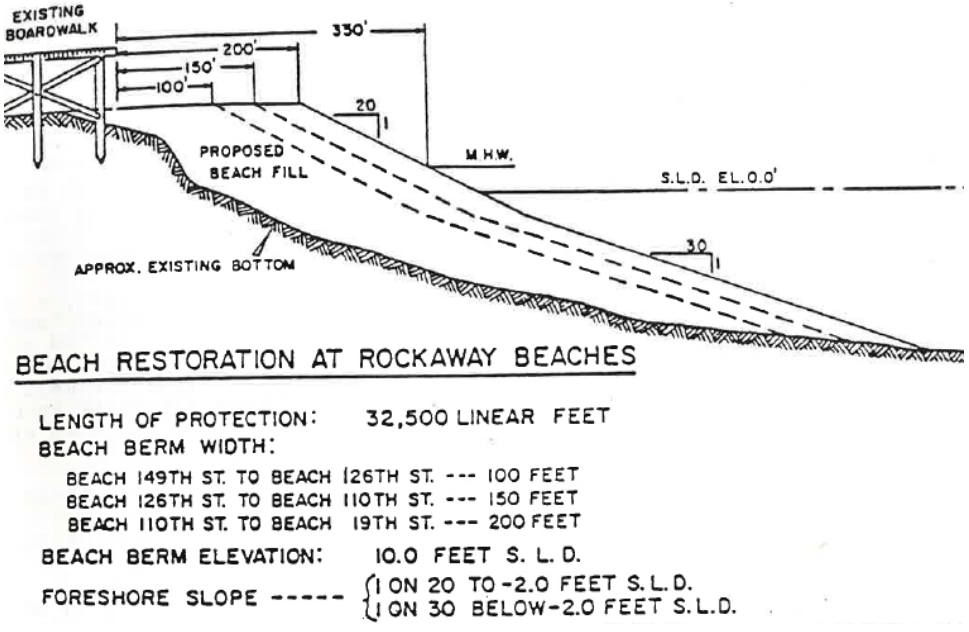


Figure 3-1: Authorized Construction Profile for Flood Control Act of 1965

Five renourishment operations and one emergency renourishment operation were performed over the 10 years following initial construction (Table 3-1). Renourishment operations occurred at two-year intervals and entailed constructing Feeder Beaches in the two most highly erosive areas in the project area:

- Western Feeder Beach (Reach 4) = ~5,700 feet
- Eastern Feeder Beach (Reach 6) = ~3,700 feet

The expectation was that the material would be eroded from those areas and would therefore supply, or feed, sand to the rest of the project area, thereby offsetting the long-term erosion.

During each renourishment operation, the beach along the designated Feeder Beaches was constructed to its construction profile dimension (200-foot berm). As shown in Table 3-1, this required placing on average 480,000 cy per operation in Reach 4 and 587,000 cy per operation in Reach 6. This is equivalent to placing 240,000 cy/yr and 293,500 cy/year in Reaches 4 and 6 respectively (533,500 cy/yr total). During each renourishment operation the shoreline at the feeder beach was extended seaward approximately 70 feet in Reach 4 and 130 feet in Reach 6. As anticipated, the material placed in the feeder beaches was quickly transported to other areas along The Atlantic Ocean Shorefront. The high erosion rates observed at the feeder beaches are attributed to the high background erosion rates in these areas as well as to beachfill diffusion (e.g. end losses). Beachfill diffusion is more pronounced when the alongshore length of the project is relatively short in comparison to the cross-shore width of beachfill, as was the case at the feeder beaches.

Monitoring of the shoreline positions between renourishment cycles showed that the authorized beach dimensions were not maintained along the project area (USACE, 1993). A total of 21 beach profile surveys were collected four years after the last renourishment event, 1988, and the existing beach dimensions were compared to the authorized beach dimensions. Only 3 of the 21 the profiles were close to meeting the design profile dimensions. The rest of the profiles had narrower beach dimensions than the authorized dimensions.

Table 3-1: WRDA 1974 Beachfill Events

Year	Description	Source of Fill	Reach	Total Fill Placed (cy)
1975	Initial Construction	Borrow area 1	Reach 4 & 5	3,669,000
1976	Initial Construction	Borrow area 3	Reach 6	1,490,000
1977	Initial Construction	Borrow area 2	Reach 3	1,205,000
1978	Emergency Renourishment	Borrow area 1	Reach 4	453,000
1978	Emergency Renourishment	Borrow area 3	Reach 6	231,000
1980	Renourishment 1	Borrow area 3	Reach 6	466,000
1982	Renourishment 2	Borrow area 2	Reach 4	414,000
1982	Renourishment 2	Borrow area 3	Reach 6	479,000
1982	Terminal Groin at B149th Street and fill	N/A	Reach 3	163,300
1984	Renourishment 3	Borrow area 2	Reach 4	828,000
1984	Renourishment 3	Borrow area 3	Reach 6	631,000
1986	Renourishment 4	Borrow area 2	Reach 4	654,000
1986	Renourishment 4	Borrow area 3	Reach 6	691,000
1988	Renourishment 5	Borrow area 2	Reach 4	501,000
1988	Renourishment 5	Borrow area 3	Reach 6	666,000

3.2 Section 934 Beach Erosion Control Project (1996-2004)

Additional erosion after the WRDA 1974 authorization expired led to a second major construction effort authorized through Section 934 of the Water Resources Development Act of 1986, which allowed continued Federal participation in periodic beach fill nourishment. Under this authority, a reevaluation report approved in May 1994 prescribed three additional nourishment cycles occurring three years apart although actual renourishment operations occurred four years apart. Initial construction was completed in 1996 and two renourishment operations occurred in 2000 and 2004 (Table 3-2). Due to the high cost of construction and continued nourishment, the New York District was directed in 2003 to reformulate the original plan, with the objective of finding a long term, cost-effective solution to the effects of continued erosion on the Rockaway peninsula. The eroded conditions of the beach in 1994, about two years before initial construction, are shown in Figure 3-2. The beach width is particular narrow in Reaches 4 and 6a. The shoreline had retreated all the way back to the boardwalk in Reach 6a.

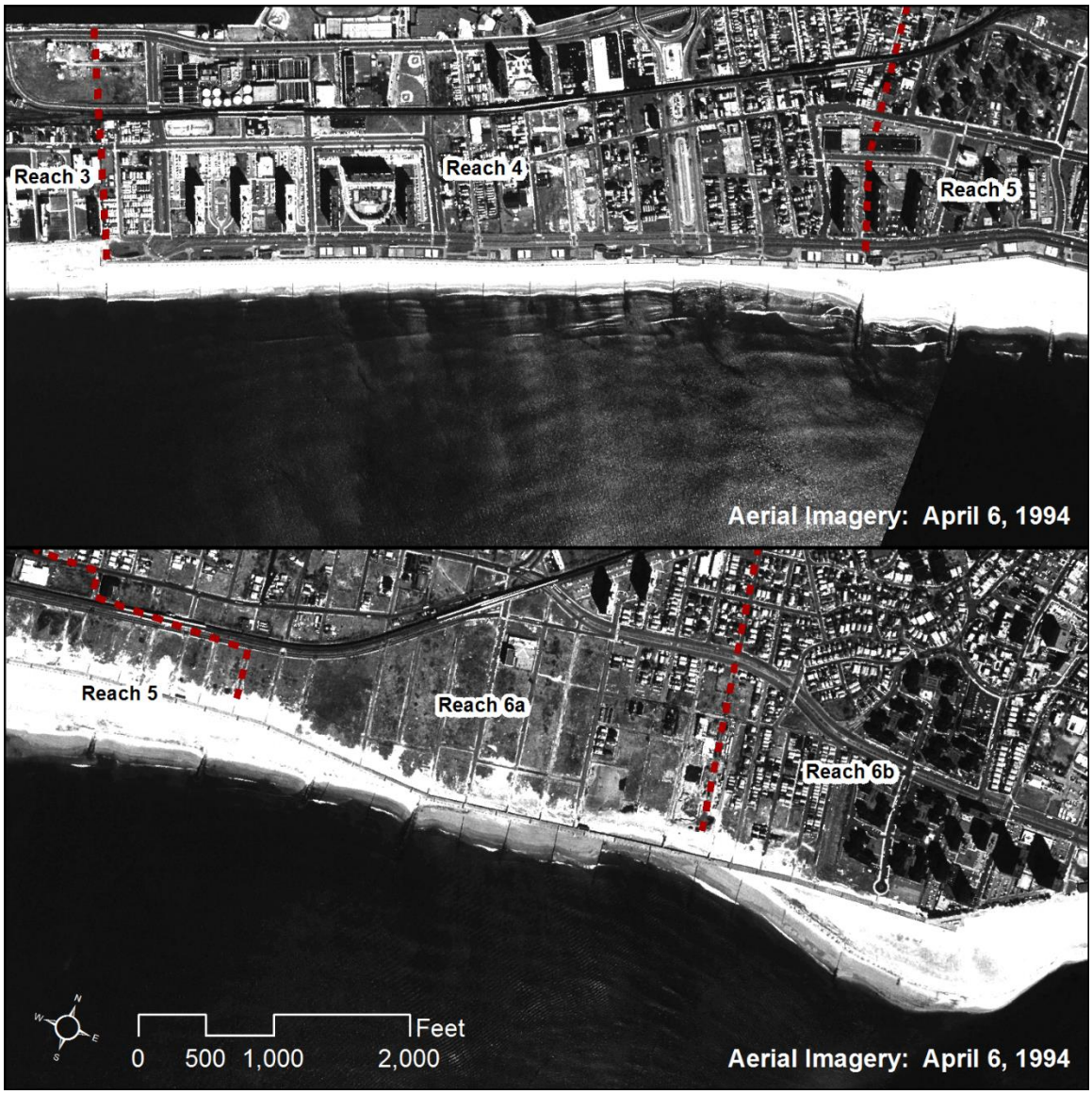


Figure 3-2: Erosional Hot Spots

The construction profile dimensions for the Section 934 Beach Erosion Control Project are the same as the WRDA 1974 Project except that all the berm widths are 100 feet. The 150 foot and 200 foot berm widths that were originally justified based on recreational benefits in the WRDA 1974 Project were not included in the Section 934 Project.

The Section 934 Project took a different approach to renourishment. Instead of relying on the feeder beaches to supply sediment to the entire project area and offset long-term erosion, the Section 934 Project placed renourishment along the entire project area during each renourishment operation. In addition, the Section 934 Project included advance fill in initial construction and renourishment operations. Advance fill is a sacrificial quantity of sand which acts as an erosional

buffer against long-term and storm-induced erosion with the goal of preventing erosion of the design profile between renourishment cycles.

A summary of the Section 934 Project beachfill operations is provided in Table 3-2. Inlet maintenance dredging operations also occurred over the Section 934 Project period and a summary of these operations is included below in Table 3-2. During each renourishment the beach was restored to its authorized dimension plus advance fill. Including inlet maintenance dredging operations at total of 354,000 cy/year was placed in the project area in the eight years after initial construction between 1996 and 2004.

Table 3-2: Section 934 Beachfill Events

Year	Description	Source of Fill	Reach	Total Fill Placed (cy)
1996	Initial Construction	Borrow area 1B	Reach 4 & 5	1,485,800
1996	Initial Construction	Borrow area 1B	Reach 6	606,400
1996	Initial Construction	Borrow area 1B	Reach 3	592,800
1998	Inlet Maintenance Dredging	E. Rock Inlet	Reach 6	218,000
2000	Inlet Maintenance Dredging	E. Rock Inlet	Reach 6	241,000
2000	Renourishment 7	Borrow area 2	Reach 4 & 5	1,009,288
2002	Inlet Maintenance Dredging	E. Rock Inlet	Reach 6	140,000
2004-2005	Inlet Maintenance Dredging	E. Rock Inlet	Reach 6	221,002
2004	Renourishment 8	Borrow area 2	Reach 3	94,968
2004	Renourishment 8	Borrow area 2	Reach 4	634,557
2004	Renourishment 8	Borrow area 2	Reach 6	271,953

3.3 Section 934 Beach Profile Surveys

3.3.1 Data Availability

Atlantic Coast of New York Monitoring Program (ACNYMP) profiles from 1997 to 2001 are available at twelve locations along Rockaway Beach, NY. An overview of the profile locations is provided in Figure 3-3.

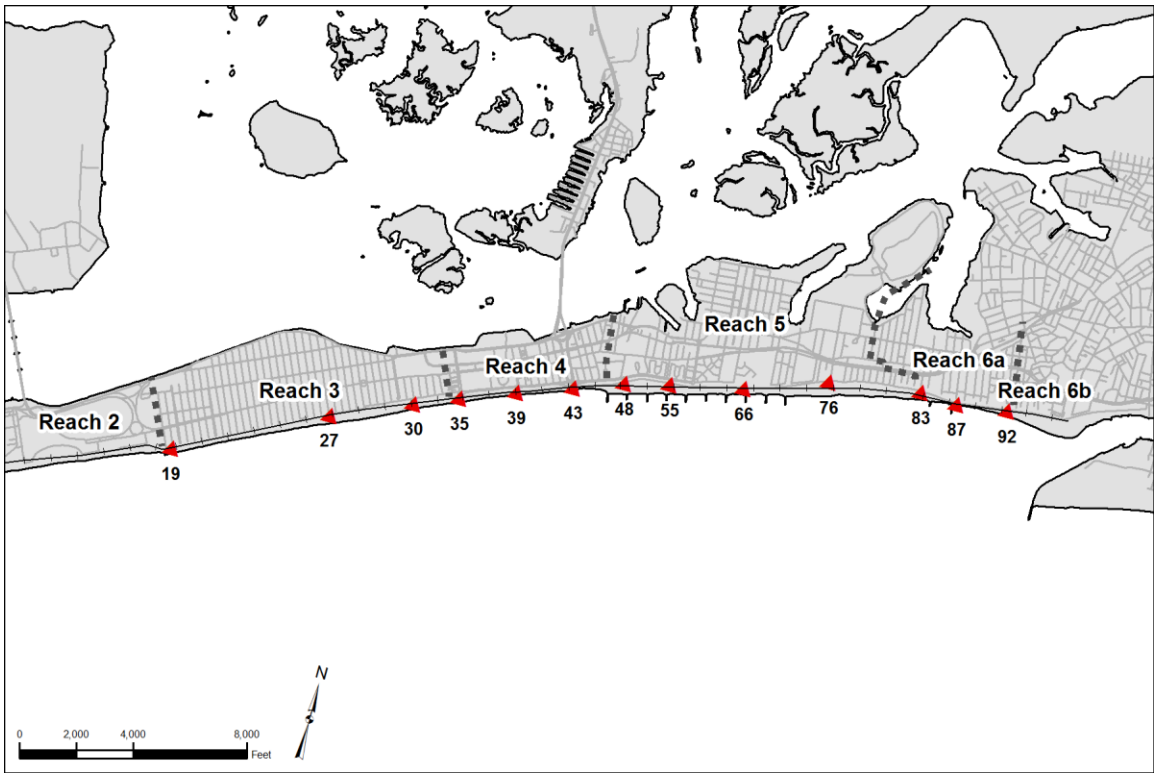


Figure 3-3: ACNYMP Locations

Profile availability over this time period is summarized in Table 3-3. The focus of this analysis is on spring profile surveys in 1997, 1998, and 2000. These profiles are used to quantify the performance of the Section 934 Project between initial construction and the first renourishment operation in 2000. The history of beachfill placement for the Section 934 Project is shown in Table 3-2. It is noted that the spring (S) 1997 profile was surveyed shortly after initial construction and the S2000 profile was surveyed prior to the first renourishment operation (Renourishment 7). The survey data from 1997 to 2000 captures a period without any beachfill operations. The only exception is Reach 6a, which received 218,000 cubic yards (cy) in the fall of 1998 as part of inlet maintenance dredging of East Rockaway Inlet.

Table 3-3: Profile Survey Availability

Reach	Profile	Station	S1997	F1997	S1998	F1998	S2000	S2001
Reach 3	19	319+00	x	x	x	x	x	x
Reach 3	27	262+00	x	x	x	x	x	x
Reach 3	30	232+00	x	x	x	x	x	x
Reach 4	35	216+00	x	x	x	x	x	x
Reach 4	39	195+00	x	x	x	x	x	x
Reach 4	43	175+00	x	x	x	x	x	x
Reach 5	48	157+00	x	x	x	x	x	x
Reach 5	55	141+00	x	x	x	x	x	x
Reach 5	66	115+00	x	x	x	x	x	x
Reach 5	76	85+00	x	x	x	x		x
Reach 6a	83	53+00	x	x	x		x	x
Reach 6a	87	40+00	x	x	x	x	x	x
Reach 6a	92	22+00	x	x	x	x		x

3.3.2 Volumetric Changes

Volumetric changes from S1997 to S1998 and S2000 are calculated at each profile location. Changes are computed over the full extent of the overlapping profiles (beyond depth of closure, -25 ft NAVD88, if possible). Table 3-4 presents the net volumetric changes (cy/ft) at each profile location. As mentioned earlier, the profiles in Reach 6a show an increase in volume between S1997 and S2000 because of beachfill placed as part of inlet maintenance dredging in the fall of 2008. Figure 3-4 and Figure 3-5 show ACNYMP profile surveys in the S1997, S1998, and S2000 at Profile 30 and 35.

Table 3-4: Volumetric Changes (cy/ft)

Reach	Profile	S1997-S1998	S1997-S2000
Reach 3	19	-7.6	8.1
Reach 3	27	-9.0	-3.8
Reach 3	30	-18.1	-43.6
Reach 4	35	-73.8	-125.9
Reach 4	39	-62.0	-76.8
Reach 4	43	-4.4	-63.5
Reach 5	48	-8.0	-55.8
Reach 5	55	-0.1	-36.5
Reach 5	66	6.2	-22.6
Reach 5	76	-42.9	
Reach 6a	83	-16.2	20.8
Reach 6a	87	5.2	2.9
Reach 6a	92	-6.6	

Note: Net Volumetric Changes (e.g. reflect volume added in Reach 6a as part of inlet maintenance dredging).

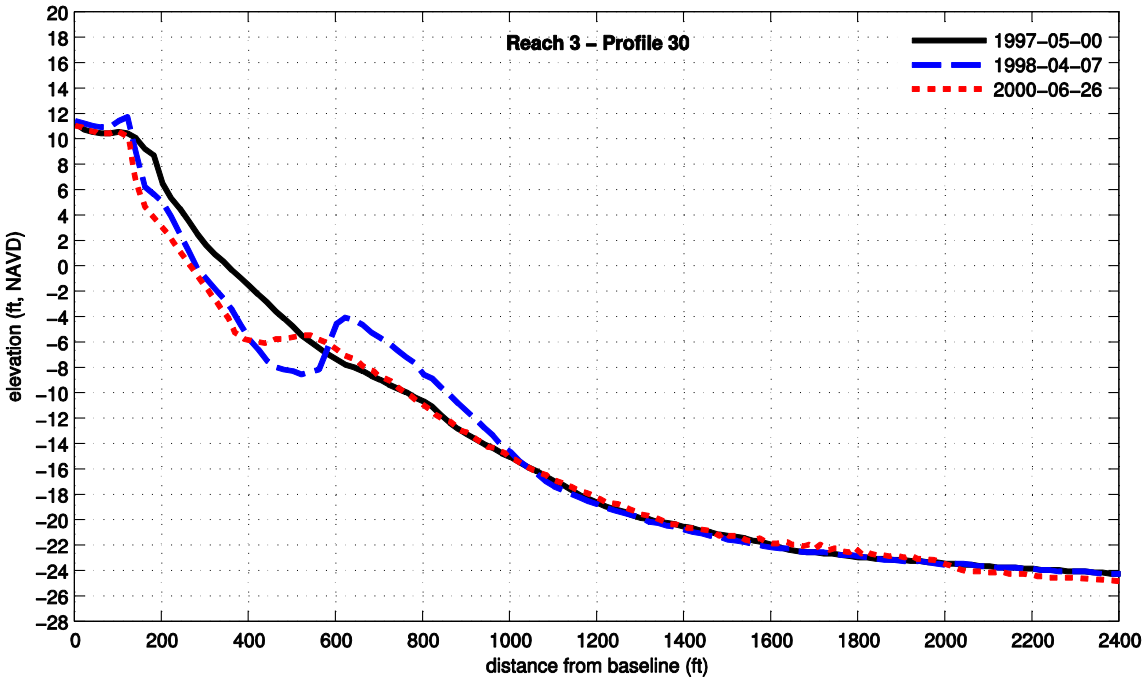


Figure 3-4: ACNYMP Data at Profile 30

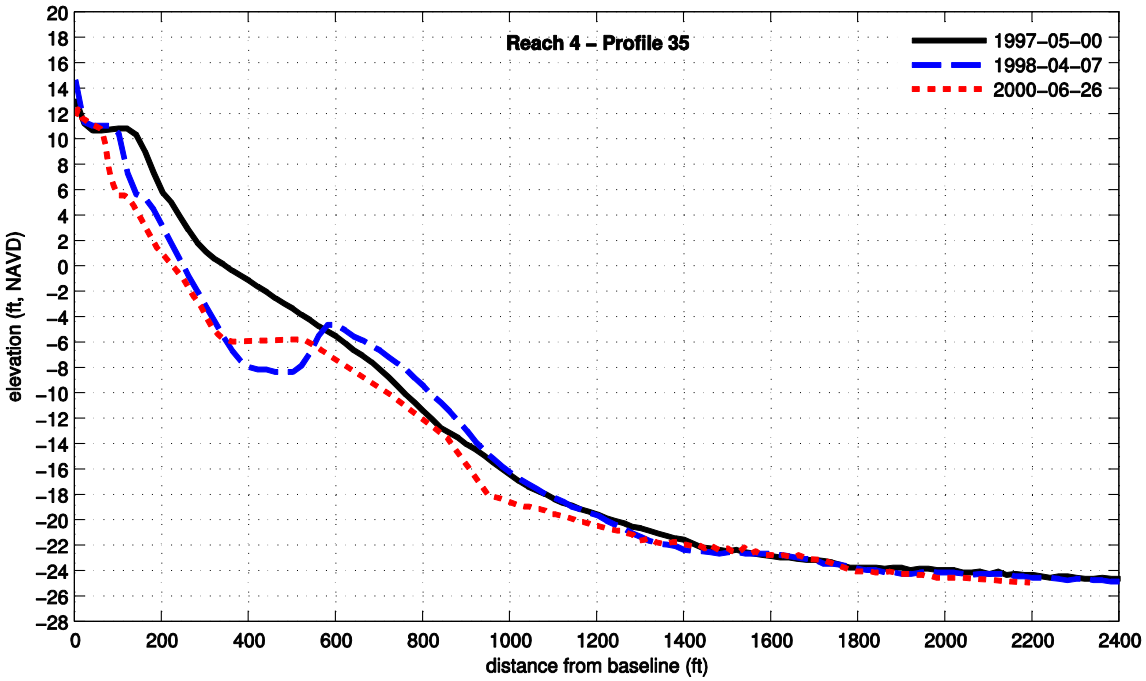


Figure 3-5: ACNYMP Data at Profile 35

Average end area calculations are performed based on the volumetric changes at each profile station to determine the reach-averaged changes. Volumetric changes are converted to equivalent shoreline changes based on the active height of the beach profile (33 feet). The equivalent shoreline changes presented in Table 3-5 represent the "gross" changes because the 1998 inlet maintenance dredging event (218,000 cy) has been subtracted from the reach-averaged volume changes in Reach 6a.

Table 3-5: Summary of Shoreline Changes (ft/yr)

Reach	Length (ft)	ACNYMP S1997-S1998	ACNYMP S1997-S2000
Reach 1	11,900		
Reach 2	11,100		
Reach 3	10,200	-12.7	-4.5
Reach 4	5,600	-35.3	-22.7
Reach 5	10,800	-11.2	-10.6
Reach 6a	3,600	-3.4	-14.5
Reach 6b	2,000		
Project Area	30,200	-15.3	-11.3

Note: Gross shoreline changes (e.g. inlet maintenance dredging event subtracted from Reach 6a)

3.4 Summary

A comparison of beachfill quantities for the WRDA 1974 and Section 934 Erosion Control Projects is provided in Table 3-6. Before comparing the two projects it is important to acknowledge the limitations of such a comparison:

- Neither project was successful at maintaining the design shoreline between renourishment operations. Also, it is not clear if one project provided a wider beach between renourishment operations than the other.
- The interval of renourishment operations for the two projects was different. It is likely that the shorter renourishment interval in the WRDA 1974 Project resulted in greater beachfill diffusion.
- The wave climate may be considerably different from year to year, resulting in very different erosion rates from year to year. It is possible that one project may have experienced a more energetic wave climate than the other.

Despite these limitations some observations are made about the two projects. The renourishment quantities in the WRDA 1974 Project are 50 percent higher than the Section 934 Project. The high renourishment quantities during the WRDA 1974 Project are attributed to high beachfill diffusion associated with the feeder beaches and shorter renourishment interval. The renourishment approach in the Section 934 Project, nourishing the entire project area as needed, may have led to a decrease beachfill diffusion.

Table 3-6: Comparison of WRDA 1974 and Section 934 Renourishment Operations

Reach	Beachfill Quantity (cy/year)	
	WRDA 1974[1]	Section 934[2]
Reach 3		12,000
Reach 4	239,700	142,500
Reach 5		63,000
Reach 6	293,300	136,500
Total	533,000	354,000

Notes: [1] A total of 5 renourishment operations occurred in 2-year intervals from 1980-1988

[2] A total of 2 renourishment operations occurred in 4-year intervals from 1990-1994

4 EXISTING CONDITIONS

4.1 General

Existing conditions for the Rockway Shorefront were analyzed and documented prior to developing Erosion Control and CSRM alternatives.

Vertical elevations (EL.) of project components and features are referenced to the North American Datum of 1988 (NAVD88), Geoid12A vertical reference system. All elevations throughout the report are referenced to NAVD88 Geoid12A and presented in feet unless otherwise stated.

The horizontal datum shall be the North American Datum of 1983 (NAD83) Long Island, New York State Plane with units in feet, unless specifically noted otherwise.

4.2 Astronomical Tides

Daily tidal fluctuations at the project site are semi-diurnal, with two highs and two lows per 24-hour day. The tidal datum relationships on the ocean side and bay side are presented in Table 4-1.

Table 4-1: Tidal Datum Relationships

Datum	Ocean (ft, NAVD88)	Bay (ft, NAVD88)
MHHW	2.35	2.71
MHW	2.02	2.36
NAVD88	0.00	0.00
MSL	-0.22	-0.23
NGVD29	-1.11	-1.11
MLW	-2.54	-2.84
MLLW	-2.73	-3.04

Notes: Tidal datums based on NOAA's VDATUM 1983-2001 Epoch

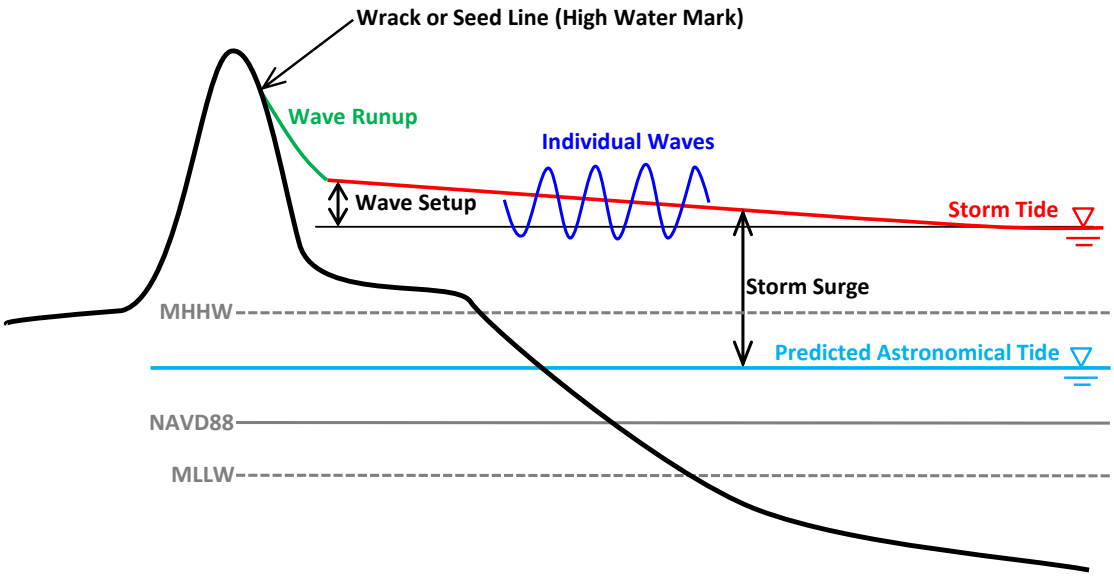
4.3 Storm Tides

Storm tide is the total observed water level during a storm due to the combination of storm surge and astronomical tide. Storm surge is defined as a rise above normal water level on the open coast due to the action of wind stress on the water surface and the decrease in atmospheric pressure during major storms. Water levels rise at the shoreline when the motion of wind driven waters is arrested by the coastal landmass. Two types of storms, as mentioned in section 2.1) are of primary significance along in the Project Area: (1) tropical storms which typically impact occur from July to October, and (2) extratropical storms which are primarily winter storms occurring from October to March. These extratropical storms are often referred to as "nor'easters" due to the predominate direction from which the winds originate. Figure 4-1 shows the different contributions to the water

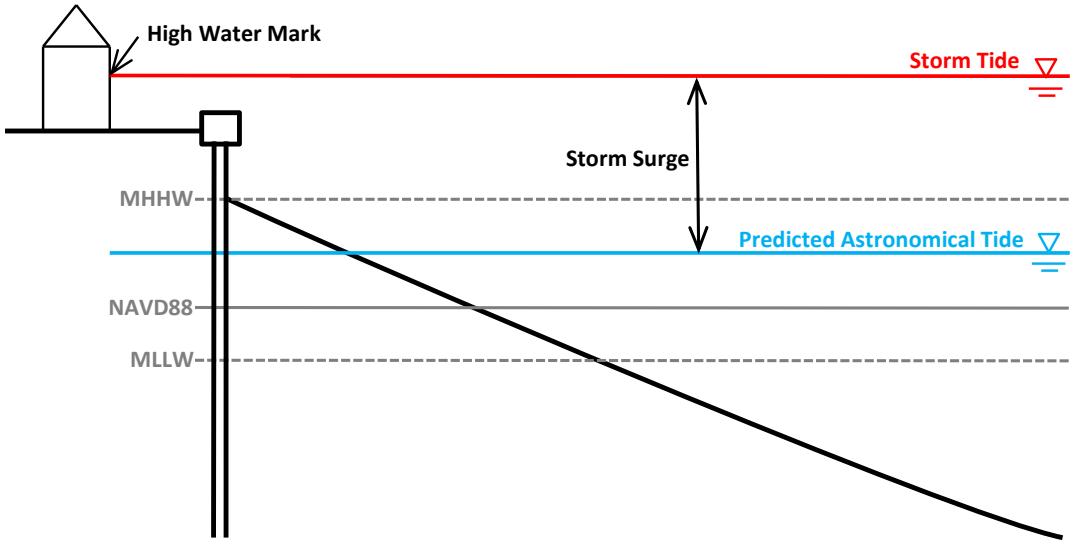
surface elevation along an exposed coastline with waves (panel a) and along a sheltered coastline with little or no waves (panel b). The storm tide elevation does not include temporary fluctuations in the water surface elevation from individual waves or wave runup.

Several storm surge modeling studies have been completed for the region that may be used to define the storm tide frequency of occurrence relationships (i.e. stage frequency curves) in the Project Area. The storm surge studies reference here are:

- Camp Dresser McKee (CMD, 1981)
- Fire Island to Montauk Point (USACE-NAN, 2005)
- FEMA Flood Insurance Study (FEMA, 2013)
- North Atlantic Comprehensive Study (NACCS, 2015)



(a) Shoreline Exposed to Storm Tide and Waves



(b) Shoreline Exposed to Storm Tide (no waves)

Figure 4-1: Components of Water Surface Elevation

The stage frequency curves from FEMA (2013) were adopted and used to define the ocean and Jamaica Bay stage frequency curves in the Project Area. Previous work on the Rockaway Reformulation Study used the FIMP modeling results to define the ocean-side stage frequency curves (USACE-NAN, 2005). The Jamaica Bay stage frequency curves were previously based on modeling results from Camp Dresser McKee study (CDM, 1981). Preliminary FEMA stage

frequency curves were released in the summer of 2013 and represent the best available information and science to date. The preliminary FEMA results indicate that the extreme water levels on both the ocean and bay-side of Rockaway are significantly higher than previously predicted by the FIMP and CDM studies (for stage frequency elevations up the 100 year return period).

Table 4-2: Ocean Stage Frequency Elevations (ft, NAVD88)

Return Period, yr	NACCS (2015)	FEMA (2013)	FIMP (2005)	CDM (1981)
5	6.0	5.3	4.9	
10	6.6	6.5	5.9	6.2
25		7.9	7.2	
50	8.3	9.1	8.1	7.9
100	9.6	10.5	9.2	8.6
200	11.3	12.2	10.1	9.6
500	13.5	14.7	11.2	11.1

FIMP Station 52, CDM Station 8, FEMA Station "FEMA - Offshore", NACCS Station 3917

Table 4-3: Bay Stage Frequency Elevations (ft, NAVD88)

Return Period, yr	NACCS (2015)	FEMA (2013)	FIMP (2005)	CDM (1981)
5	6.5	5.5	5.3	
10	7.2	6.6	6.2	4.7
25		7.9	7.4	
50	8.9	8.8	8.6	6.0
100	9.8	9.8	10.1	6.7
200	11.0	10.8	11.3	7.5
500	12.8	12.3	12.7	8.6

FIMP Station 61, CDM Station 110, FEMA at CDM Station 110, NACCS Station 3992

4.4 Sea Level Rise

By definition, sea level rise (SLR) is an increase in the mean level of the ocean. Eustatic sea level rise is an increase in global average sea level brought about by an increase to the volume of the world's oceans (thermal expansion). Relative sea level rise takes into consideration the eustatic increases in sea level as well as local land movements of subsidence or lifting. Two NOAA gages are available near the Project site; the Battery, and Sandy Hook. Both gages similar distances from the project site, i.e. approximately 12-15 miles. However, the Sandy Hook gage and the project area are more similar as they are located in the Coastal Plain geologic formation, whereas the

Battery gage is located on different geologic formations. Land subsidence is estimated at -2.17 mm/yr and -1.22 mm/yr at the Sandy Hook and Battery gages respectively. For comparison, Montauk Point, at the eastern end of Long Island, has an estimated vertical land movement of -1.23 mm/ yr (NOAA, 2013). Direct estimates of vertical land subsidence for the project area are unavailable. Regionally, sea level rise for New York, Connecticut, and New Jersey range from 2.10 mm/yr at New London, CT to 3.97 mm/yr at Atlantic City, NY, with Sandy Hook at 3.85 mm/yr (Gornitz at al. 2002). The Sandy Hook gage was chosen to represent sea level rise at the project site as the most appropriate available gage.

Historic information and local MSL trends used for the Study Area are provided by the NOAA/NOS Center for Operational Oceanographic Products and Services (CO-OPS) using the tidal gauge at Sandy Hook, New Jersey. The historic sea level rise rate (1935-2013) is approximately 0.0128 feet/year or about 1.3 feet/century.

Recent climate research has documented observed global warming for the 20th century and has predicted either continued or accelerated global warming for the 21st century and possibly beyond (IPCC 2013). One impact of continued or accelerated climate warming is continued or accelerated rise of eustatic sea level due to continued thermal expansion of ocean waters and increased volume due to the melting of the Greenland and Antarctic ice masses (IPCC, 2013). A significant increase in relative sea level could result extensive shoreline erosion and dune erosion. Higher relative sea level elevates flood levels which may result in smaller, more frequent storms that could result in dune erosion and flooding equivalent to larger, less frequent storms.

The current guidance (ER 1100-2-8162) from the Corps states that proposed alternatives should be formulated and evaluated for a range of possible future local relative sea level rise rates. The relative sea level rates shall consider as a minimum a low rate based on an extrapolation of the historic rate, and intermediate and high rates which include future acceleration of the eustatic sea level rise rate. These rates of rise correspond to 0.7 ft, 1.1 ft, and 2.5 ft over 50 years (2018-2068) for the low, intermediate and high rates of relative sea level rise.

4.5 Waves

The offshore wave conditions for the Project Area are based on WISWAVE modeling results completed as part of the Fire Island to Montauk Point (FIMP) Reformulation Study (USACE-NAN, 2005). WISWAVE model simulations were performed for 36 historical storm events. A detailed discussion of the storm suite is provided in the Engineering Modeling Appendix (Sub-Appendix A). WISWAVE modeling results at station I07J04, located approximately 17 miles offshore of Rockaway at a water depth of 76 ft, were extracted and used to develop the offshore design wave conditions. Wave conditions during Hurricane Irene and Hurricane Sandy were added to the historical storm events based on observed wave heights at NOAA NDBC Buoy 44065.

Nearshore wave conditions are based on local wave modeling (STWAVE and SWAN) simulations for the historical storm events. Nearshore wave conditions are defined based on the modeling

results at three locations along the Project Area at a water depth of 36 feet. Figure 4-2 shows the location of the nearshore and offshore wave stations.

Offshore and nearshore wave height frequency of occurrence relationships were developed using the Empirical Simulation Technique (EST) based on the peak wave heights for the historical storm events and probability of storm occurrence. A detailed description of the EST is provided in the Engineering Modeling Appendix (Sub-Appendix A). The results of the EST analysis, wave height frequency of occurrence relationships, are provided in Table 4-4.

Table 4-4: Offshore and Nearshore Wave Conditions

Return Period, yr	Offshore Significant Wave Height (ft)	Nearshore Significant Wave Height (ft)
2	14.8	7.7
10	22.1	15.3
25	24.8	18.6
50	27.3	21.4
100	30.7	23.9
200	35.4	26.3
500	41.6	29.3

Notes: Nearshore Wave Height at nominal depth of 36 ft

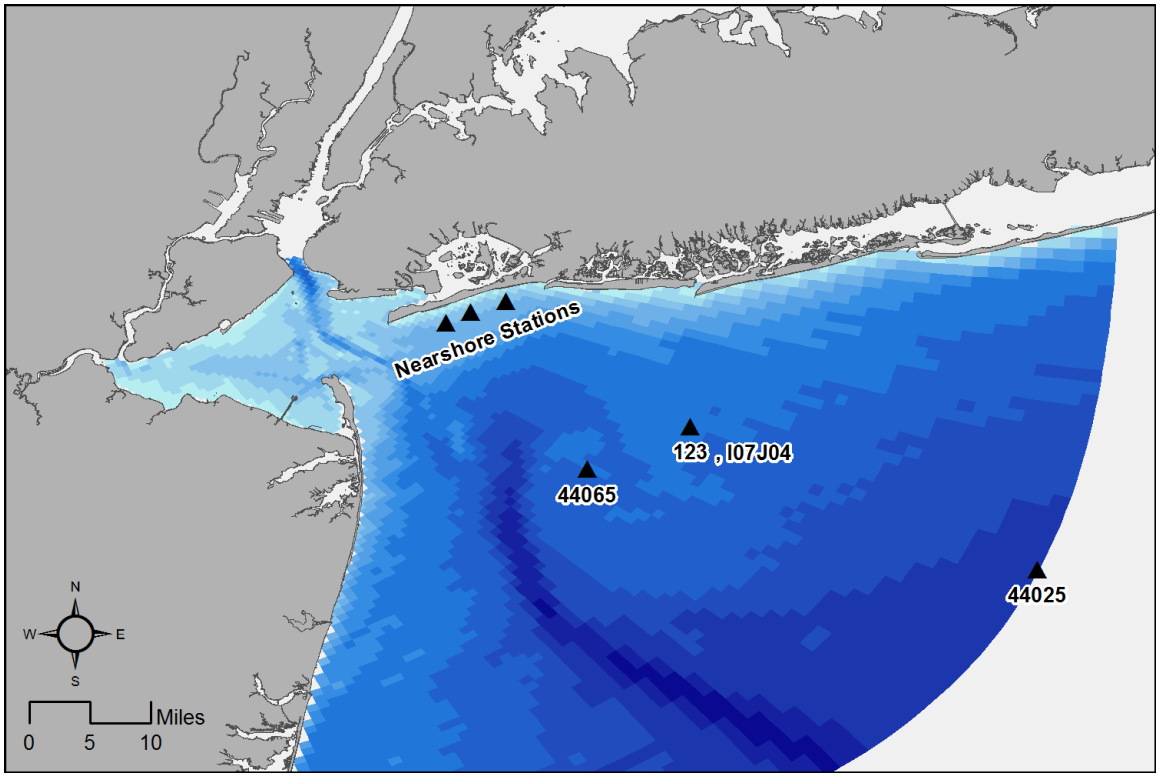


Figure 4-2: Location of Wave Stations

4.6 Wave Setup

Wave setup is characterized by a superelevation of the water surface in the surfzone as the result of wave breaking. As waves begin to break, the onshore-directed radiation stress, S_{xx}, decreases, resulting in onshore-directed forces. These forces are balanced by a shoreward slope in the water surface (wave setup). Wave setup for this study was calculated based on SBEACH model simulations of the Historical Storm Suite and Multivariate EST. The wave setup shown in Table 4-5 represents the wave setup contribution to the joint probability of wave setup and storm surge.

Table 4-5: Wave Setup

Return Period, yr	Wave Setup (ft)
2	1.4
5	2.0
10	2.3
25	2.6
50	3.1
100	4.0
200	4.4
500	4.4

In this study the wave setup value near the shoreline was extracted from the SBEACH model simulations. Figure 4-3 shows the cross-shore location at which the wave setup is extracted from SBEACH. The wave setup extracted from the cross-shore location of the intersection of the offshore water elevation and initial profile. This location varies with the offshore boundary conditions to SBEACH; however, this location is generally near the instantaneous shoreline. This is the same location that was used to determine the nearshore wave setup for FIMP (Gravens et al, 1999).

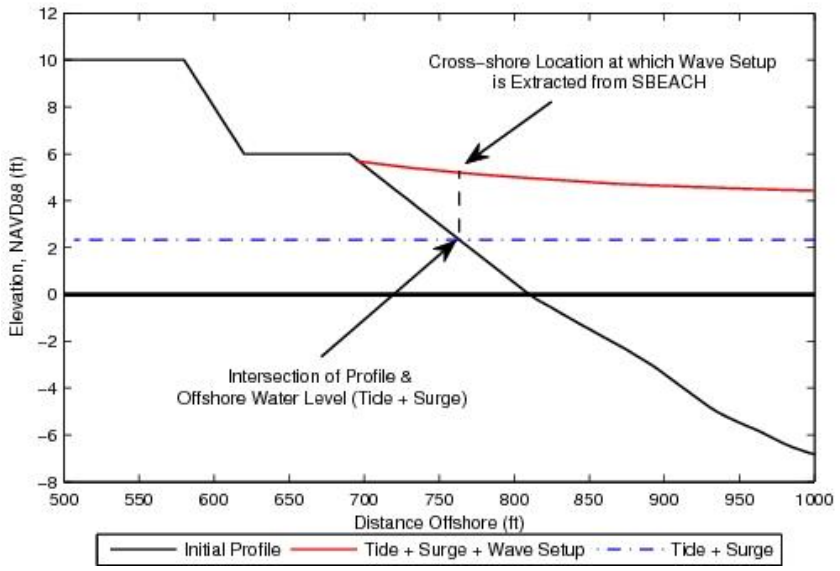


Figure 4-3: Cross-shore Location at which Wave Setup is extracted from SBEACH

4.7 Structural Condition

A coastal structures condition survey was conducted in spring of 2009, 26th to 27th of May. The condition survey was focused on determining the existing condition of shore protection structures, including groins, retaining walls, and remnants of timber groins (shown as pile groups). For rock groins, the crest elevation, width, side slope, armor size, core stone condition are inspected and documented. For wood groins (timber sheet piles), the elevation and existing conditions are inspected. Groin effectiveness in terms of updrift fillet formation and updrift/downdrift shoreline condition are inspected. The results of field survey/inspection are summarized in Table 2-15.

Based on the table, the majority of the timber groins are either buried or deteriorated and are no longer functioning effectively. All stone groins constructed after 1943 are generally in fair to good condition and are effective in trapping littoral material. The concrete retaining walls are generally in good condition. There is no evidence that the coastal structures are under periodic maintenance.

Table 4-6: Coastal Structures Condition Survey Summary

East Rockaway Reformulations Coastal Structures Condition Survey
Structures 1-43 surveyed 5/26/09, 44-103 surveyed on 5/27/09

Structure Number (field assigned)	Type	Street No	Construction Material	Side Slope (1v: h)	Crest Width (ft)	Width Crest + sides (ft)	Connection with wall, bulkhead, revetment?	Overall Structure Condition	Stone Structures				Sheetpile		Updrift Fillet		Retaining Wall
									Armor Diam. (ft)	Armor Unit Interlocking	Armor Stone Cracked?	Core Stone Visible btwn Armor units?	Sheetpile Type	Sheetpile Condition	Updrift Fillet Present?	Beach width offset (ft)	Wall Height above Grade (ft)
1	groin	B34	wood	na	na	na	none	nonfunctional					wood	nonfunctional	none	0	
2	groin	B34	wood	na	na	na	none	nonfunctional					wood	nonfunctional	none	0	
3	groin		stone	sides buried	10-15	20-25	none	good	4.0	good	intact	no			west side	25	
4	groin		stone	undiscernable	no flat crest	25	none	nonfunctional	4.0	nonfunctional	intact	no			none	0	
5	groin		stone	sides buried	15-20	25	none	good	4.5	good	intact	no			east side	20	
6	groin		stone	1.5	15-20	20-25	none	good	4.5	good	intact	no			none	0	
7	groin		stone	undiscernable	no flat crest	25	none	nonfunctional	4.5	nonfunctional	intact	no			none	0	
8	groin		stone	1.5	10-15	20-25	none	excellent	4.5	excellent	intact	no			east side	20	
9	single pile, pile group		wood	na	na	na	none	nonfunctional							na		
10	groin		stone	1.5	10-15	20-25	none	excellent	4.5	excellent	intact	no			west side	5	
11	single pile, pile group		wood	na	na	na	none	nonfunctional							na	na	
12	vehicle accessway	B64	cut under bdwk	na	na	na	boardwalk	good							na		
13	groin		stone	1.5	10-15	20-25	none	good	4.5	good	intact	no			east side	5	
14	single pile, pile group		wood	na	na	na	none	nonfunctional							na		
15	groin		stone	1.5	10-15	20-25	none	good	4.5	good	intact	no			east side	5	
16	vehicle accessway	B68	wood	na	na	na	boardwalk	good							na		
17	groin		stone	1	10-15	20	none	fair	4.5	fair	intact	no			west side	10	
18	single pile, pile group		wood	na	na	na	none	nonfunctional							na		
19	groin		stone	1.5	10-15	25	none	good	4.5	good	intact	no			west side	10	
20	single pile, pile group		wood	na	na	na	none	nonfunctional							na		
21	groin		stone	1.5	15-20	25	none	good	4.5	good	intact	yes			east side	10	
22	groin		stone	1.5	15-20	25	none	fair	4.5	fair	intact	no			none	0	
23	groin		stone	2	10-15	20-25	none	excellent	4.5	good	intact	no			west side	20	
24	groin		stone	1.5	10-15	25	none	excellent	4.5	good	intact	no			east side	75	
25	groin		wood	na	na	na	none	poor					wood	poor	none	0	
26	handicap access ramp	B91st	wood	na	na	na	boardwalk	good							na	na	
27	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
28	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
29	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
30	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
31	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
32	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
33	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
34	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
35	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
36	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
37	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
38	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
39	single pile, pile group		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
40	retaining wall	B130	cmu	na	na	na	na	good							na	na	3
41	retaining wall	B140	concrete	na	na	na	na	good							na	na	4
42	retaining wall	B149	concrete	na	na	na	na	good							na	na	4
43	groin	B149	stone	2	20-25	40	retaining wall	good	5.0	good	intact	no			east side	100	4
44	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
45	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
46	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
47	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
48	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
49	groin		wood	na	na	na	none	nonfunctional					wood	poor	none	0	
50	single pile, pile group		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
51	retaining wall		concrete	na	na	na	na	good							na	na	4

Structure Number (field assigned)	Type	Street No	Construction Material	Side Slope (1v: h)	Crest Width (ft)	Width Crest + sides (ft)	Connection with wall, bulkhead, revetment?	Overall Structure Condition	Stone Structures				Sheetpile		Updrift Fillet		Retaining Wall
									Armor Diam. (ft)	Armor Unit Interlocking	Armor Stone Cracked?	Core Stone Visible btwn Armor units?	Sheetpile Type	Sheetpile Condition	Updrift Fillet Present?	Beach width offset (ft)	Wall Height above Grade (ft)
51	retaining wall		concrete	na	na	na	na	good							na	na	4
52	retaining wall		concrete	na	na	na	na	good									5
53	vehicle accessway		concrete	na	na	na	na	good									
54	groin		combination	na	na	na	none	indeterminate					steel	indeterminate	none	0	
55	retaining wall		concrete	na	na	na	promenade	indeterminate									0.25
56	groin		combination	na	na	na	retaining wall	fair							east side	20	1
57	groin		wood	na	na	na	retaining wall	poor							none	0	
58	groin		combination	na	na	na	retaining wall	fair					concrete	indeterminate	east side	1-2' vert	
59	groin		wood	na	na	na	none	poor					wood	poor	none	0	
60	groin		wood	na	na	na	none	poor					wood	poor	none	0	
61	groin		wood	na	na	na	none	poor					wood	poor	none	0	
62	groin		wood	na	na	na	retaining wall	poor					wood	poor	none	0	
63	groin		wood	na	na	na	none	poor					wood	poor	none	0	
64	groin		wood	na	na	na	none	poor					wood	poor	none	0	
65	groin		wood	na	na	na	none	poor					wood	poor	none	0	
66	vehicle accessway	B169	concrete	na	na	na	retaining wall	good									
67	groin		stone	1.5	no flat crest	15	none	fair	4	fair	hairline cra	no			none	0	
68	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
69	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
70	groin		stone	1.5	no flat crest	10-20	none	fair	4	fair	hairline cra	no			none	0	
71	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
72	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
73	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
74	groin		stone	1.5	no flat crest	15	none	fair	4	fair	hairline cra	no			none	0	
75	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
76	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
77	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
78	groin		stone	1.5	no flat crest	10	none	fair	4	fair	hairline cra	no			none	0	
79	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
80	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
81	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
82	groin		stone	1.5	no flat crest	10	none	fair	4	fair	hairline cra	no			none	0	
83	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
84	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
85	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
86	groin		wood	na	na	na	none	nonfunctional					wood	indeterminate	none	0	
87	groin		stone	1.5	no flat crest	15	none	fair	4	fair	hairline cra	no			none	0	
88	groin		wood	na	na	na	defunct bulkhead	nonfunctional					wood	indeterminate	none	0	
89	groin		wood	na	na	na	defunct bulkhead	nonfunctional					wood	indeterminate	none	0	
90	groin		wood	na	na	na	defunct bulkhead	nonfunctional					wood	indeterminate	none	0	
91	groin		wood	na	na	na	defunct bulkhead	nonfunctional					wood	indeterminate	none	0	
92	groin		stone	1.5	no flat crest	15	none	good	4	good	hairline cra	no			none	0	
93	groin		wood	na	na	na	defunct bulkhead	nonfunctional					wood	indeterminate	none	0	
94	groin		wood	na	na	na	defunct bulkhead	nonfunctional					wood	indeterminate	none	0	
95	groin		wood	na	na	na	defunct bulkhead	nonfunctional					wood	indeterminate	none	0	
96	groin		stone	1.5	no flat crest	15	defunct bulkhead	good	4	fair	hairline cra	yes			east side	30	
97	revetment or toe stone		stone	2	no flat crest	10		poor	3	fair		no	wood	nonfunctional	na	na	
98	groin		wood	na	na	na	none	nonfunctional					wood	nonfunctional	none	0	
99	groin		wood	na	na	na	none	nonfunctional					wood	nonfunctional	none	0	
100	groin		combination	1.5	wood core	15	defunct bulkhead	fair	3.5	poor	intact	no	wood	poor	none	0	
101	groin		combination	1.5	wood core	15	defunct bulkhead	fair	3.5	poor	intact	no	wood	poor	none	0	
102	groin		combination	1.5	wood core	15	defunct bulkhead	fair	3.5	poor	intact	no	wood	poor	east side	75	
103	groin		wood	na	na	na		indeterminate					wood	indeterminate	none	0	
104	groin		wood	na	na	na		indeterminate					wood	indeterminate	none	1	

5 BORROW SOURCE

A borrow source investigation was carried out to identify and delineate sources of beachfill borrow material for use as initial design fill and future nourishment material for this project. Suitable grain size and distribution were investigated and present in available volume within a reasonable distance from the project shoreline. Grain size distributions and available volumes of the borrow sources were obtained from samples collected at various potential sources including upland, nearshore, and offshore locations. The grain sizes were compared with typical native beach model distribution taken from the project site to determine the compatibility of the borrow material. Those suitable borrow sources were checked to determine if volume at the borrow site would be sufficient for the beachfill project. The following summarize borrow source investigation results.

5.1 Historical Borrow Areas

Construction of the WRDA 1974 and Section 934 projects used several borrow areas offshore of Rockaway. Figure 5-1 shows the prior borrow areas and the delineation of the three borrow areas identified for the Reformulation Study.

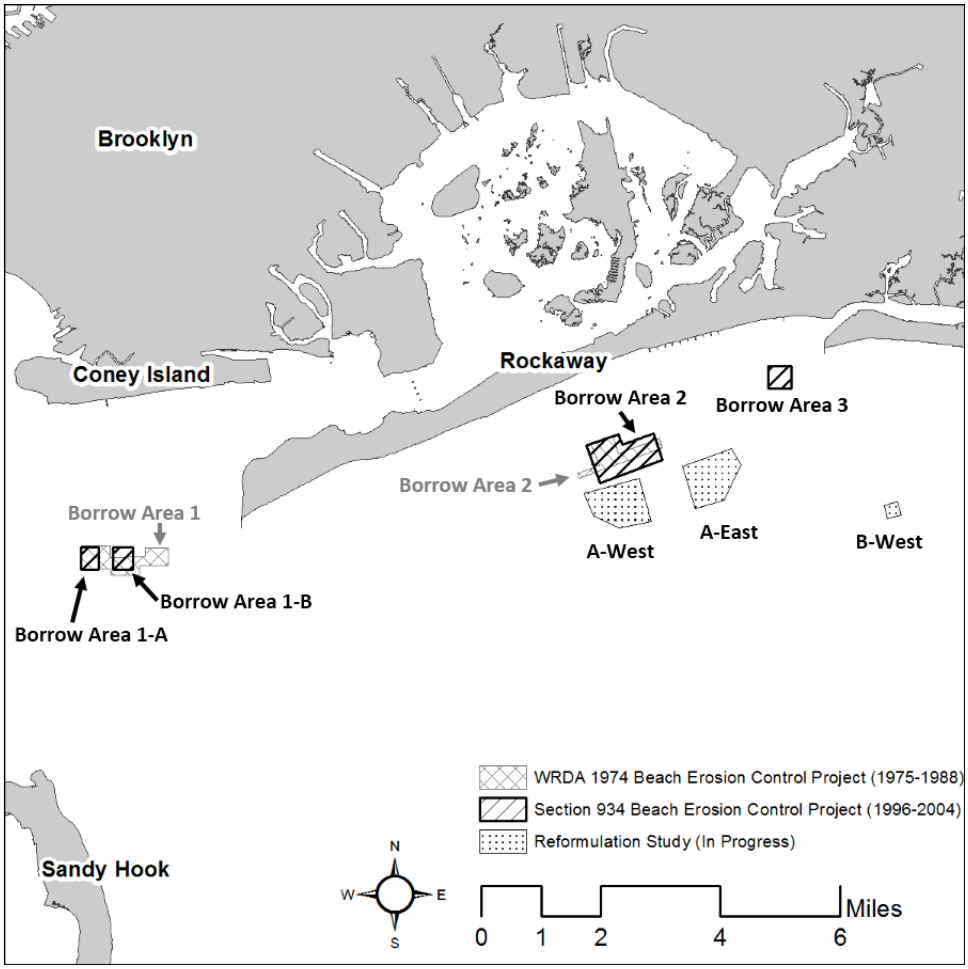


Figure 5-1: Historical Offshore Borrow Areas for Rockaway Beach

5.2 Native Beach Model

Eroded beaches that are in need of nourishment are considered to have remnant sediments of a grain size distribution that is more stable and in better equilibrium. Native beach sediments must be matched with similar grain size of borrow material so that the beach fill (initial and renourishment quantities) will reasonably endure over the required project life by being similar to more stable grain size distribution. In order to determine this representative sediment, samples of native (i.e., pre-fill) beach were collected and analyzed for grain size distribution. Beach sample parameters derived from the grain size distribution (GSD) curves are then compared mathematically using methodology from the USACE Shore Protection Manual, 1984 with the GSD curves of the borrow area sediments to determine the adjusted fill factor (Ra) and stability factor (Rj) of potential borrow sediments.

5.2.1 Native Beach Sediment Data

Native beach sediment samples were collected in 1961 and 1974 in pre-fill beach areas. The 1961 data consists of a summary of mean grain size, sorting coefficient, and a skewness coefficient, from which the 25th and 75th percentile grain sizes can be back calculated, and from that the 16th and 84 percentiles (required by current methodology) can be extrapolated. However, the 1974 data presents the raw grain size data, encompassing the 16th and 84th percentile. A comparison of the 1961 and 1974 mean grain size results shows, on average, the sediment neither becoming more coarse or more fine; therefore the more comprehensive 1974 data was used to estimate the native beach sand characteristics.

5.2.2 Native Beach Model Development

The 1986 monitoring report (unpublished) contains the following on-offshore spatial sediment composite information: Berm/Backshore, Mean High Water/Mean Tide Level/Mean Low Water, and -6/-12/-18/-24 ft. NGVD. Typically, beach fill equilibrates in shallower water; therefore, the -6/-12/-18/-24 ft. NGVD composite data was omitted from the model. The alongshore composite information was developed (in the monitoring report) for Beach Area A, which extends from B110th to B46th Streets; Area B, which extends from B46th to B19th Streets; and Area C, which extends from B149th to B100th Streets. As fill is proposed potentially in all three of these areas, all three areas were included in the model. The individual beach area sediment characteristics are shown in Table 5-1. The final beach model is determined by composition of all raw data (omitting the -6, -12, -18, -24, -30 ft. NGVD samples) for each beach area. The Rockaway Native Beach Model based on the mathematically mixed composition of all samples of the three beach areas (excluding deep samples) is shown on Table 5-2 below, and is 0.29 mm mean grain size, and standard deviation of 0.52 in phi units. Figure 5-2 shows the resulting native model grain size distribution curve.

Table 5-1: Average Values of the Rockaway Beach Sediment Samples by Beach Area

Beach Area	Sample Location	Phi 16 (ϕ_{16})	Phi 50 (ϕ_{50})	Phi 84 (ϕ_{84})	Mean Grain Size (ϕ)	Mean Grain Size (mm)	Standard Deviation (ϕ)
A (B110th to B46th)	Berm/Backshore	1.27	1.74	2.2	1.74	0.3	0.46
	MHW/MTL/MLW	1.09	1.74	2.27	1.7	0.31	0.59
	-6, -12, -18, -24, -30 ft.	1.55	2.5	3.46	2.5	0.18	0.96
B (B46th to B19th)	Berm/Backshore	1.31	1.79	2.29	1.79	0.29	0.49
	MHW/MTL/MLW	0.43	1.71	2.33	1.49	0.36	0.95
	-6, -12, -18, -24, -30 ft.	1.71	2.57	3.4	2.56	0.17	0.085
C (B149th to B110th)	Berm/Backshore	1.37	1.83	2.37	1.85	0.28	0.5
	MHW/MTL/MLW	1.31	1.83	2.54	1.9	0.27	0.62
	-6, -12, -18, -24, -30 ft.	1.55	2.87	3.57	2.67	0.16	1.01

Table 5-2: Native Beach Model Characteristics

Mean (ϕ)	**1.79**
Mean (mm)	0.29
Standard Deviation (ϕ)	0.52

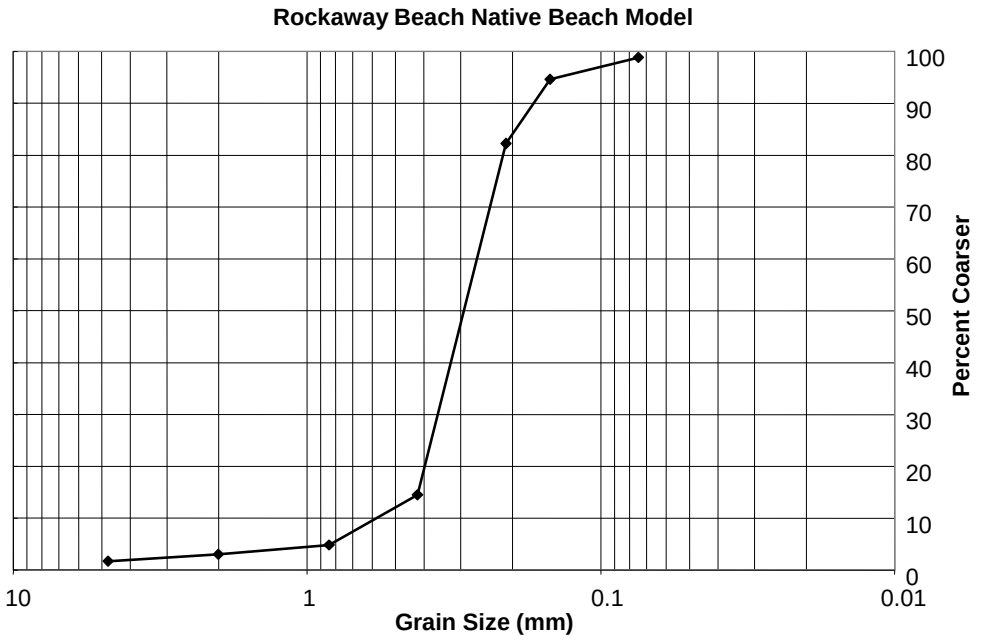


Figure 5-2: Native Beach Model

5.3 Potential Upland Source

An upland source using trucks to convey beach fill material to a project can be a cost effective alternative for small projects. However with large projects, the operational expense for the heavy equipment is often prohibitive and the environmental impact on the local communities may be prohibitive as well. However, if offshore sources are not available within reasonable traveling distance to the project site, it may be feasible to bring sand from upland suppliers by barge transfer. This could be the case if the sand suppliers have access to the waterways of Long Island Sound, the south shore of Long Island, Raritan Bay, New York Harbor or the Hudson River. Sand conveyed by barge in bulk can be fluidized and piped to the beach in the same manner that a cutter head dredge pumps sand ashore. Potential sites with suitable grain size, available volume, and within economic distance that warrant further investigation are described below and summarized in Table 5-3.

- Amboy Aggregates, South Amboy, NJ. This company is one of the largest suppliers of aggregate in the Unites States and the largest in the New York metropolitan area. One of its largest sources of sand and gravel is the channels leading into the New York Harbor (Ambrose, Chapel Hill, and Sandy Hook Channels, etc.). Amboy has a large processing plant in South Amboy, NJ that is capable of sorting dredged material into gradations needed by the construction industry. Recently, Amboy has begun importing coarse sediments from Canada, due to the scarcity of sand in the channels. Samples collected in 2000 varied in mean grain size from 0.26 to 0.56 mm, with a composite having a mean of 0.32 mm and

sorting ratio of 1.15 in phi units, and were described as dark gray, fine to medium, poorly sorted, mainly quartz, but with small shell fragments (characteristic of marine sands).

- R.W. Vogel, Barnegat, NJ. The samples collected were from the Jackson, NJ processing plant, and were described as light tan, moderately sorted, medium quartz sand, with a mean grain size varying from 0.59 to 0.71 mm, with a composite of 0.63 mm and a sorting ratio of 1.11 in phi units.
- Horan Sand and Gravel Corp., Syosset, NY. Mean grain size varied from 0.41 to 0.85 mm, with a composite of 0.66 mm and a standard deviation of 1.26 in phi units.
- Ranco Sand and Stone, Manorville, NY. Mean grain size varied from 0.48 to 1.31 mm, with a composite of 0.63 mm and a standard deviation of 0.84 in phi.
- East Coast Mines, Limited, East Quogue, NY. Material is described as coarse fine sand. The mean grain size was 0.61 mm, and the standard deviation was 1.11 in phi units.

Table 5-3: Characteristics of Upland Sand Sources for Rockaway

Name of Quarry	Location	Mean Size (mm)	Standard Deviation (ø)
Amboy Aggregates	South Amboy, NJ	0.32	1.15
R.W. Vogel	Barnegat, NJ	0.63	1.11
Horan Sand and Gravel	Bayshore, NY	0.66	1.26
Ranco Sand and Gravel	Manorville, NY	0.63	0.84
East Coast Mines	East Quogue, NY	0.61	1.11

5.4 Potential Nearshore Source

Sources investigated included the navigation channels and inlets including Rockaway Inlet, East Rockaway Inlet, Jones Inlet, and the Jamaica Bay Channels. The bay channels were ruled out due to environmental sensitivities. Furthermore, bay sediments tend to be unstable for ocean beach stability. East Rockaway Inlet sediments are currently placed on the Rockaway beach, however, are not an ideal initial beachfill material. The dredged material could be used for renourishment due to its close proximity to the project site.

5.5 Potential Offshore Borrow Areas

There are several potential offshore borrow areas with suitable grain size and available volume based on available core data. The following criteria were used to select offshore borrow areas for further investigation:

- suitable grain size compared with native grain size (mean size = 0.29mm);

- sufficient volume (greater than 75,000 contiguous cy);
- proximity (as close as possible to fill area for cost purposes;
- minimal adverse effect of the local wave conditions;
- a minimum of 30 feet water depth;
- minimal environmental constraints, fishing interests;
- clear of cables, pipelines, shipping lanes, etc..

Two potential sites are short-listed based on their available size, suitability, and environmental considerations (see Appendix D). The sites are described in the following paragraphs. The location coordinates of the offshore sites are summarized in Table 5-4 and described in Figure 5-1.

5.6 Borrow Area A-West

The area for Borrow Area A-West is roughly rectangular in shape approximately 4,800 feet from east to west, and 4,000 feet from north to south. The average dredging depth is approximately 18 feet below grade. Due to numerous magnetic anomalies detected during the magnetometer investigation in this vicinity, a diver investigation is recommended prior to dredging to determine the nature of the anomalies. If the anomalies are small enough and without cultural impact, a hopper dredge with a screen could be utilized. In this case, it is estimated that the borrow area could supply approximately 9 million cubic yards (assuming 1V:3H side slopes and 25% of material to be unusable). If the anomalies are not small enough, or have cultural significance and the anomalies may not be disturbed, the borrow area could still supply approximately 4 million cubic yards (assuming a minimum 200 ft buffer surrounding each anomaly and 1V:3H side slopes and 35% of the material to be unusable). The average overfill factor for this area is approximately 1.08.

5.7 Borrow Area A-East

Borrow Area A-East is roughly rectangular (5,000 feet in the alongshore direction by 4,000 feet in the on-offshore direction. The average overfill factor for this delineation is approximately 1.15. The approximate depth of suitable materials is 17 feet. The volume contained in this area is approximately 8 million cubic yards (assuming 1V:3H side slopes and omitting approximately 25% for poor material interlayer found while dredging). Either a hopper dredge or a cutterhead dredge may be used for this area.

5.8 Borrow Area B-West

Borrow Area B-West is roughly a 1,200 by 1,200 feet box. The average overfill factor for this delineation is approximately 1.06. The approximate depth of suitable materials is 17.8 feet. The volume contained in this area is approximately 1 million cubic yards (assuming 1V:3H side slopes and omitting approximately 25% for poor material interlayers found while dredging). A cutterhead

dredge would be the most efficient for this area. Environmental investigation must be performed on this area prior to use.

Table 5-4: Potential Borrow Area Coordinates

Borrow Area	Corner	Northing (feet)	Easting (feet)
A-West	1	137,150	1,031,900
A-West	2	139,100	1,031,050
A-West	3	140,500	1,035,900
A-West	4	136,650	1,037,000
A-West	5	136,100	1,034,150
A-East	1	137,750	1,040,850
A-East	2	141,550	1,039,750
A-East	3	143,100	1,044,100
A-East	4	141,700	1,044,900
A-East	5	138,550	1,043,450
B-West	1	136,950	1,057,900
B-West	2	138,100	1,057,600
B-West	3	138,400	1,058,750
B-West	4	137,250	1,059,100

Notes: NAD83 State Plane, Long Island Lambert System

5.9 Recommended Borrow Source for Further Investigation

Borrow Areas A-West and A-East are recommended for further investigation. The recommended borrow volume range from 13,000,000 to 18,000,000 cubic yards. Further investigation will be necessary prior to construction.

5.10 Impacts of Borrow Area Dredging

Nearshore wave impacts resulting from the excavation of proposed borrow areas offshore of Rockaway were evaluated using the spectral nearshore wave transformation model STWAVE. The simulated dredging conditions represent the removal of all suitable material (18 million cubic yards, USACE-NAN 2008) in borrow areas, A-West, A-East, B-West. Ten offshore wave conditions (six extreme events and six events representing normal conditions) were simulated to characterize the impact of excavating the proposed borrow areas on nearshore waves. The relative change of the nearshore wave conditions at the -39 ft contour was calculated based on the existing conditions and dredged conditions.

The impact of excavating the proposed borrow areas is dependent on the wave direction, and wave period. The excavated borrow areas can alter wave transformation over the pits, resulting in alternating zones of wave focusing and wave divergence with an increase in the wave height up 14.4% and a decrease up to 26%. Generally an increase in wave height occurs adjacent to the borrow pits whereas a decrease in the wave height occurs over and in the lee of the borrow pit. A change in the direction of the offshore waves can shift the zones of wave focusing and wave divergence along the shoreline. An example of the modeled change in wave heights is shown in Figure 5-3. Given the magnitude of the changes in the nearshore wave height resulting from dredging the borrow areas a 15% increase in the nearshore design wave heights is recommended.

However, the net impact of sediment transport can be neglected due to both decrease and increase of wave heights of the nearshore waves, which would result in minimal net impact. In addition, the borrow pits will not be excavated to the maximum capacity within one excavation, and the dredged pit will most likely re-filled before the next operation.

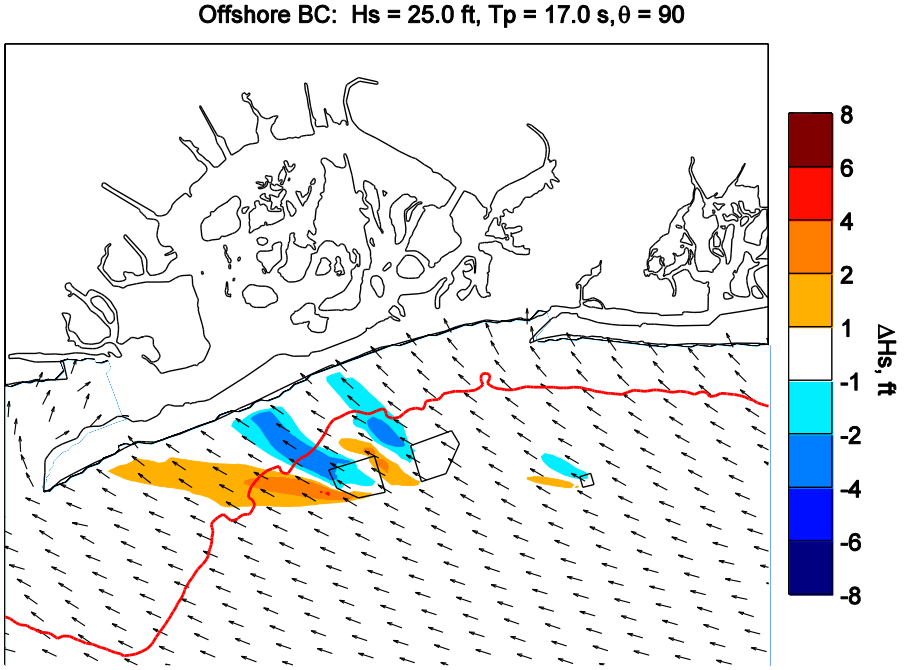


Figure 5-3: Example of Nearshore Wave Changes from Dredging

6 SEDIMENT BUDGET

6.1 Formulating a Sediment Budget

A sediment budget is an accounting of sediment gains and losses, or sources and sinks, within a specified control volume (cell), or a series of connecting cells, over a given period of time. Sediment budgets can provide a conceptual and quantitative model of sediment transport pathways in coastal systems, as well as a framework for understanding complex coastal systems and their responses to coastal engineering projects.

The sediment budgets developed for the Atlantic Ocean Shorefront include a number of cells and are based on the following balance:

$$\sum Qsource - \sum Qsink + P + BP - SLR = \Delta V + Residual$$

ΔV = net volume change within cell (eroding shoreline is a negative value)

P = volume of material placed within cell (positive contribution to cell)

BP = volume of material natural bypassed around inlet (positive contribution to cell)

SLR = volume of material lost to sea level rise (negative contribution to cell).

$Qsource$ = Net longshore sediment transport (LST) into cell

$Qsink$ = Net longshore sediment transport (LST) out of cell

6.2 Historical Sediment Budget

A historical sediment budget representing the time period between 1975-2010 was developed based on observed shoreline changes and engineering records of beachfill placement. This time period encompasses two major beach nourishment projects and intermittent renourishment and routine maintenance dredging of East Rockaway Inlet. The sediment budget was formulated based on the known quantities, setting the residual equal to zero, and solving for the net longshore sediment transport rates by balancing the budget.

Shoreline Changes (ΔV)

Net volume changes within the cells are calculated from observed shoreline changes between 1975 and 2010. The October 1975 shoreline represents the High Water Line (HWL) digitized from NOAA T-Sheets (TP00754 & TP00747). The August 2010 shoreline represents the Mean High Water Line (MWH) digitized from a Lidar survey performed by the USACE Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX). Observed shoreline changes are converted to volumetric changes based on the height of the active profile (33 feet) and length of the shoreline within the sediment budget cell.

The observed shoreline changes over this time period are presented in Figure 6-1. The red areas in Figure 6-1 indicate accretion and the blue areas erosion. It is evident that the two ends of the

Rockaway Beach, Reach 1 and Reach 6, experienced the greatest rates of shoreline accretion with values up to +15 feet per year. In contrast the middle of the peninsula experienced smaller rates of shoreline change with Reaches 4 and 5 experiencing erosion rates up to -5 feet per year. It is noted that these shoreline change rates reflect the net shoreline change over this 35 year period and include the impact of beachfill operations. It is likely that the shoreline would have experienced much more erosion if it wasn't for the beachfill operations that helped stabilize the shoreline. The overall sediment budget will highlight the role beachfill operations had during this period in stabilizing the shoreline.

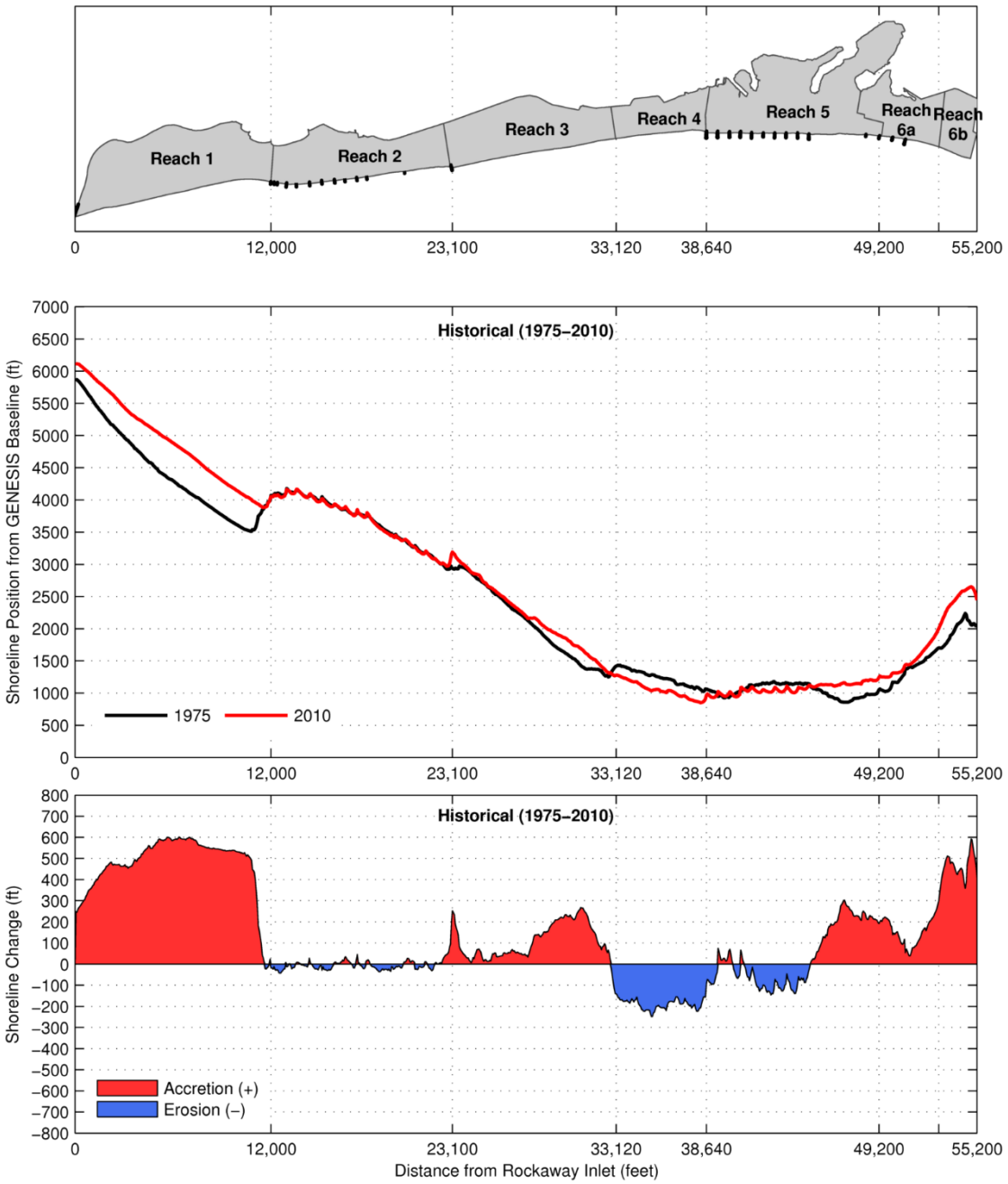


Figure 6-1: Historical Shoreline Changes (1975-2010)

Beachfill Placement (P)

A total 15.6 million cubic yards of beachfill were placed along Rockaway Beach from 1975-2010. This time period encompasses the WRDA 1974 Beach Erosion Control Project and the Section 934 Beach Erosion Control Project. A portion of the beachfill placed along Rockaway Beach is part of regular inlet maintenance dredging of East Rockaway Inlet. A majority (87%) of the beachfill over this time period was placed in Reaches 4, 5, and 6.

Natural Inlet Bypassing (BP)

East Rockaway Inlet is located at the eastern limit of Rockaway Beach. The East Rockaway Inlet is a Federal navigation channel 250-ft wide and maintained to -14 ft mean low water (MLW) plus 2 ft allowable overdepth. It is estimated that approximately 300,000 cy of updrift material needs to pass the Inlet in a westerly direction annually, either by natural bypassing or channel maintenance dredging (USACE NYD, 2012). Some material is lost permanently out of the littoral system. Historical dredging records indicate that the channel dredging rate increased from an average 30,000 cy/yr in the 1938-to-1978 time period to an average 115,000 cy/yr recently (USACE NYD, 2012). The increase in dredging volumes is associated with the growth of the updrift fillet at East Rockaway Inlet.

Previous studies have estimated that between 70,000 cy and 170,000 cy sediment naturally bypasses East Rockaway Inlet (OCTI, 2011 and USACE NYD, 2012). Recent shoreline modeling efforts as part of this study using GENESIS-T found that a bypassing rate of 100,000 cy/year provided the best model calibration for the 1996-2010 calibration time period.

Based on the available data and GENESIS-T modeling results the following Inlet Bypassing Rates are used in sediment Budgets:

- 1975-2010 Time Period: 50,000 cy/yr
- 1996-2010 Time Period: 100,000 cy/yr
- Future Conditions: 100,000 cy/yr

Sea Level Rise (SLR)

Cross-shore sediment losses due to sea level rise (SLR) are incorporated in the sediment budget after Bruun (1962).

$$R = \frac{S}{\theta}$$

S = change in sea level

θ = average profile slope over active beach profile

R = horizontal recession of beach

The historic rate of SLR in the study area is +0.0128 ft/yr (NOAA Sandy Hook Tide Gage). The average profile slope over the active beach profile, θ, was estimated to be 1V:60.5H based on long

profile surveys in the project area. Over the 35 year time period the sea level (S) has risen approximately 0.45 ft corresponding to a horizontal recession of the beach (R) of 27 ft. This is equivalent to a volumetric loss of 53,000 cy/yr over the entire Rockaway Beach shoreline.

Two-Cell Sediment Budget

A two-cell sediment budget, Figure 6-2, was developed for Rockaway Beach based on the sediment sources and sinks described above. The two-cell sediment budget shows that net annual longshore sediment transport increases from -10,000 cy/yr (east) to +376,000 cy/yr (west) over the eastern cell. This sharp increase in sediment transport creates a 386,000 cy/yr deficit in the eastern sediment budget cell. Historically this sediment deficit has been offset by placing a 387,000 cy/yr of beachfill in this cell. The sediment budget shows that without this beachfill this cell would have experienced considerably more erosion.

The western sediment budget cell has a surplus of sediment since much more sediment is entering the cell at Beach 110th Street than is leaving the cell at Rockaway Inlet. The surplus of sediment resulted in shoreline accretion, most notably in Reach 1 (Figure 6-1).

The two-cell historical sediment budget clearly shows that net longshore sediment transport rates increasing from east to west along Rockaway Beach are the primary cause of shoreline erosion in eastern Rockaway Beach and shoreline accretion in western Rockaway Beach. Shoreline erosion in eastern Rockaway has been largely avoided by placing a considerable amount of beachfill in this area.

Seven-Cell Sediment Budget

A more detailed seven-cell sediment budget, Figure 6-3, was also developed for Rockaway Beach based on the same set of data to provide additional detail about areas that have historically been erosional "hotspots". The WRDA 1976 Erosion Control Project only performed renourishment operations in the two Feeder Beaches (Reach 4 and Reach 6a). These feeder beaches were also identified prior to the WRDA 1976 Project as erosional hot spots. It is clear from the sediment budget that Reaches 4 and 6a are indeed erosional hotspots. A nodal point in the net annual longshore sediment transport occurs within Reach 6a and there sediment transport rates cause a sediment deficit of 223,000 cy/yr. This deficit has been historically offset by beachfill placement (212,000 cy/yr).

The other erosional hotspot, Reach 4, appears to be caused by the groin field in Reach 5 which suppresses the sediment transport, starving Reach 4 of sand. Once again the sediment deficit has been managed by beachfill placement (130,000 cy/yr).

The sediment budget shows that Reaches 2, 3, and 5 have been relatively stable and have about the same net longshore sediment transport entering and leaving the cells. These cells have likely been beneficiaries of updrift beachfill operations.

Reaches 1 and 6b have a sediment surplus because more net annual longshore sediment transport is entering than leaving these cells.

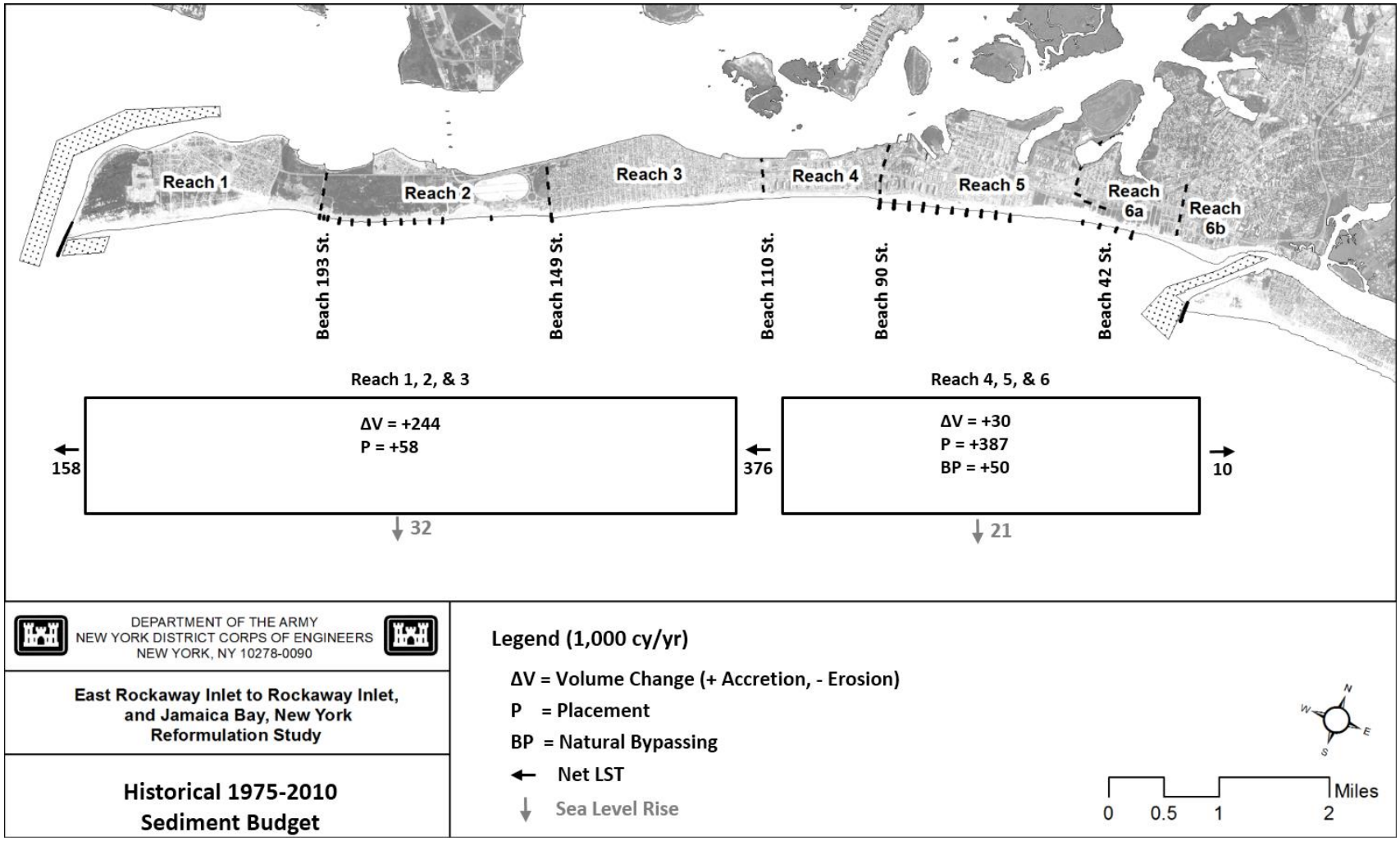


Figure 6-2: 2-Cell Historical Sediment Budget (1975-2010)

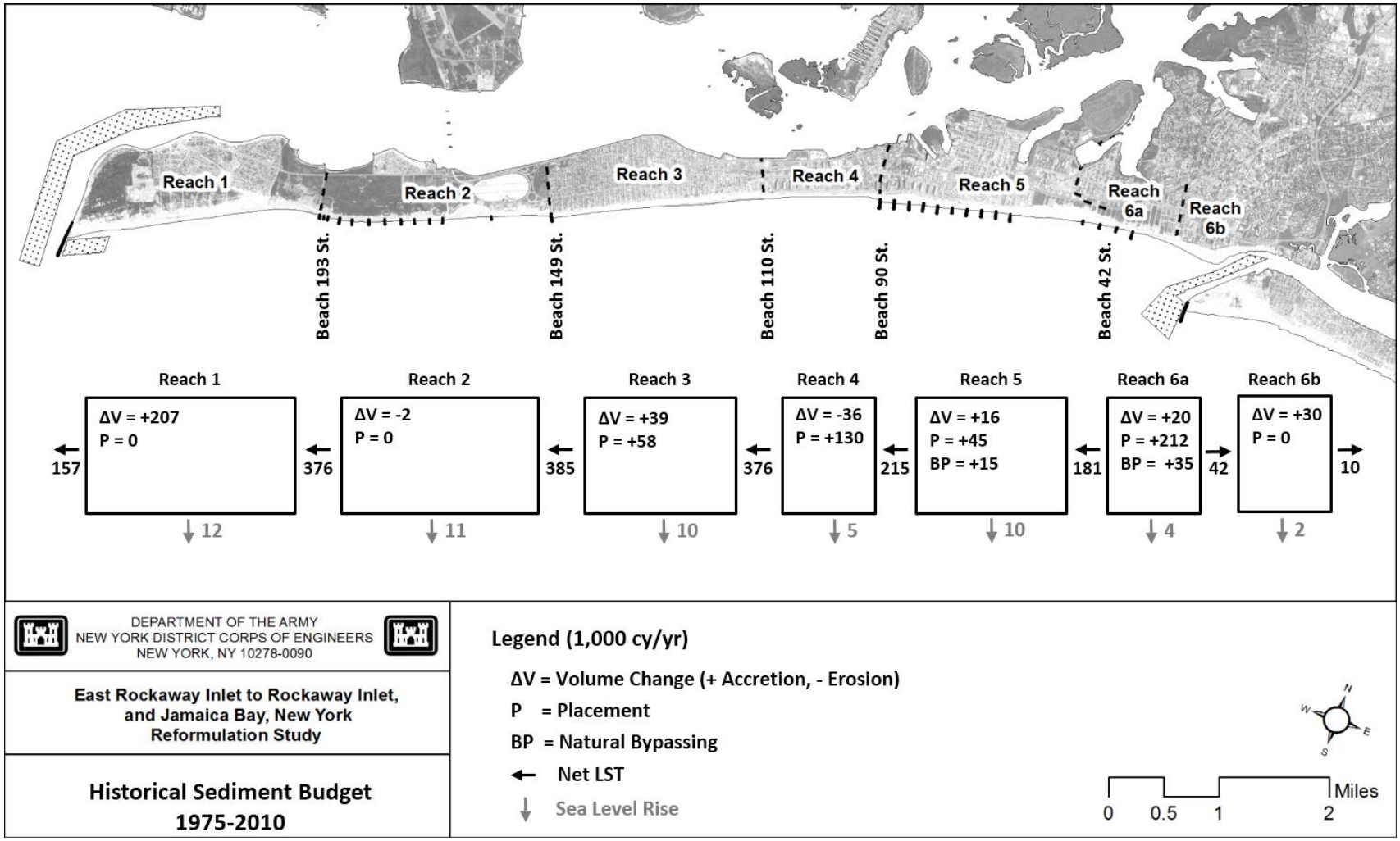


Figure 6-3: 7-Cell Historical Sediment Budget (1975-2010)

6.3 Without Project Sediment Budget

The Without Project Future Condition (WOPFC) is by definition the projection of the most-likely future conditions in the project area if no actions are taken as a result of this study. The WOPFC must be representative of what is most likely to occur in the absence of a Federal project, and as such must be based upon historic practice and trends. The WOPFC serves as the base conditions for all the alternative analyses.

Identifying the WOPFC at The Atlantic Ocean Shorefront is particularly challenging because the historical conditions include a Federal project. Therefore, historical data alone may not be used to describe the shoreline and beach conditions if no actions are taken in the project area. Instead, a shoreline change model (GENESIS-T) is used to simulate longshore sediment transport and shoreline changes that are likely to occur in the WOPFC.

In defining the WOPFC, the following assumptions are made to establish the framework of what is likely to occur.

Beachfill Placement (P)

As defined by existing Federal/State navigation authorities, the existing inlets (Rockaway Inlet and East Rockaway Inlet) and their corresponding approach and Jamaica Bay navigation channels will be maintained near the present widths depths, and locations. Approximately 230,000 cubic yards of material will be dredged from East Rockaway Inlet every 2 years and placed in Reach 6a.

Natural Inlet Bypassing (BP)

A natural inlet bypassing rate of 100,000 cy/year at East Rockaway Inlet is used to characterize the WOPFC. This bypassing rate provided the best calibration in GENESIS-T and is within the range of previous estimates (OCTI, 2011 and USACE NYD, 2012).

6.3.1 GENESIS-T Modeling

GENESIS-T is designed to simulate long-term shoreline change based on spatial and temporal differences in longshore sediment transport induced primarily by wave action while accounting for coastal structures and beach fills. The GENESIS-T model was calibrated to historical conditions from 1996-2010. A detailed description of the GENESIS-T model development is provided in the Numerical Modeling Appendix (Sub-Appendix A).

A 16-year GENESIS-T simulation was performed to characterize the WOPFC. The wave conditions for the 16-year period are based on the wave conditions from 1996 to 2012. The predicted net annual longshore sediment transport from GENESIS-T is used in the WOPFC sediment budget. Figure 6-4 shows the predicted net annual longshore sediment transport rates and corresponding shoreline changes. The WOPFC simulations include both natural inlet bypassing and inlet maintenance dredging, both of which reduce the shoreline erosion

in Reach 6a. The GENESIS-T simulations do not include the impact of sea level change or any other cross-shore coastal processes.

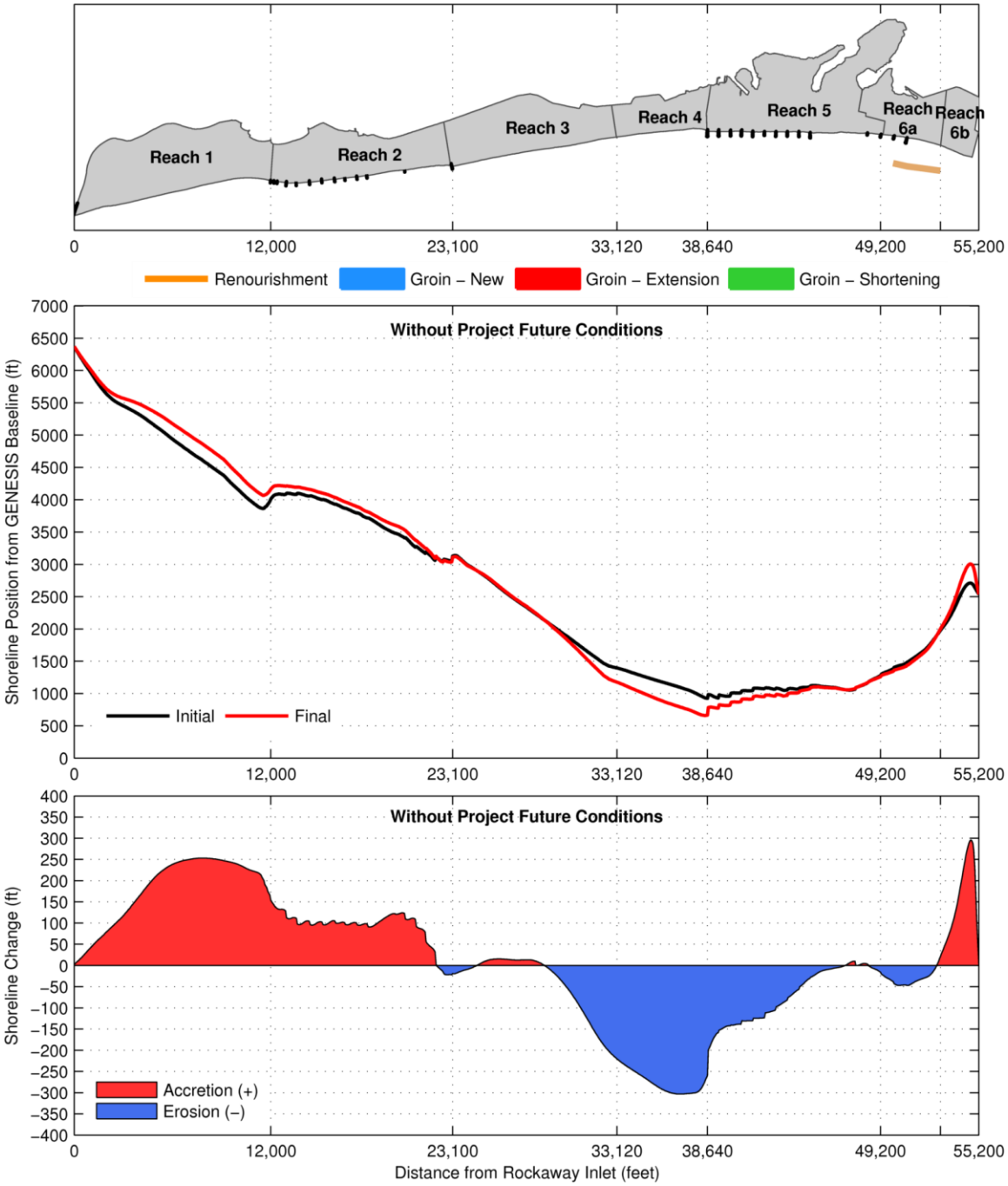


Figure 6-4: WOPFC Shoreline Changes

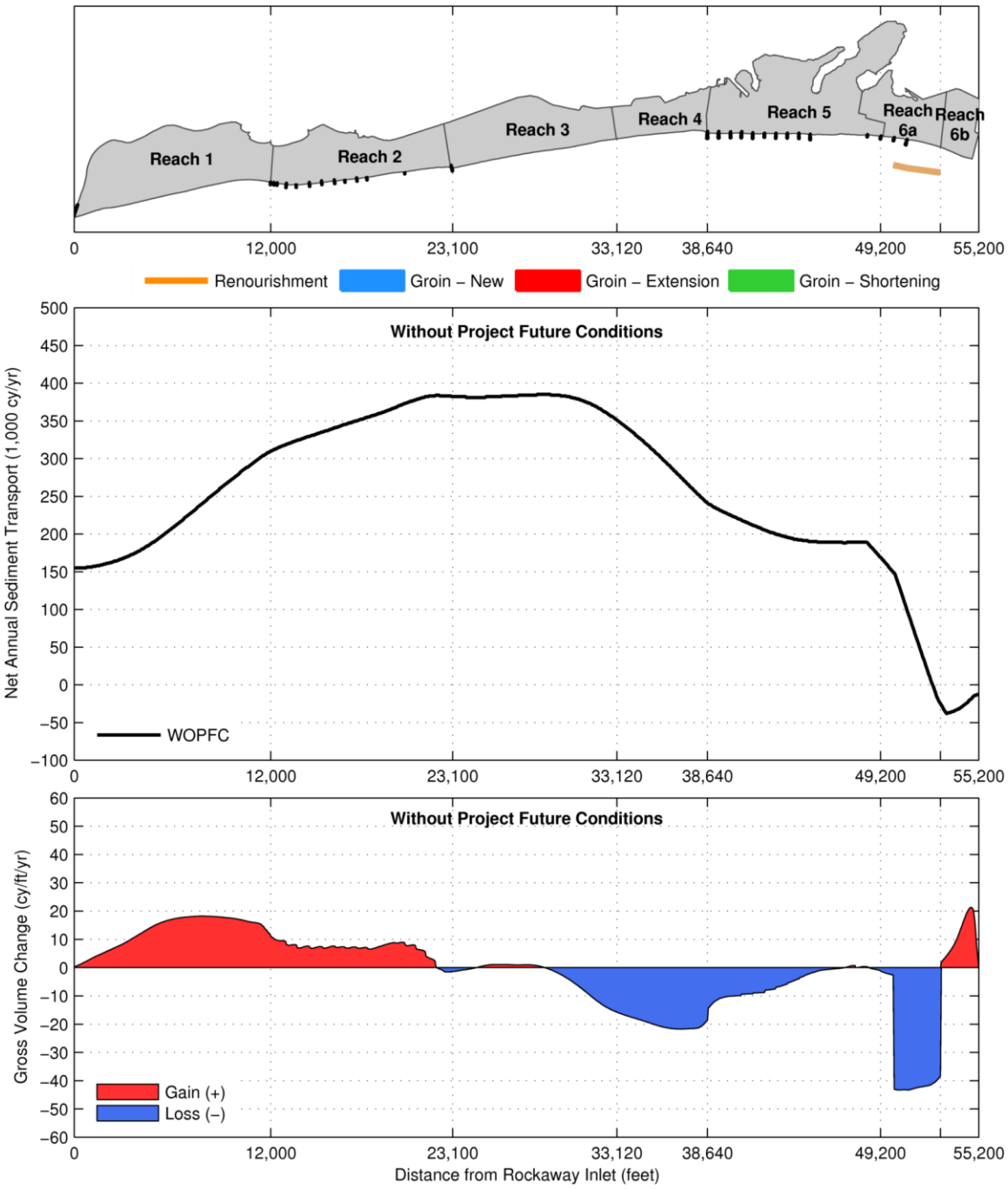


Figure 6-5: WOPFC Sediment Transport & Gross Volume Changes.

6.3.2 Without Project Future Conditions Sediment Budget

A WOPFC sediment budget was developed based on modeled shoreline changes, modeled net annual longshore sediment transport rates, sea level rise, and inlet bypassing and inlet maintenance dredging assumptions.

6.3.3 Sea Level Rise (SLR)

Cross-shore sediment losses due to sea level rise (SLR) are incorporated in the sediment budget after Bruun (1962). The WOPFC sediment budget uses the historic rate of SLR at the NOAA Tide Gage at Sandy Hook, NJ. The sensitivity to of the WOPFC to higher rates of sea level rise is shown based on current USACE guidance (ER 1100-2-8162). Future SLR rates were evaluated for a 50-year period from 2018-2068. Table 6-1 provides an overview of the impact sea level rise.

Table 6-1: Sea Level Rise Impacts on Shoreline Changes and Sediment Budget

Sea Level Rise Scenario	SLR over 50-years (ft)	Shoreline Change (ft/yr)	Volumetric Loss[1] (cy/yr)
USACE-Low (Historical)	0.64	-0.78	53,000
USACE-Intermediate	1.09	-1.32	90,000
USACE-High	2.80	-3.07	209,000

[1]Volumetric Loss over the entire Rockaway Beach Shoreline (55,650 feet)

6.3.4 Two-Cell Sediment Budget

As expected, the WOPFC sediment budget is similar to the Historical Sediment Budget, except that the only beachfill placement in the WOPFC is associated with East Rockaway Inlet maintenance dredging. The two-cell WOPFC sediment budget, Figure 6-7, shows that eastern half of Rockaway Beach has a sediment deficit of approximately 145,000 cy/yr while the western half has a sediment surplus of approximately 200,000 cy/yr. As a result it is expected that the eastern half of Rockaway will continue to experience shoreline erosion and the western half shoreline accretion in the absence the WOPFC. The corresponding shoreline change rates for the WOPFC are presented in Table 6-2. The impact SLR acceleration has on the shoreline change rates is also shown in Table 6-2.

Table 6-2: Two-Cell WOPFC Shoreline Changes

Sea Level Rise Scenario	Shoreline Change (ft/yr)	
	Reaches 1, 2, 3	Reaches 4, 5, 6
USACE-Low (Historical)	+4.1	-6.2
USACE-Intermediate	+3.5	-6.8
USACE-High	+2.2	-8.5

6.3.5 Seven-Cell Sediment Budget

The seven-cell WOPFC sediment budget, Figure 6-8, provides a more detailed look at the sediment budget and identifies erosional hotspots along Rockaway Beach. The net annual longshore sediment transport rates are similar to the Historical Conditions, and increase from east to west along Rockaway Beach peaking in Reach 3. The steady increase in net annual longshore transport rate creates a sediment deficit in Reaches 3, 4, 5, and 6a. The overall trend in longshore sediment transport is driven by the alongshore variability in the wave conditions. Figure 6-6 shows the alongshore variability in the net annual longshore sediment transport problems.

The primary difference between the WOPFC and Historical Conditions sediment budgets is that there is no beachfill in the WOPFC to offset the sediment deficit created by the overarching trend longshore sediment transport. Table 6-3 shows the corresponding shoreline change rates based on the seven-cell WOPFC sediment budget. The most striking cell is Reach 4, which is predicted to erode by 17.5 ft/yr. This erosion hotspot is caused by 1) overarching trend in longshore sediment transport along eastern Rockaway Beach, 2) sediment impoundment of updrift groin field in Reach 5.

Table 6-3: Seven-Cell WOPFC Shoreline Changes

Reach	Shoreline Change (ft/yr)
1	+9
2	+4.4
3	-3.2
4	-17.5
5	-3.8
6a	-5.3[1]
6b	+9.4

[1]Shoreline change rate in Reach 6a would be much greater if not for beach fill from Inlet Maintenance Dredging

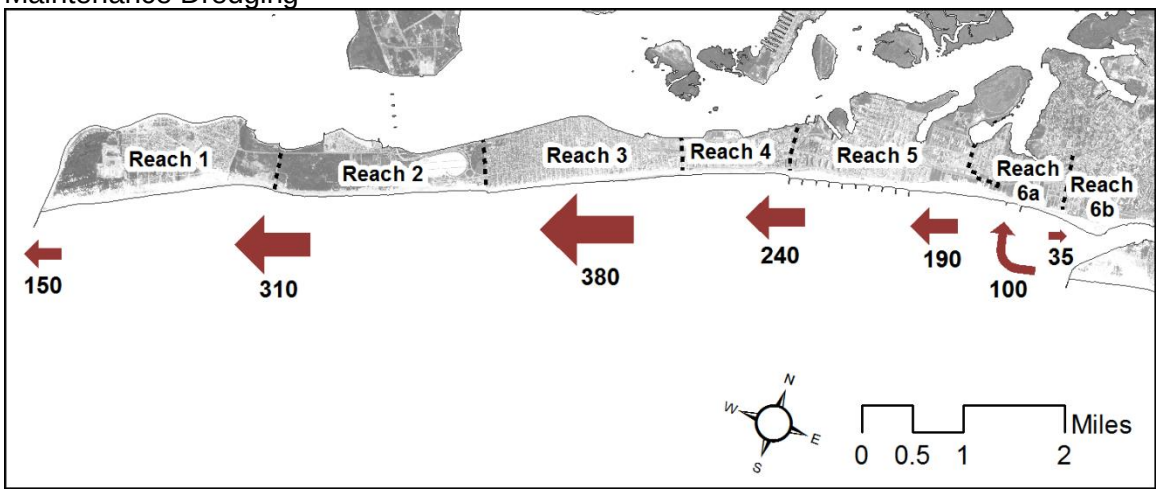


Figure 6-6: WOPFC Sediment Transport Pathways at Rockaway Beach

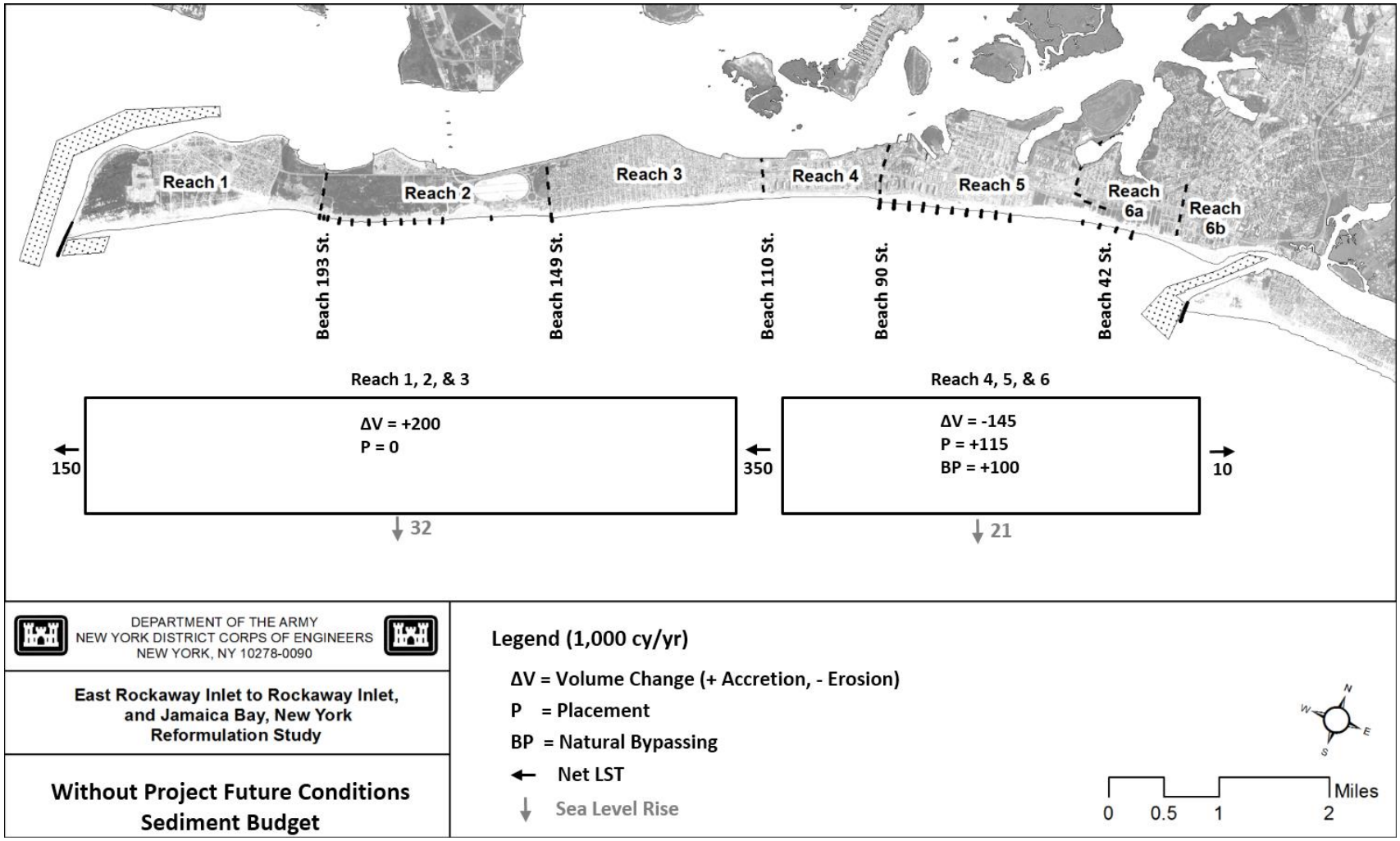


Figure 6-7: 2-Cell WOPFC Sediment Budget

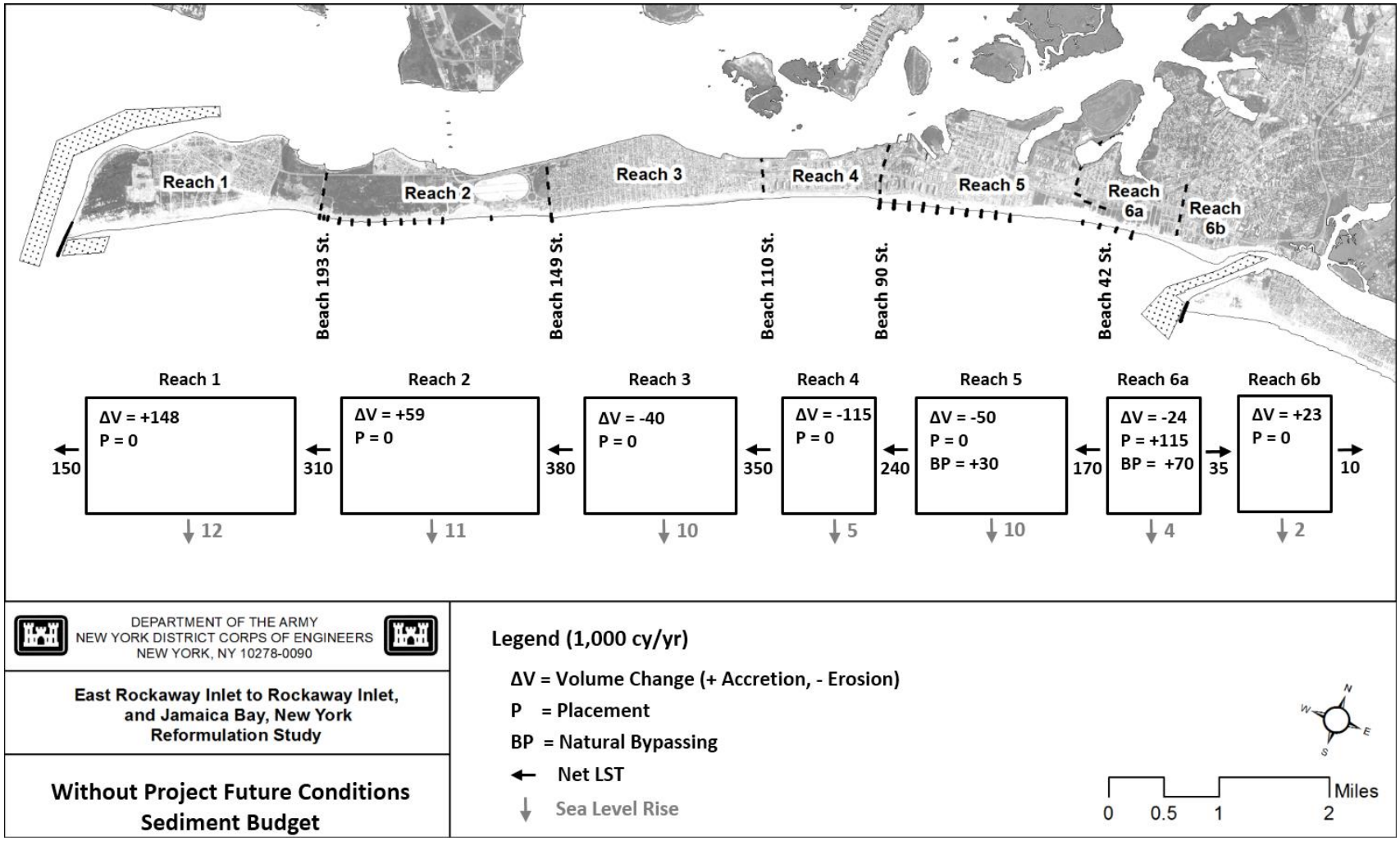


Figure 6-8: 7-Cell WOPFC Sediment Budget

6.4 With Project Sediment Budget

The GENESIS-T modeling results for each alternative were simplified by reaches and used to create With Project Conditions (WPFC) sediment budgets. The net annual longshore sediment transport rates and renourishment quantities from the GENESIS-T simulations are incorporated into the sediment budgets (Figure 6-9 to Figure 6-11). A detailed description of the GENESIS-T modeling results is provided in the Engineering Modeling Appendix (Sub-Appendix A).

The WPFC sediment budgets account for the low (historic) sea level change prediction, resulting in a 29,000 cy/yr increase in renourishment quantities from the GENESIS-T modeling results which do not account for sea level rise. Renourishment quantities would increase by an additional 20,000 and 84,000 cy/yr respectively if the intermediate and high sea level change predictions are applied.

This section documents the evaluation of several beach restoration and erosion control alternatives for the Atlantic Ocean Shorefront. The alternative evaluation focuses on ways to reduce future renourishment requirements and life-cycle costs. The alternative analysis does not consider storm damage reduction benefits; all of the alternatives provide roughly the same level of risk reduction since the alternatives have the same design profile (e.g. berm and dune dimensions). Different measures, such as new groins, shortening / lengthening of existing groins, and boardwalk relocation, are evaluated based on their ability to reduce future renourishment requirements and life-cycle costs. The three alternatives evaluated are (Figure 7-1 in Section 7.1):

- Alternative 1: Beach Restoration
- Alternative 2: Beach Restoration + Reduced Erosion Control
- Alternative 3: Beach Restoration + Increased Erosion Control

The objective of all three alternatives is the same: maintain the design beach profile over the life of the project at the lowest possible cost. The focus of Alternatives 2 and 3 are managing the two historical erosional hot spots in Reach 4 and 6 with either reduced erosion control (groin shortening and boardwalk relocation) or increased erosion control (new groins and extension of existing groins).

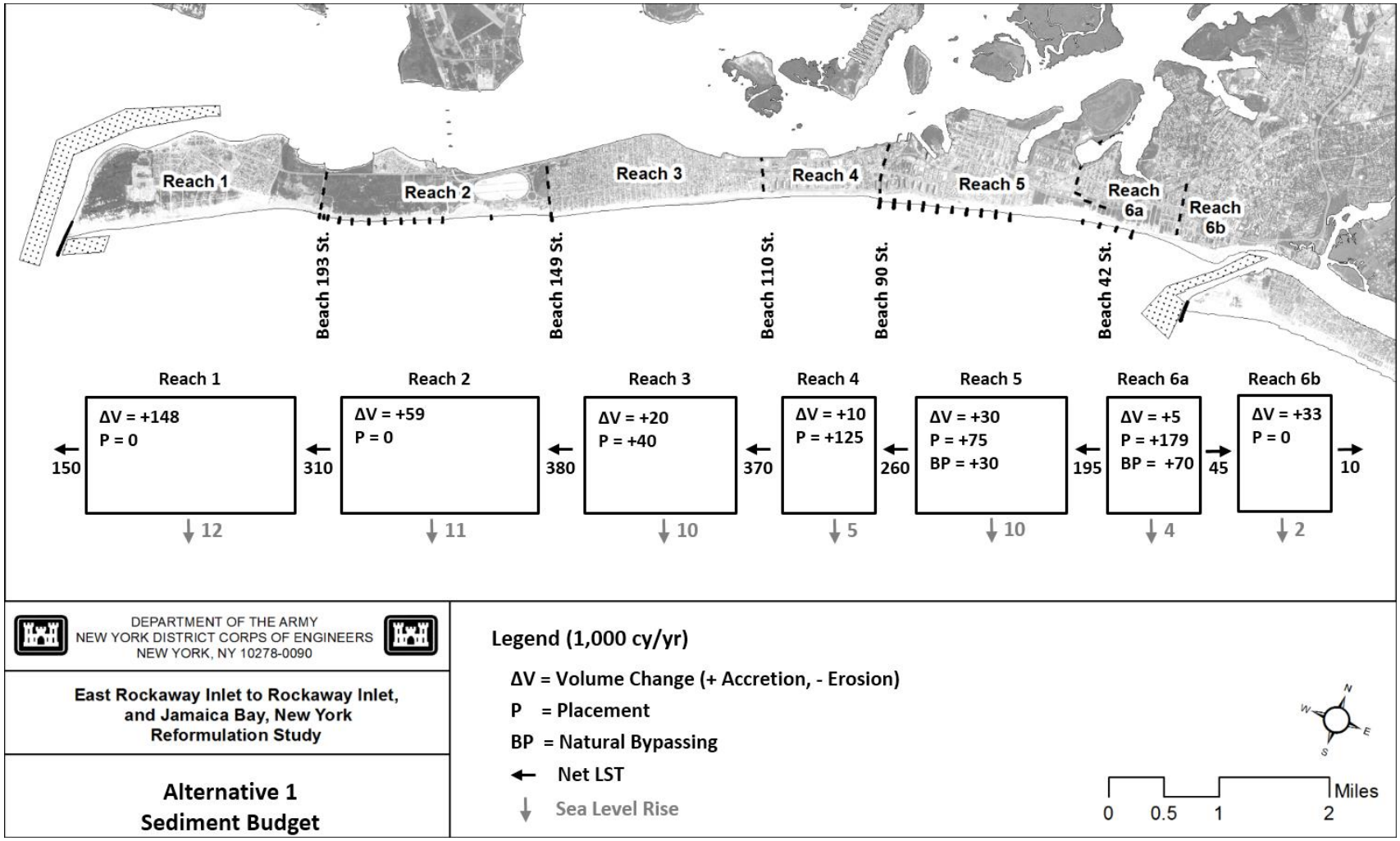


Figure 6-9: 7-Cell Alternative 1 Sediment Budget

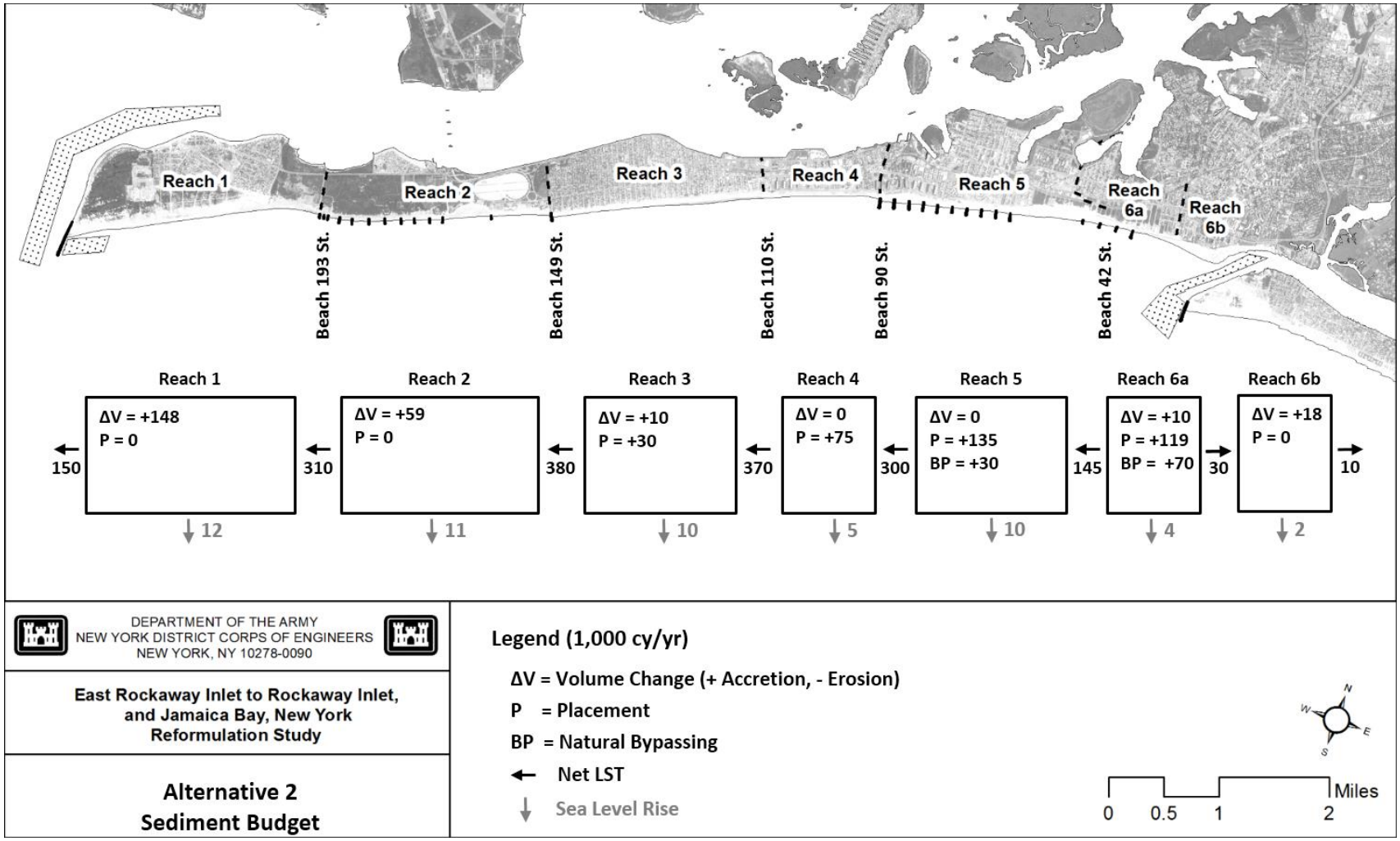


Figure 6-10: 7-Cell Alternative 2 Sediment Budget

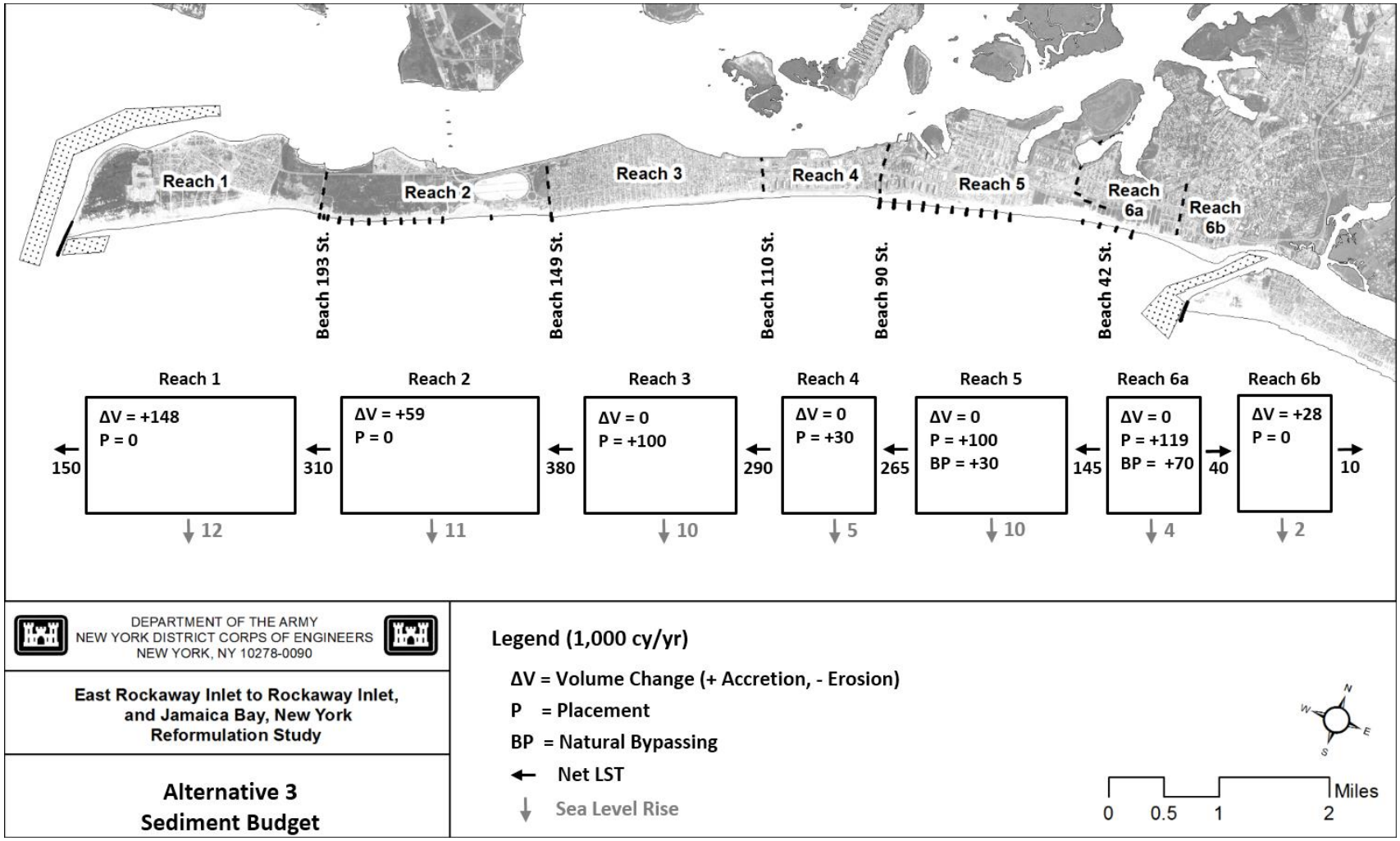


Figure 6-11: 7-Cell Alternative 3 Sediment Budget

7 ALTERNATIVE DEVELOPMENT

7.1 Overview

An initial screening effort was undertaken to identify potentially feasible erosion control and storm protection measures. These measures have been incorporated in a series of plans to address the identified problems.

The general approach to identifying a tentatively selected plan is to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective approach to reducing project renourishment. This analysis is a lifecycle cost comparison to ensure that the most cost effective renourishment approach has been identified prior to the evaluation of alternatives for the coastal storm risk management.

The Coastal Storm Risk Management (CSRM) plans consist of various beachfill, dune and seawall measures to reduce future storm damages for the Atlantic Ocean Shorefront (Reach 3 through Reach 6b). The plans were evaluated based on a comparison of their quantified storm risk management benefits in comparison to their costs. The plan that provides the greatest net CSRM benefits in excess of costs is identified as the National Economic Development Plan.

Recreation benefits are also being evaluated and will be incorporated into the final Benefit to Cost Ratio (BCR). For any plan to be implemented the BCR must be greater than 1.0.

The alternatives comparison is initially performed based on the low/ historic sea level rise scenario, which assumes a continuation of historic sea level changes. The scenario analysis considers two additional accelerated sea level change scenarios.

7.2 Erosion Control Alternatives

Plan formulation of the erosion control alternatives focused on identifying the least-costly solution to maintaining a wide beach and dune over the 50-year planning horizon. The erosion control alternative analysis did not consider storm damage reduction benefits; each of the erosion control alternatives were evaluated based on the same generic design berm and dune. Four erosion control alternatives (Figure 7-1) were short-listed by the PDT and selected to be evaluated in detail:

- Alternative 0: No Action
- Alternative 1: Beach Restoration
- Alternative 2: Beach Restoration + Reduced Erosion Control
- Alternative 3: Beach Restoration + Increased Erosion Control

The short-listed alternatives include various measures such as new groins, shortening/lengthening of existing groins, and boardwalk relocation that have the potential to reduce future renourishment requirements and life-cycle costs

Detailed one-dimensional shoreline change modeling (GENESIS) was conducted to identify future renourishment requirements for each alternative. The screening level design consisting of plan layouts, cross-sections, quantities, and costs, was performed for each alternative to estimate the life-cycle costs.

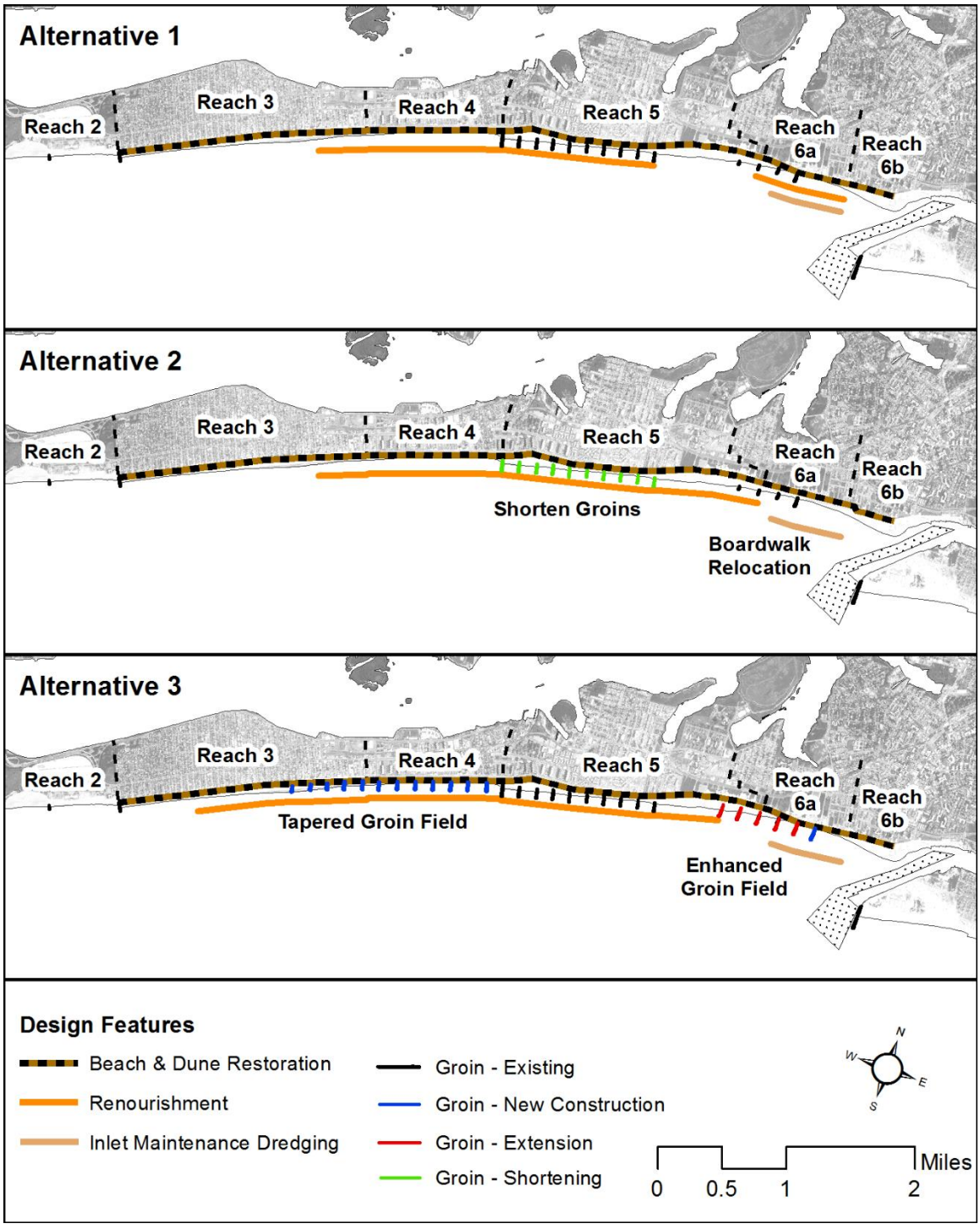


Figure 7-1: Short-Listed Alternatives

7.2.1 Screening Level Design

This section presents the screening level design for the alternatives. The screening level design consisted of developing layouts, cross-sections, quantities, and costs. The objective

of the screening level design is to develop enough detail regarding the designs to be able to reliably estimate the life-cycle costs.

7.2.2 Preliminary Design Profile

At the start of Erosion Control Alternative evaluation the optimal design profile was still being evaluated as part of the Beach-fx study, which led to the selection of an optimal design berm width and dune height. Some features of the design profile (i.e. berm elevation, dune slope, foreshore slope) were already known. In order to allow the Erosion Control Alternative Analysis to proceed an assumption regarding the design profile was necessary. It is not expected that changes in the design profile would have a significant impact on the relative cost of the alternatives. All elevations throughout this appendix are reference to the North American Vertical Datum of 1988 (NAVD88) unless specifically stated otherwise.

Figure 7-2 shows the design profile used in the erosion control analysis, which has a dune elevation of +16 ft NAVD88 and a berm width of 60 ft. The advance berm width is a sacrificial quantity of sand which acts as an erosional buffer against long-term and storm-induced erosion with the goal of preventing erosion of the design profile between renourishment cycles. Specifically, the advance fill is to offset the expected losses between initial construction and the first renourishment operation. Advance berm widths vary by alternative and reach since it the advance berm width is proportional to the expected shoreline erosion between renourishment operations.

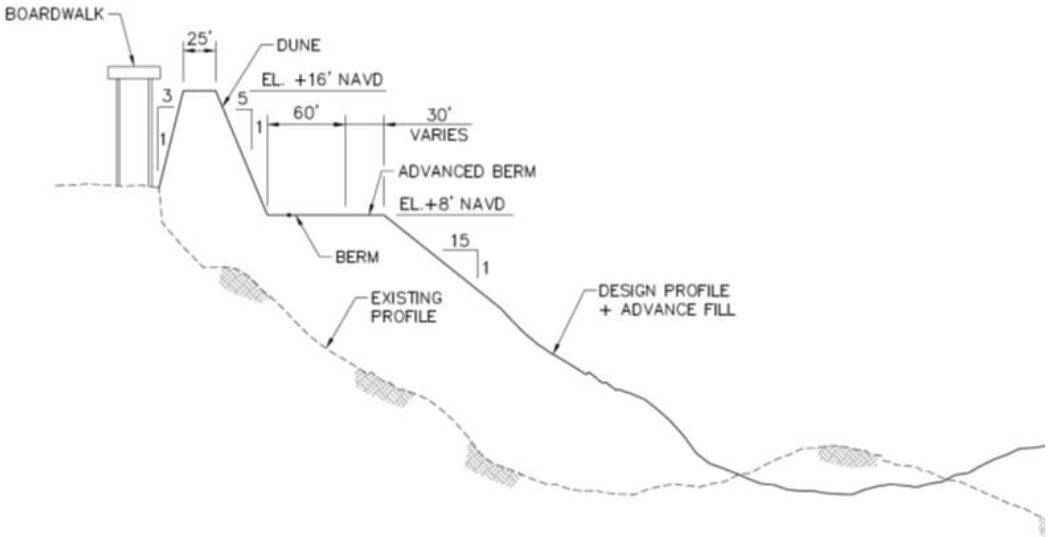


Figure 7-2: Preliminary Design Profile (Applied in Erosion Control Evaluation)

The New York District has over twenty years of successful project performance with the Westhampton Project (Long Beach, NY) which is comparable and has an equal berm width. The 25 ft dune crest width was selected based on Section 934 beach renourishment design profile which was constructed through the Flood Control and Coastal Emergencies Act, PL 84-99, (post Sandy). This 25 ft dune crest is considered to be a pre-existing condition and will be preserved.

7.2.3 Project Baseline & Alignment

The project baseline controls the alignment of the project and sets the location of the design shoreline. The project baseline for this project represents the landward toe of the dune (+10' NAVD88). The seaward edge of the design berm (excluding advance fill) is always located 143 ft seaward of the baseline. In most instances the project baseline follows the seaward edge of the boardwalk. However, in some locations the project baseline deviates from the boardwalk in order to ensure a relatively straight design shoreline that follows the natural shoreline curvature. However, the dune always follows the boardwalk and is not constrained by the project baseline. In some locations, such as Reach 5, the berm width measured from the boardwalk is much greater than 143 feet. The project baseline is the same in all three alternatives, with the exception of Reach 6a where the baseline and boardwalk are relocated further inland in Alternative 2.

7.2.4 Initial Construction Beachfill Quantities

It is impossible to predict the exact shoreline position for the point in time that construction is expected to start since the wave conditions vary from year to year and affect shoreline change rates. Beachfill quantities required for initial construction of each alternative are estimated based on the expected shoreline position in December 2019. A hybrid approach based on numerical model results and historical shoreline change rates have been used to estimate the shoreline position in December 2019. This includes a 3.5 year GENESIS-T numerical model simulation representative of typical wave conditions (detailed in Sub-Appendix A) and the reach specific erosion rates discussed in section 6.3.

Beachfill quantities are based on the difference in the design shoreline position (including advance fill) and the estimated December 2019 shoreline. For every foot that the shoreline at the start of construction needs to be translated seaward it is estimated that it requires 1.22 cy/ft of fill, based on berm elevation of +8 ft NAVD88 and a depth of closure of -25 ft NAVD88. Average end area calculations were performed to convert the difference in shoreline positions to volumes over the entire project area.

The design shoreline is a constant offset from the project baseline since it is uniform throughout the project area. Advance fill is included such that the constructed advance shoreline varies along the project area in conjunction with the expected shoreline change rates (further detailed in Sub-Appendix A). All beachfill quantities, Table 7-1, include an

overfill factor of 11% based on the compatibility analysis for the borrow areas. In addition the initial construction quantities include an additional 15% for construction tolerance. It is noted that the advance fill and renourishment quantities do not include tolerance since the purpose of the advance fill and renourishment is to place a specific volume of sediment to offset anticipated losses between renourishment operations, rather than build a specific template.

Table 7-1: Initial Construction Beachfill Quantities

Reach	Length (ft)	Alternative 1	Alternative 2	Alternative 3
Reach 1	12,480			
Reach 2	11,090			
Reach 3	10,320	279,000	290,000	331,000
Reach 4	5,380	383,000	305,000	221,000
Reach 5	10,650	221,000	310,000	290,000
Reach 6a	3,730	375,000	70,000	234,000
Reach 6b	2,000	20,000	20,000	20,000
Total	**55,650**	**1,278,000**	**995,000**	**1,096,000**

7.2.5 Renourishment Operations

GENESIS-T model simulations were used to determine the renourishment quantities (cy/yr), and advance fill requirements for each alternative. Renourishment intervals for the three alternatives is based on a combination of GENESIS-T model simulations and past project performance.

Renourishment Interval

The two prior beach restoration projects, WRDA 1974 and Section 934, had renourishment operations in two-year and four-year cycles respectively. The two-year renourishment cycles during the WRDA 1974 project may have been partially attributed to the nature of the project, feeder beaches, which led to high end losses. Nonetheless, it is apparent from the renourishment quantities that nearly all of the fill placed in the feeder beaches had transported elsewhere two years later.

In contrast the Section 934 project had renourishment operations every four years. However, the beach conditions at the end of the four year cycle were eroded well beyond the design template and a shorter renourishment interval or wider advance berm would likely have been needed to maintain the design template between renourishment operations.

GENESIS-T model simulations for all three alternatives were conducted based on four-year renourishment intervals. The models results for Alternative 1 show that an advance berm width of nearly 80 ft is required in Reach 4 to maintain the design shoreline between renourishment operations. Similarly, in Reach 6a an advance berm width of 55 ft plus the continued inlet maintenance dredging and placement (~115,000 cy/yr) is required. These relatively high advance berm widths are indicative of the erosive nature of these reaches.

One of the advantages of Alternative 2 and Alternative 3 is that With Project shoreline rates are more uniform over the project area. As a result the advance berm widths are more even throughout the project area and less than 60 ft. As a result, it is expected that Alternative 2 and Alternative 3 will on average allow for longer renourishment intervals than Alternative 1.

Based on past project performance a renourishment interval of 3 years is applied in the cost estimates for Alternative 1. A renourishment interval of 4 years is applied to Alternatives 2 and 3.

Shoreline change modeling results indicate that the design beach profile can be maintained over the life of project in all three alternatives if sufficient advance fill is placed and regular renourishment operations are performed. Alternative 1 experienced high sediment losses in the two historical erosional hot spots (EHS) requiring large renourishment quantities and a relatively short 3-year renourishment cycle.

Alternative 2 and 3, reduced the sediment losses in the two historical EHS by either increasing sediment flow into the hot spots (Alternative 2) or reducing sediment flow out of the hot spots (Alternative 3). As a result, Alternative 2 and 3 had lower renourishment quantities and a longer, 4-year, renourishment cycle than Alternative 1.

Renourishment Quantities

A summary of the renourishment quantities, per operation, including overfill and losses from sea level rise is provided in Table 7-2. It is noted that the renourishment quantities for Alternative 1 are based on a 3-year renourishment cycle, whereas the quantities for Alternative 2 and 3 are based on a 4-year cycle.

Table 7-2: Renourishment Quantities per Operation

Reach	Renourishment (cy)		
	Alternative 1[3]	Alternative 2[4]	Alternative 3[4]
Reach 3	133,000	133,000	444,000
Reach 4	416,000	333,000	133,000
Reach 5	250,000	599,000	444,000
Reach 6a	200,000[2]	0[2]	0[2]
Total	999,000	1,065,000	1,021,000

Notes [1] All renourishment quantities include SLR and overfill (11%)

[2] Excludes Inlet Maintenance Dredging (115,000 cy/yr)

[3] 3-year renourishment cycle

[4] 4-year renourishment cycle

7.2.6 Boardwalk Relocation

The Boardwalk Relocation measure entails the demolition and reconstruction of 2,900 feet of boardwalk and is only applicable to Alternative 2. The reconstructed boardwalk would be relocated about 200 to 300 feet landward so that the design shoreline follows the natural curvature of the shoreline reducing renourishment costs.

The old boardwalk was destroyed during Hurricane Sandy, and a new boardwalk has been designed and constructed by NYC Parks. The new boardwalk includes 24" steel pipe piles with a pre-cast concrete pile cap and precast concrete deck plank. The boardwalk also includes sand retaining wall made out of HP 14x89 steel piles and precast concrete panels. The cost estimate for Alternative 2 assumes that some of the materials could be salvaged and reused, such as the 24" steel pipe piles, HP 14x89 piles, and precast concrete panels. However, the majority of the boardwalk would have to be demolished, disposed of, and rebuilt with new materials.

In addition, 6.61 acres of permanent easements are required. The majority of the easements are on parcels owned by the New York City Housing Preservation (HUD). The costs for the permanent easements could be very high making this measure cost prohibitive.

7.2.7 Groin Design

Three types of groin measures are considered in the alternative analysis: new groin construction, groin extension, and groin shortening. The exact dimensions and stone sizes of the existing groins at Rockaway Beach are not available. Therefore, it is assumed that the existing groins in Reaches 5 and 6 are similar to the proposed new groin designs.

Generally a groin is comprised of three sections: 1) horizontal shore section (HSS) extending along the design berm; (2) an intermediate sloping section (ISS) extending from the berm to the design shoreline, and (3) an outer section (OS) that extends from the shoreline to offshore. The head section (HD) is part of the OS and is typically constructed at a flatter slope than the trunk of the groin and may require larger stone due to the exposure to breaking waves.

The spacing between groins in this study is based on the existing spacing in Reach 5 (720 ft) and Reach 6a (780 ft). The required lengths of the new groins is based on the GENESIS-T model simulations.

After identifying the groin lengths and spacing the following steps are applied in the groin design:

1) Layout groin section on typical profile surveys to determine appropriate bed elevations along the groin.
2) Calculate required armor stone size for stability under 100-year wave conditions (CIRIA, 2007).
3) Determine remaining groin dimensions and quantities for a typical groin. The crest width of the groin varies by section and is controlled by the armor stone size ($3D_{50}$).

The typical groin profiles and sections for Reaches 3& 4, Reach 6a, and Reach 5 are shown in Figure 7-3 to Figure 7-7. The groin sections in Reach 5 are the same as in Reaches 3 and 4. A complete list of the groin measures for each alternative, including the length, location, and feature is provided in Table 7-3. It is noted that groin extensions and shortening require removal of the existing groin head (50 ft), stockpiling nearby, and then reconstructing the head with the stockpiled stone. All of the re handling of the stone is reflected in the cost estimate for groin shortening. The cost of removing the head and stockpiling the stone for groin extensions in Reach 6a is approximately equal to the cost of obtaining and transporting the stone to the project site. Therefore, the cost estimate for the groin extensions only reflects the cost to construct 200 to 300 feet of new groin. Typical quantities required to build the groins are presented in Table 7-4 to Table 7-6.

Table 7-3: Summary of Groin Lengths

Alternative	Reach	Number	Groin ID	Street	Horizontal Shore Section (ft)	Intermediate Sloping Section (ft)	Outer Section (ft)	Total (ft)	Notes
Alt 2	5	1		60th St	90	108	278	476	shorten 100'
Alt 2	5	2		62nd St	90	108	178	376	shorten 100'
Alt 2	5	3		65th St	90	108	178	376	shorten 100'
Alt 2	5	4		68th St	90	108	178	376	shorten 100'
Alt 2	5	5		71st St	90	108	153	351	shorten 100'
Alt 2	5	6		74th St	90	108	203	401	shorten 100'
Alt 2	5	7		77th St	90	108	178	376	shorten 100'
Alt 2	5	8		80th St	90	108	203	401	shorten 100'
Alt 2	5	9		83rd St	90	108	228	426	shorten 100'
Alt 2	5	10		86th St	90	108	278	476	shorten 100'
Alt 3	6a	1	63	34th St	62	108	328	498	new 498'
Alt 3	6a	2	62	37th St	55	108	328	491	extension 209'
Alt 3	6a	3	61	40th St	90	108	328	526	extension 307'
Alt 3	5	4	53	43rd St	90	108	228	426	extension 114'
Alt 3	5	5	52	46th St	90	108	228	426	extension 155'
Alt 3	5	6	51	49th St	90	108	228	426	extension 180'
Alt 3	4	1	47	92nd St	66	108	128	302	new 302'
Alt 3	4	2	46	95th St	62	108	128	298	new 298'
Alt 3	4	3	45	98th St	63	108	128	299	new 299'
Alt 3	4	4	44	101st St	62	108	128	298	new 298'
Alt 3	4	5	43	104th St	66	108	128	302	new 302'
Alt 3	4	6	42	106th St	67	108	128	303	new 303'
Alt 3	4	7	41	108th St	66	108	128	302	new 302'
Alt 3	3	8	35	110th St	90	108	153	351	new 351'
Alt 3	3	9	34	113th St	90	108	178	376	new 376'
Alt 3	3	10	33	115th St	90	108	178	376	new 376'
Alt 3	3	11	32	118th St	90	108	178	376	new 376'
Alt 3	3	12	31	121st St	63	108	128	299	new 299'

Table 7-4: Typical Groin Quantities for New Construction Reaches 3 & 4 (Alt 3)

Feature	QTY/ft	UNIT	Length (ft)	Quantity
Armor Stone	13.5	TON	4,087	55,175
Underlayer Stone	4.4	TON	4,087	17,983
Core Stone	2.7	TON	4,087	11,035
Blanket Stone	6.9	TON	4,087	28,200
Geotextile Filter	7.7	SY	4,087	31,470
Excavation - Sand	23.1	CY	4,087	94,410

Table 7-5: Typical Groin Quantities for New Construction Reach 6a (Alt 3)

Feature	QTY/ft	UNIT	Length (ft)	Quantity
Armor Stone	13.0	TON	526	6,838
Underlayer Stone	4.6	TON	526	2,420
Core Stone	2.8	TON	526	1,473
Blanket Stone	6.3	TON	526	3,314
Geotextile Filter	7.5	SY	526	3,945
Excavation - Sand	18.6	CY	526	9,784

Table 7-6: Typical Groin Quantities for Extensions Reach 6a (Alt 3)

Feature	QTY/ft	UNIT	Length (ft)	Quantity
Armor Stone	24.7	TON	800	19,760
Underlayer Stone	5.2	TON	800	4,160
Core Stone	3.3	TON	800	2,640
Blanket Stone	10.4	TON	800	8,320
Geotextile Filter	9.4	SY	800	7,520
Excavation - Sand	15.3	CY	800	12,240

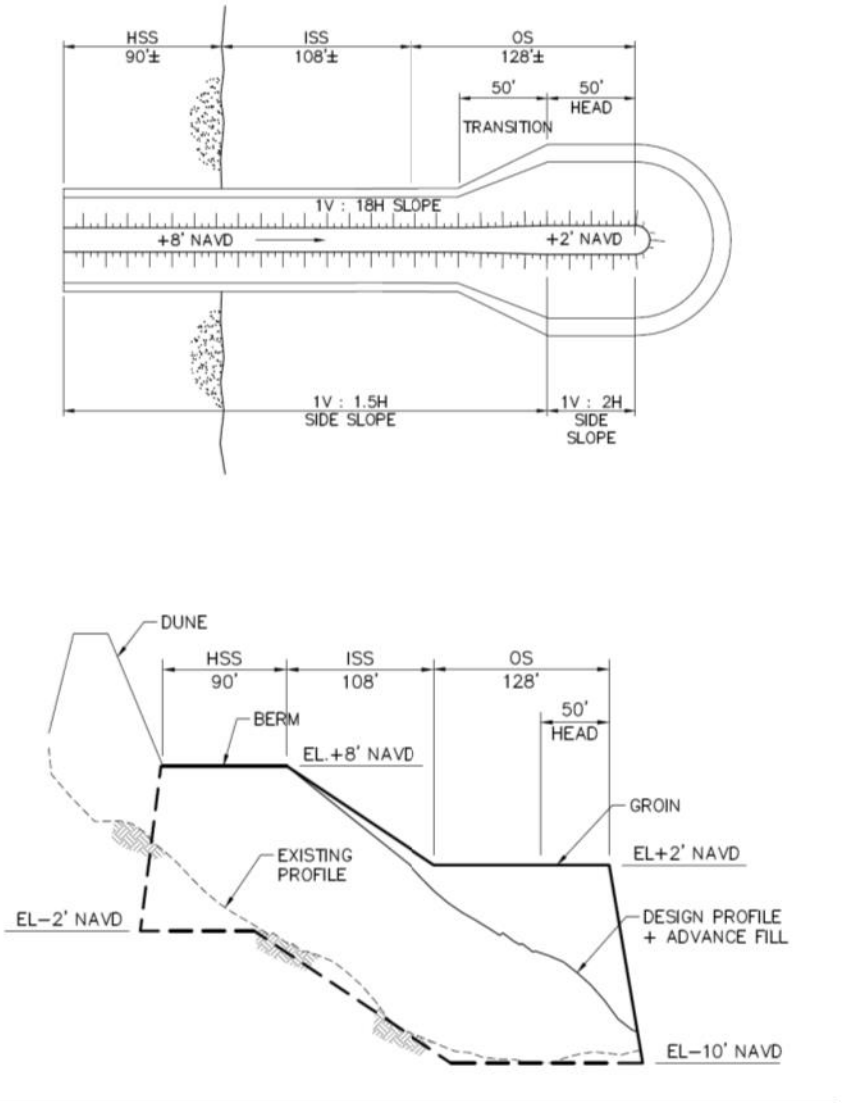


Figure 7-3: Typical Groin in Reaches 3 & 4 – Profile View

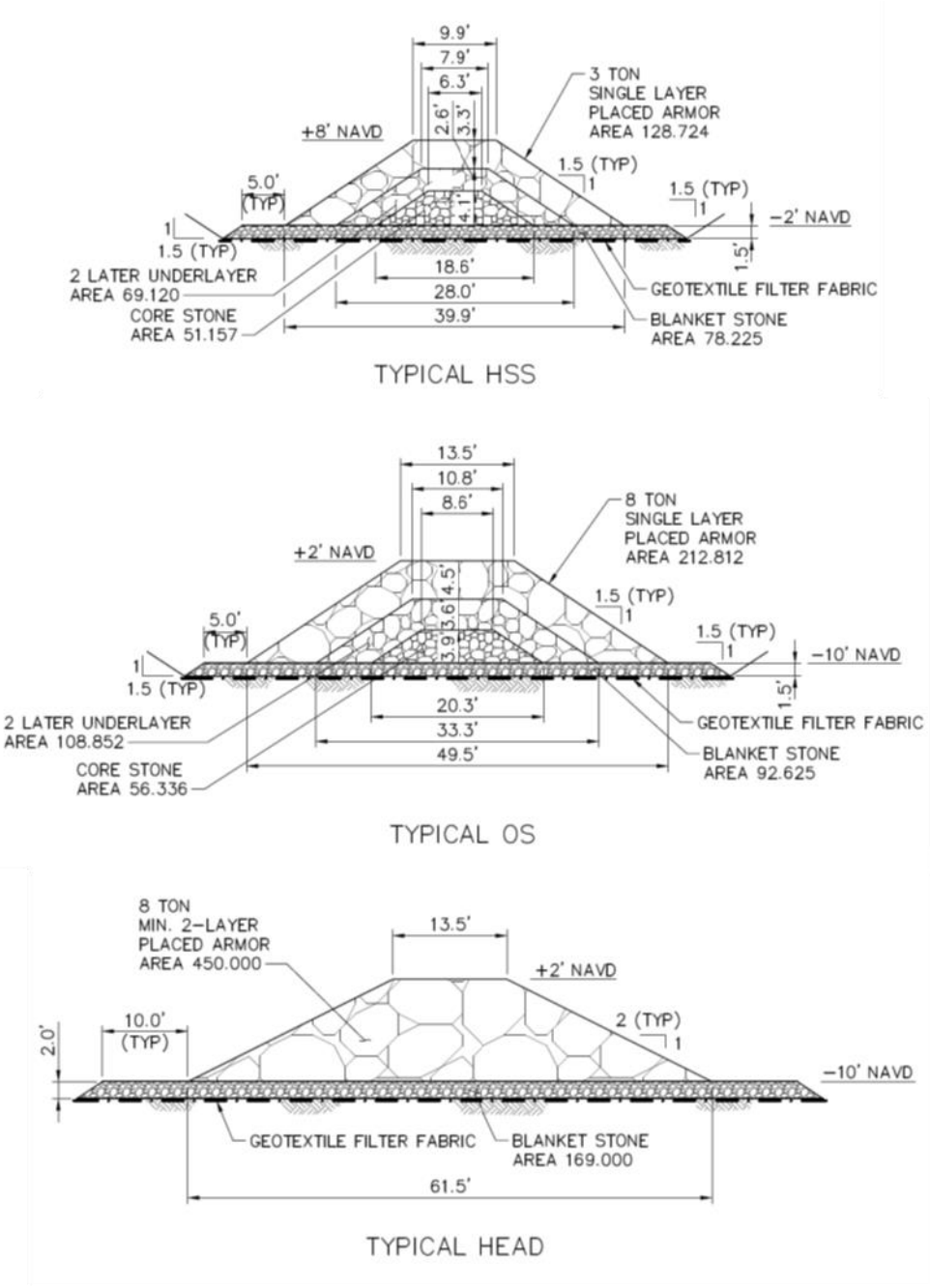


Figure 7-4: Typical Groin in Reaches 3 & 4 – Section View

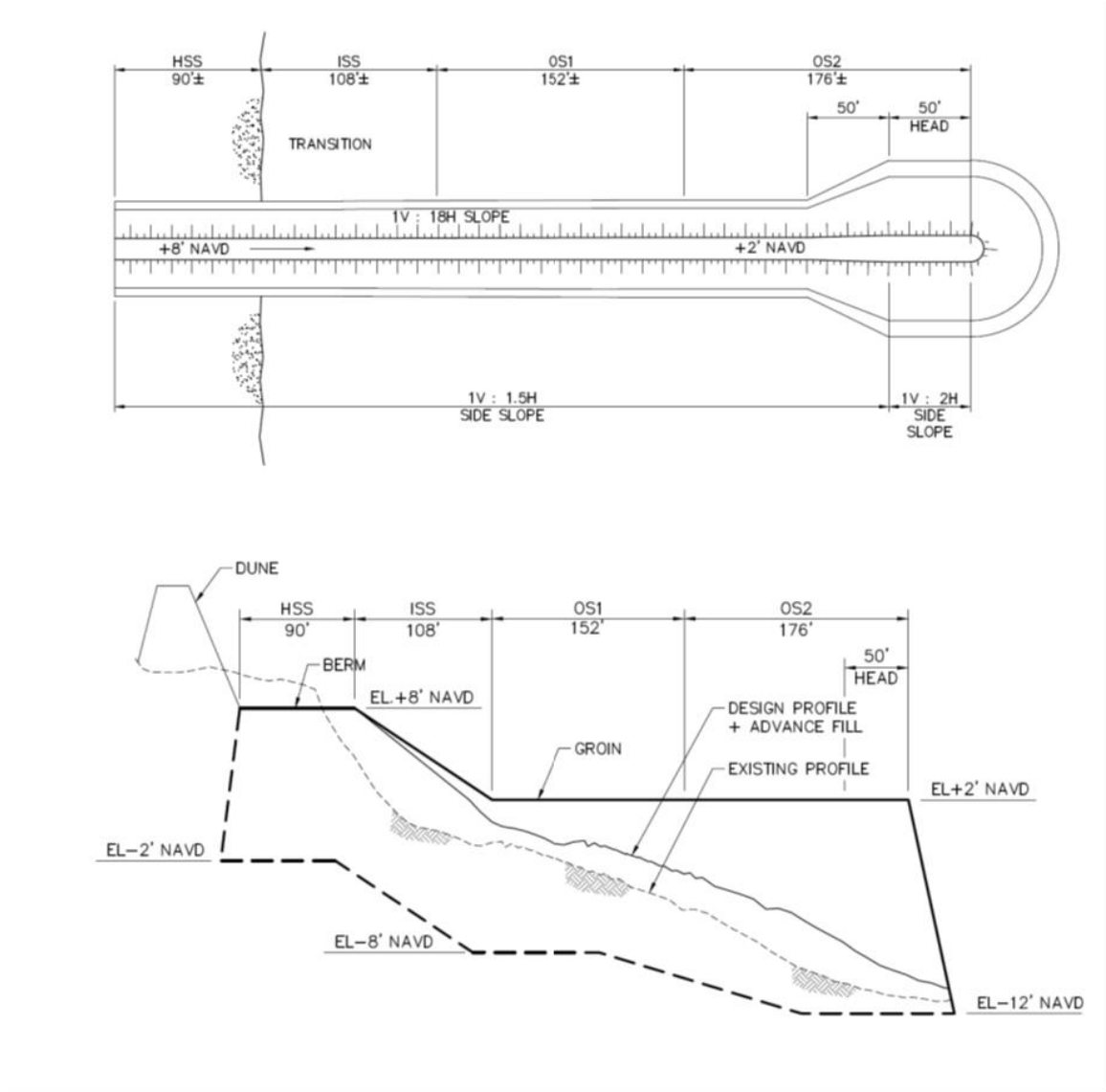
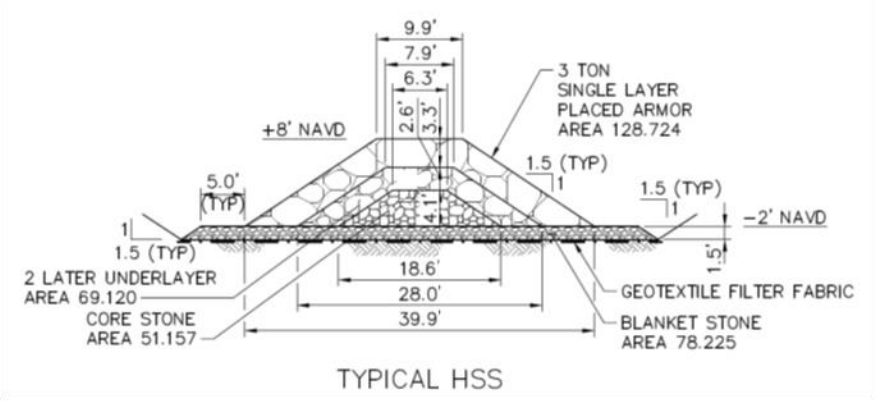
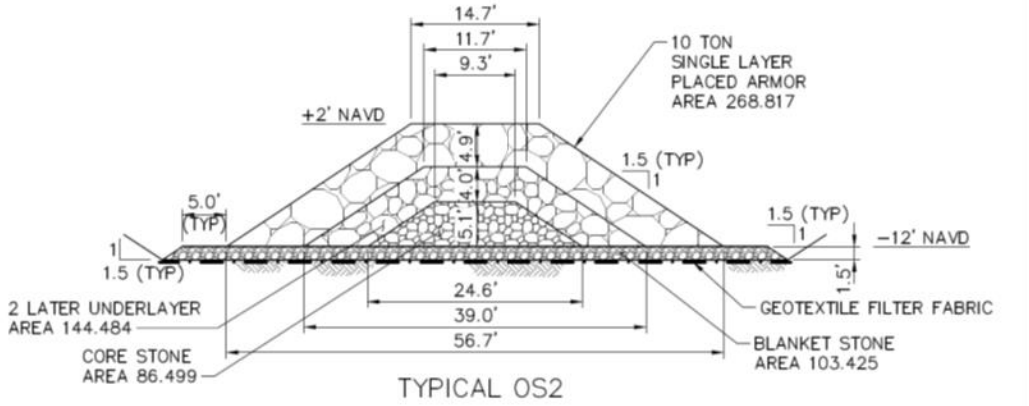


Figure 7-5: Typical Groin in Reach 6a – Profile View





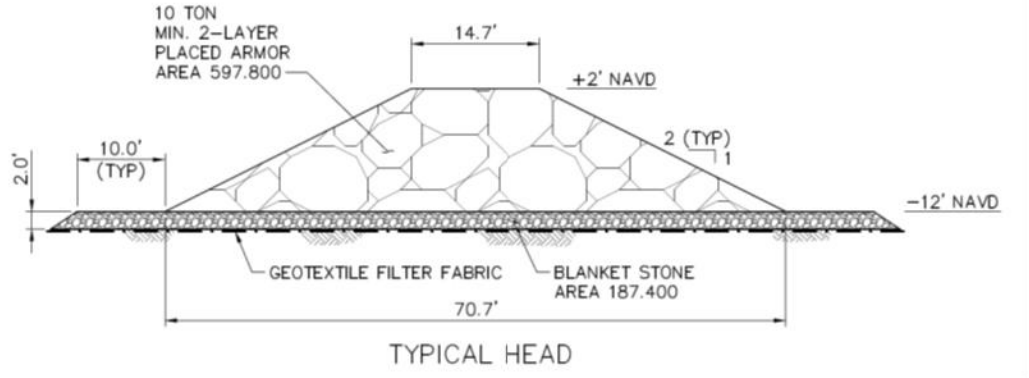


Figure 7-6: Typical Groin in Reach 6a – Section View

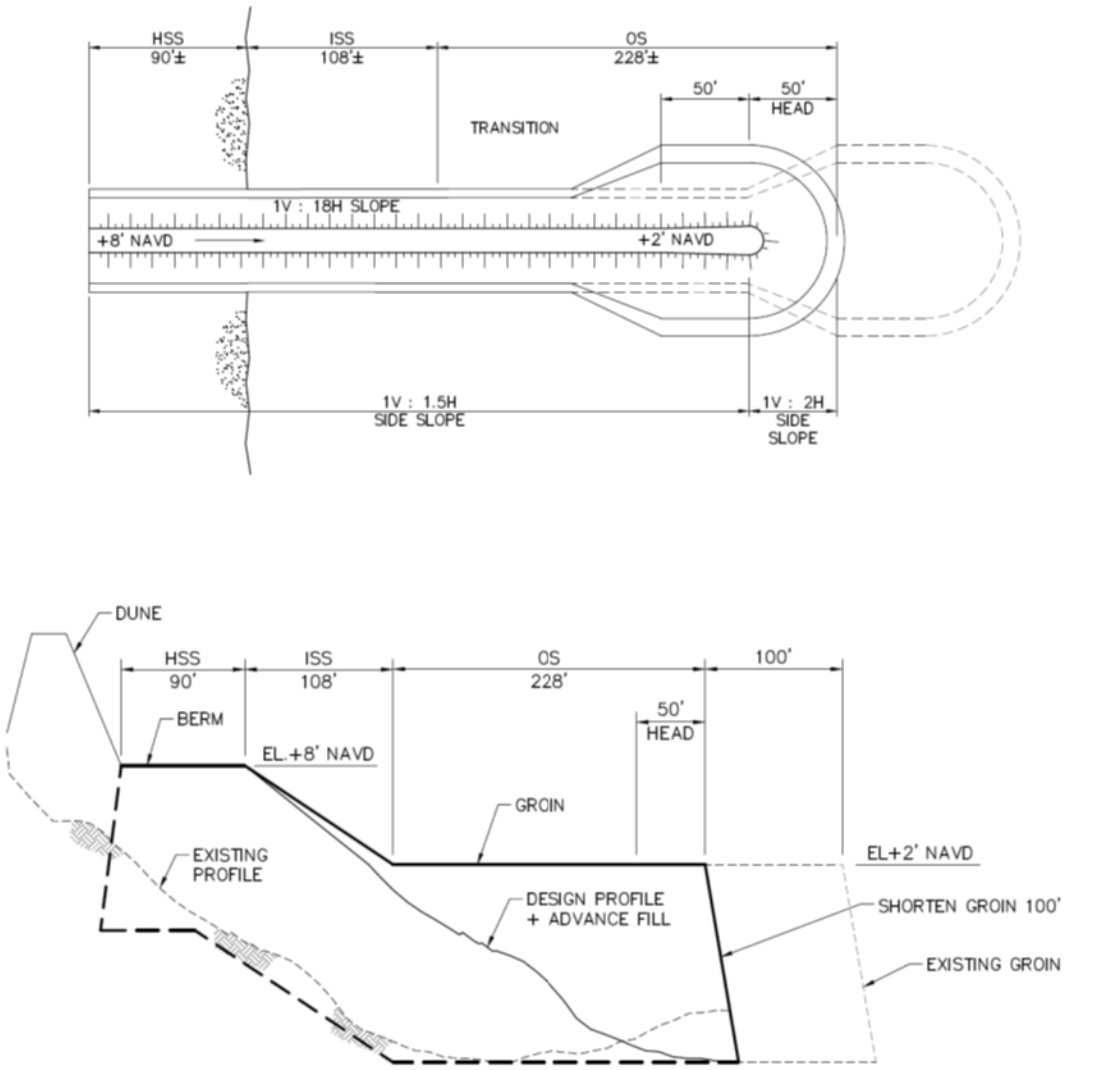


Figure 7-7: Typical Groin Shortening in Reach 5 – Profile View

7.2.8 Cost Estimates

Life-cycle cost estimates for the three alternatives are presented here. An exhaustive set of cost estimates is provided in Sub-Appendix C "Cost Estimates". For brevity only a summary of the initial construction, renourishment, and annualized costs are presented here. The effective price level for the cost estimate is the second quarter of 2018, and a 2.750% interest rate, and 50-year project life is used to determine the annualized cost. Interest during construction (IDC) is also included for each of the alternatives based on their respective construction durations.

Dredging costs for the project are estimated based on the USACE Dredging Software CEDEP and a MII cost estimate for the shore crew. A beachfill unit price of $12.88 per

cubic yard and mob/demob of $3.3 million is used throughout the screening level cost estimates.

The unit prices for groin construction are based on an MII cost estimates using local labor rates. An overview of unit prices for all construction items is provided in Table 7-7.

Table 7-7: Unit Prices

Item	Unit Price	Source
Construction		
Armor Stone Placement	$193.30 per TON	MII Cost Estimate
Underlayer Stone Placement	$104.68 per TON	MII Cost Estimate
Core/Bedding Stone Placement	$92.87 per TON	MII Cost Estimate
Geotextile Placement	$23.68 per SY	MII Cost Estimate
Beachfill Placement	$12.88 per CY	CEDEP & MII Cost Estimate
Dune Grass Placement	$20,000 per Acre	SSSI Cost Estimate
Sand Excavation	$7.24 per CY	MII Cost Estimate
Armor Stone Rest	$66.38 per TON	MII Cost Estimate
Bedding Stone Rest	$27.54 per TON	MII Cost Estimate
Removal		
Armor Stone Removal	$59.74 per TON	MII Cost Estimate
Underlayer Stone Removal	$43.38 per TON	MII Cost Estimate
Core/Bedding Stone Removal	$34.70 per TON	MII Cost Estimate
Geotextile Removal	$9.18 per SY	MII Cost Estimate
Disposal		
Armor Stone	$118 per TON	~2/3 of Construction Costs
Underlayer Stone	$66 per TON	~2/3 of Construction Costs
Core/Bedding Stone	$52 per TON	~2/3 of Construction Costs
Geotextile	$9 per SY	~1/3 of Construction Costs

Notes: effective price level January 2015

The total initial cost for the demolition and reconstruction of the 2,900 ft long section of the boardwalk is $27,129,000 (including a 33.46% contingency). The real estate costs associated with obtaining the permanent easements could be as high as $40 million to $60 million due to (1) loss of first and possibly second floor views; and (2) the loss of air rights for a high rise project. In addition the loss of property reduces the FAR (Floor Area Ratio) leading to a potential loss in profit from less developable space on the remaining parcel. The high costs associated with the real estate preclude Alternative 2 from being viable. The

life-cycle cost estimates use $59,588,000 (including a 48.97% contingency) as the estimate for the real estate costs associated with boardwalk relocation.

The cost estimates also include Planning, Engineering and Design (PED) and Construction Management. PED is estimated to be equal to 10% of the construction costs. Construction management is estimated as a function of the construction costs and is approximately 8% the construction costs. An Abbreviated Risk Analysis (ARA) was completed to estimate risk based contingencies associated with the various construction features for each alternative.

Initial construction and renourishment operation cost estimates for the three alternatives are presented in Table 7-8 and Table 7-9. Alternative 1 has the lowest initial construction costs, but the highest renourishment costs. The cost of each renourishment operation in Alternative 1 is about the same as in Alternative 2 and 3 but because renourishment operations are required every 3 years for Alternative 1, instead of every 4 years the total renourishment costs for Alternative 1 are much higher.

Renourishment costs for Alternative 2 and 3 are similar, however the initial construction costs for Alternative 3 are much lower. The initial construction costs for Alternative 2 are relatively high due to the real estate costs associated with boardwalk relocation.

A summary of the overall life-cycle cost estimate for each alternative is presented in Table 7-10. The recommended alternative is Alternative 3 Beach Restoration and increased erosion control. This alternative had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life. However, the difference in the annualized cost estimates between Alternative 1 and Alternative 3 is relatively small, 2%, and well within the margin of uncertainty in the cost estimates.

Table 7-8: Erosion Control - Initial Construction Cost Estimates

Item	Alternative 1	Alternative 2	Alternative 3
Beachfill	$22,848,000	$19,190,000	$20,504,000
Groins	$0	$11,498,000	$27,844,000
Boardwalk Relocation	$0	$59,677,000	$0
PED	$2,285,000	$5,037,000	$4,835,000
Construction Management	$1,794,000	$3,591,000	$3,462,000
Contingency	$5,923,000	$42,276,000	$14,372,000
Total	**$32,850,000**	**$141,269,000**	**$71,017,000**

Notes: effective price level Q2 2018

Table 7-9: Erosion Control - Renourishment Cost Estimates

Item	Alternative 1[1]	Alternative 2[2]	Alternative 3[2]
Beachfill	$16,167,000	$17,017,000	$16,450,000
PED	$1,617,000	$1,702,000	$1,645,000
Construction Management	$1,319,000	$1,382,000	$1,341,000
Contingency	$6,183,000	$6,507,000	$6,291,000
Total Per Operation	**$25,286,000**	**$26,608,000**	**$25,727,000**
Total Over Project Life[3]	**$186,579,322**	**$143,626,085**	**$140,943,415**

Notes: [1] 3-year renourishment cycle

[2] 4-year renourishment cycle

[3] Present Worth using 2.750% interest rate

Table 7-10: Erosion Control Life-Cycle Cost Estimates – Atlantic Ocean Shorefront Formulation Summary

		Low SLR		
		Alternative 1	**Alternative 2**	**Alternative 3**
Initial Cost	Initial Construction	$32,850,000	$141,269,000	$71,017,000
	IDC	$215,000	$2,207,000	$1,307,000
	Investment Cost	**$33,065,000**	**$143,476,000**	**$72,324,000**
Annualized Cost	Investment Cost	$1,225,000	$5,314,000	$2,679,000
	Renourishment (Planned/Emergency)	$7,975,000	$6,153,000	$5,950,000
	O&M	$403,000	$465,000	$579,000
	Major Rehab	$332,000	$332,000	$332,000
	SLR Adaption	$0	$0	$0
	Total Annual Cost	**$9,935,000**	**$12,264,000**	**$9,540,000**

Note: Effective price level Q2 2018

7.3 Coastal Storm Risk Management Alternatives

Five coastal storm risk management alternatives are under consideration:

1. Beach Restoration, +16 foot Dune, 60 foot Berm
2. Beach Restoration, +18 foot Dune, 80 foot Berm
3. Beach Restoration, +20 foot Dune, 100 foot Berm
4. Beach Restoration, +18 foot Reinforced Dune – Buried Seawall
5. Beach Restoration, +18 foot Reinforced Dune – Composite Seawall

All of the alternatives include beach restoration and a dune. The most cost effective erosional control features described above will be included as part of all five of the coastal storm risk management alternatives.

A screening analysis was performed prior to the detailed economic modeling to narrow down the number of possible alternatives to five. The screening analysis evaluated the performance under a range of dune and berm dimensions as well as reinforced dunes to aid in the selection of appropriate dimensions. Other factors such as prior projects at Rockaway Beach, project constraints, stakeholder concerns, and engineering judgment were also applied in the selection of the final set of alternatives.

7.3.1 Prior Projects

There have been three major beach restoration project at Rockaway Beach since the 1970s:

- WRDA 1974 Beach Erosion Control Project (1975-1988)
- Section 934 Beach Erosion Control Project (1996-2004)
- FCCE Project (2013-2014)

A direct comparison of the design profiles for the WRDA 1976, Section 934, and FCCE projects is difficult since these projects were defined by construction templates. Construction templates are the profile constructed by the dredging contractor in field and typically have a wider berm and steeper slope than the natural profile. Immediately after construction the construction template begins to adjust to the local wave conditions often resulting in a cross-shore transfer of sediment from the upper half to the lower half of the profile.

Design profiles are an idealized profile that has adjusted to the local site conditions and matches the natural shape of the beach profile. If the pre-construction profile is known the design profile dimensions may be estimated from the construction template. However, the adjusted design profile dimensions are very sensitive to the pre-construction profile. At Rockaway Beach for example, the adjusted design dimensions will be very close to the

constructed dimensions if pre-construction profile is relatively wide (e.g. Reaches 3 and 5). However, if the pre-construction profile is much narrower than the construction template (i.e. Reach 4) then adjusted design berm width may be approximately half the width of the construction berm width. The pre-construction conditions at Beach 108th Street in Reach 4 are used here to characterize the three projects. Figure 7-8 to Figure 7-10 show the construction template and corresponding design profile for all three projects in Reach 4. Table 7-11 provides a summary of the construction beach berm width and design beach berm. The beach berm width is measured from the seaward edge of the boardwalk to the seaward crest of the berm.

Table 7-11: Adjusted Beach Berm Width for Prior Projects (Including Advance Fill)

Project	Construction Berm Width (ft)[1]	Design Beach Berm Width (ft)[1]
WRDA 1974	200	120 (134[2])
Section 934	160	106 (120[2])
FCCE	280	180

Notes: [1] Design Beach Berm Width measured from profile origin/boardwalk.

[2] Design Berm Width at +8' NAVD88

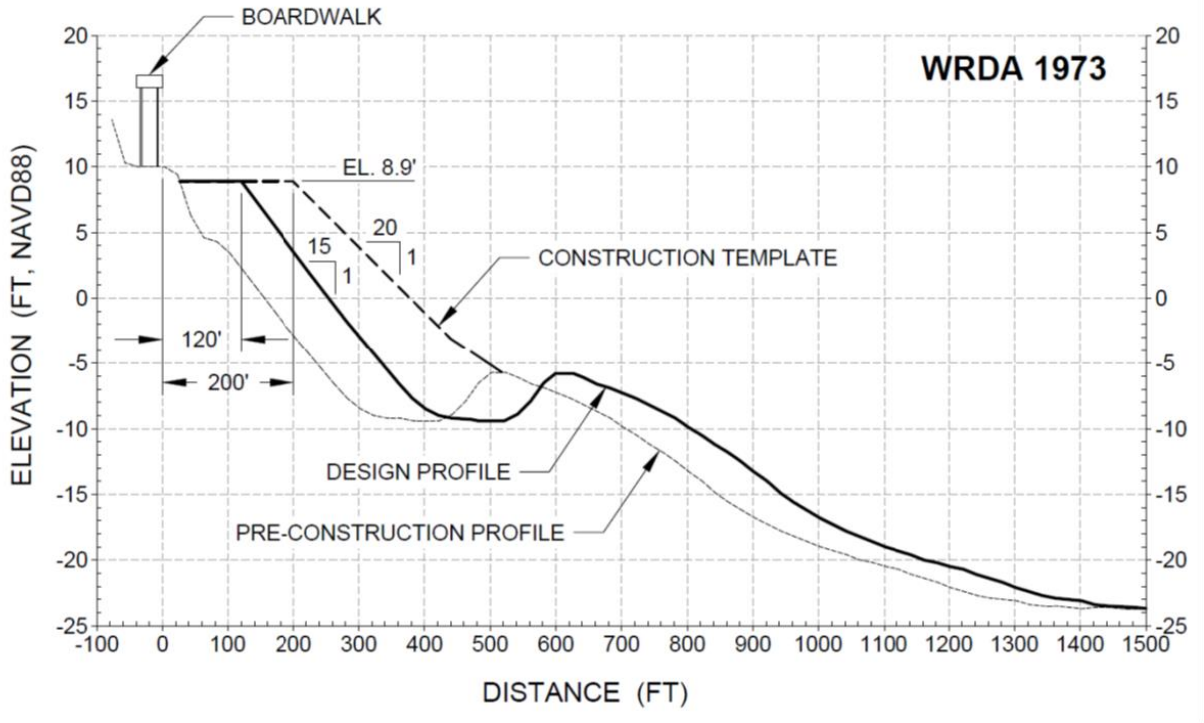


Figure 7-8: WRDA 1974 Construction Template and Design Profile (Reach 4)

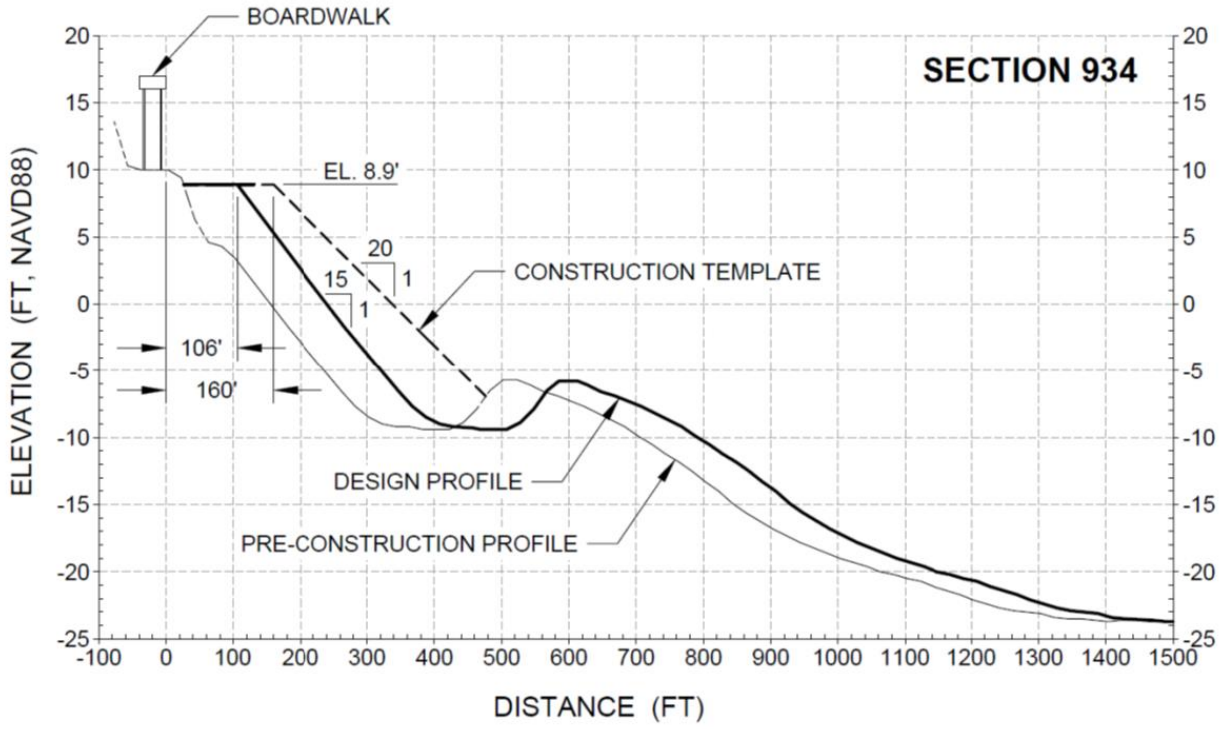


Figure 7-9: Section 934 Construction Template and Design Profile (Reach 4)

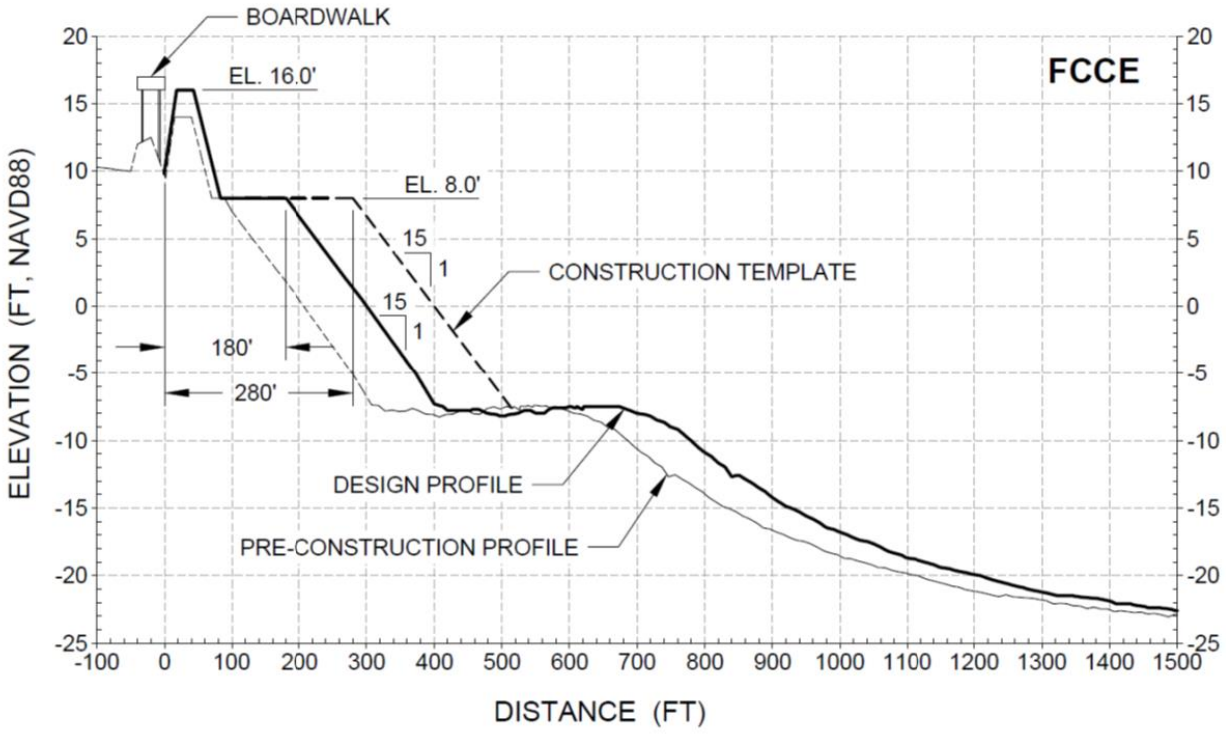


Figure 7-10: FCCE Construction Template and Design Profile (Reach 4)

7.3.2 Performance

A screening analysis was performed for a range of design beachfill profile and reinforced dune sections. The screening analysis considered a range of dune heights and berm widths as well as several different reinforced dune design concepts. The purpose of the screening analysis is to narrow down the number of possible profile combinations for further evaluation in Beach-fx. The screening analysis led to the selection of three design beachfill profiles and two reinforced dune designs to be further evaluated in Beach-fx.

The screening analysis evaluated the probability of exceedance for a range of dune and berm dimensions as well as reinforced dunes is performed to aid in the selection of appropriate dimensions. Other factors such as prior projects at Rockaway Beach, project constraints, stakeholder concerns, and engineering judgment were also applied in the selection of the final set of design profiles.

7.3.3 Beach Restoration and Dune Alternatives

Range of Proposed Beachfill Configurations

To screen potential design beach profiles the following combinations of berm width and dune height are evaluated:

- Berm Widths: 0, 50, 100, 120, 150, 180, and 210 feet;
- Dune Height: 14, 16, 18, 20, and 22 feet NAVD88.

The berm elevation and dune width for all the beachfill design sections are +8 feet NAVD88 and 25 feet, respectively. The berm width is measured from the seaward toe of the dune. Whereas, the "beach berm width" is measured from the project baseline / boardwalk.

Screening Criteria

The level of risk reduction for each of the design beachfill profile configurations was estimated based on three separate screening criteria: dune lowering, upland flooding, and wave overtopping. The level of risk reduction is defined as the return period of an event that produces storm conditions that exceed the design thresholds. The return period is the inverse of the probability that the event will be exceeded in any one year. For example, a 10 year flood has a 1/10 or 10% chance of being exceeded in any one year and a 500 year flood has a 1/500 or 0.2% chance of being exceeded in any one year.

Three beach profile response parameters are used to evaluate the level of risk reduction associated with each of the design beach profiles. These response parameters and corresponding failure threshold values are:

- Dune Lowering: 20% reduction in dune height (measured from the berm);
- Upland Flood Depth: 1.0 feet;
- Wave Overtopping: 1.0 cfs per foot (93 liters/s/m).

Two of the three criteria, dune lowering and wave overtopping, were also considered in the selection of the design beach profiles for Fire Island to Montauk Point (FIMP) (Alfageme, 2001). A third criterion, upland flood depth, is considered here to provide a link between the damages calculated by Beach-fx and the level of risk reduction. The upland flood depth is defined in this study as the difference in elevation between the post-storm profile and the maximum water surface elevation including wave setup but excluding wave crests and wave runup. There are three damage driving parameters in Beach-fx: water level, wave height, and vertical erosion. Since the upland wave heights are depth limited, the upland flood depth and upland wave height are very closely correlated and it would be redundant to also consider upland wave heights. Vertical erosion is not expected to be a major driver of damages at the Atlantic Ocean Shorefront under the with-project conditions and is therefore not included in the screening criteria.

Note that although these values were selected somewhat arbitrarily all three criteria capture the onset of significant erosion from dune lowering, upland flooding, or wave overtopping. In addition all three criteria yield similar results providing an additional level of comfort and suggest that the selected criteria are consistent. Ultimately, the wave overtopping

criterion, 1.0 cfs per foot, was used to determine the level of risk reduction of the profiles in FIMP (Alfageme, 2001).

A comparison of the level of risk reduction evaluated from each of the three criteria is provided below. Similarly to FIMP, wave overtopping generally limits and defines the level of risk reduction.

Screening Methodology

SBEACH model simulations, previously used to develop the Beach-fx Storm Response Database (SRD), are reused here to develop response versus frequency curves for dune lowering, upland flood depth, and wave overtopping. SBEACH model simulations were performed for each profile and all 456 historical storm combinations. Profile responses (e.g. dune lowering, and upland flood depth) were extracted from the SBEACH model output.

Wave overtopping on the beachfill profiles dune was calculated based on the Van der Meer (1995, 1998) methodology intended for estimating wave overtopping on coastal structures, the Kobayashi et al. (1996) extension of the Van der Meer formula to sandy dunes based on an equivalent uniform beach slope parameter, and the Alfageme (2001) empirical coefficient adjustment based on large scale tests performed by Delft Hydraulics Laboratory (1983). Attachment A "FIMP - Selection of Alternative Design Beach Profiles" provides additional details about the wave overtopping calculations. Note that a different wave overtopping analysis is applied for the seawall structures and is discussed in more detail later in the memorandum.

Response versus frequency curves were generated for the selected screening criteria by applying a multivariate Empirical Simulation Technique (EST) analysis. Multivariate EST is a statistical procedure used to develop design parameter frequency relationships as a function of the input parameters (e.g. offshore wave height, storm surge, tide) that are descriptive of the storm event but have unknown joint probabilities. The multivariate EST approach applied in this study is the same as the one used for FIMP (Gravens et al., 1999). Details of the approach, as applied to wave setup along Rockaway Beach, are provided in Gravens et al. (1999) "Fire Island Inlet to Montauk Point, Reformulation Study (FIMP): Historical and Existing Condition Coastal Processes Assessment." The nine input parameters capture the variability in the maximum and average value of the storm surge, tide, and wave height as well as the duration of the storm event.

The multivariate EST analysis was modified to include three additional responses: upland flood depth, upland wave height, and wave overtopping.

Results

The smallest design beachfill profile recommended for further consideration is slightly narrower than the FCCE project but wider than the prior WRDA 1974 and Section 934

projects, with a dune height of +16 ft NAVD88 and a berm width of 60 feet. The other two design profiles expand on this profile with wider berms, higher dunes, and greater levels of risk reduction. The dimensions of the three design beach profiles and associated level of risk reduction is provided in Table 7-12. The total beach berm width including advance fill, measured from the boardwalk, is also shown in Figure 7-11. Although Beach-fx was applied to optimize the (minimum required) beachfill design configuration, it is common practice to add advance fill until the next scheduled nourishment to guarantee the design level of protection and reduce the risk of damages due to unexpected severe storm occurrence prior to the first renourishment. The advance fill within the project area varies from reach to reach based on the expected erosion rates with a typical value along the shoreline of approximately 30 feet.

Table 7-12: Design Beach Profiles

Design	Dune Height (feet, NAVD88)	Design Berm Width (feet)	Beach Berm Width (feet)	Level of Risk Reduction (average return period in years)
Medium	+16	60	173[1]	44
Large	+18	80	209[1]	70
XL	+20	100	245[1]	100

Notes: [1]Includes an advance berm width of 30 feet.

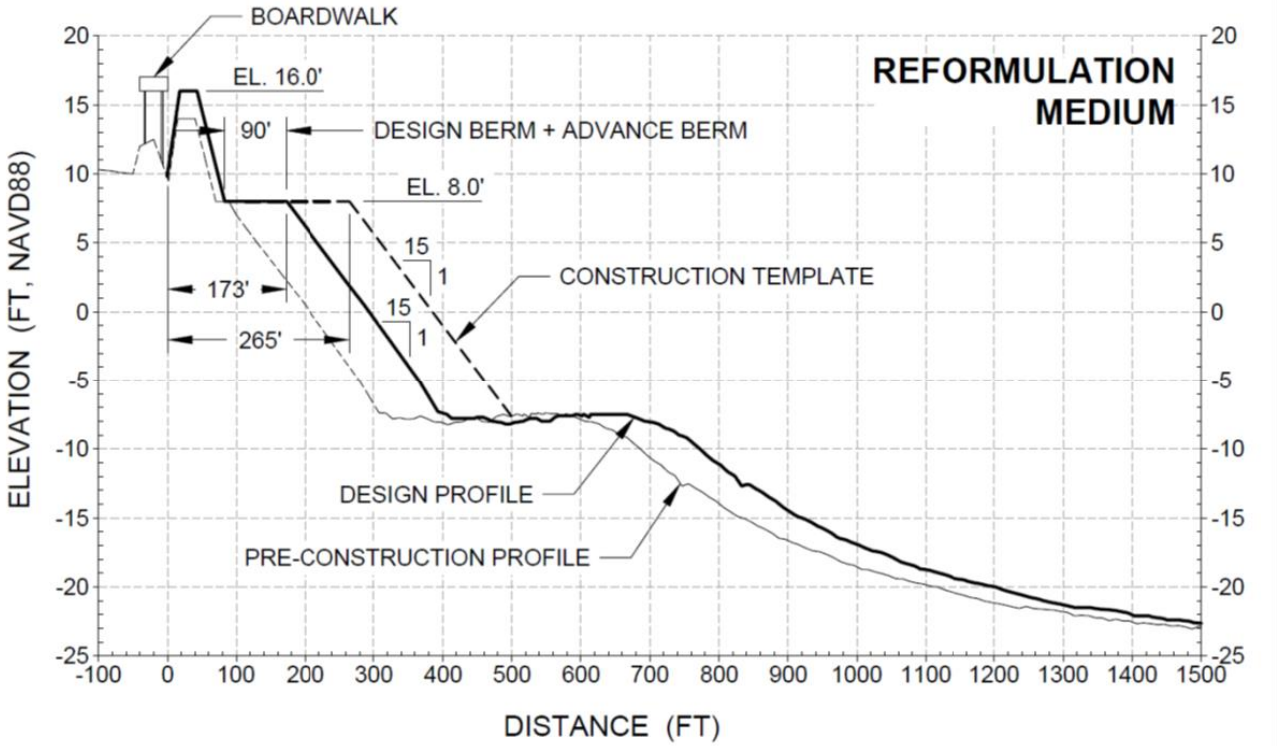


Figure 7-11: Medium Design Profile

Reinforced Dune Alternatives

Two reinforced dune concepts have been proposed for the Atlantic Ocean Shorefront. The first type, buried seawall, is designed to protect inland areas from erosion and wave damages during severe storm events such as Hurricane Sandy. The second type, composite seawall, is designed to also limit storm surge inundation and cross-island flooding during severe storm events. The composite seawall is compatible with a comprehensive storm surge barrier for Jamaica Bay.

Buried seawalls are essentially dunes with a reinforced rubble mound core. An example of constructed buried seawall is shown in Figure 7-12 (Dam Neck, Virginia). Buried seawalls were developed as an alternative to larger standalone seawalls and are designed to function in conjunction with beach restoration projects and dunes. The primary advantage of buried seawalls over traditional dunes are the additional protection against erosion and wave attack provided by the stone core. As an example, during Hurricane Sandy a long forgotten stone seawall in Bay Head, NJ originally built in 1882 that had formed the core of a dune, protected a community from severe damage from wave attack (Irish et al. 2013). The adjacent community (Mantoloking, NJ) only had a sandy dune which was eroded during Hurricane Sandy exposing the island to damaging waves and leading to the formation of a breach. The relic buried seawall in Bay Head, NJ was shown by Irish et al. to reduce

potential wave loads by a factor of two and was the difference between widespread destruction (Mantoloking, NJ) and minor structural impacts (Bay Head, NJ).

The proposed buried seawall for the Atlantic Ocean Shorefront is very similar to the examples in Bay Head, NJ and Dam Neck, VA. Since the purpose of the structure is wave protection, it may be constructed intermittingly along the shoreline in the most vulnerable areas.

Figure 7-12: Buried Seawall Example at Dam Neck, Virginia (USACE, 1999)

The second reinforced dune concept is a composite seawall with an impermeable core (i.e. steel sheet pile). The purpose of the composite seawall is to not only protect against erosion and wave attack but also to limit storm surge inundation and cross-island flooding. The composite seawall provides a high level of risk reduction that may not be practical to achieve with a dune because of the necessary height and footprint of such a dune. In addition, the composite seawall is compatible with a comprehensive storm surge barrier for Jamaica Bay.

Several design concepts were initially considered for the seawall: rubble mound, vertical steel sheet pile wall, vertically composite, and horizontally composite structure. The vertical sheet pile wall and vertically composite wall were eliminated from further consideration because of the large lateral forces acting on the steel sheet pile and the required length and size of steel piles to withstand these forces. The armor stone in horizontally composite structures has been demonstrated to significantly reduce the wave breaking pressure (Takahashi, 2002). This allows smaller steel sheet pile walls to be used in the design if the face of the wall is completely protected by armor stone as shown in Figure 7-13 (d).

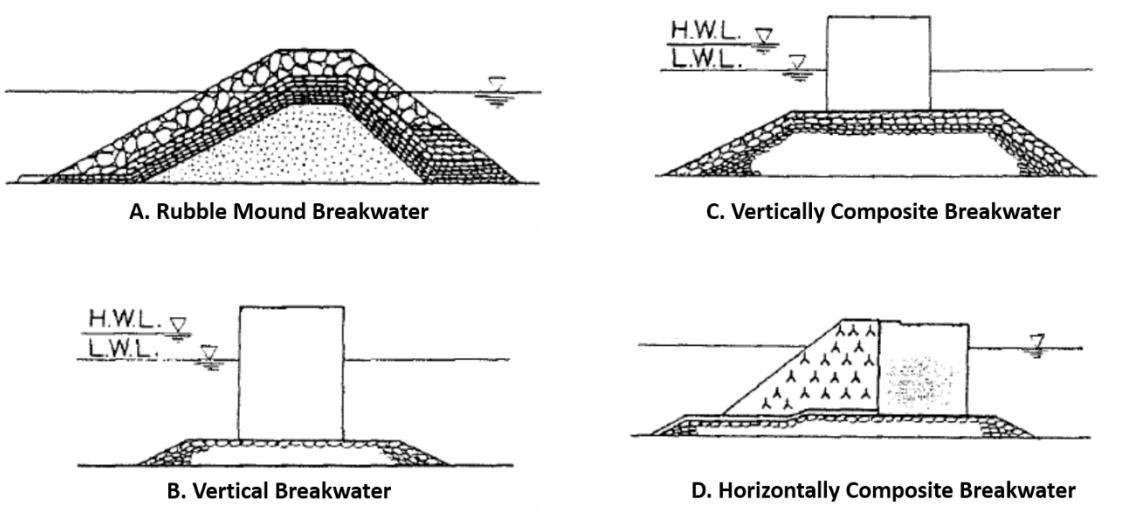


Figure 7-13: Seawall/Breakwater Structure Types (from Takahashi, 2002)

The rubble mound seawall and horizontally composite seawall have been selected for further evaluation and screening level cost estimates. The rubble mound seawall is necessary in locations where there is not an existing boardwalk (i.e. Reach 3). Both seawalls behave similarly from a wave overtopping perspective since both structures have a rubble slope on the seaward side of the structure.

The remaining sections will discuss the screening level analyses applied in the selection of an appropriate crest elevation for the reinforced dune structures.

7.4 Buried Seawall

The required crest elevation of the buried seawall was set in order to provide wave protection against sandy scale storm events. An analysis of wave transmission coefficients for low-crested breakwaters over a range of crest elevations was performed. Wave transmission through a low-crested stone breakwater is dependent on the structure geometry, principally the crest freeboard, crest width, water depth, and permeability, as well as the wave period and surf similarity parameter. The simplified prediction method from CIRIA (2001) which relates the relative crest height of the structure to the wave transmission coefficient is used here to estimate the wave transmission (Figure 7-14). The CIRIA wave transmission relationship indicates that roughly a 50% decrease in the transmitted wave height occurs if the structure freeboard (Rc) is zero. Therefore, the crest elevation of the structure must be roughly equal to the local water level at the toe of the structure (including wave setup) to achieve a 50% reduction in the wave transmitted wave height. Table 7-13 provides a summary of the wave transmission coefficient analysis.

Table 7-13: Wave Transmission Coefficients

Return Period (years)	Local Water Level[1] (ft, NAVD88)	Crest Elevation (ft, NAVD88)			
		12’	14’	16’	18’
50	12.2	0.51	0.10	< 0.1	< 0.1
100	14.5	0.80	0.56	0.17	< 0.1
150	15.7	> 0.8	0.75	0.41	0.10
200	16.6	> 0.8	0.80	0.55	0.24
250	17.2	> 0.8	0.80	0.63	0.34
500	19.1	> 0.8	> 0.8	0.80	0.59

Notes: [1] Includes wave setup.

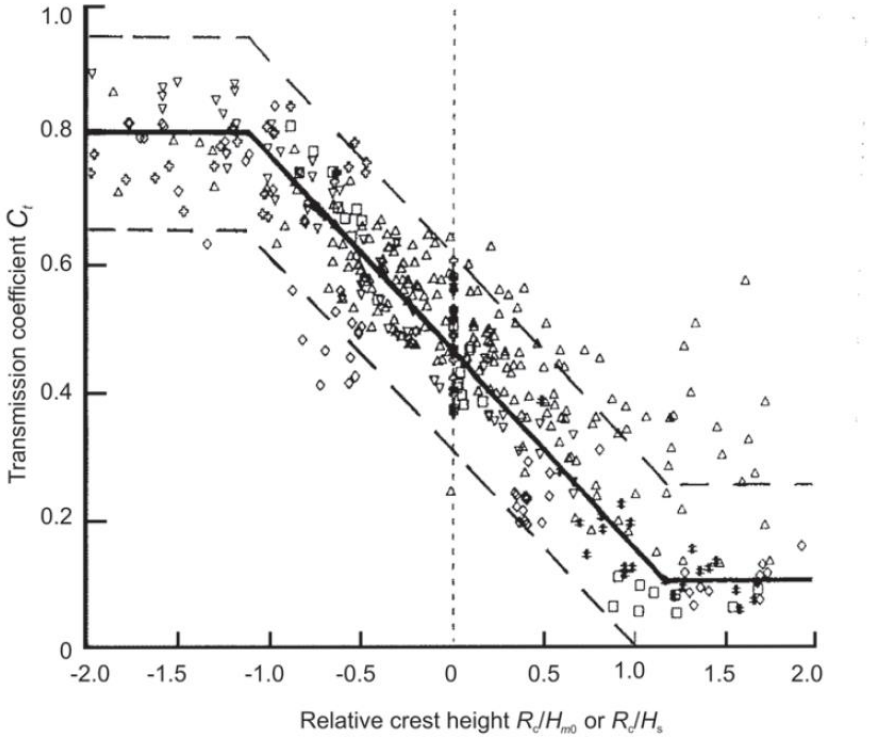


Figure 7-14: CIRIA Relationship for Wave Transmission at Low-Crested Structures

7.5 Composite Seawall

Rubble mound or horizontally composite seawalls are considered here as an alternative approach to large dunes to provide high levels of risk reduction. All the seawall

configurations are based on the same general seawall design: 1-layer rubble structure with an impermeable core, and a 1V:2H slope.

7.5.1 Range of Proposed Seawall Configurations

To determine the optimum seawall sections the following seawall sections are evaluated:

- Seawall Crest Elevation: 14, 16, 18, and 20 feet NAVD88;
- Berm Widths: 0, 50, 100, 120, 150, 180, and 210 feet.

The berm elevation for all the design sections is +8 feet NAVD88.

7.5.2 Screening Criteria

Two response parameters are used to evaluate the level of risk reduction of the seawall sections:

- Upland Flood Depth: 1.0 feet;
- Wave Overtopping: 1.0 cfs per foot (93 liters/s/m).

It is important to note that seawall will provide additional benefits even after the level of risk reduction is exceeded as the seawall will still likely prevent direct wave attack on the leeside of the structure.

7.5.3 Screening Methodology

Similarly to the beachfill analysis, SBEACH modeling results and a multivariate EST are used to develop response versus frequency curves for upland flood depth and wave overtopping.

The methods in the EurOtop Overtopping Manual (2007) were adopted to perform the wave overtopping analysis on rubble seawalls. The wave overtopping methodology applied in the previous section on dunes is not applicable to rubble seawalls. The input parameters, significant wave height at the toe of the structure are extracted from SBEACH simulations and the peak wave period and still water level are extracted from wave and water level boundary condition files. The upland flood depth was then calculated based on the wave overtopping rate and uniform open channel flow theory (Manning's formula). Details of the upland flooding approach can be found in Sub-Appendix A.

7.5.4 Results

Table 7-14 tabulates the results, which is summarized as follows. A crest elevation of +16 ft NAVD88 is recommended for the buried seawall because it reduces the transmitted wave heights by 50% during a 150 year wave event. A smaller buried seawall (e.g. +14 ft NAVD88) would not provide as significant reduction in the transmitted wave heights

during large storm events. A larger buried seawall may become costly and would face the same problems as the XL dune (e.g. view shed and footprint). The crest elevation of the proposed structure is the same as the buried seawall in Bay Head, NJ which also had a crest elevation of +16 ft NAVD88.

A crest elevation of +17 feet NAVD88 is recommended for the composite seawall, which is the same elevation as the boardwalk. The composite seawall provides an alternative to the XL dune which may not be supported by stakeholders due to its impact on view shed and its relatively large footprint on the beach. The composite seawall is also compatible with a comprehensive storm surge barrier for Jamaica Bay. A larger horizontally composite seawall is not recommended for further consideration because of the jump in costs and stakeholder concerns if the structure were to exceed the crest elevation of the boardwalk.

Table 7-14: Recommended Level of Risk Reduction of Reinforced Dunes

Structure Type	Structure Crest Elevation (feet, NAVD88)	Dune Elevation	Design Berm Width (feet)	LORR[1] (years)
Buried Seawall	+16	+18	60	100[2]
Composite Seawall	+17	+18	60	150[2]

Notes: [1] Level of Risk Reduction (LORR)

[2] Provides additional risk reduction for wave attack

7.5.5 Screening Level Design

7.5.5.1. Beach Restoration and Dune Alternatives

The smallest design beach fill profiles alternatives under consideration is slightly narrower than the Flood Control and Coastal Emergencies (FCCE) project but wider than the prior WRDA 1974 and Section 934 projects, with a dune height of +16 ft NAVD88 and a berm width of 60 feet. The two additional design beach fill profiles under consideration have wider berms and higher dunes (Figure 7-15). The dimensions of the three design beach profiles and associated level of risk reduction is provided in Table 7-15. Using Figure 7-15 and the figures presented in section 7.3.1 allows for the comparison of the alternative dimensions to prior projects.

Table 7-15: Recommended Level of Risk Reduction for Design Beachfill Profiles

Design	Dune Height (feet, NAVD88)	Design Berm Width (feet)	LORR[1] (years)
Medium	+16	60	44
Large	+18	80	70
XL	+20	100	100

Notes: [1] Level of Risk Reduction (LORR)

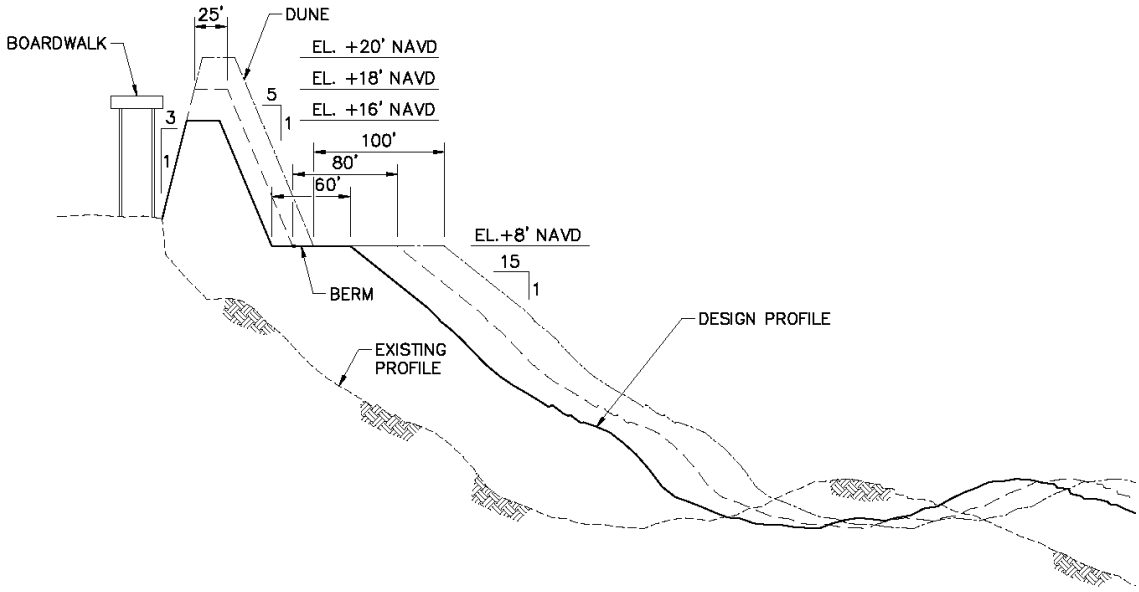


Figure 7-15: Beach Restoration and Dune Alternatives

7.5.5.2. Beach Restoration and Reinforced Dune Alternatives

Two reinforced dune concepts have been proposed for the Atlantic Ocean Shorefront. The first type, buried seawall, is designed to protect inland areas from erosion and wave damages during severe storm events such as Hurricane Sandy. The second type, composite seawall, is designed to also limit storm surge inundation and cross-island flooding during severe storm events. The composite seawall is compatible with a comprehensive storm surge barrier for Jamaica Bay. A typical section of the buried seawall and composite seawall is shown in Figure 7-16.

The first concept is a buried seawall. Buried seawalls are essentially dunes with a reinforced rubble mound core and were developed as an alternative to larger standalone seawalls. Buried seawalls are designed to function in conjunction with beach restoration projects and dunes. The primary advantage of buried seawalls over traditional dunes is the additional risk reduction provided by the stone core for damage due to erosion and wave attack. Since the purpose of the buried seawall is the reduction of wave energy for the area landward of it, it may be constructed intermittingly along the shoreline in the most vulnerable areas.

The second reinforced dune concept is a composite seawall with an impermeable core (i.e. steel sheet pile). The purpose of the composite seawall is to not only protect against erosion and wave attack but also to limit storm surge inundation and cross-island flooding. The composite seawall provides a high level of risk reduction that may not be practical to achieve with a dune because of the necessary height and footprint of such a dune. In addition, the composite seawall is compatible with a comprehensive storm surge barrier for Jamaica Bay.

Several design concepts were initially considered before selecting a horizontally composite seawall: rubble mound, vertical steel sheet pile wall, vertically composite, and horizontally composite structure. The vertical sheet pile wall and vertically composite wall were eliminated from further consideration because of the large lateral forces acting on the steel sheet pile and the required length and size of steel piles to withstand these forces. The armor stone in horizontally composite structures has been demonstrated to significantly reduce the wave breaking pressure (Takahashi, 2002). This allows smaller steel sheet pile walls to be used in the design if the face of the wall is completely protected by armor stone.

Table 7-16: Recommended Level of Risk Reduction of Reinforced Dunes

Structure Type	Structure Crest Elevation (feet, NAVD88)	Dune Elevation	Design Berm Width (feet)	LORR[1] (years)
Buried Seawall	+16	+18	60	70[2]
Composite Seawall	+17	+18	60	150[2]

Notes: [1] Level of Risk Reduction (LORR)

[2] Provides additional risk reduction against wave attack

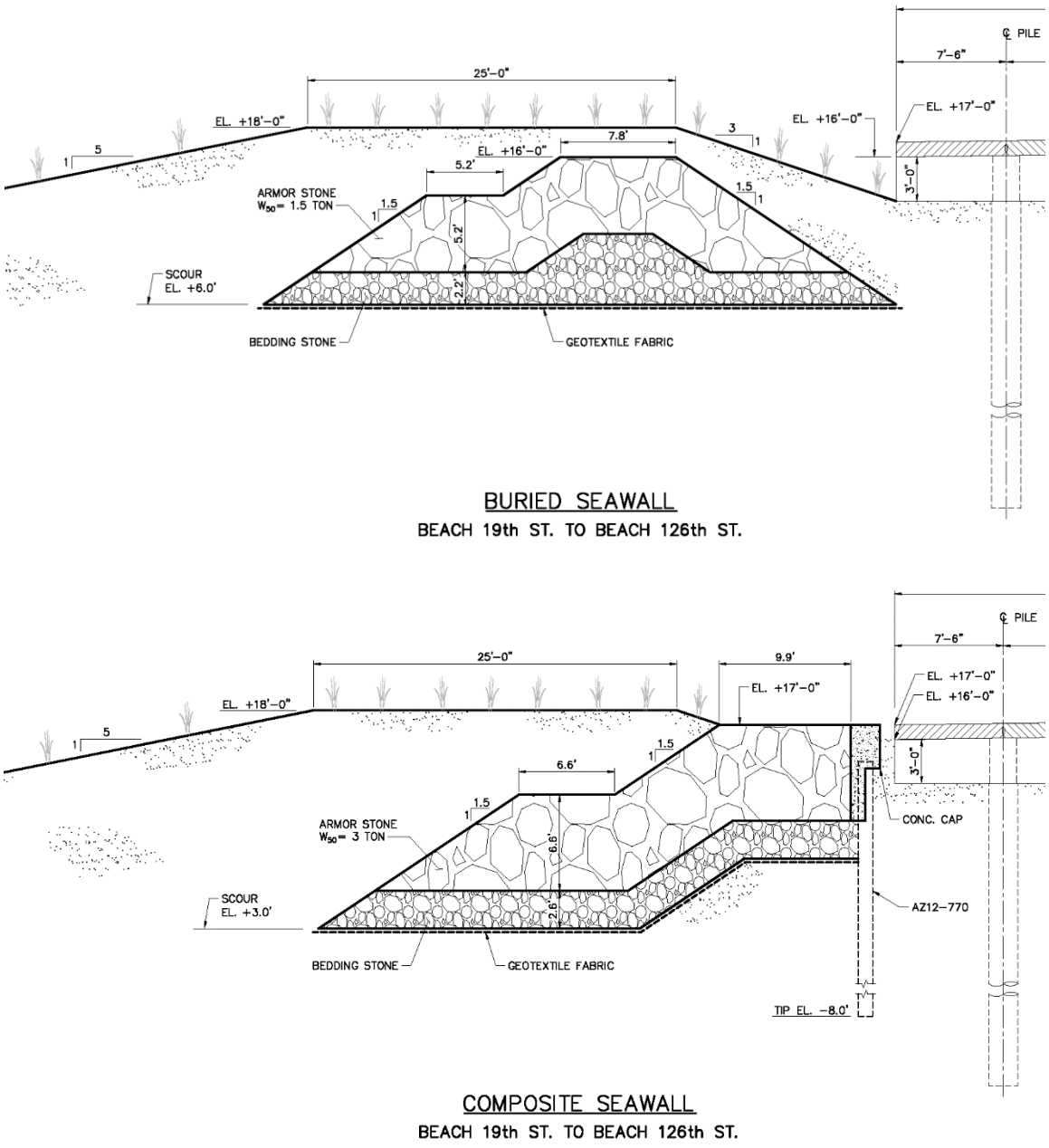


Figure 7-16: Reinforced Dune Alternatives (Buried Seawall in top panel, composite seawall in lower panel)

7.6 Plan Adaptations to SLC

The data compilation and analysis presented above reflect future conditions based on the Low Sea Level Rise scenario, which assumes a continuation of historic sea level changes. The scenario analysis considers two additional accelerated sea level change scenarios as required under USACE guidance (ER 1100-2-8162 and ETL 1100-2-1).

The assessment of sea level rise impacts include a technical analysis of the adaptability of each alternative to accelerate sea level rise under intermediate (Curve 1) and high (Curve 3) scenarios as defined in section 4.4. Annual costs and benefits under these scenarios were recalculated to allow an assessment of whether the plans identified under the low sea level rise scenario remain appropriate and cost effective under the accelerated sea level rise scenario. The analysis is detailed in the following sections with a summary presented in section 7.6.4.

7.6.1 Dune and Beach Restoration

It is relatively easy to adapt the dune and beach restoration alternatives to sea level change. Additional sediment can be included in each renourishment operation to offset losses from sea level rise. The natural berm elevation will rise in concert with the rising sea surface, so the design berm should be adjusted accordingly. The dune crest elevation will also need to be raised in response to sea level rise to maintain the design performance. It is recommended that the design berm elevation and dune crest elevation be increased in 1-foot increments in the future to accommodate sea level rise.

The Bruun rule is used to evaluate the relationship between sea level rise and beach erosion. Using the Bruun rule, estimates can be made of the losses due to sea level rise and the volume of sediment required to raise the beach profile to offset losses from sea level rise. The additional renourishment quantities on the Rockaways, based on Bruun rule, are manageable, with increases of approximately 22,000 cy/yr and 93,000 cy/yr for the USACE intermediate and USACE high sea level change scenarios, respectively.

Approximately 550,000 CY would be required each time the dune crest elevation needs to be raised 1 foot. This quantity includes both the volume of sediment within the footprint of the dune as well as the quantity of sediment required to shift the berm and entire active profile 8 ft seaward. An additional cost associated with raising the dune is the impact on existing beach access. It is assumed that the 8 concrete access ramps would be elevated the first time the 18 ft dune and 20 ft dune is raised. It is assumed that up to 2 ft increases in the 16 ft dune height could be accommodated within the existing ramps.

Revised life-cycle cost estimates were prepared for all the alternatives under the USACE intermediate and USACE high sea level rise scenarios. The following adaptability costs were included in the life-cycle cost estimates:

1) Additional beachfill in each renourishment operation (i.e. Bruun Rule).
2) Raising the dune crest elevation in 1 foot increments.
3) Demolishing and rebuilding concrete boardwalk access ramps after 1st dune height change (excluding the +16 foot dune).

The trigger for adaptation measure 2 is when sea level rise exceeds the design sea level rise, 0.7 ft, which was based on the USACE low scenario. In the USACE intermediate scenario adaptation measures #2 and #3 occur in year 32 (2050). In the USACE high scenario adaptation measures #2 and #3 occur in year 12 (2030) and adaptation measure #2 occurs again in year 32 (2050). The reader is referred to Figure 7-18 for a graphic representation of the potential for adaptive measures over time.

7.6.2 Seawalls

The buried seawall and composite seawall both may be adapted in the future to rising sea levels by adding 1-layer of armor stones as shown in Figure 7-17. The composite seawall would also require extending the concrete cap up to the elevation of the armor stone. Since the size of the median diameter of armor stone is fixed the adapted height of the seawalls may actually increase more than the sea level. It's not feasible to increase the height of the seawalls by exactly 1 or 2 feet by adding smaller armor stone because the smaller stone would not be stable under design storm conditions. Raising only the concrete cap in the composite seawall is also not feasible because the wave forces on the cap and steel pile would increase without the the armor stone in front. Consequently, there is considerably less flexibility in the adaptation of the seawalls in comparison to the dunes.

In addition to adapting the seawalls, the dune height would increase to keep the seawalls buried and renourishment fill quantities would need to increase to offset losses due to sea level rise.

Revised life-cycle cost estimates were prepared for the two seawall alternatives under the USACE intermediate and USACE high sea level rise scenarios. The following adaptability costs were included in the life-cycle cost estimates:

1) Additional beachfill in each renourishment operation (i.e. Bruun Rule).
2) Adding 1-layer of armor stone to the seawalls & increasing dune height.
3) Demolishing and rebuilding concrete boardwalk access ramps after increasing seawall height.

The trigger for adaptation measure 2 is when sea level rise exceeds the design sea level rise, 0.7 ft, which was based on the USACE low scenario. In the USACE intermediate scenario adaptation measures #2 and #3 occur in year 32 (2050). In the USACE high scenario adaptation measures #2 and #3 occur in year 12 (2030). The reader is referred to Figure 7-18 for a graphic representation of the potential for adaptive measures over time.

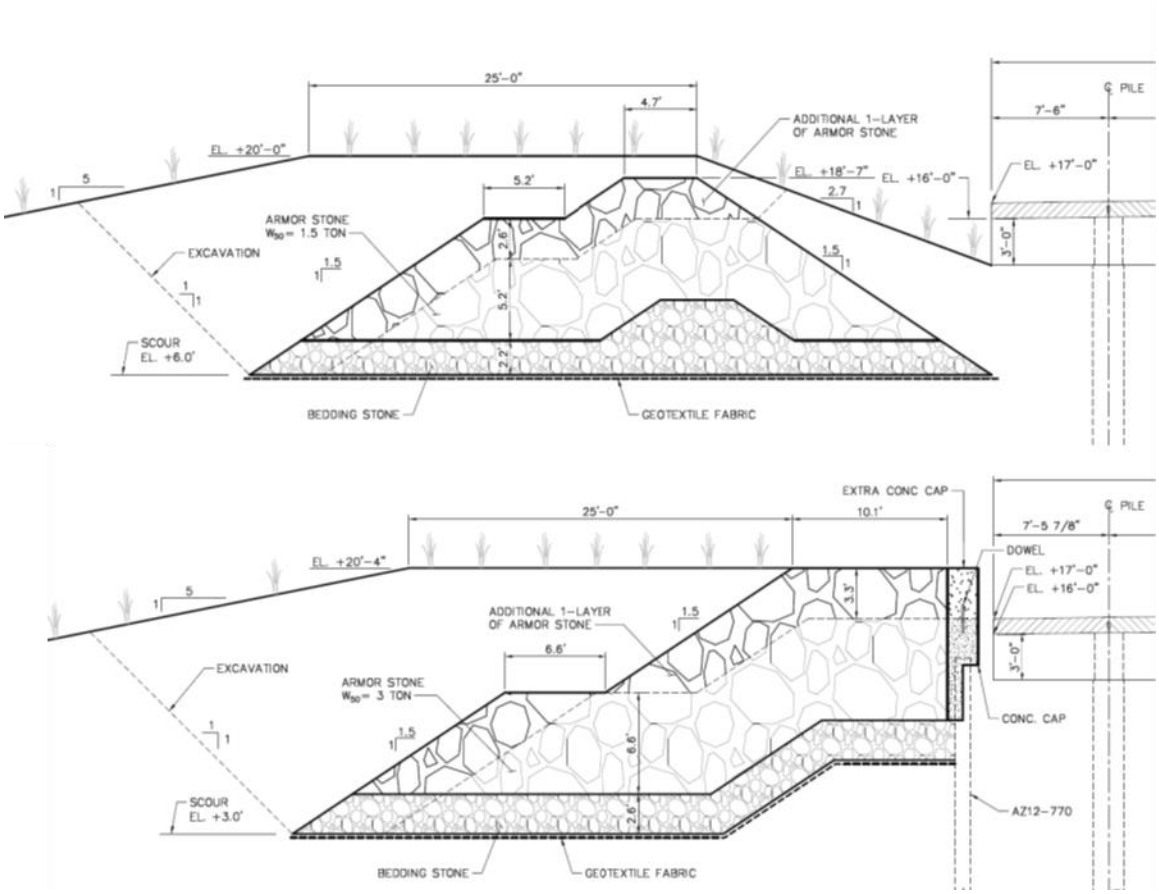


Figure 7-17: Seawall Adaptability Measures

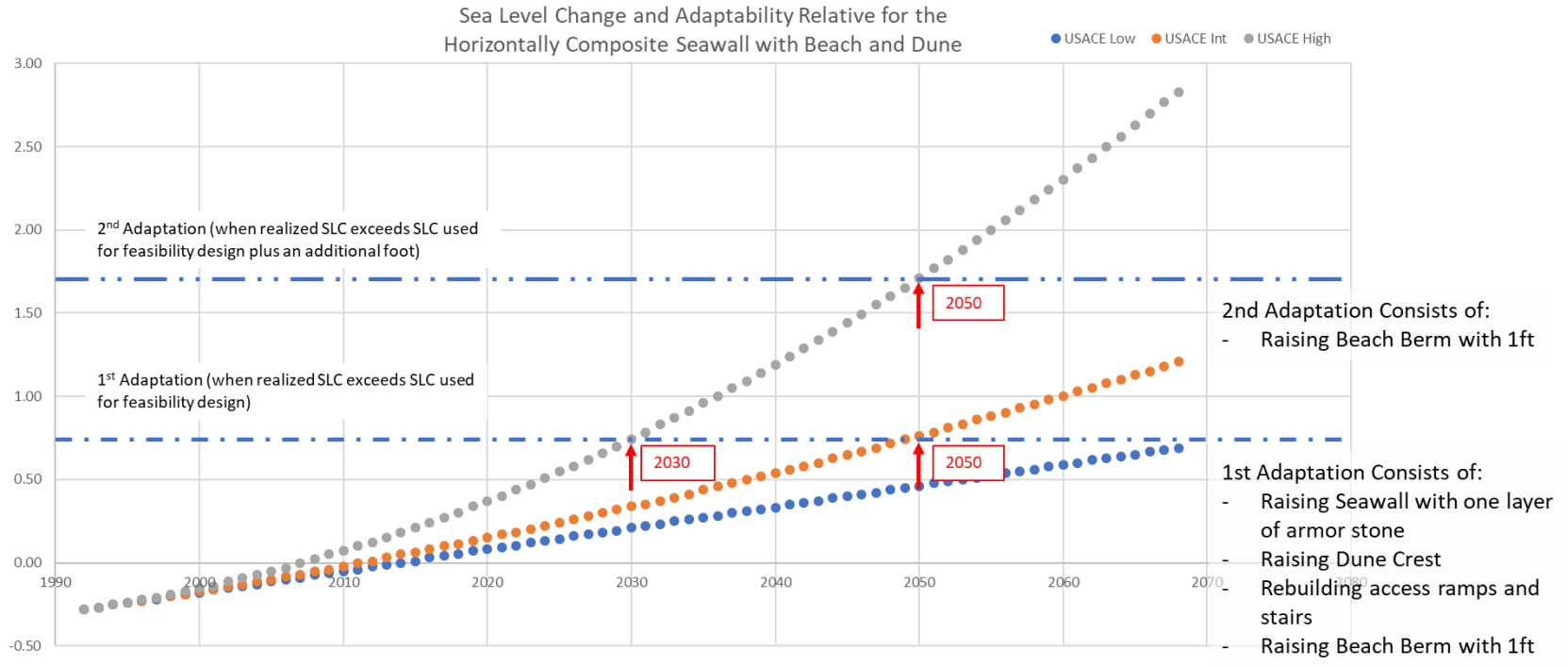


Figure 7-18: Graphic Representation of Adaptability of Atlantic Ocean Shorefront Measures (red markers indicate the years at which adaptation measures are expected to occur).

7.6.3 Groins

Due to the uncertainty in sea level change as well as the design/performance of the groin system it is recommended that the groins be adapted in the future by adjusting renourishment quantities and placement locations. Even without considering sea level changes there will be some differences in the actual performance of the groins and the expected or modeled performance that will need to be adapted to by adjusting fill placement.

The relative difference in sea level rise between the USACE low and USACE high sea level rise scenarios is about 2 feet. Typically groins are designed with a crest elevation between MHHW and MLLW. Considering that the existing tidal range in the project area is 5 feet, the impact of sea level rise on sediment bypassing over the groins is anticipated to be relatively minor since even the high sea level rise changes fall well within the tidal range.

Groin performance could also be impacted as the design beach profile is adjusted in the future in response to sea level change. As discussed above, the dune height and berm elevation should be raised in response to sea level rise. A 2 ft increase in the dune and berm elevation results in a 46 ft seaward projection in the design profile, which would decrease the effective length of the groins by 46 ft. As the effective groin length decreases, bypassing around the tips of the groins will increase.

Both of the groin performance impacts above can be managed by adjusting renourishment fill quantities and placement locations. As bypassing over and around the groins increases, more fill will be required within the groin field and less fill will be required downdrift of the groins. Adapting the groins structurally by increasing the groin elevation or length could also be considered, but is likely to be expensive and not justified based on the small improvements in groin performance. Structural adaptation of the groins could entail either adding an additional layer of armor stone or extending the groin seaward.

7.6.4 CSRM Alternatives Comparison

The cost and benefits for each of the alternatives were evaluated. The results of the comparison, presented in Table 7-17, indicate that all of the alternative plans are cost effective and that the highest net benefits are provided by the composite seawall. Among the beach restoration and dune alternatives, the highest net benefits are provided by the largest alternative considered.

The benefit estimates include reduced damages for the shorefront area, reduced damages from cross island flooding, and reduced future maintenance costs. For the shorefront areas the Beach-fx models were revised to incorporate each design profile and to adjust future

profiles to reflect the planned renourishment to maintain the design profile into the future. The reduced damage due to cross shore flooding was estimated by using the HEC-FDA levee function to truncate/eliminate damages for storm events that would not generate significant overtopping volumes (1.0 cfs). Because the project will maintain the design profile there will be no need for non-federal actions to repair the design profile after major storm events. These future costs avoided are estimated to add $577,000 in average annual benefits to each plan.

The initial construction costs for each of the CSRM alternatives includes all of the required project features including erosion control measures, beach, dune and seawall features for each plan, any modifications to existing structures, such as boardwalk access ramps, and associated costs for engineering design and construction management. For economic comparison purposes, interest during construction has been added to the initial construction costs to reflect different investment opportunity costs between alternatives.

Average annual costs include the amortized value of the initial construction (50 years, 2.750% interest rate), annualized value of periodic renourishment, Operations and Maintenance (O&M), average annual costs for structure repair after major storm events, and any costs for adapting the structure for accelerated sea level rise (assumed zero under the low sea level rise or base condition). Screening level cost estimate and supporting data are included within Sub-Appendix B.

The analysis of sea level rise included the average annual costs of future plan adaptations and the change in with and without project damage and benefits associated with higher water levels and higher rates of shoreline change. Shorefront benefits under these scenarios were recalculated in Beach-fx. The Jamaica Bay side of the peninsula inundation damages were estimated to increase in response to higher flood levels in Jamaica Bay. Because of the higher flood levels in Jamaica bay, the area subject to cross shore flooding becomes smaller in the accelerated sea level rise scenarios. As a result the damages and benefits associated with cross shore flooding become smaller as sea level rise increases

As seen in Table 7-18 and Table 7-19, all of the plans considered remain cost effective. Because of the high cost of modifying the structural alternatives and the reduction in cross shore flood benefits the seawall plans become relatively less cost effective. Under the intermediate sea level rise scenario the composite seawall plan continues to provide the overall highest net benefits while the highest net benefits of the dune and beach restoration plans is provided by the 20 foot dune alternative. Under the high sea level rise scenario the composite seawall plan continues to provide the overall highest net benefits while the 20 foot dune alternative provides slightly higher net benefits than the composite seawall alternative.

Table 7-17: Low SLR CSRM Benefits

Atlantic Ocean Shorefront Formulation Summary		Low SLR					
		Without Project	16 Foot Dune	18 Foot Dune	20 Foot Dune	Buried Seawall	Composite Seawall
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	IDC	$0	$1,307,000	$2,129,000	$3,462,000	$3,752,000	$6,760,000
	Investment Cost	$0	$72,324,000	$97,626,000	$150,661,000	$159,235,000	$227,748,000
Annualized Cost	Investment Cost	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/Emergency)	$867,000	$5,950,000	$6,392,000	$6,829,000	$5,950,000	$5,950,000
	O&M	$0	$579,000	$598,000	$621,000	$727,000	$836,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaption	$0	$0	$0	$0	$0	$0
	Total Annual Cost	$867,000	$9,540,000	$10,938,000	$13,363,000	$12,907,000	$15,554,000
Damages	Damages - Shore Front	$17,502,000	$8,389,000	$5,180,000	$2,752,000	$5,097,000	$1,986,000
	Damages - Cross Shore Flood Damages	$28,757,000	$26,393,000	$19,350,000	$15,413,000	$19,350,000	$11,360,000
	Jamaica Bay Damages	$65,548,000	$65,548,000	$65,548,000	$65,548,000	$65,548,000	$65,548,000
	Total Damages	$111,807,000	$100,330,000	$90,078,000	$83,713,000	$89,995,000	$78,894,000
Benefits	Total Benefits (Reduced Damages)	-	$9,113,000	$12,322,000	$14,750,000	$12,405,000	$15,516,000
	Cost Avoided (Emergency Nourishment)	-	$867,000	$867,000	$867,000	$867,000	$867,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$9,980,000	$13,189,000	$15,617,000	$13,272,000	$16,383,000
	Cross Shore Flood Damage Reduced	-	$2,364,000	$9,407,000	$13,344,000	$9,407,000	$17,397,000
	Total Storm Damage Reduction Benefits	-	$12,344,000	$22,596,000	$28,961,000	$22,679,000	$33,780,000
	Recreation Benefits	-	$29,430,000	$29,430,000	$29,430,000	$29,430,000	$29,430,000
	Total Benefits	-	$41,774,000	$52,026,000	$58,391,000	$52,109,000	$63,210,000
	Net Benefits (Damage Reduction Only)	-	$2,804,000	$11,658,000	$15,598,000	$9,772,000	$18,226,000
BCR		**-**	**4.4**	**4.8**	**4.4**	**4.0**	**4.1**

Table 7-18: Intermediate SLR CSRM Benefits

Atlantic Ocean Shorefront Formulation Summary		Intermediate SLR					
		Without Project	16 Foot Dune	18 Foot Dune	20 Foot Dune	Buried Seawall	Composite Seawall
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	IDC	$0	$1,307,000	$2,129,000	$ 3,462,000	$ 3,752,000	$ 6,760,000
	Investment Cost	$0	$72,324,000	$97,626,000	$150,661,000	$159,235,000	$227,748,000
Annualized Cost	Investment Cost	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/Emergency)	$943,000	$6,364,000	$6,801,000	$7,243,000	$6,364,000	$6,364,000
	O&M	$0	$579,000	$598,000	$621,000	$728,000	$836,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaption	$0	$210,000	$373,000	$377,000	$1,020,000	$1,453,000
	Total Annual Cost	$943,000	$10,164,000	$11,720,000	$14,154,000	$14,342,000	$17,421,000
Damages	Damages - Shore Front	$18,512,000	$7,750,000	$4,882,000	$2,641,000	$4,783,000	$2,245,000
	Damages - Cross Shore Flood Damages	$27,384,000	$25,191,000	$18,515,000	$14,794,000	$18,515,000	$10,947,000
	Jamaica Bay Damages	$70,505,000	$70,505,000	$70,505,000	$70,505,000	$70,505,000	$70,505,000
	Total Damages	$116,401,000	$103,446,000	$93,902,000	$87,940,000	$93,803,000	$83,697,000
Benefits	Total Benefits (Reduced Damages)	-	$8,172,000	$11,040,000	$13,281,000	$11,139,000	$13,677,000
	Cost Avoided (Emergency Nourishment)	-	$626,368	$626,368	$626,368	$626,368	$626,368
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$8,798,368	$11,666,368	$13,907,368	$11,765,368	$14,303,368
	Cross Shore Flood Damage Reduced	-	$2,193,000	$8,869,000	$12,590,000	$8,869,000	$16,437,000
	Total Storm Damage Reduction Benefits	-	$10,991,368	$20,535,368	$26,497,368	$20,634,368	$30,740,368
	Recreation Benefits	-	$35,292,000	$35,292,000	$35,292,000	$35,292,000	$35,292,000
	Total Benefits	-	$46,283,368	$55,827,368	$61,789,368	$55,926,368	$66,032,368
	Net Benefits (Damage Reduction Only)	$0	$827,368	$8,815,368	$12,343,368	$6,292,368	$13,319,368
BCR		**-**	**4.2**	**4.5**	**4.1**	**3.7**	**3.6**

Table 7-19: High SLR CSRM Benefits

Atlantic Ocean Shorefront Formulation Summary			High SLR				
		Without Project	16 Foot Dune	18 Foot Dune	20 Foot Dune	Buried Seawall	Composite Seawall
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	IDC	$0	$1,307,000	$2,129,000	$3,462,000	$3,752,000	$6,760,000
	Investment Cost	$0	$72,324,000	$97,626,000	$150,661,000	$159,235,000	$227,748,000
Annualized Cost	Investment Cost	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/Emergency)	$1,299,000	$7,666,000	$8,108,000	$8,544,000	$7,666,000	$7,666,000
	O&M	$0	$579,000	$598,000	$621,000	$554,000	$417,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaption	$0	$564,000	$849,000	$859,000	$2,197,000	$2,288,000
	Total Annual Cost	$1,266,000	$11,820,000	$13,503,000	$15,937,000	$16,647,000	$19,139,000
Damages	Damages - Shore Front	$18,302,000	$9,559,000	$6,321,000	$3,728,000	$6,114,000	$3,330,000
	Damages - Cross Shore Flood Damages	$22,511,000	$21,191,000	$15,865,000	$12,924,000	$15,865,000	$9,663,000
	Jamaica Bay Damages	$90,505,000	$90,505,000	$90,505,000	$90,505,000	$90,505,000	$90,505,000
	Total Damages	$131,318,000	$121,255,000	$112,691,000	$107,157,000	$112,484,000	$103,498,000
Benefits	Total Benefits (Reduced Damages)	-	$8,743,000	$11,981,000	$14,574,000	$12,188,000	$14,972,000
	Cost Avoided (Emergency Nourishment)	-	$1,266,000	$1,266,000	$1,266,000	$1,266,000	$1,266,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$10,009,000	$13,247,000	$15,840,000	$13,454,000	$16,238,000
	Cross Shore Flood Damage Reduced	-	$1,320,000	$6,646,000	$9,587,000	$6,646,000	$12,848,000
	Total Storm Damage Reduction Benefits	-	$11,329,000	$19,893,000	$25,427,000	$20,100,000	$29,086,000
	Recreation Benefits	-	$29,430,000	$29,430,000	$29,430,000	$29,430,000	$29,430,000
	Total Benefits	-	$40,759,000	$49,323,000	$54,857,000	$49,530,000	$58,516,000
	Net Benefits (Damage Reduction Only)	-	-$491,000	$6,390,000	$9,490,000	$3,453,000	$9,947,000
BCR		**-**	**3.4**	**3.7**	**3.4**	**3.0**	**3.1**

8 THE RECOMMENDED PLAN

8.1 The Recommended Plan for the Atlantic Ocean Shorefront

The Atlantic Ocean shorefront reach is subject to wave attack, wave run up, and over topping along the Rockaway peninsula. The general approach to developing CSRM along the Atlantic Ocean Shorefront (Reach 2 through Reach 6b of the Atlantic Ocean Shorefront) was to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective renourishment approach prior to the evaluation of alternatives for coastal storm risk management. The most cost effective erosion control alternative is beach restoration with increased erosion control. This erosion control alternative had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life.

A screening analysis was performed to evaluate the level of risk reduction provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with beach restoration with increased erosion control to optimize CSRM at the Atlantic Ocean Shorefront. Other factors such as prior projects at Rockaway Beach, project constraints, stakeholder concerns, and engineering judgment were also applied in the evaluation and selection. A composite seawall was selected as the best coastal storm risk management alternative. The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding. The Recommended Plan spans from Reach 3 through Reach 6b and combines Beach restoration and Erosion Control and has the following features.

The Recommended Plan for the Atlantic Ocean Shorefront reach (Figure 8-1) consists of:

- A composite seawall with a structure crest elevation of +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet;
- A beach berm elevation of +8 ft NAVD88 and a depth of closure of -25 ft NAVD88;
- A total beach fill quantity of 1,596,000 cy for the initial placement, including tolerance, overfill and advanced nourishment with a 4-year renourishment cycle of 1,111,00 cy, resulting in a minimum berm width of 60 feet;
- Extension of 5 existing groins; and
- Construction of 13 new groins.
- Construction of two beachfill taper sections at both the project east and west ends, with 3 new groins as part of the west taper.

The following sections provide additional details on the reinforced dune with composite seawall, the shorefront beach restoration and the groins, respectively. A set of preliminary plans and sections for the Recommended Plan for the Atlantic Ocean Shorefront reach is provided in Sub-Appendix C.

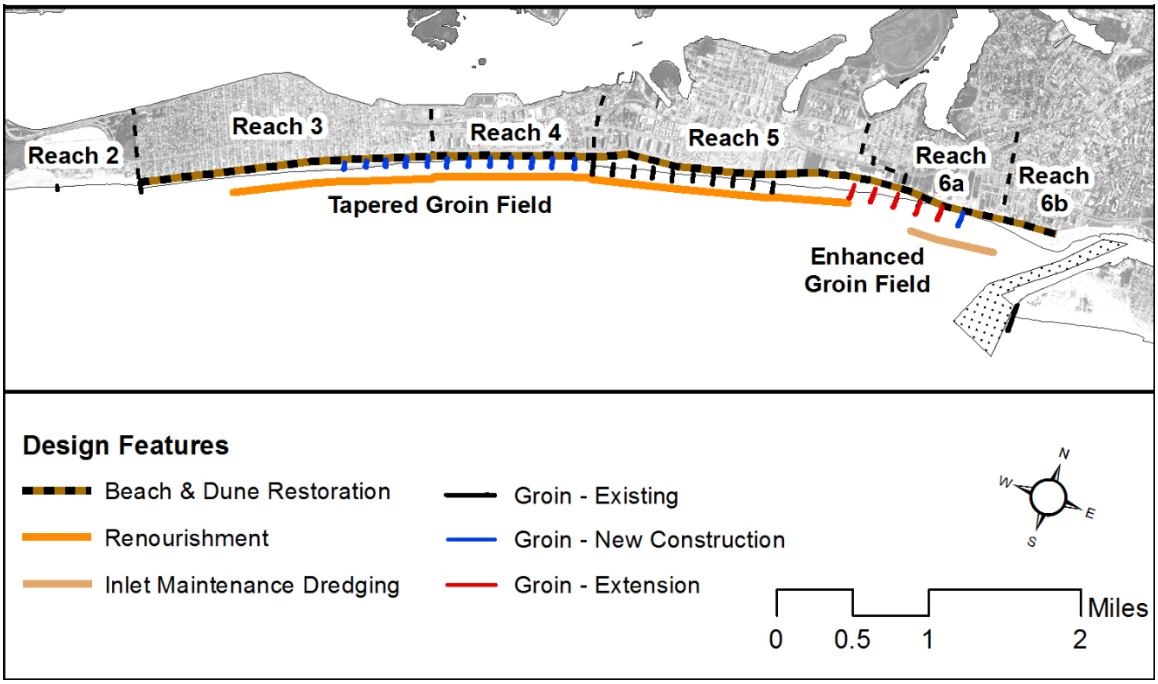


Figure 8-1: Schematic overview of the Beach Restoration and Groin features of the Recommended Plan for the Atlantic Ocean Shorefront Reach

8.1.1 Reinforced Dune – Composite Seawall

A composite Seawall is proposed for the Atlantic Ocean Shorefront from Beach 149th Street up to Beach 20th Street. The composite seawall alignment follows the existing boardwalk alignment. The Composite seawall concept consists of an impermeable core (i.e. sheet pile wall with concrete cap) and rubble mound structure on the seaward side of the wall. The composite seawall is covered with sand and only the top and concrete cap are exposed on the land side of the dune (see Figure 8-2). The structure crest elevation is +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet. The armor stone in the horizontally composite structure significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls to be used in the design if the face of the wall is completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding 1-layer of armor stone and extending the concrete cap up to the elevation of the armor stone. Due to spatial constraints within Reach 3 between Beach 149th Street and Beach 126th Street, a modified version of the composite seawall that includes a splash apron on the leeward side of the sheet pile wall is proposed for this section (Figure 8-3). Detailed plans and sections are provided in Sub-Appendix C.

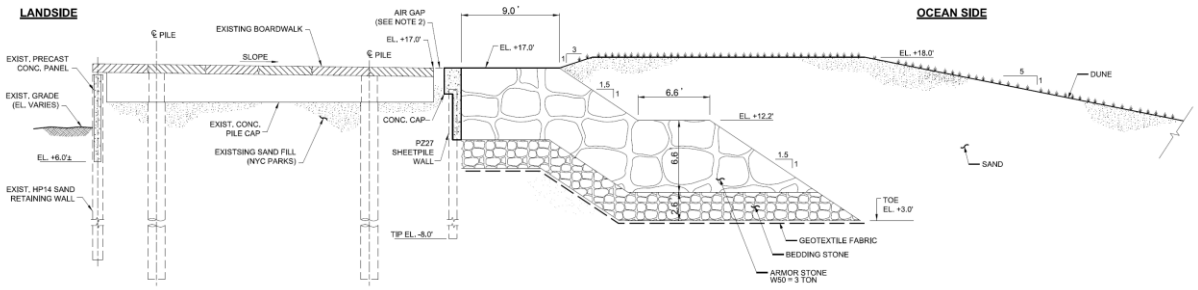


Figure 8-2: Composite Seawall

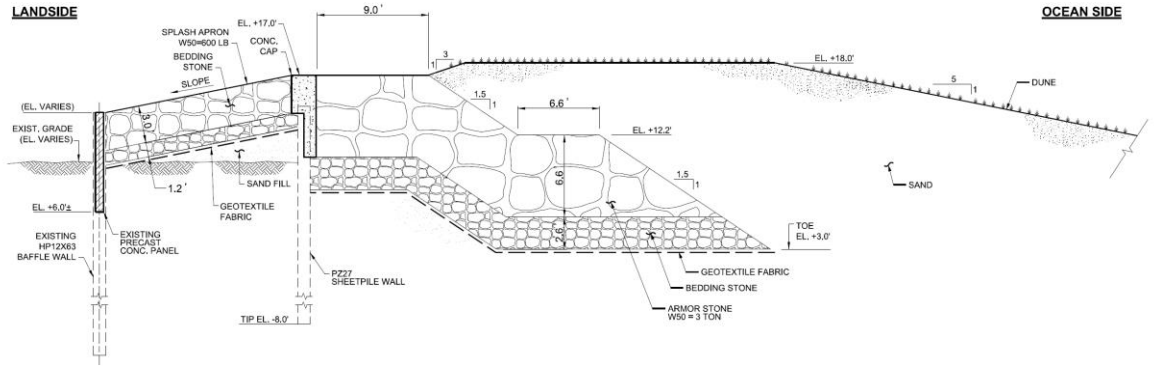


Figure 8-3: Composite Seawall (Beach 126th Street to Beach 149th Street)

8.1.2 Beach Restoration

The Recommended Plan includes all the features of Alternative 3 as earlier presented in Chapter 7 and consists of beach restoration for Reach 3 through 6. A design profile is proposed that includes a dune with a 25 ft wide with a crest at elevation +18 ft NAVD88 and a back slope of 1V:3H and a front slope of 1V:5H. The design includes a berm with a minimum width of 60 ft at an elevation of +8 ft NAVD88. The width of the design berm is controlled by the alignment of the baseline. The baseline is aligned with the natural shoreline and the distance from the baseline to the design shoreline is always 243 ft. The alignment of the dune follows the unnatural alignment of the boardwalk and as a result the distance between the toe of the dune and the seaward crest of the berm varies. Detailed plans and sections are provided in Sub-Appendix C.

For the transitions at the project ends two smaller beachfill taper sections are included within the Recommended Plan. The east beachfill taper is approximately 3,000 ft in shorefront length from Beach 19th Street east to Beach 9th Street. The taper comprises of approximately 1,000 ft of dune and beach taper including reinforced dune feature and approximately 2,000 ft of dune and beach fill without reinforced dune feature. In addition to the tapering of berm width, the dune elevation

also tapers from an elevation of +18 ft NAVD88 at 19th Street down to approximately +12 ft NAVD88 at Beach 9th Street which will be tied into the existing grade. The west beachfill taper is approximately 5,000 ft in shorefront length from Beach 149th Street west to Beach 169th street fronting Riis Park. The beachfill taper will be beach fill only with a berm width tapered from the design width at 149th Street to the existing width and height at 169th Street.

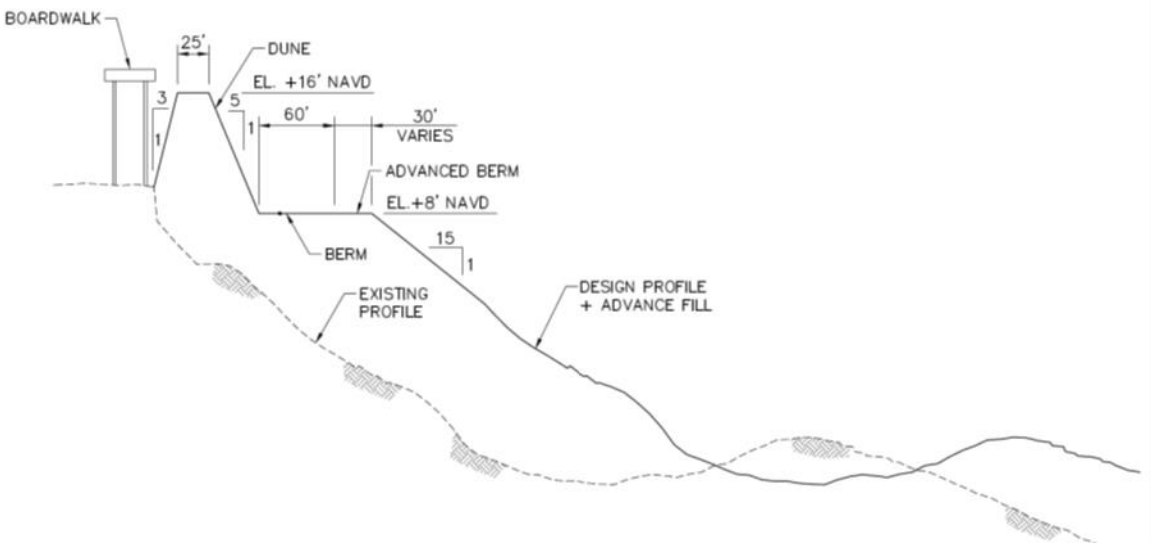


Figure 8-4: Design Beach Profile (note: Baseline location varies)

The initial beach fill construction quantities per reach are provided in Table 8-1.

Table 8-1: Initial Construction Beachfill Quantities (CY)

Reach	Length (ft)	Recommended Plan
Reach 2 (West Taper)		306,000
Reach 3	10,320	356,000
Reach 4	5,380	294,000
Reach 5	10,650	321,000
Reach 6a	3,730	250,000
Reach 6b	2,000	20,000
East Taper		49,000
Total	55,650	1,596,000

A summary of the renourishment quantities, per operation, including overfill and losses is provided in Table 8-2. The renourishment quantities for the Recommended Plan are based on a 4-year cycle.

Inlet Maintenance Dredging is assumed to continue and dredged materials to be paced in Reach 6a.

Table 8-2: Renourishment Quantities per Operation[1]

Reach	Renourishment (cy) based on a 4-year renourishment cycle
	Recommended Plan
Reach 3	475,000
Reach 4	149,000
Reach 5	476,000
Reach 6a	11,000[2]
Total	1,111,000

Notes [1] All renourishment quantities account for SLR and overfill (11%)

[2] Excludes Inlet Maintenance Dredging (115,000 cy/yr)

8.1.3 Groins

New Groins are proposed for the Atlantic Ocean Shorefront Recommended Plan and include two types of groin measures: new groin construction and groin extension. Existing groins are extended in Reach 5 and 6 and 1 new groin is constructed in Reach 6. In reach 4 seven (7) new groins are constructed and in Reach 3 five (5) new groins are constructed (Figure 8-1). In addition to the beachfill taper in Reach 2, a tapered groin system comprised of three (3) rock groins is also included for this section. Table 8-3 provides and overview of the groin length, type and location. Detailed plans and sections are provided in Sub-Appendix C.

Table 8-3: Summary of Groin Lengths for the Recommended Plan

Reach	Number	Groin ID	Street	Horizontal Shore Section (ft)	Intermediate Sloping Section (ft)	Outer Section (ft)	Total Length (ft)	Notes
6a	1	63	34th St	62	108	328	498	new 498 ft
6a	2	62	37th St	55	108	328	491	extension 209 ft
6a	3	61	40th St	90	108	328	526	extension 307 ft
5	4	53	43rd St	90	108	228	426	extension 114 ft
5	5	52	46th St	90	108	228	426	extension 155 ft
5	6	51	49th St	90	108	228	426	extension 180 ft

Reach	Number	Groin ID	Street	Horizontal Shore Section (ft)	Intermediate Sloping Section (ft)	Outer Section (ft)	Total Length (ft)	Notes
4	1	47	92nd St	66	108	128	302	new 302 ft
4	2	46	95th St	62	108	128	298	new 298 ft
4	3	45	98th St	63	108	128	299	new 299 ft
4	4	44	101st St	62	108	128	298	new 298 ft
4	5	43	104th St	66	108	128	302	new 302 ft
4	6	42	106th St	67	108	128	303	new 303 ft
4	7	41	108th St	66	108	128	302	new 302 ft
3	8	35	110th St	90	108	153	351	new 351 ft
3	9	34	113th St	90	108	178	376	new 376 ft
3	10	33	115th St	90	108	178	376	new 376 ft
3	11	32	118th St	90	108	178	376	new 376 ft
3	12	31	121st St	63	108	128	299	new 299 ft
2	1	23	Reach 2	161	108	100	369	new 369 ft
2	2	22	Reach 2	205	108	100	413	new 413 ft
2	3	21	Reach 2	223	108	100	431	new 431 ft

8.2 Quantities & Costs

Cost estimates for the Recommended Plan were developed at a second quarter 2018 price level for labor, material, and equipment. The material quantities for the Recommended Plan have been developed from the plans shown in Sub-Appendix C (sub-Appendix to this Appendix A1) and full details on the development of the cost estimate are provided in Appendix C. The MII Estimate is included in Appendix C and includes the details of the estimate including the different tasks required to complete the construction. Details provided for these tasks include the production rate of the crews and the crew composition, including the equipment used and the number and description of labor categories required. It should be noted that the cost estimate was updated from the values used for the alternative analysis. All labor is assumed to be from prevailing wage rates for New York City and equipment rates were estimated for USACE Region 1, with supplemental information from published Blue Book Rates for equipment. The total project cost, fully funded, for the Atlantic Ocean Shorefront is $277.4 million, without contingency. The cost risk analysis determined the contingency to be 28.36%, making the total project cost $356,1 million for budgeting purposes (2018 price levels). Obtaining the armor stone is difficult for quarries to supply and the project requires over 350,000 tons of armor stone. The armor stone represented over 89%

of the project's expected variability, with no other item representing over 10% of the project's total cost variation. The Civil Work Breakdown Structure (CWBS) feature codes as shown in Table 8-4 are utilized to establish the project cost. The project cost presented in Table 8-4 are a summary of the detail provided in Appendix C.

Table 8-4: MII Estimate Recommended Plan – Atlantic Ocean Shorefront Reach

CWBS account code #	Account Code Description	Total Project Cost (Fully Funded)
01	Lands and Damages	$653,000
10	Breakwaters & Seawalls	$260,931,000
17	Beach Replenishment	$36,393,000
18	Cultural Resource Preservation	$13,766,000
30	Planning, Engineering and Design	$24,765,000
31	Construction Management	$19,616,000
	Total	**$356,124,000**

8.3 Construction Schedule

The construction schedule for the Atlantic Ocean Shorefront Reach is included in Appendix C. The total duration is approximately 44 months. The first construction activity will be the beachfill starting in December 2019 with a duration of approximately 6.5 months. Starting Spring of 2020 the groins and the composite seawall and dune will be constructed in parallel with project completion mid-2023.

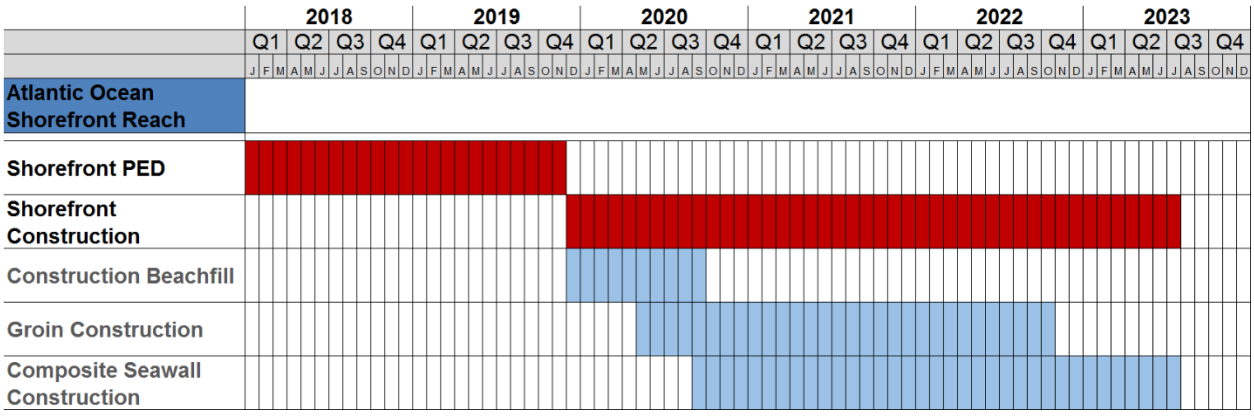


Figure 8-5: Schematic overview of the construction schedule for the Atlantic Ocean Shorefront Reach of the Recommended Plan

8.4 Recommendations for PED

This Engineering & Design Appendix provides an overview of the analyses supporting the development of the recommended plan for the Atlantic Ocean Shorefront Reach. This appendix furthermore describes the development of erosion control and CSRM alternatives and a screening analysis of these alternatives to establish the Recommended Plan. Based on the data gathered during the feasibility study and engineering analyses, a preliminary design for the project has been completed. The dimensions and sizing of the specific project features such as the composite seawall, the groins and splash apron are preliminary but of sufficient detail for feasibility study.

It is expected that the project feature's designs and the composite seawall design would be further developed in PED. It can be noted that based upon the review of the proposed project during the feasibility phase, DEC will require further justification or component revisions to ensure the protection of water quality, habitat quality, and public access during the PED Phase. In addition, initial beach fill quantities will need to be updated based on current survey data. The preliminary designs shall not be construed as requirements for actual dimensions for implementation and significant additional engineering and design is required to substantiate the designs including, but not limited to, a full evaluation of topographical and bathymetric elevations, subsurface soil conditions and an inventory and condition assessment of existing structures and utilities for the project area. A preliminary list of potential future engineering analyses and design refinements include the following:

- Bathymetric and topographic survey to establish beachfill quantities and inform detailed designs for the groins and buried seawall,
- Survey extent of sand fill underneath the existing boardwalk,
- Geotechnical data collection (site specific borings, samples and geotechnical data collection),
- Utility survey and an inventory and condition assessment of existing structures and utilities for the project area,
- Morphological modeling analysis to assess the performance of the tapered groin field in Reach 2 and beyond the terminal groin at 149th street and incorporate recent survey data on the performance of the FCCE project post Hurricane Sandy,
- Borrow area analysis, including, but not limited to surveys, grain size compatibility and site capacity analyses,
- Refined engineering analyses for the armor rock sizing and geometry for the new and extensions of existing coastal groins, as well as the composite seawall,
- Refined engineering analyses for the beach tapers, dune transitions and tie-ins to higher ground at the project ends,
- Engineering analyses and detailed design to integrate the existing baffle wall into the design of the composite seawall between Beach 126th and Beach 49th Street,
- Assess the potential for landward sand migration and if deemed needed complete project measure evaluations to address landward sand migration,
-

- Detailed design to account for the existing boardwalk, beach access (stairs and ramps) and modifications needed during construction of the composite seawall,
- Design of transition of the composite seawall at Beach 126th Street as well as at the project ends, and
- Analyses of temporary construction features and construction sequencing.

REFERENCES

Bedient, P.B., and Huber, W.C. (1992). "Hydrology and Floodplain Analysis (2nd Edition)." Addison-Wesley Publishing Company: Reading, Massachusetts.

Chow, V.T. (1959). "Open-Channel Hydraulics." McGraw-Hill: New York.

EurOtop. (2007). "Wave Overtopping of Sea Defences and Related Structures: Assessment Manual." Eds. T. Pullen., N.W.H Allsop, T. Bruce., A. Kortenhaus, H. Schuttrumpf, and J.W. van der Meer.

Federal Emergency Management Agency (FEMA). (2007). "Guidelines and Specifications for Flood Hazard Mapping Partners." Section D.2.7 Overland Wave Propagation.

Goda, Y. (2000). "Random Seas and Design of Maritime Structures." World Scientific: New Jersey.

M&N. (2001). "Selection of Alternative Design Beach Profiles." Draft Memorandum. Fire Island Inlet to Montauk Point (FIMP) Study.

NOAA Technical Report NOS CO-OPS 065 'Estimating Vertical Land Motion form Long Term Tide Guage Rec-ords', May 2013.

Smith, J. M., Sherlock, A. R., Resio, D. T., 2001. "STWAVE: Steady-State Spectral Wave Model User's Manual for STWAVE, Version 3.0". ERDC/CHL SR-01-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Smith, J. M. 2007. "Full-plane STWAVE: II. Model overview". ERDC TN-SWWRP-07-05. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Wamsley, V., and Kraus, N.C. (2004). "SBEACH dune lowering sensitivity analysis for the Fire Island to Montauk Point, New York, study." USACE ERDC/CHL TR-05.

U.S. Army Corps of Engineers (USACE).(2004). "Coastal overwash Part1: Overview of processes." USACE ERDC/RSM-TN-14

U.S. Army Corps of Engineers, New York District (USACE-NAN), (2005). "Baseline Conditions Storm Surge Modeling and Stage Frequency Generation: Fire Island to Montauk Point Reformulation Study", U.S. Army Corps of Engineers, New York District.

U.S. Geological Survey (USGS) by Arcement, G.J. and Schenider, V.R. (1984). "Guide for Selecting Manning's Roughness Coefficients for Natural Channels ad Flood Plains." U.S. Geological Survey Water-supply Paper 2339.

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Sub Appendix A1-A:
ENGINEERING MODELING APPENDIX

US Army Corps of Engineers

A. SUB-APPENDIX A1.A: ENGINEERING MODELING APPENDIX

EAST ROCKAWAY TO ROCKAWAY INLET, NY

REFORMULATION STUDY

ENGINEERING MODELING APPENDIX

U.S. Army Corps of Engineers

December 2018

TABLE OF CONTENTS

1.0 INTRODUCTION 8

1.1 Overview of Numerical Modeling 8

1.2 Reach Delineation 8

2.0 HISTORICAL STORM SUITE 10

2.1 Storm Selection 10

2.2 Average Rate of Storm Occurrence 11

2.3 Storm Suite Expansion for Beach-fx 12

2.4 Determination of Equivalent Jamaica Bay Water Levels 14

3.0 REGIONAL STORM SURGE AND WAVE MODELING 16

3.1 ADCIRC 16

3.2 Computational Grid 16

3.3 Model Forcing 17

3.4 WISWAVE 19

4.0 NEARSHORE WAVE MODELING 21

4.1 STWAVE 21

4.2 SWAN 25

5.0 STORM-INDUCED MODELING (SBEACH) 31

5.1 SBEACH Overview 31

5.2 SBEACH Model Calibration 31

5.3 SBEACH Without- and With-Project Simulations 67

6.0 EMPIRICAL SIMULATION TECHNIQUE (EST) 82

6.1 Important Probability Concepts 82

6.2 Empirical Simulation Technique (EST) 83

7.0 CROSS-ISLAND FLOODING MODELING (XBEACH) 88

7.1 XBEACH Overview 88

7.2 XBEACH Model Setup 91

7.3 XBEACH Validation 94

7.4 XBEACH Without Project Simulations 100
7.5 XBEACH With Project (Seawall) Simulations 104
8.0 SHORELINE CHANGE MODELING (GENESIS) 106
8.1 GENESIS Overview 107
8.2 GENESIS Calibration 109
8.3 GENESIS Without Project Simulation 123
8.4 GENESIS Alternative Simulations 126
9.0 REFERENCES 145
ENCLOSURE A SBEACH MODEL RESULTS 146
ENCLOSURE B GENESIS-T MODEL RESULTS 147

LIST OF FIGURES

Figure 1-1: Rockaway Engineering Reaches 9

Figure 2-1: Historical Storm Suite – Ocean Stages 14

Figure 2-2: Example Showing How Peak Bay Water Levels are Determined 15

Figure 3-1: ADCIRC computational domain 18

Figure 3-2: ADCIRC Storm water level output stations 19

Figure 3-3: WISWAVE 5-min, 1-min, and 0.5 min model grid. 20

Figure 4-1: STWAVE Model Grid Extent 23

Figure 4-2: STWAVE Model Grid Resolution 24

Figure 4-3: STWAVE Model Bathymetry 24

Figure 4-4: SWAN Model Grids 25

Figure 4-5: Spectrograph at NBDC 40025 during Hurricane Sandy 27

Figure 4-6: SWAN Model Sensitivity to Bulk vs. Spectral Boundaries 27

Figure 4-7: SWAN Model Sensitivity to Raw vs. Adjusted Spectrum Boundaries 28

Figure 4-8: SWAN Calibration at 44065 29

Figure 4-9: SWAN Calibration at SSI-NY-RIC-001WV 29

Figure 4-10: SWAN Model Results for Hurricane Sandy (2013-10-30 00:00 UTC) 30

Figure 5-1: Hurricane Belle and Emmy Storm Tracks 34

Figure 5-2: ADCIRC station 52, FIMP WISWAVE station I05J04, WISWAVE (Historical Hindcast) station 73, and the NOAA tidal station at Sandy Hook were used to generate the storm time series for Calibration at Rockaway Beach 34

Figure 5-3: Observed Wave Conditions between Profile Surveys 35

Figure 5-4: Modeled Wave Conditions for Calibration 35

Figure 5-5: Profile Origins for SBEACH Model Calibration 36

Figure 5-6: Pre and Post Storm Profile 24 37

Figure 5-7: Pre and Post Storm Profile 28 37

Figure 5-8: SBEACH Calibration results at Profile 20-21 42
Figure 5-9: SBEACH Calibration results at Profile 24 43
Figure 5-10: SBEACH Calibration results at Profile 27 44
Figure 5-11: SBEACH Calibration Results at Profile 28 45
Figure 5-12: SBEACH Calibration results at Profile 31 46
Figure 5-13: SBEACH sensitivity to sediment transport rate coefficient (K) 48
Figure 5-14: SBEACH sensitivity to coefficient for slope-dependent transport (EPS) 49
Figure 5-15: SBEACH sensitivity to mean sediment grain size 50
Figure 5-16: SBEACH sensitivity to magnitude of the significant wave height (Hs) 50
Figure 5-17: SBEACH sensitivity to magnitude of the water level 51
Figure 5-18: SBEACH sensitivity to model time step (grid spacing 10 ft) 53
Figure 5-19: SBEACH sensitivity to model grid size (time step of 1 min) 53
Figure 5-20: SBEACH dune overwash with default overwash transport parameter 55
Figure 5-21: SBEACH dune overwash sensitivity to overwash transport parameter (K_B) 56
Figure 5-22: SBEACH dune erosion sensitivity to overwash transport parameter (KB) 57
Figure 5-23: SBEACH Hurricane Sandy validation for Profile 03 and Profile 73 59
Figure 5-24: SBEACH Hurricane Sandy Validation Profile Locations 60
Figure 5-25: SBEACH Hurricane Sandy Validation Results – Reach 1 62
Figure 5-26: SBEACH Hurricane Sandy Validation Results – Reach 2 63
Figure 5-27: SBEACH Hurricane Sandy Validation Results – Reach 3 64
Figure 5-28: SBEACH Hurricane Sandy Validation Results – Reach 4 66
Figure 5-29: SBEACH Hurricane Sandy Validation Results – Reach 5 67
Figure 5-30: Measured profiles at Station 5. S96-05 stands for Profile 5, surveyed in the spring of 1996 68
Figure 5-31: Aligned profiles at Station 5. The Representative Station Profile is the average of the aligned (at MHW) profiles 69

Figure 5-32: Both Representative Station Profiles in this Reach have been aligned at MHW. The Reach Representative Profile is the average of the aligned representative profiles 69
Figure 5-33: Beach-fx Simplified Profile 71
Figure 5-34: Sensitivity of flood depth (h) to Manning's number (n) 78
Figure 5-35: Illustration of composite Manning's number approach for Reach 3 78
Figure 5-36: Sensitivity of flood depth to the various composite Manning's numbers 79
Figure 5-37: SBEACH output with flooding behind seawall 80
Figure 5-38: Number of storms to be modeled based on overtopping threshold 80
Figure 6-1: EST Results for Upland Flood Depth and Wave Height 87
Figure 7-1: Pre- and Post-Hurricane Sandy Comparison at Rockaway Beach (USGS) 90
Figure 7-2: Ocean Wave Spectrum Classification (Munk, 1950) 91
Figure 7-3: XBeach Model Domain 92
Figure 7-4: XBeach Model Bathymetry 93
Figure 7-5: Hurricane Sandy Tide and Wave Stations 95
Figure 7-6: XBEACH Storm Tide Boundary Conditions – Hurricane Sandy 95
Figure 7-7: XBEACH Wave Boundary Conditions – Hurricane Sandy 96
Figure 7-8: XBEACH Snapshot of Water Level near Jacob Riis Park 97
Figure 7-9: XBEACH Modeled Maximum Water Elevations – Hurricane Sandy 98
Figure 7-10: XBEACH Modeled Maximum Inundation – Hurricane Sandy 99
Figure 7-11: XBEACH Time Series of Modeled Water Elevations – Hurricane Sandy 100
Figure 7-12: XBEACH Synthetic Nor'easter and Hurricane Boundary Conditions 101
Figure 7-13: XBEACH Modeled Maximum Water Elevations – Synthetic Storms 103
Figure 7-14: XBEACH Water Levels during Hurricane Sandy with Seawall 104
Figure 7-15: XBEACH Water Elevation Relative to Bay during Hurricane Sandy 105
Figure 8-1: GENESIS-T Model Extent 107
Figure 8-2: GENESIS-T Offshore Wave Data Locations 111

Figure 8-3: GENESIS-T Nearshore Wave Stations 112
Figure 8-4: GENESIS-T Representative Wave Roses 113
Figure 8-5: GENESIS-T Calibration (Existing) Structures 114
Figure 8-6: GENESIS-T Beach Fill Project Map 116
Figure 8-7: GENESIS-T Bypassing at East Rockaway Inlet 117
Figure 8-8: GENESIS-T Calibration - Sediment Transport Rate 118
Figure 8-9: GENESIS-T Regional Contour Location 119
Figure 8-10: GENESIS-T Calibration Results – Shoreline Position Overview 121
Figure 8-11: GENESIS-T Measured vs. Modeled Shoreline Change 122
Figure 8-12: GENESIS-T Measured vs. Modeled Shoreline Position Difference 122
Figure 8-13: GENESIS-T WOPFC Shoreline Changes 125
Figure 8-14: GENESIS-T WOPFC Sediment Transport & Gross Volume Changes 126
Figure 8-15: GENESIS-T Alternatives 128
Figure 8-16: GENESIS-T Alternative 1 Shoreline Changes 131
Figure 8-17: GENESIS-T Alternative 1 Sediment Transport & Gross Volume Changes 132
Figure 8-18: GENESIS-T Alternative 2 Shoreline Changes 134
Figure 8-19: GENESIS-T Alternative 2 Sediment Transport & Gross Volume Changes 135
Figure 8-20: GENESIS-T Alternative 3 Shoreline Changes 138
Figure 8-21: GENESIS-T Alternative 3 Sediment Transport & Gross Volume Changes 139
Figure 8-22: GENESIS-T Sediment Transport for Other Alternatives 141
Figure 8-23: GENESIS-T Downdrift Erosion in Alternative A (red dots) 142
Figure 8-24: GENESIS-T Impact of Tapered Groins in Alternative B (orange dots) 142

LIST OF TABLES

Table 2-1: Historical Storm Training Set 10

Table 2-2: Tropical Events (2000 to 2013) 12

Table 2-3: Extratropical Events (2000 to 2013) 12

Table 3-1: ADCIRC Astronomic Tidal Constituents. 17

Table 4-1: STWAVE Bathymetric Data Sources 22

Table 5-1: Differences between Pre and Post Storm Profiles 38

Table 5-2: SBEACH Calibration Scenarios 40

Table 5-3: SBEACH Erosion Parameters for Profile 20-21 40

Table 5-4: SBEACH Sensitivity Analyses 47

Table 5-5: SBEACH Sensitivity to Time Step and Grid Spacing 52

Table 5-6: SBEACH Final Model Calibration Parameters 58

Table 5-7: Wave Transmission Inputs 74

Table 5-8: Wave Overtopping Inputs 75

Table 5-9: Manning's number for main surfaces covering Reaches 3 to 6 77

Table 5-10: Composite Manning's number for each reach 77

Table 7-1: XBEACH Boundary Conditions – Synthetic Storms 101

Table 8-1: GENESIS-T Groin Permeability Coefficients 114

Table 8-2: GENESIS-T Calibration Beach Fill Data 115

Table 8-3: GENESIS-T Measured vs. Modeled Shoreline Error Analysis 121

Table 8-4: GENESIS-T Alternative 1 Renourishment Quantities 129

Table 8-5: GENESIS-T Alternative 2 Renourishment Quantities 133

Table 8-6: GENESIS-T Alternative 3 Renourishment Quantities 136

Table 8-7: GENESIS-T Summary of Renourishment Quantities 143

1.0 INTRODUCTION

1.1 Overview of Numerical Modeling

The numerical modeling strategy for Rockaway addresses a comprehensive list of physical processes by utilizing a range of hydrodynamic, wave, sediment transport, and shoreline change models. The following numerical models were applied in the study:

- ADCIRC – storm surge propagation;
- WISWAVE – regional wave transformation;
- STWAVE – nearshore wave transformation;
- SWAN – nearshore wave transformation;
- GENESIS – long-term shoreline evolution;
- SBEACH – storm induced profile change;
- XBEACH – cross-island flooding.

1.2 Reach Delineation

The Project Area has been divided into smaller segments known as reaches for the purpose of engineering and economic analysis. As shown in Figure 1-1, the Project Area is an 11 mile long narrow peninsula with Rockaway Inlet at the western project limit near Breezy Point and East Rockaway Inlet at the eastern limit near Beach 19th Street. The purpose of reach delineation is to facilitate the engineering and economics analyses. The engineering analyses include historical erosion rates, sediment budget, historic shoreline changes and alternatives design considerations. The economic analyses include damages, cost, and benefit estimates. The reaches are developed based on physical, economic, and institutional differences including sediment transport rate boundaries, shoreline orientation, coastal structures, topographic elevations, and existing economic developments. The engineering reaches do not have to coincide with the economic reaches; however, they must be interrelated. The Project Area has been divided into six major reaches based on both engineering and economic considerations as follows:

- Reach 1: Rockaway Point to Beach 193rd Street
- Reach 2: Beach 193rd Street to Beach 149th Street
- Reach 3: Beach 149th Street to Beach 109th Street
- Reach 4: Beach 109th Street to Beach 86th Street
- Reach 5: Beach 86th Street to Beach 42nd Street
- Reach 6a: Beach 42nd Street to Beach 28th Street

- Reach 6b: Beach 28th Street to Beach 19th Street

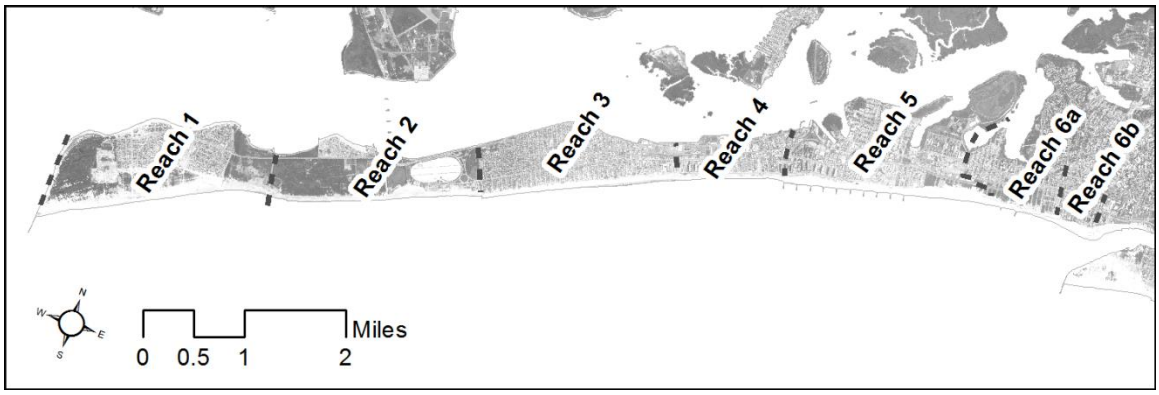


Figure 1-1: Rockaway Engineering Reaches

2.0 HISTORICAL STORM SUITE

2.1 Storm Selection

The historical storm suite for this study used in the Beach-fx model is based on a training set of 38 historical tropical and extratropical storms. The training set of storms was developed originally for the Fire Island to Montauk Point (FIMP) Reformulation Study (USACE-NAN, 2005). Two of the 38 storms, Hurricane Irene (2011) and Hurricane Sandy, are recent events and were added specifically for the Rockaway Reformulation Study. The original 36 storms were selected for FIMP by evaluating the National Hurricane Center's (NHC) hurricane tracks database and NOAA water level measurements at Sandy Hook, NJ, Montauk, NY, and Newport, RI. All tropical storms from 1930 through 2001 whose track came within 500 nautical miles of Long Island were considered. Of these storms those with peak surges greater than 2.23 ft, at any of the three tidal stations were selected for storm surge modeling. The September 1954 hurricane was added because Harris (1963) reports a peak surge over 3.3 ft at Montauk.

All historical extratropical events from 1950 to 1998 with a peak surge greater than 3.3 ft at any of the three tidal stations was included in the extratropical storm training set. The storm suite includes 16 tropical events and 22 extratropical events. A complete list of the storm training set is shown in Table 2-1.

Table 2-1: Historical Storm Training Set

Storm	Hs (ft)	Tp (s)	Dir (deg TN)	Peak Surge (ft)	Tropical (T) or Extratropical (E)
1938-09-20	15.9	14	98	4.3	T
1944-09-12	13.7	14	97	4.9	T
1950-11-22	18.9	14	112	4.3	E
1953-11-04	14.6	14	106	3.2	E
1954-08-27	7.1	11	98	2.7	T
1954-09-09	7.9	14	97	1.6	T
1954-10-14	19.6	11	134	3.7	T
1955-08-08	16.3	11	120	1.8	T
1955-10-11	12.8	11	108	2.9	E
1956-09-25	7.4	14	97	1.7	E
1960-09-11	11.5	14	97	4.4	T
1961-09-19	9.6	14	96	1.4	T
1962-03-03	12.2	14	96	3	E
1971-08-27	16.1	11	140	3	T
1972-06-19	12.9	11	115	2.7	T

1976-08-08	12.7	11	103	3.3	T
1977-11-05	10.2	11	107	2.1	E
1978-01-17	7.1	11	97	2.4	E
1978-02-04	7.2	14	96	2.2	E
1979-01-22	13.6	11	128	2.3	E
1980-10-22	15.4	11	141	3.2	E
1984-03-26	9.7	14	96	3.5	E
1985-02-09	12.3	11	120	2.1	E
1985-09-26	13.9	11	135	6.6	T
1991-08-17	8.6	11	97	1.6	T
1991-10-27	8.4	14	96	2	E
1992-01-01	7.1	11	97	2	E
1992-12-08	13.8	14	98	3.9	E
1993-03-02	8.5	11	99	2.1	E
1993-03-09	12.7	11	151	3.2	E
1994-02-28	8.8	11	99	2.7	E
1994-12-21	3.9	11	96	1.8	E
1996-01-05	7.6	14	96	2.6	E
1996-10-07	4.9	9	97	1.5	E
1998-02-02	7.4	14	96	1.9	E
1999-09-15	10.7	9	112	2.7	T
2011-08-28	18.9	13.7	144	4.6	T
2012-10-29	22.8	14.6	137	9.8	T

2.2 Average Rate of Storm Occurrence

The original storm training set was developed based on tropical events from 1930 through 2001 and extratropical events from 1950 through 1998. Tide measurements at Sandy Hook, Montauk, and Newport were analyzed from 2000 through 2013 in order to adjust the average rate of storm occurrence. The storm surge at each station was calculated from the measured and predicted tide. All storm events that fall within the hurricane season (June 1 to Nov 30th) with a storm surge greater than 2.23 ft were identified as possible tropical events. Any storm events from Dec 1 to May 31 with a storm surge greater than 3.3 ft were identified as new extratropical events.

Potential tropical events were cross-referenced against records of past hurricane seasons to determine if the surge was the result of a tropical or extratropical disturbance. All but three of the possible tropical storm surge events were actually extratropical storms. In total three tropical

(Table 2-2) and nine extratropical (Table 2-3) events were identified from 2000 to 2013. Bringing the total number of tropical events from 1930 to 2013 (84 years) to 17, and the total number of extratropical events from 1950 to 2013 (64 years) to 31. The updated average rate of storm occurrence is 0.20 for tropical events, and 0.48 for extratropical events. It is noted that only Hurricane Irene and Sandy were included in the revised storm training set. However, the purpose of this analysis was to adjust the average rate of storm occurrence. The storm training set includes sufficient range of tropical storm and extratropical storm events. It was imperative to include Hurricane Sandy since it is the storm of record and may have a significant impact on the profile changes and storm damages calculated in the study.

Table 2-2: Tropical Events (2000 to 2013)

Date	Storm	Measured Peak Surge at Sandy Hook (feet)
2012-10-29	Hurricane Sandy	7.79[1]
2011-08-28	Hurricane Irene	4.50
2005-10-25	Hurricane Wilma	3.96

[1]Sensor failed, peak surge is estimated to be 9.8 ft

Table 2-3: Extratropical Events (2000 to 2013)

Date	Measured Peak Surge at Sandy Hook (feet)
2012-12-27	5.29
2010-03-14	4.40
2012-12-21	3.96
2009-12-09	3.88
2010-12-27	3.54[1]
2003-12-15	3.53
2007-02-14	3.36
2002-12-25	3.36[1]
2007-04-16	3.34

[1]Peak Surge measured at Montauk

2.3 Storm Suite Expansion for Beach-fx

The historical storm training set was expanded to the Beach-fx storm suite by assuming that the historical storm could have occurred at one of 12 possible tidal phase/range combinations. The storm surge for each of the storms in the historical training set was combined with three tidal ranges (spring, mean, and neap) and four different phases of the tidal cycle by aligning the peak surge with high tide, mean falling tide, low tide, or mean rising tide. As a result 12 different

hydrographs were generated for each storm in the training set, increasing the total number of storms in the Beach-fx storm suite to 456 (38 x 12).

An overview of the peak water level for all 456 events in the Beach-fx storm suite is provided in Figure 2-1. Each dot in Figure 2-1 represents one of the 456 storms in the storm suite and the solid black line represents the overall FEMA stage frequency curve offshore of Rockaway. It is apparent from the top and bottom panels that tropical storm events represent the most severe storm events, form a storm tide perspective. The largest extratropical storm only has a return period of less than 20 years. The majority of severe storm tide events are derived from Hurricane Sandy (blue dots). The largest of the storm events has a peak water level of 12.7 ft NAVD and a return period of 217 years.

It is important to recognize that factors other than the just the storm tide affect the magnitude of coastal erosion and potential damages. The wave height, wave period, and duration of the storm all also have a large impact on coastal erosion. The evaluation of combinations of variations to these inputs variables with the SBEACH model allows to assess the beach profile responses under varying storm conditions.

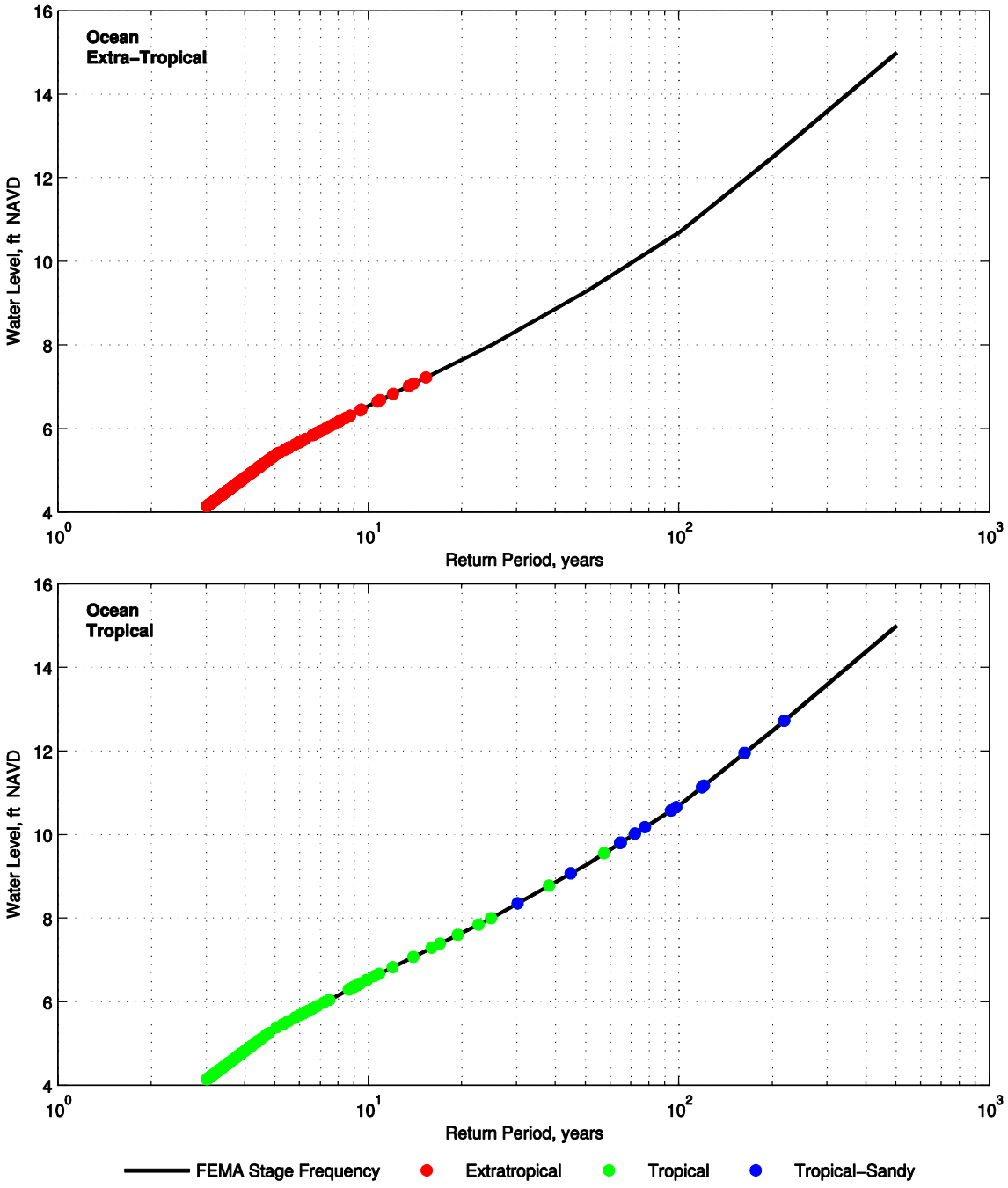


Figure 2-1: Historical Storm Suite – Ocean Stages

2.4 Determination of Equivalent Jamaica Bay Water Levels

Jamaica Bay flooding may be incorporated in Beach-fx based on a single peak Jamaica Bay water level during each storm event. Jamaica Bay water levels were estimated in this study by assuming that the return period of the peak water levels on the ocean-side and bay-side are the same for each

storm. In reality the bay-side and ocean-side return periods may differ for individual storm events due to timing of the storm and local wind patterns.

An example of how the equivalent Jamaica Bay water level is obtained from two storm events is presented in Figure 2-2. In this example the peak ocean water level of the two storms is 8 and 12 ft NAVD. The return period associated with these peak ocean water levels is 24 and 164 years. The equivalent peak bay water level, 7.8 and 10.5 ft NAVD, is obtained from the Jamaica Bay stage frequency curve for these two return periods.

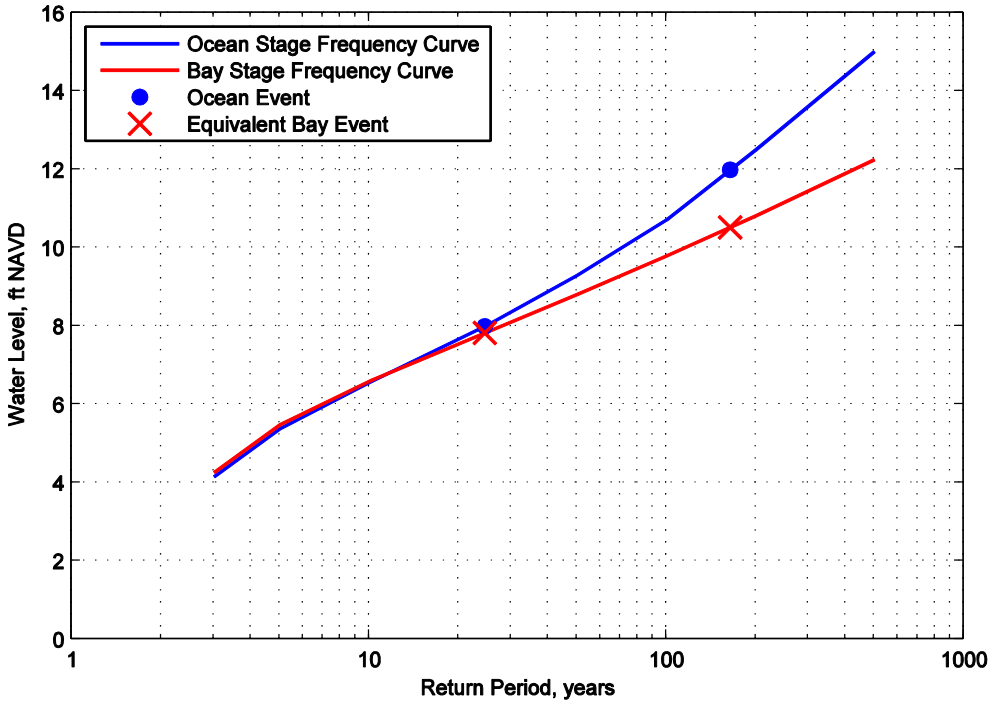


Figure 2-2: Example Showing How Peak Bay Water Levels are Determined

3.0 REGIONAL STORM SURGE AND WAVE MODELING

A comprehensive regional storm surge and wave modeling study was completed for the entire south shore of Long Island as part of the Fire Island to Montauk Point (FIMP) Reformulation study. The FIMP study provides the offshore storm tide and wave conditions for 36 of 38 storm events in the historical storm suite. The remaining two storms, Hurricanes Irene and Sandy, were based on observed storm tide and wave conditions. The regional storm surge and wave modeling results from FIMP are used here for Rockaway to define the conditions at Rockaway during the 36 historical storm events.

An overview of the FIMP modeling study is provided here, a complete description of the FIMP storm surge and wave modeling study is provided in the FIMP Baseline Conditions Report (USACE-NAN, 2005). Detailed wind and barometric pressure fields were developed by OCTI/Ocean Weather Inc. for each of the 36 historical storm events using either a Planetary Boundary Layer (PBL) model for tropical storm events or by Ocean Weather Inc.'s Interactive Kinematic Objective Analysis of publicly available wind fields from NOAA/NCEP Global Reanalysis Project (NRA). These wind and pressure fields were used to force the regional hydrodynamic and wave models. The FIMP study used the Advanced Circulation Model (ADCIRC) to model storm surge and the Wave Information Studies Wave Model (WISWAVE) to model wave conditions.

The ADCIRC and WISWAVE model domains encompassed nearly the entire eastern Atlantic Ocean and the entire east cost of the United States. Nesting or variable grid resolution was utilized by the models with finer resolution along the South Shore of Long Island. Modeling results from ADCIRC and WISWAVE provide time series of the wave conditions and storm tides offshore of Rockaway for the 36 historical storm events.

3.1 ADCIRC

Ocean and nearshore, outside the surf zone, storm water levels are simulated with ADCIRC Version 43.02 (ADvanced CIRculation model; Luettich et al., 1992). ADCIRC is a long-wave hydrodynamic numerical model that simulates water surface elevations and currents from astronomic tides, wind, and barometric pressure. ADCIRC solves the two-dimensional, depth-integrated momentum and continuity equations on a finite element grid in spherical coordinates.

3.2 Computational Grid

For the FIMP study, the numerical grid covers a large computational domain, spanning the northeastern Atlantic Ocean, to fully capture large-scale wind and pressure effects during storm events (Figure 3-1). In addition, the numerical grid has high resolution at inshore areas, such as the tidal inlets and bays, to fully capture the complexity of the hydrodynamics in these areas. The subaerial portions of the barrier islands are not included in the computational domain. Instead the shorelines are represented with shoreline boundary conditions. In total, the computational domain

includes 44329 nodes. Model bathymetry is based on several data sources. At the three FIMP tidal inlets and in Shinnecock Bay, recent high-resolution SHOALS LIDAR or multibeam survey data was used. In Moriches and Great South Bays and in the nearshore areas of FIMP, data from the GEODAS (GEOphysical DAta System) database, supplemented with data provided on NOAA charts, was employed. In all other areas, the bathymetry is based on that compiled for developing the East Coast 2001 Tidal Constituents Database (Mukai et al., 2002). This data set was developed using the ETOPO5, Digital Nautical Charts, and National Ocean Service raw sounding databases.

3.3 Model Forcing

The ADCIRC model is forced:

- On its offshore boundaries with astronomic tidal constituents from the ADCIRC East Coast 2001 Tidal Constituent Database for seven main tidal constituents (Mukai et al., 2002; Table 3-1).
- Throughout the computational domain with simulated wind and barometric pressure fields (see USACE-NAN 2005).

3.3.1 Model Setup

For each storm simulation, time series of simulated water level are output from the model every 6 minutes (real-time) at station 52 (Figure 3-2). Station 52 is used to force subsequent SBEACH and STWAVE simulations.

Table 3-1: ADCIRC Astronomic Tidal Constituents.

Tidal Constituent	NOAA Measured Amplitude (ft (m))	
	Sandy Hook, NJ (west of FIMP)	Montauk Fort Pond, NY (eastern FIMP)
M2	2.258 (0.688)	0.992 (0.302)
N2	0.518 (0.158)	0.260 (0.079)
S2	0.438 (0.134)	0.213 (0.065)
K2	0.126 (0.038)	0.061 (0.019)
K1	0.338 (0.103)	0.244 (0.074)
O1	0.176 (0.054)	0.176 (0.054)
Q1	0.037 (0.011)	0.049 (0.015)

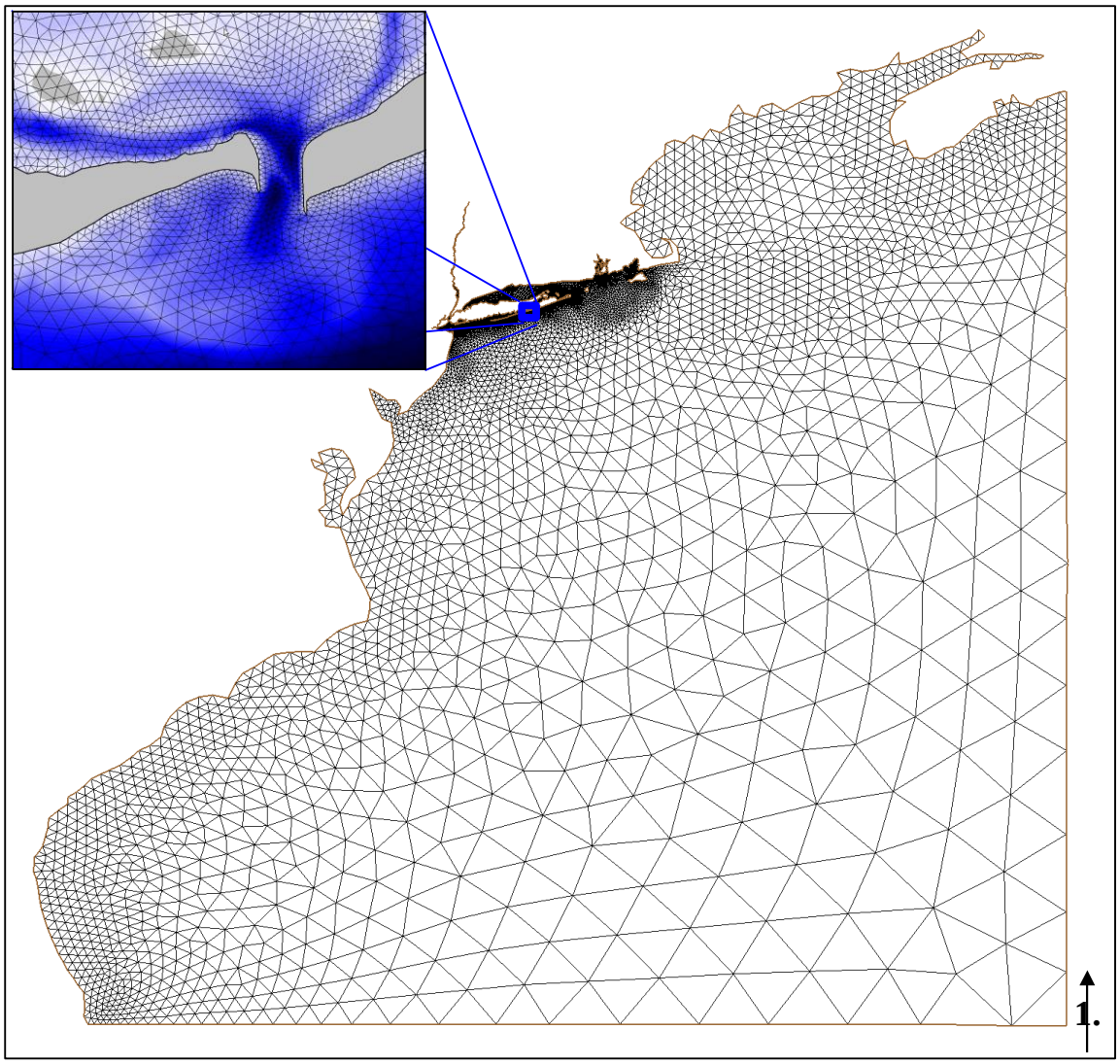


Figure 3-1: ADCIRC computational domain

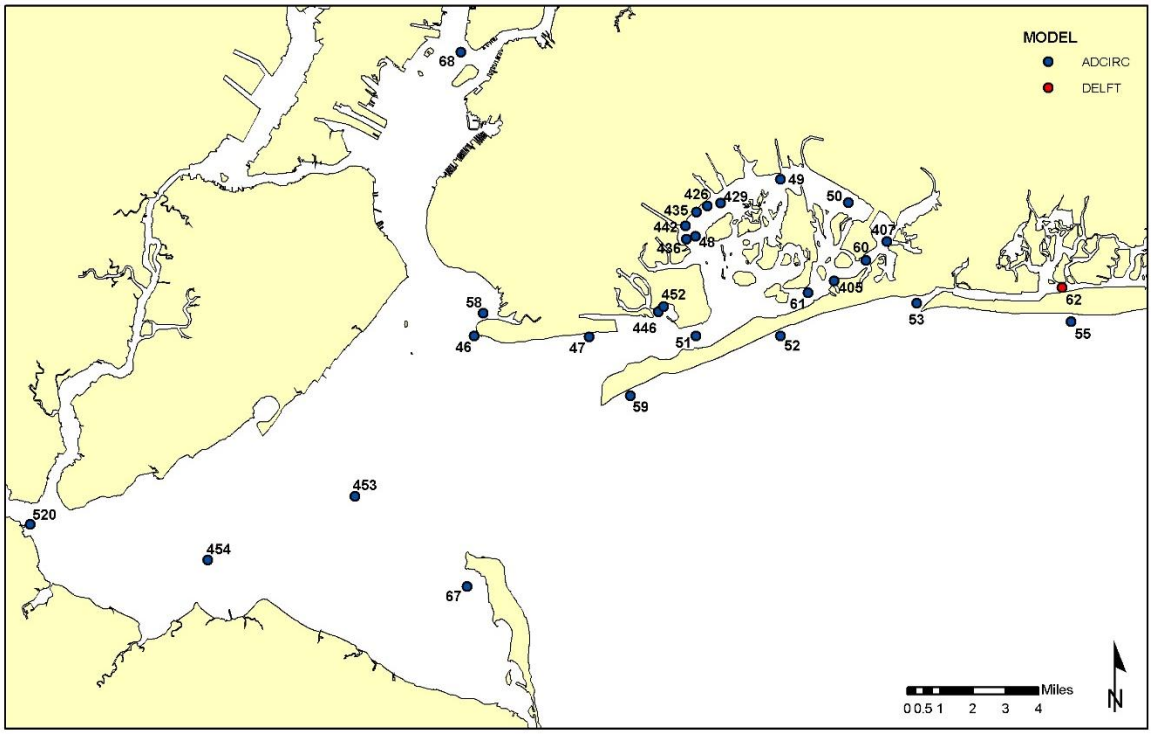


Figure 3-2: ADCIRC Storm water level output stations

3.4 WISWAVE

In an effort to determine extreme storm wave conditions during the training set of 36 storms (14 tropical and 22 extratropical), a directional spectral, temporally sensitive wave model WAVAD (also known as WISWAVE) was applied.

3.4.1 Model Input and Output Parameters

The wave model was driven by the wind fields developed for the wind hindcast, described in Chapter 2.5 of USACE-NAN (2005). The wind fields were interpolated onto the wave grid domains for each level of nesting. Input parameters for the model included the model time step, (30 seconds for the finest grid), the 15 wave frequencies over which the wave spectrum was computed (0.03 to 0.31 Hz with an increment of 0.02 Hz), and the discretization increment for the directional spectrum (22.5 degrees). Output included bulk parameters (zero-moment wave height, peak wave period, peak wave direction) and full two-dimensional wave spectra. Storm simulations were reported at output locations on an hourly basis.

3.4.2 Computational Grid

Open ocean bathymetry was obtained from NOAA nautical charts, with the New York Bight area resolved from chart 12300, "Approaches to New York" and from chart 12352, "Shinnecock Bay to East Rockaway Inlet." Five levels of nesting were used to generate the wave data for FIMP:

- A 1.0-degree grid extending from 50 degrees to 80 degrees west longitude and from 20 to 45 degrees north latitude.
- A 0.25-degree grid extending from 67.75 degrees to 74.25 degrees west longitude and from 36.75 to 42.25 degrees north latitude.
- A 0.08333-degree grid (5-min) extending from 69.50 degrees to 74.083 degrees west longitude and from 40.1666 to 41.3333 degrees north latitude (purple box in Figure 3-3).
- A 0.01667-degree (1-min) (approximately 1 nautical mile) grid extending from 70.750 degrees to 74.083 degrees west longitude and from 40.417 degrees to 41.000 degrees north latitude (red box in Figure 3-3).
- A 0.008333-degree (0.5-min) (approximately 0.5 nautical mile) grid extending from 72.08333 degrees to 73.5000 degrees west longitude and from 40.500 degrees to 40.833 degrees north latitude (green box in Figure 3-3).

The offshore wave forcing for STWAVE model simulations was extracted from station I07J04 in the 5 min resolution grid (purple box in Figure 3-3).

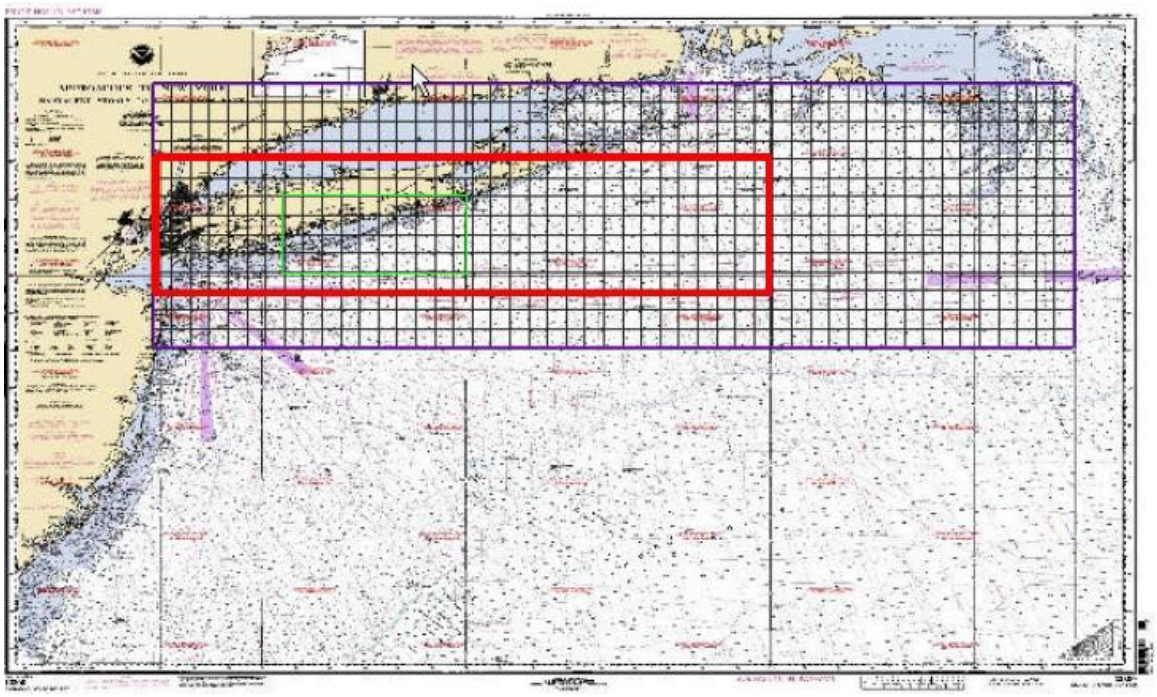


Figure 3-3: WISWAVE 5-min, 1-min, and 0.5 min model grid.

4.0 NEARSHORE WAVE MODELING

Two nearshore wave modeling studies were conducted for Rockaway. Prior to Hurricane Sandy STWAVE was used to determine the nearshore wave conditions at Rockaway during 36 of the 38 storms in the Historical Storm Suite. After Hurricane Sandy SWAN was used to determine the nearshore wave conditions during Hurricane Irene and Hurricane Sandy.

4.1 STWAVE

STWAVE modeling is required in this study to determine the nearshore wave conditions for each historical storm in the FIMP training set and to evaluate the impact excavating proposed borrow areas offshore of Rockaway have on nearshore wave conditions. STWAVE (Steady State spectral WAVE) is a phase-averaged spectral wave model appropriate for modeling wave transformation and wind wave generation in the nearshore (Smith, 2001). Here the full plane version, STWAVE-FP (Smith, 2007), is applied to simulate wave transformation and generation on the full 360-degree plane. The model accounts for the following physics: Linear wave refraction and shoaling over a bottom of variable depth; dissipation due to both depth and steepness induced wave breaking; dissipation due to bottom friction; wind-wave growth; non-linear wave-wave interactions and whitecapping. Wave-current interactions have not yet been implemented for STWAVE-FP. Since the model does not account for pure diffraction effects or wave-current interactions the wave field computed in the immediate vicinity of obstacles, harbors, and inlets will not be accurate.

STWAVE-FP is a finite difference model based on the wave action balance equation. STWAVE-FP computations are carried out on a rectangular grid. In STWAVE-FP the wave conditions must be homogenous along the offshore boundary. Wave conditions on the lateral boundaries can either be specified in the same way as the offshore boundary or determined from one-dimensional wave transformation along the boundary. Non-stationary conditions are simulated with STWAVE-FP by performing a steady state simulation at each time step. Such stationary wave computations are usually considered to be acceptable since the travel time of the waves from the seaward boundary to the coast is relatively small relative to the time scale of variations in the incoming wave field, the wind or tidal induced variations in depth and currents.

4.1.1 STWAVE Model Grid and Bathymetry

The STWAVE model grid extends from the western end of Coney Island to Jones Beach. From east to west it includes Coney Island, East Rockaway, Long Beach, and a portion of Jones Beach. The distance between the ocean shoreline and the offshore model boundary varies between 9 and 14 miles. However, the western lateral boundary is only 2.2 miles offshore of New Jersey. A Cartesian model grid is built with a constant grid resolution throughout the domain. The cross-shore resolution is (100 m) and the alongshore resolution is (200 m). Figure 4-1 shows the extent of the model grid and Figure 4-2 the resolution of the model grid. The model bathymetry was developed from a combination of offshore surveys, navigation charts, inlet surveys, and nearshore

beach profiles. Table 4-1 shows a list of the data sources used to create the model bathymetry. Figure 4-3 shows the model bathymetry constructed from these data sources. The depth at the offshore model boundary varies from (20.5 m) to (43.1 m). The datum of the model is NAVD88.

Table 4-1: STWAVE Bathymetric Data Sources

Data Source	Applied Region of Model
ACNYMP Beach Profiles (1996-2005)	Coney Island, Rockaway, Long Beach
NOAA Navigational Charts, Chart # 12327, 12350, 12352a, (2006-2009)	NY Harbor, Rockaway Inlet, Jones Inlet, Jones Beach
USGS Trackline Bathymetry from single beam echo sounder (1995-1998)	NY Bight Continental Shelf
USACE Single Beam Survey (2004)	East Rockaway Inlet

4.1.2 STWAVE Model Boundary Conditions

Boundary conditions for the historical storm training set simulations are developed from previous FIMP WISWAVE and ADCIRC modeling work (USACE-NAN, 2005). The WISWAVE model was driven by wind fields developed from a wind hindcast study. Bulk spectral parameters (zero-moment wave height, peak wave period, peak wave direction) are available from the WISWAVE model for the either the full 360° spectra or for a 160° banded spectra. The 160° banded spectra only contains wave energy propagating plus or minus 80° away from shore-normal. Since the offshore wave data will be transformed to nearshore, the WISWAVE model output derived from the 160° banded spectra was used to determine the nearshore wave conditions.

As noted earlier a limitation of STWAVE-FP is that the wave conditions along the offshore boundary must be homogenous. Comparison of the WISWAVE results along the offshore boundary suggests that the variation in the wave conditions along the offshore boundary is generally small. Therefore, WISWAVE results at I07J04 were used as input along the entire offshore boundary. The water depth at I07J04 is 23.3 m (NAVD88). The zero-moment wave height (Hs), peak wave period (Tp), and peak wave direction (θ) at I07J04 was used to create a TMA spectrum with a cosine power directional spreading distribution. The spectral grid consists of 30 wave frequencies (.04 Hz to .33 Hz with an increment of 0.01 HZ) and 72 directions (0° to 360° with an increment of 5°). The lateral boundaries are determined internally from one-dimensional (1-D) wave transformation along the boundary.

The water level (tide + storm surge) for the training set of storms is available from previous FIMP ADCIRC modeling (USACE-NAN, 2005). The water level for each STWAVE-FP steady state simulation can either be specified as a spatially varying or homogenous across the entire grid. Local wind wave generation is not included in the STWAVE-FP model, since the focus of this study is on wave conditions along Rockaway and locally generated waves are limited due to the

fetch. Bottom friction is also not included in the model since the dissipation from bottom frictions is negligible at this site. The offshore wave and water level conditions at the peak of the storm are shown in Table 2-1.

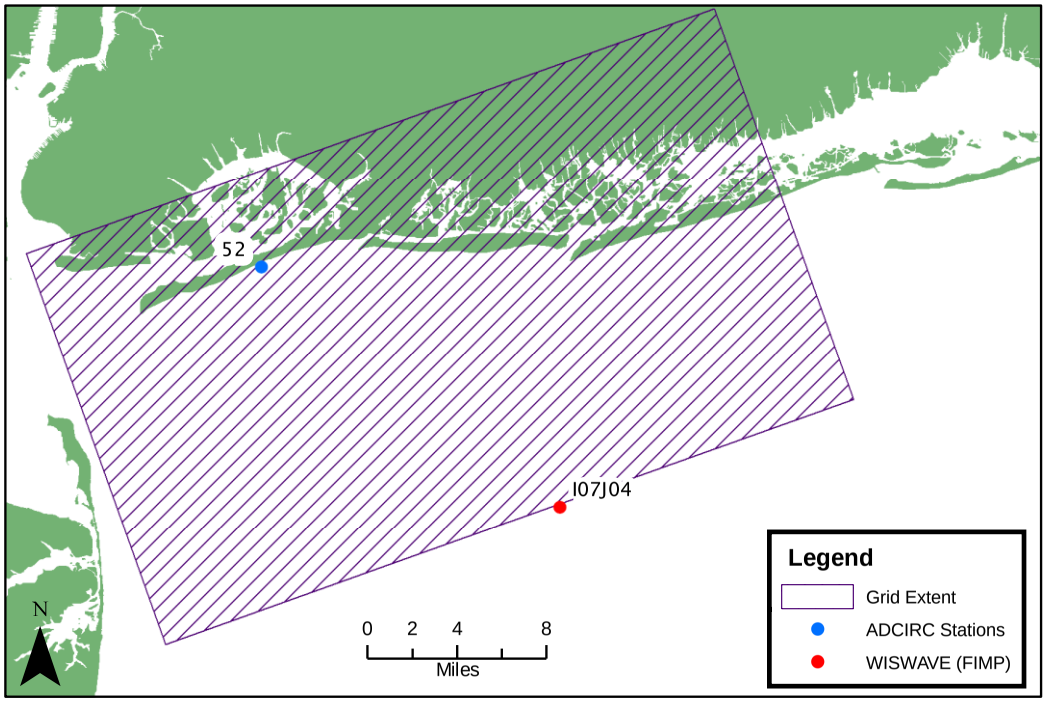


Figure 4-1: STWAVE Model Grid Extent

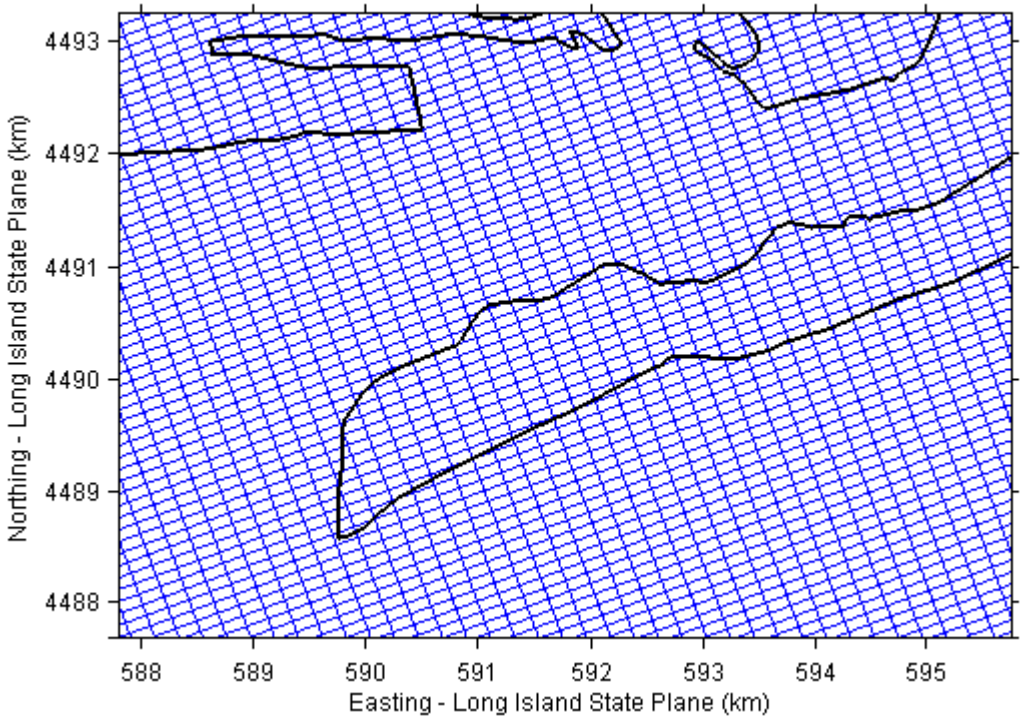


Figure 4-2: STWAVE Model Grid Resolution

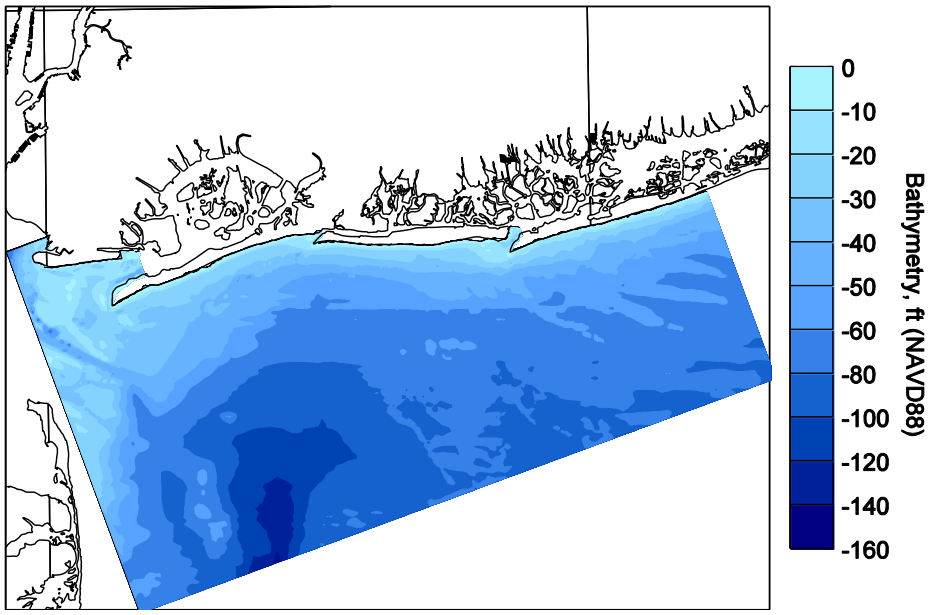


Figure 4-3: STWAVE Model Bathymetry

4.2 SWAN

Additional wave hindcast simulations were performed for Hurricanes Irene and Sandy using the spectral wave model SWAN. These model simulations were carried out several years after the 36 STWAVE hindcast simulations. SWAN, developed at Delft University of Technology in Netherlands, is a 3rd generation fully spectral (in all directions and frequencies) wave model based on the discrete spectral action balance equation. SWAN computes the evolution of random, short-crested waves in coastal regions with deep, intermediate and shallow water and ambient currents. SWAN includes wave generation (exponential wave growth by wind), wave propagation (shoaling and refraction), wave transformation (quadruplet and triad non-linear wave-wave interactions), and wave dissipation (wave breaking, whitecapping, and bottom friction). The SWAN model has successfully been validated and verified in several laboratory and complex field cases (Ris et al., 1999).

4.2.1 SWAN Model Grid

Four nested SWAN grids were used to simulate wave conditions offshore at NOAA NDBC Buoy 44025 to nearshore. The "Rockaway" model grid (shown in gold) is identical to the STWAVE model grid in extent, resolution, and bathymetry. The model bathymetry sources for the larger model domains are based on the NOAA Coastal Relief Model.

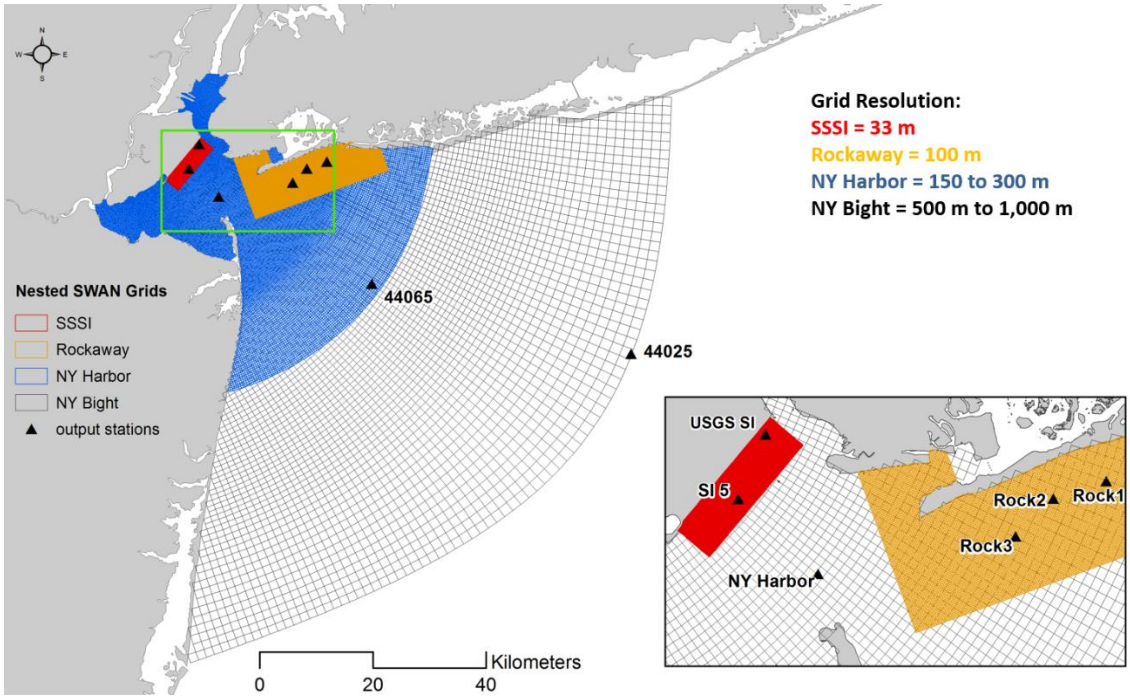


Figure 4-4: SWAN Model Grids

4.2.2 SWAN Model Boundary Conditions

SWAN boundary conditions for Hurricane's Sandy and Irene were obtained from NOAA NDBC Buoy 44025. Initially the model was force with the bulk wave parameters (H_s, T_p, MWD), however it became apparent that the bulk parameters were insufficient to achieve an acceptable model calibration (Figure 4-6). Instead, the model was forced with a directional frequency spectrum (1 hour time steps) from NDBC buoy. The frequency spectrum (energy in each frequency bin) is provided directly by NOAA (Figure 4-5), however the directional spectrum must be calculated based on the provided Longuet-Higgins Fourrier coefficients (r_1, r_2, α_1, α_2). Earle & Steele (1999) provide method to convert Longuet-Higgins Fourier coefficients to cross-spectral parameters (C11, C22, C33, C23, Q12, Q13). The cross-spectral parameters converted to a directional spectrum using the Maximum Likelihood Method (MLM) (Oltman-Shay and Guza, 1984).

During model calibration a shadow zone was also observed near Rockaway, which is attributed to the substantial wave energy being transported east, away from the boundary. This is a limitation of forcing the model with wave conditions at a single location. It is likely that the mean wave direction varies along the offshore boundary. To reduce the wave shadow zone the mean wave direction was set greater than or equal to 110 degrees for all frequency bins. Figure 4-7 shows a comparison of the model calibration using the raw direction spectrum vs. the adjusted direction spectrum.

A uniform wind field based on the observed data at NBDC buoy 40025 and uniform water levels based on a reconstructed water level time series at Sandy Hook are also applied in the SWAN simulations.

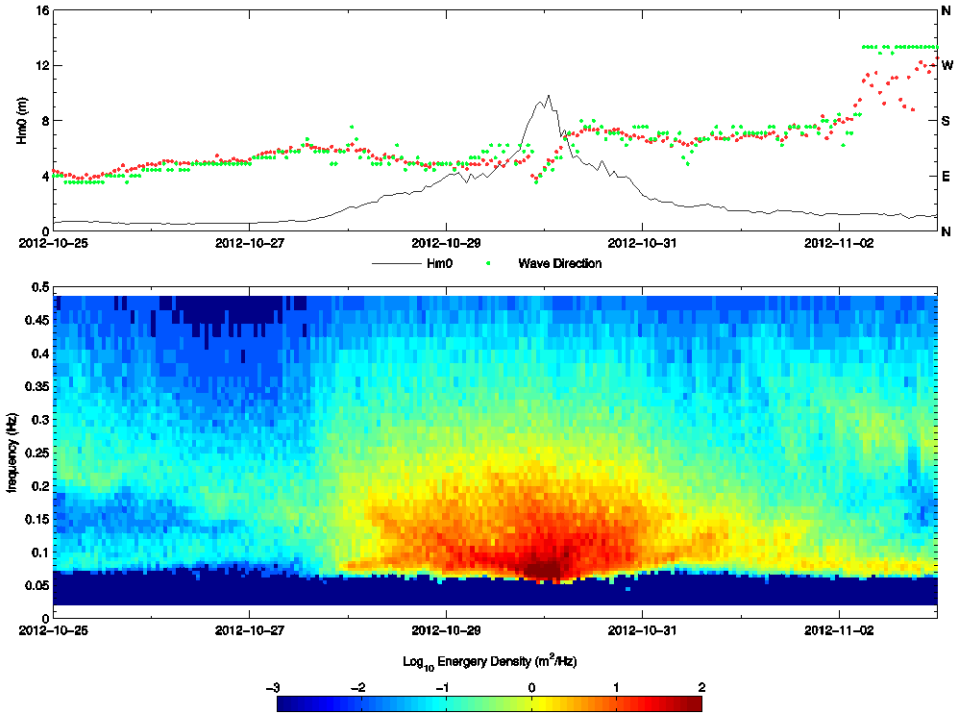


Figure 4-5: Spectrograph at NBDC 40025 during Hurricane Sandy

2013-10-29 01:00 UTC 2013-10-30 00:00 UTC

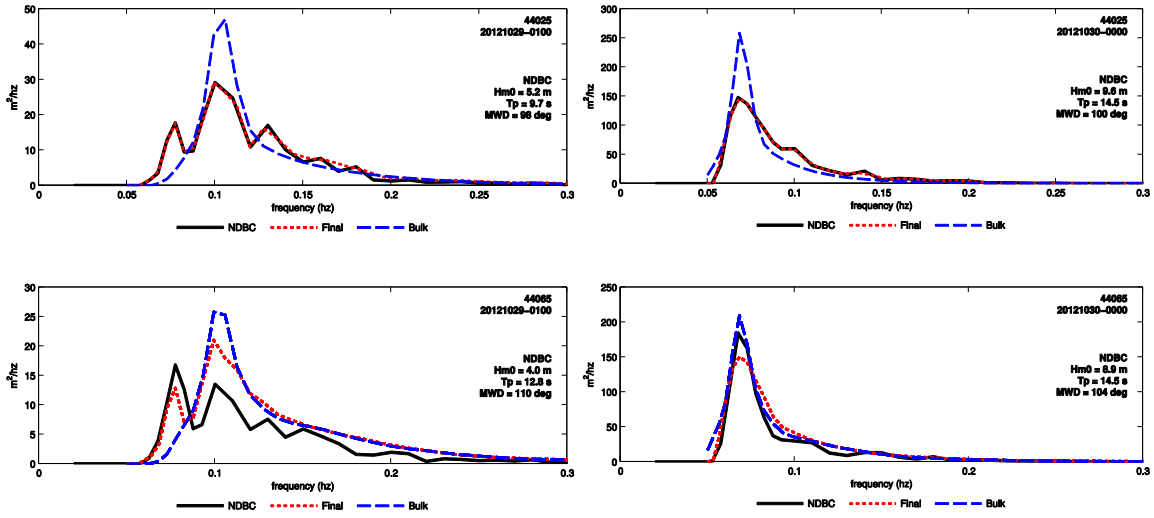


Figure 4-6: SWAN Model Sensitivity to Bulk vs. Spectral Boundaries

2013-10-29 20:00 UTC 2013-10-30 00:00 UTC

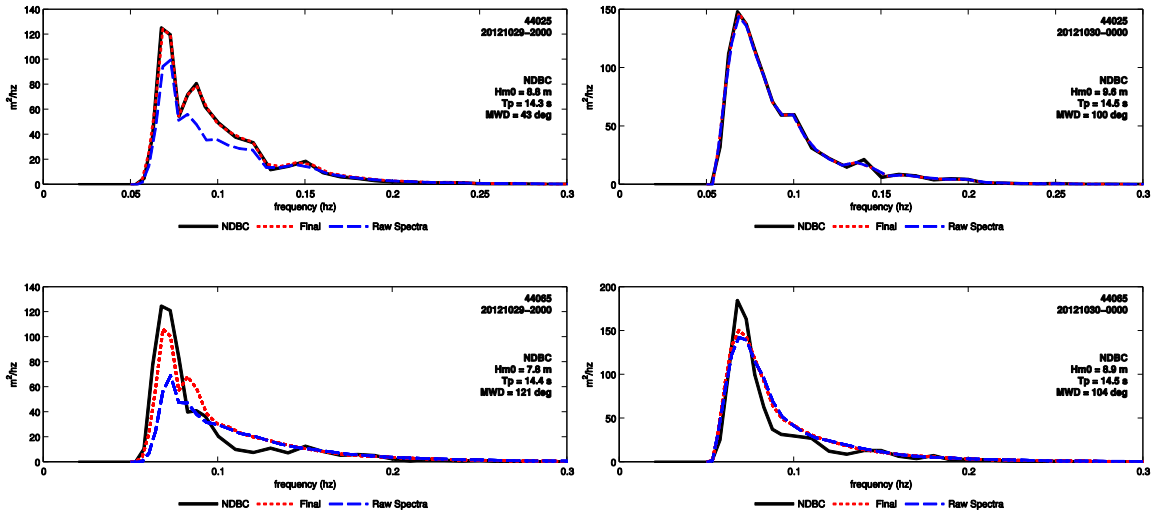


Figure 4-7: SWAN Model Sensitivity to Raw vs. Adjusted Spectrum Boundaries

4.2.3 SWAN Model Calibration

Site specific model calibration was performed to observations during Hurricane Sandy. NOAA NDBC buoys 44025 and 40065 and temporary USGS wave gauge SSI-NY-RIC-001WV. Model calibration at 44065 is excellent with good agreement in the wave height, peak wave period, and mean wave direction (Figure 4-8). A comparison of observed and modeled wave conditions at Staten Island (Figure 4-9) also indicate that the model is able to accurate predict the complex wave transformation processes all the way into New York Harbor. It is encouraging that the shape of the frequency spectrum at Staten Island is generally reproduced by the model, showing a bi-modal frequency spectrum with a combination of energy from sea (high-frequency) and swell (low-frequency) at the site.

An overview of the bulk wave parameters (significant wave height, peak wave period, and mean wave period) are shown in Figure 4-10. It is apparent that the waves lose energy, decrease in height, upon entering New York Harbor. Depth-induced wave breaking and energy dissipation from bottom friction are responsible for the decrease in energy, which is primarily associated with energy in the low-frequency portion of the spectrum. As a result, the mean wave period drops significantly upon entering the harbor. However, in much of the Harbor the peak wave period is still associated with the ocean swell since the energy in the low-frequency bins is more concentrated than in the higher-frequency bins.

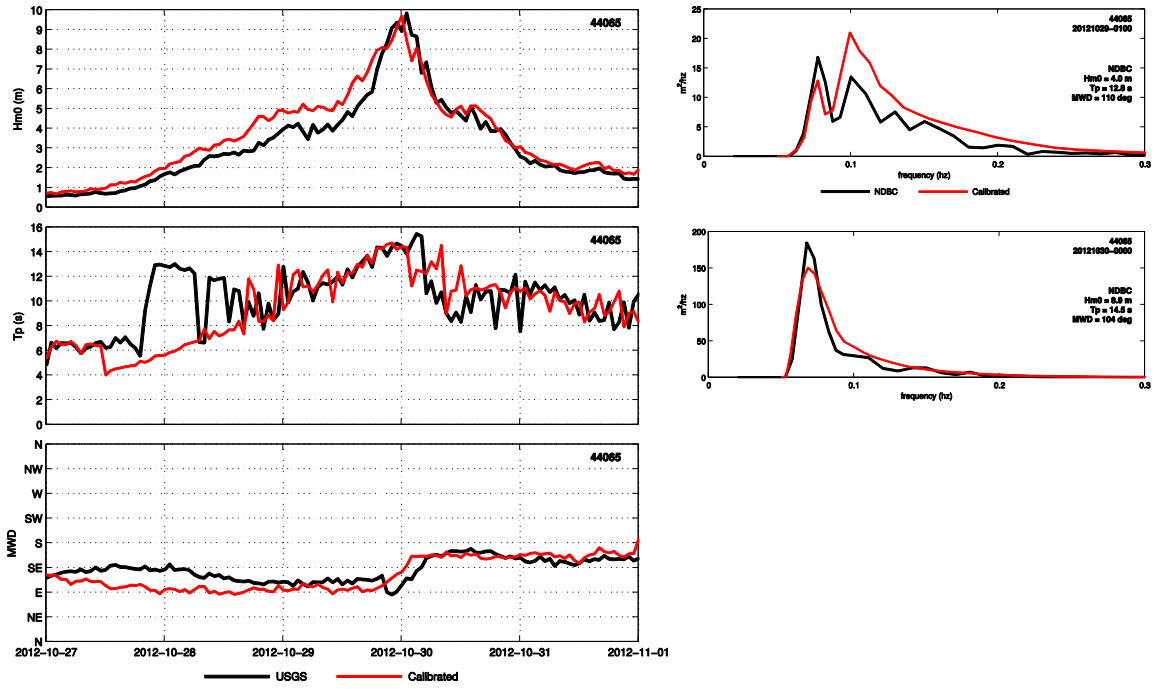


Figure 4-8: SWAN Calibration at 44065

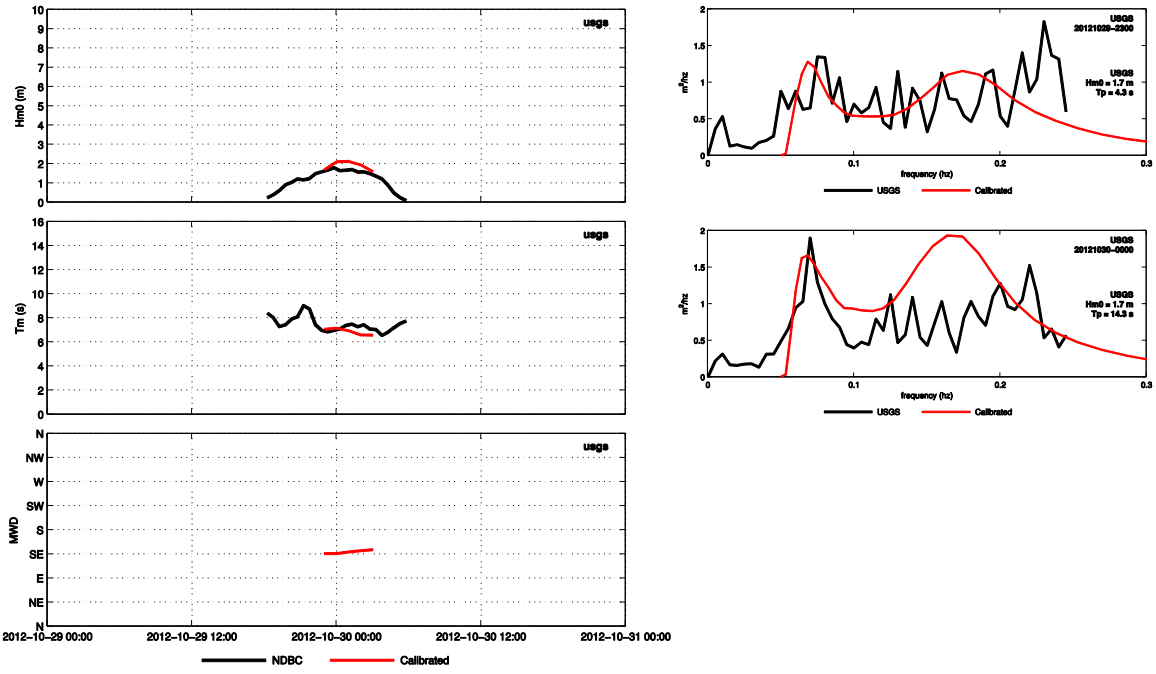


Figure 4-9: SWAN Calibration at SSI-NY-RIC-001WV

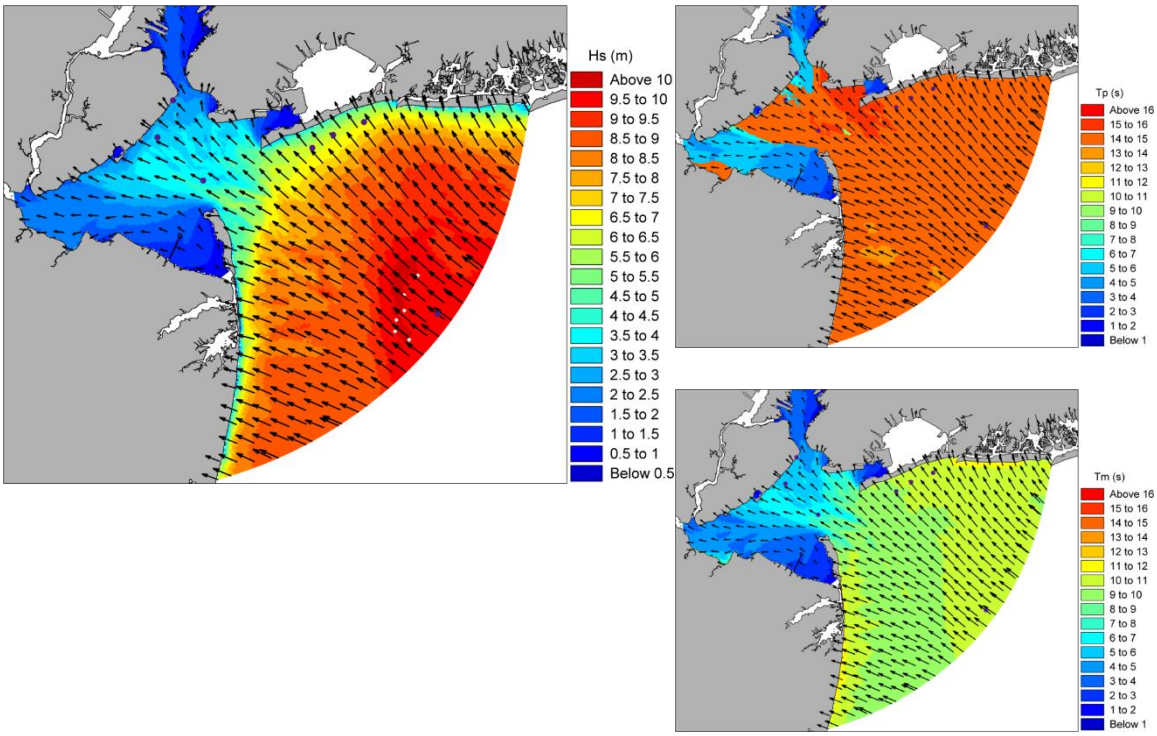


Figure 4-10: SWAN Model Results for Hurricane Sandy (2013-10-30 00:00 UTC)

5.0 STORM-INDUCED MODELING (SBEACH)

5.1 SBEACH Overview

Storm induced profile changes were investigated for the project area using the Storm-Induced Beach Chance Model (SBEACH). SBEACH is a one-dimensional model, developed by the United States Army Corps of Engineers (USACE), which simulates cross-shore erosion of beaches, berms, and dunes under storm water levels and waves. A basic assumption of SBEACH is that all profile change is produced by cross-shore processes, with no net gain or loss of sediment. This is only true if longshore sediment transport processes are uniform, which is typical considered a reasonable assumption during storm events on open coasts away from inlets and structures. Long-term morphologic changes (e.g. shoreline erosion) are typically controlled by longshore sediment processes, which are not simulated by SBEACH. The SBEACH model calculates beach profile change using an empirical morphologic approach with emphasis on beach and dune erosion. In model simulations, the beach profile progresses to an equilibrium state based on the initial profile, median grain size, and storm conditions (wave height, wave period, wave condition, wind speed and direction, and water level). The model also simulates overwash and dune lowering.

SBEACH is primarily used in this study to build the Beach-fx Storm Response Database (SRD). The SRD is a lookup table that stores the morphological profile responses (i.e. change in berm width and dune width/height) and damage driving parameters (i.e. wave height, water level, and vertical erosion). The SRD is based on approximately half a million SBEACH simulations for a range or possible beach profile configurations and storm conditions.

SBEACH modeling results are also used in combination with the multivariate Empirical Simulation Technique (EST) to screen potential beach and seawall design alternatives and characterize their performance (further detailed Section 6).

5.2 SBEACH Model Calibration

Calibration of the SBEACH model was performed for East Rockaway using available profile storm response data. Model calibration was performed to determine the optimal model settings for the project region and evaluate the models ability to reproduce observed profile changes following a storm event. Model settings obtained through the calibration will be used in both existing and project conditions model runs. Since the intended purpose of the SBEACH modeling is to create a storm response database for Beach-fx, which simulates the morphological evolution of the dry beach, emphasis during the calibration was placed on simulating observed changes in the dry beach.

The only available set of beach profiles on East Rockaway measured closely before and after a major storm event is the Hurricane Belle and Hurricane Emmy set, obtained in June 1976 and September 1-4, 1976. In-between these surveys two major Hurricanes occurred causing significant

beach erosion. Therefore, calibration and verification of the SBEACH model parameters were made to this data set.

5.2.1 Available Data

Required input data for calibration of SBEACH include pre- and post-storm beach profiles, time histories of wave height, wave period, wave direction, and water levels. The only data set that fulfills these requirements is the Hurricane Belle and Emmy data set. At its peak strength Hurricane Belle was a category 3 hurricane with 120 mph winds. On August 10th, 1976 Hurricane Belle made landfall near Jones Beach, NY as a category 1 hurricane with winds of 75 mph. Figure 5-1 shows the path and storm history of Hurricane Belle. Storm surges along Rockaway Beach have been modeled to be in excess of 3 ft NGVD29[1] with nearshore wave heights peaking at 15 ft (USACE-NAN, 2005). In contrast to Hurricane Belle, Hurricane Emmy never came to the Atlantic shoreline, and as a result did not produce any significant storm surge at Rockaway. However, very large long period waves persisted at Rockaway from August 29th through August 31st. WISWAVE hindcast indicate wave heights in excess of 15 ft with wave periods of 17 s occurred offshore of Rockaway during Hurricane Emmy (Jensen, 1983).

Previous modeling efforts completed as part of FIMP were used to provide the storm inputs during Hurricane Belle. However, the FIMP model simulations were only carried out for the duration of the Hurricane Belle and had to be supplemented with other modeling studies to create the storm inputs for Hurricane Emmy. Since beach profile response is controlled by storm events, SBEACH was calibrated to the two storm events instead of simulating the entire time span between surveys.

Storm inputs at Rockaway Beach during Hurricane Belle were obtained from previous modeling efforts completed as part of FIMP study (USACE-NAN, 2005). Water level time series (including storm surge) were obtained from the ADCIRC modeling results. Time series of the water level at station 52, located just offshore of the center of Rockaway Beach, were extracted from the ADCIRC modeling results. Time series of the offshore significant wave height, wave period, and wave direction were obtained from WISWAVE model results at station I05J04.

Storm inputs for Hurricane Emmy were obtained from historical WISWAVE model simulations carried out by the USACE (Jensen, 1983) and a combination of tidal harmonics obtained from the FIMP ADCIRC modeling results at station 52 and the observed water surface elevations at NOAA tidal Station, Sandy Hook, NJ. Figure 5-2 shows the location of the ADCIRC station 52,

[1] Please note that all SBEACH model simulations and analyses presented within Section 5 were performed using the NGVD29 Datum. A value of 1.1ft should be subtracted from the NGVD29 value to obtain elevations in the NAVD88 datum.

WISWAVE station I05J04, WISWAVE station 73, and the NOAA tidal station at Sandy Hook which were used to generate the storm time series at Rockaway Beach.

The offshore wave height and wave direction for both the FIMP and historical WISWAVE model results were transformed from offshore to a nearshore water depth of 30 ft using linear wave theory and assuming straight and parallel contours. Figure 5-3 shows the wave conditions (i.e. significant wave height, wave period, and water level) at -30 ft (NGVD29) contour offshore of Rockaway during the time between surveys. Figure 5-4 shows the storm inputs for Hurricane Belle and Hurricane Emmy used to calibrate SBEACH.

Pre and post storm beach profiles were measured along the center of Rockaway Beach in June of 1976 and August 31st to September 4th of 1976 respectively. Each of the pre and post profiles were surveyed at the same base station allowing easy comparison. Figure 5-5 shows the profile origins for the pre and post storm surveys. The comparison shows that there was a net increase in volume (above -25 ft NGVD29[2] contour) in all of the profiles. It is probable that the accretion between surveys is related to the large Federal Nourishment project that placed over 3.5 million cubic yards (MCY) of sand east of the calibration profiles (USACE-NAN records). During Hurricane Belle and Hurricane Emmy the waves were propagating from the E-SE resulting in a westward current and westward sediment transport along Rockaway Beach. Therefore, it is possible that a large portion of the beach fill placed east of the calibration profiles was transported westward into the calibration profiles during the storm. Figure 5-6 and Figure 5-7 show the pre and post profiles at a location exhibiting a large increase in volume (Profile 24) and a relatively small increase in volume (Profile 28) between pre and post surveys. The total volumetric increase, above -25 ft contour (NGVD29[2]), between each pre and post profile is shown in Table 5-1. Volumetric increases ranged from 3.4% to 17% and in general the western profiles exhibited more accretion than the eastern profiles. Note that an increase in volume was observed at all the profiles.

The large volumetric increases between pre and post surveys indicate that longshore sediment transport processes played an important role in-between survey dates. Therefore, caution must be taken when attempting to calibrate and validate SBEACH which only simulates cross-shore sediment transport processes. Emphasis is placed here on simulating observed changes in the dry beach profile where cross-shore processes are dominant.

[2] Please note that all SBEACH model simulations and analyses presented within Section 5 were performed using the NGVD29 Datum. A value of 1.1ft should be subtracted from the NGVD29 value to obtain elevations in the NAVD88 datum.

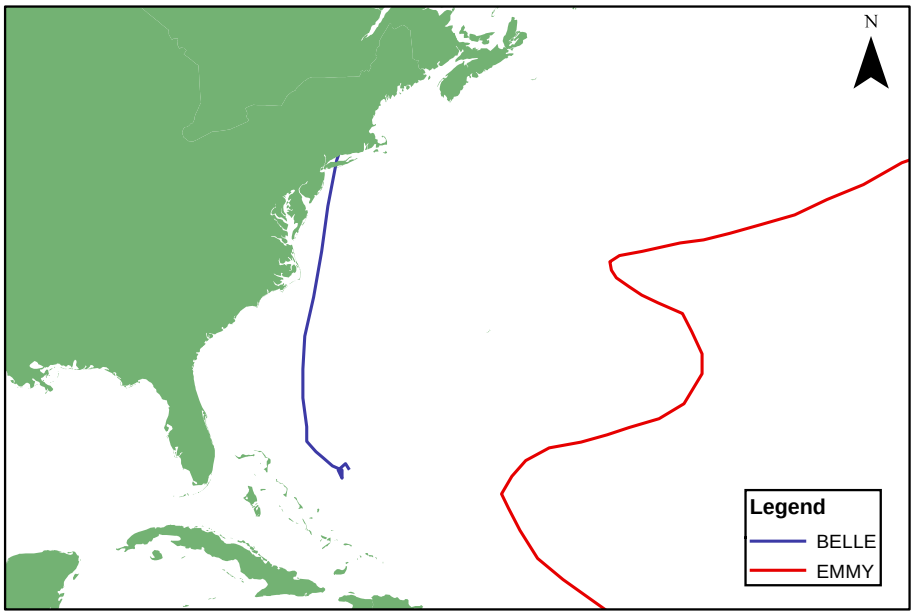


Figure 5-1: Hurricane Belle and Emmy Storm Tracks

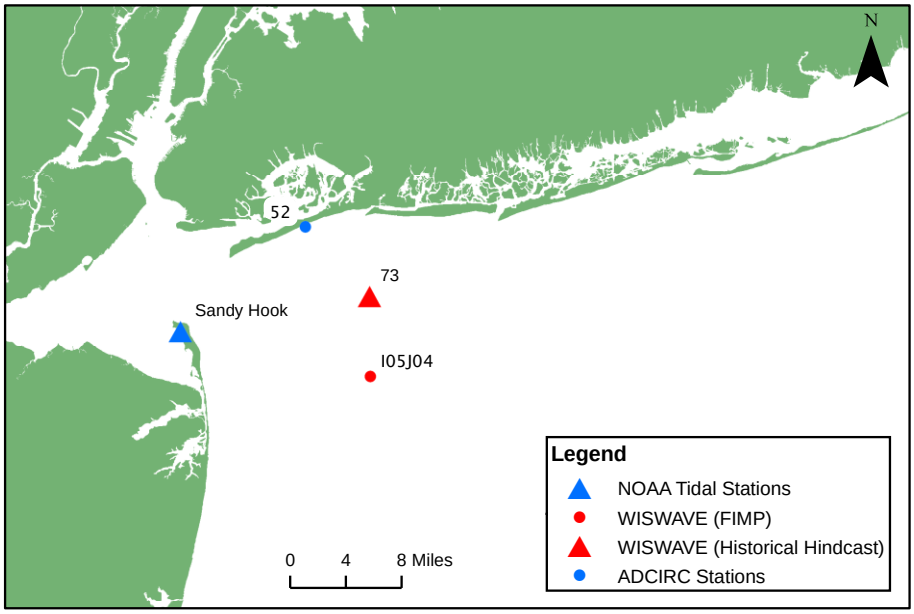


Figure 5-2: ADCIRC station 52, FIMP WISWAVE station I05J04, WISWAVE (Historical Hindcast) station 73, and the NOAA tidal station at Sandy Hook were used to generate the storm time series for Calibration at Rockaway Beach

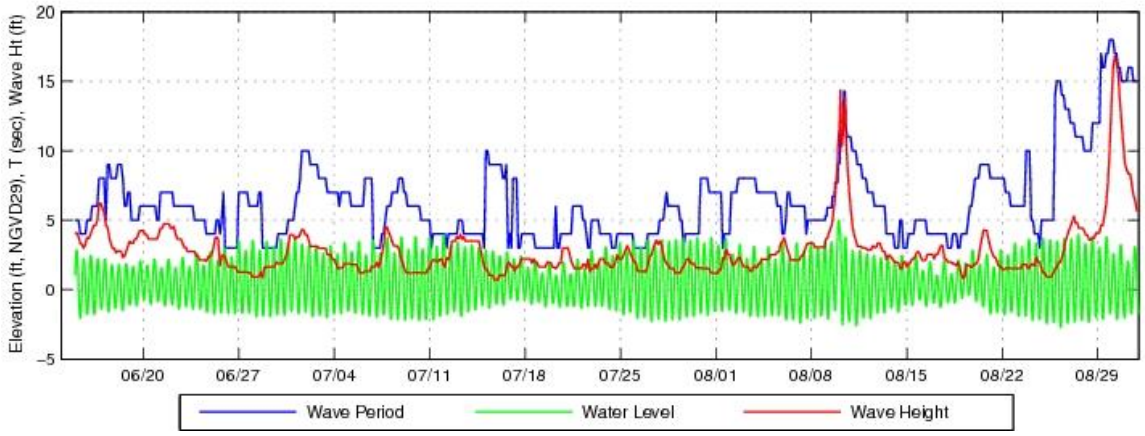


Figure 5-3: Observed Wave Conditions between Profile Surveys

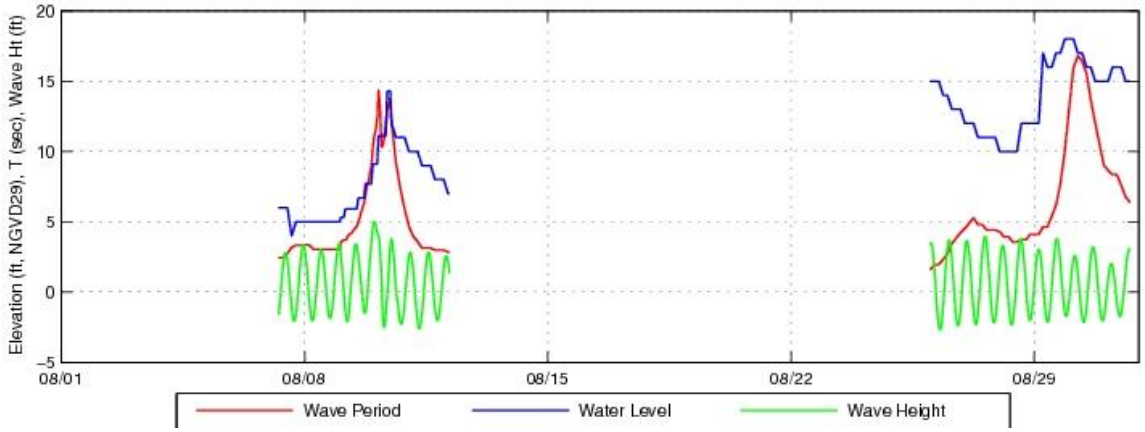


Figure 5-4: Modeled Wave Conditions for Calibration

Figure 5-5: Profile Origins for SBEACH Model Calibration

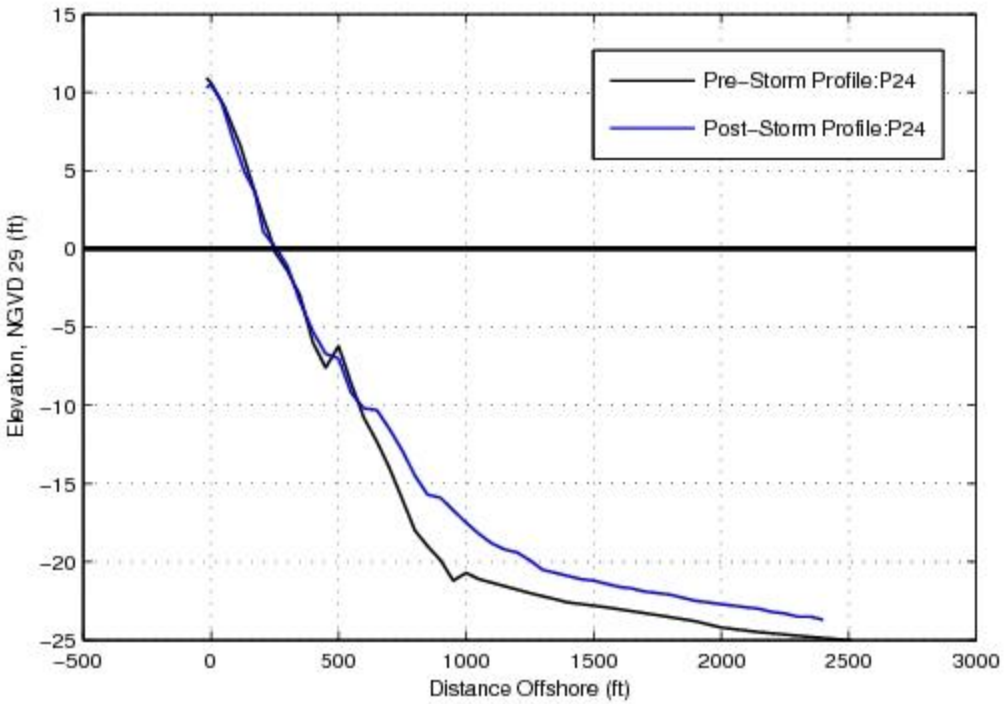


Figure 5-6: Pre and Post Storm Profile 24

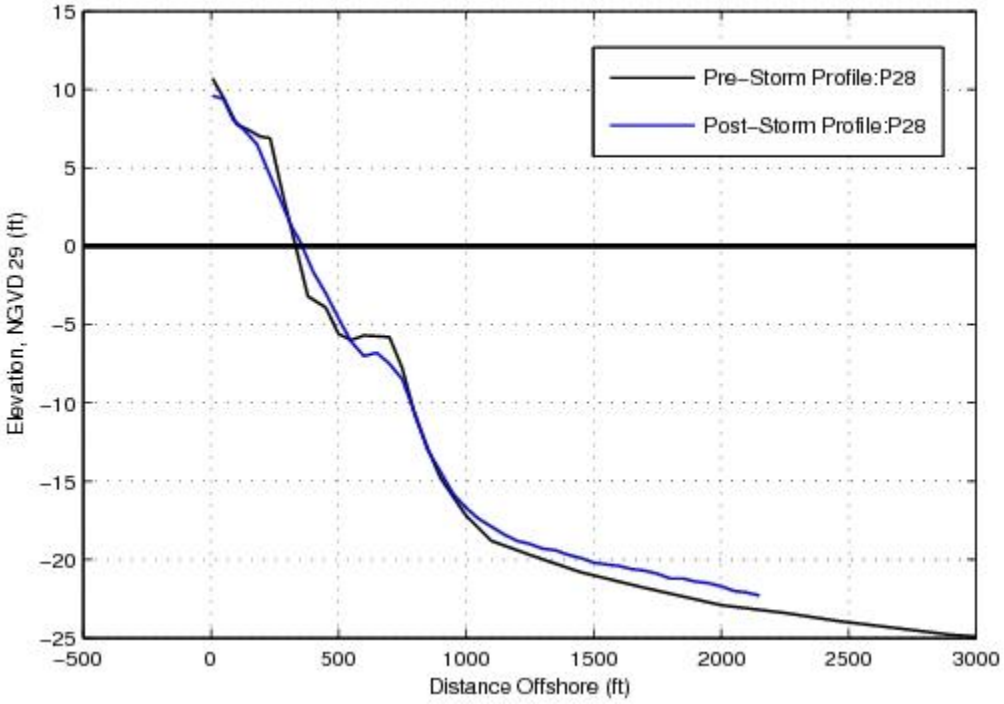


Figure 5-7: Pre and Post Storm Profile 28

Table 5-1: Differences between Pre and Post Storm Profiles

Profile	Pre Volume (CY/ft)	Post Volume (CY/ft)	Difference (CY/ft)	% Difference
P-19	876	973	97	11.1%
P-20-21	810	900	90	11.2%
P-21-22	846	905	58	6.9%
P-23	828	879	51	6.2%
P-24	762	891	129	17.0%
P-25	835	961	126	15.2%
P-26	800	889	89	11.2%
P-27	854	909	56	6.5%
P-28	946	978	32	3.4%
P-29	985	1078	94	9.5%
P-30	1045	1123	78	7.5%
P-31	826	879	53	6.4%

Note: All Post profiles experienced an increase in Volume. All volumes were measured from the -25 ft NGVD29 contour (-26.1 ft NAVD88).

5.2.2 Calibration Procedure and Results

SBEACH calibration parameters include the sediment transport rate coefficient (K), coefficient for slope-dependent transport term (EPS) and depth of foreshore (DFS). The primary calibration parameter is K which controls the rate of erosion. The slope-dependent transport term controls the impact local gradients in the profile have on the transport rate. Higher values of EPS will result in a more peaked bar and a flatter inner surf zone. The depth of foreshore defines the transition between the surf zone and swash zone and influences the magnitude of transport occurring in the swash zone.

Other parameters that are site dependent and need to be specified in SBEACH are the mean sediment grain size (μ), maximum slope prior to avalanching (BMAX), and water temperature (T). The mean sediment grain size was determined to be 0.29 mm from sediment analysis performed by USACE-NAN. The typical water temperature in the summer is 22ºC, and the maximum slope prior to avalanching is set to 30º.

For each SBEACH calibration simulation a uniform grid with a grid spacing of 5 ft was setup across the profile and simulation time step of 1 minute is used. Simulations were performed initially for both the default SBEACH parameters and the previously determined calibration parameters for FIMP. An additional 2 calibration scenarios were run to try and achieve a better calibration. Table 5-2 shows the parameters used in the calibration scenarios. The Default and FIMP calibration scenarios are nearly the same, except a higher value of EPS in the FIMP

parameters. In the remaining calibration scenarios EPS and K were reduced to try and obtain better agreement between observed and modeled morphologic response. The calibration results at 5 profiles, Profile 20-21, Profile 24, Profile 27, Profile 28, and Profile 31 are analyzed here. The 5 profiles exhibited both large and small amounts of volumetric accretion between surveys.

Quantification of the model results were obtained by comparing three erosion parameters calculated for the dry profile. The three parameters selected are: volume change above 0 NGVD29, recession of the Mean-High-Water (MHW) contour, and storm intrusion defined by the distance from the profile origin to the landward most occurrence of a given amount of vertical profile change (1 ft). These are the same parameters used by Gravens et al. (1999) to evaluate the calibration results for FIMP. Table 5-3 presents the results from the quantitative analysis for all 5 profiles. Figure 5-8 to Figure 5-12 show the modeling results for the calibration scenarios.

It is apparent in Profile 20-21 (Figure 5-8) that SBEACH reproduces erosion of the dry profile and redistribution of the eroded sediment over the submerged profile. Table 5-3 shows that each calibration scenario for Profile 20-21 over predicts the volumetric erosion of the dry beach, landward storm intrusion, and recession of the MHW line. It is also apparent in Table 5-3 that reducing K and/or EPS result in less dry beach erosion. Comparison of the submerged portion of Profile 20-21 shows that the model is not reproducing the gentle slope in surfzone and the significant accretion observed across the entire profile. Since SBEACH only simulates cross shore processes and is incapable of simulating volumetric increases resulting for longshore processes. The observed gentler slope in the surfzone is characteristic of all the profiles and could be caused by the introduction of finer sediment into the submerged profile from erosion of the dry beach or longshore transport of the nourished sediment. However, the general shape and slope of the modeled post-storm submerged profile is similar to the observed post-storm profile and in both instances the sediment in the bar has been redistributed offshore. The results at Profile 20-21 are characteristic of the calibration, and it is possible that SBEACH is over predicting dry beach erosion because the model does not include longshore processes. Volumetric accretion, as observed in all the profiles causes more dissipation of wave energy offshore and leads to less erosion of the dry beach. Therefore, a slight over prediction in dry beach erosion is anticipated in the model.

In contrast to Profile 20-21, Profile 24 experienced very little volumetric dry beach erosion (Figure 5-9). The model over predicts the volumetric dry beach erosion, and recession of the MHW. However, it accurately predicts the limit of landward storm intrusion.

The model results for Profiles 27, 28, and 31 are similar to Profile 20-21 and Profile 24, where the volumetric dry beach erosion and recession of the MHW are over predicted (Figure 5-10 to Figure 5-12). In all 3 profiles SBEACH accurately simulates erosion of the dry beach and redistributes the sediment in the bar offshore.

Generally the model produces a steeper dry beach, and greater erosion. The over estimation of dry beach erosion in the model is attributed to longshore processes not modeled in SBEACH. Of the four calibration scenarios, scenario 4 produced the best results. Scenario 4 still over estimated dry beach erosion but by reducing K and EPS the gap between the observed and modeled erosion is reduced. Therefore, the model parameters in Calibration 4 will be used in both existing and project conditions model runs. The level of calibration obtained in this study using is comparable to the FIMP calibration (Gravens et al., 1999).

Table 5-2: SBEACH Calibration Scenarios

Scenario	K (m^4/N)	EPS (m^2/s)	DFS (ft)	Grain Size(mm)	T (°C)	BMAX (°)
Cal-1	1.75E-06	0.003	0.91	0.29	22	30
Cal-2	1.75E-06	0.002	0.91	0.29	22	30
Cal-3	1.75E-06	0.0015	0.91	0.29	22	30
Cal-4	1.00E-06	0.0015	0.91	0.29	22	30

Notes: Cal-1 uses the FIMP calibration values for K and EPS. Cal-2 uses the default SBEACH calibration values for K and EPS

Table 5-3: SBEACH Erosion Parameters for Profile 20-21

Erosion Parameter	Observed	Cal-1	Cal-2	Cal-3	Cal-4
Profile 20-21					
Volume Change above 0 NGVD29 (CY/ft)	-266	-557	-481	-437	-352
Recession of MHW (ft)	-13	-56	-48	-42	-34
Limit of Landward Storm Intrusion (ft)	47	54	60	65	75
Profile 24					
Volume Change above 0 NGVD29 (CY/ft)	-12	-52	-43	-38	-29
Recession of MHW (ft)	-3	-53	-45	-40	-32
Limit of Landward Storm Intrusion (ft)	79	59	67	72	81
Profile 27					
Volume Change above 0 NGVD29 (CY/ft)	-16	-36	-29	-26	-23
Recession of MHW (ft)	-14	-52	-45	-41	-38
Limit of Landward Storm Intrusion (ft)	1	15	1	1	1
Profile 28					
Volume Change above 0 NGVD29 (CY/ft)	-23	-40	-34	-30	-27
Recession of MHW (ft)	-17	-46	-39	-35	-31
Limit of Landward Storm Intrusion (ft)	168	149	161	168	172
Profile 31					
Volume Change above 0 NGVD29 (CY/ft)	-22	-50	-42	-38	-30

Recession of MHW (ft)	-12	-42	-34	-30	-24
Limit of Landward Storm Intrusion (ft)	131	137	142	145	151

Note: A value of 1.1ft should be subtracted from the NGVD29 value to obtain elevations in the NAVD88 datum.

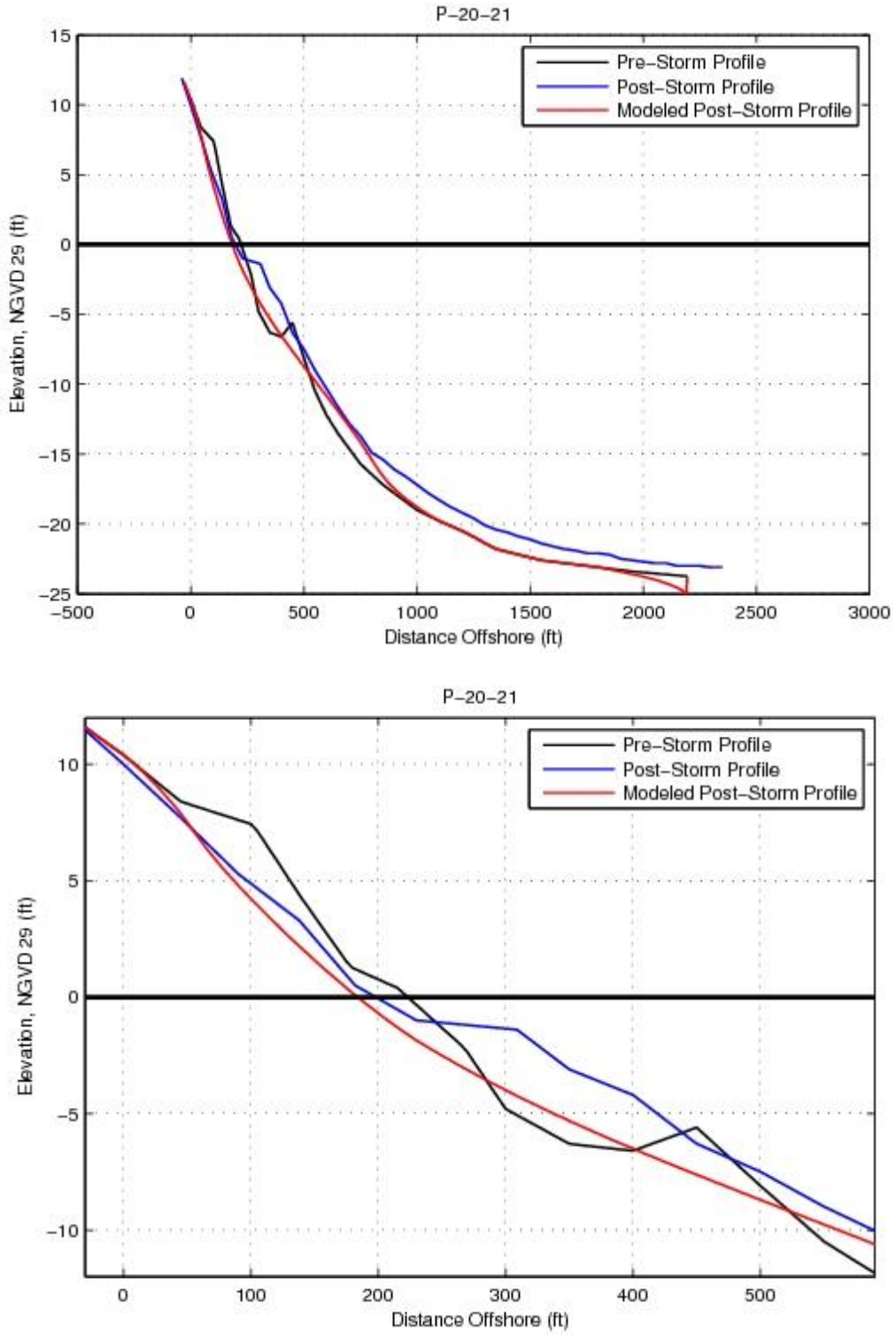


Figure 5-8: SBEACH Calibration results at Profile 20-21

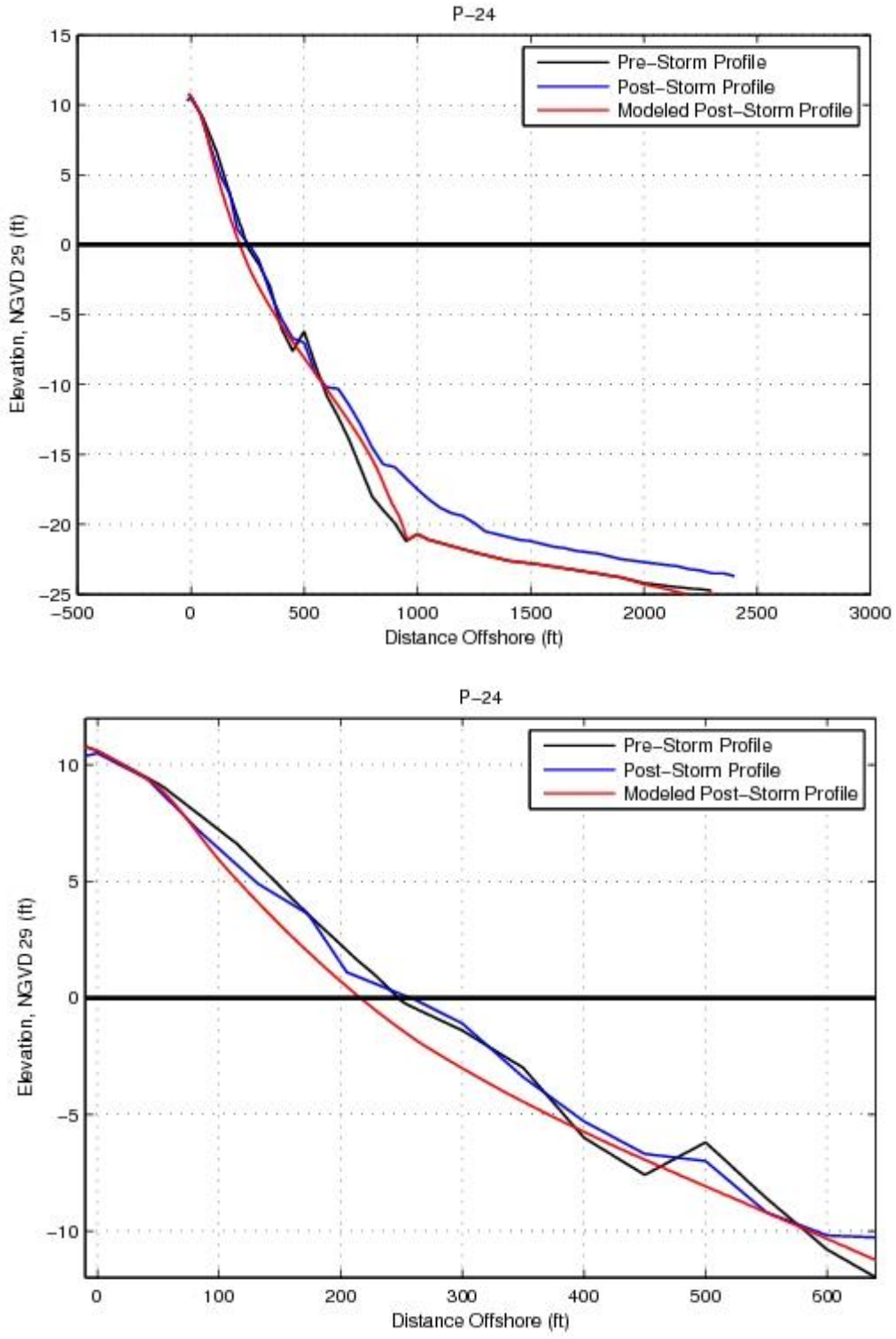


Figure 5-9: SBEACH Calibration results at Profile 24

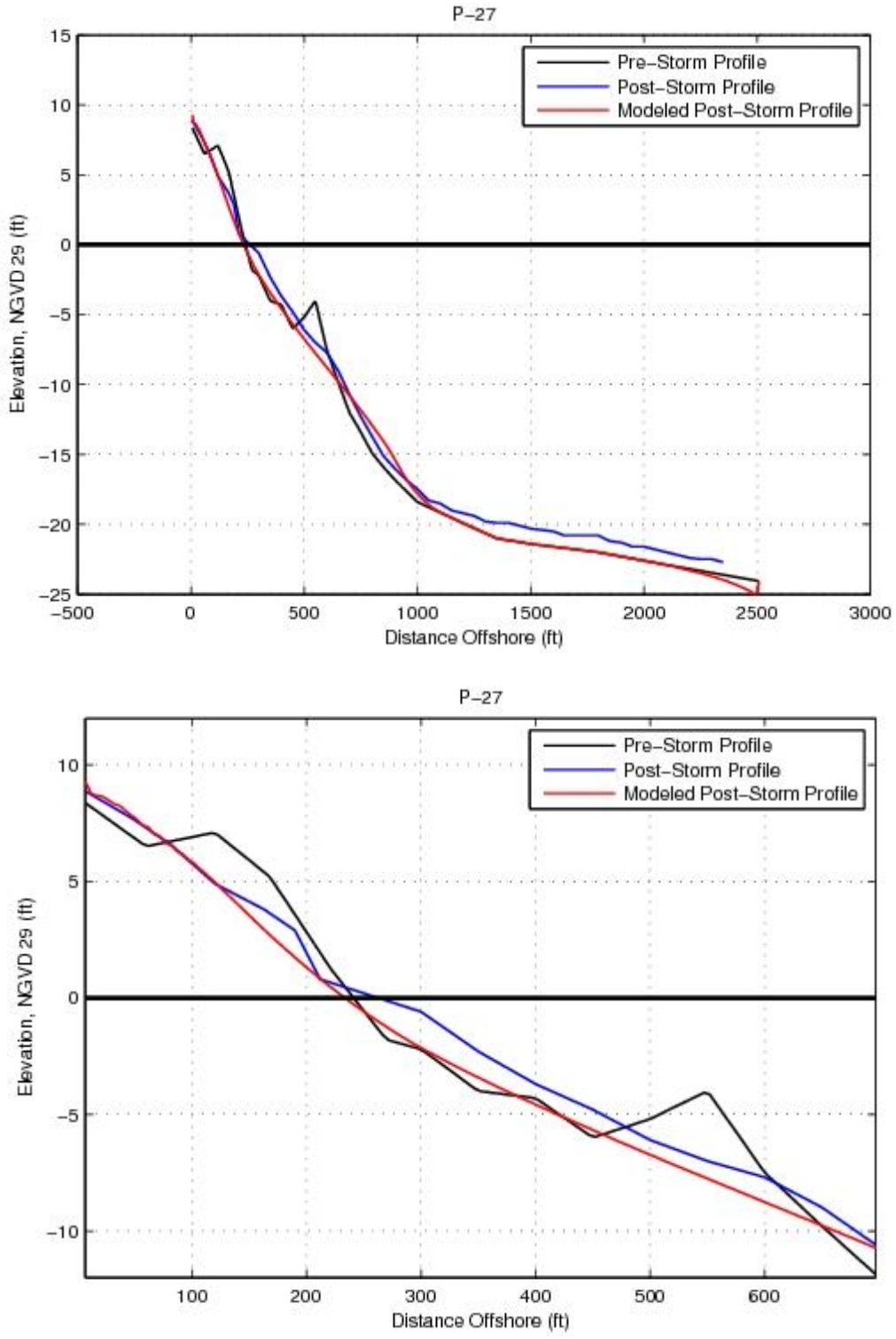


Figure 5-10: SBEACH Calibration results at Profile 27

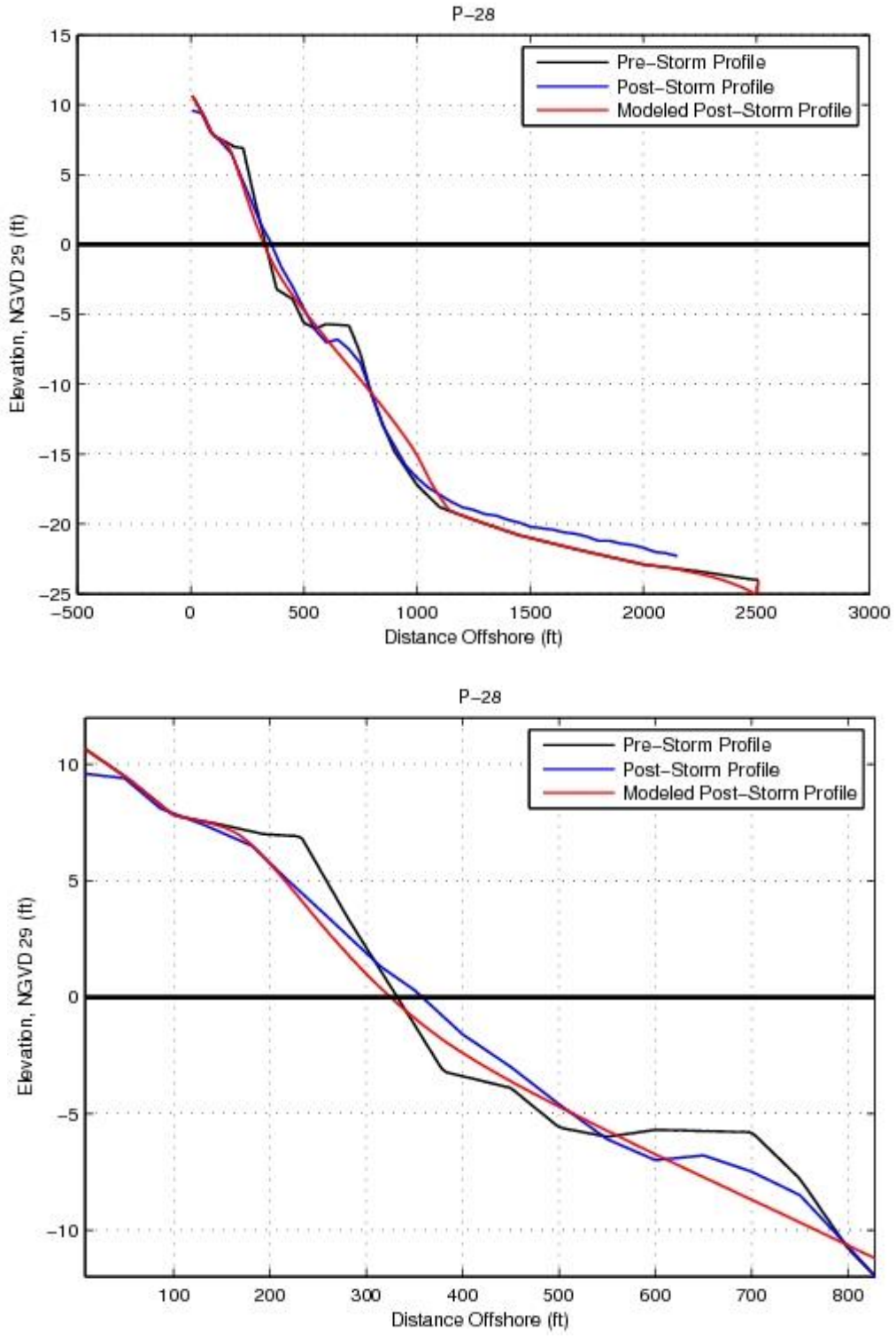


Figure 5-11: SBEACH Calibration Results at Profile 28

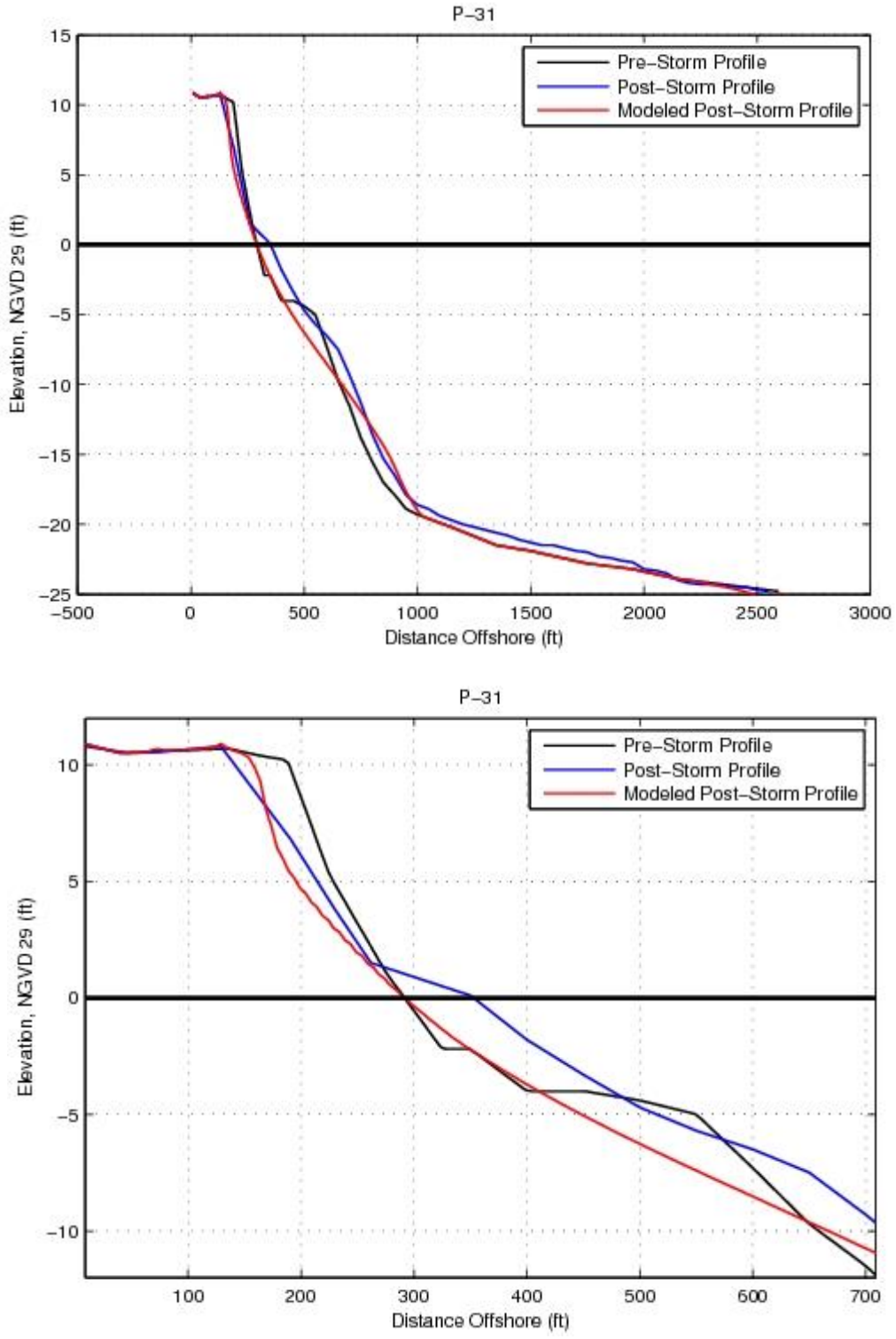


Figure 5-12: SBEACH Calibration results at Profile 31

5.2.3 SBEACH Model Sensitivity

5.2.3.1. Sensitivity to Calibration and Site Specific Parameters

A sensitivity analysis of SBEACH to the main calibration parameters and site specific parameters was performed to gain a better understanding of the influence of each parameter in the model. Specifically, the sensitivity of SBEACH results to the sediment transport rate (K), coefficient for slope-dependent transport (EPS), sediment grain size, and wave height was tested. For each of the sensitivity runs, the FIMP calibration parameters were used and four variations of sensitivity parameter were tested. Table 5-4 shows the values for each of varied parameters in the sensitivity tests. All sensitivity results are shown for Profile 28 because it displayed good agreement between the measured and SBEACH results.

Table 5-4: SBEACH Sensitivity Analyses

Sensitivity Parameter	Value 1	Value 2	Value 3	Value 4
K (m^4/N)	1.75E-06	2.50E-06	1.00E-06	2.50E-07
EPS (m^2/s)	0.001	0.002	0.003	0.004
μ (mm)	0.44	0.36	0.28	0.2
Wave Height Multiplier	0.9	1	1.1	2
Water Level Multiplier	0.9	1	1.1	2

The sensitivity of SBEACH to the sediment transport rate coefficient is shown in Figure 5-13. As discussed earlier, the impact of K is to either speed up or slow down the rate of erosion. In the instance where K is too low (pink line in Figure 5-13) SBEACH under predicts the dry beach erosion. It is also noted that the model is much more sensitive to K than any of the other calibration parameters. The sensitivity of SBEACH to the coefficient for slope-dependent transport is shown in Figure 5-14. Lowering EPS clearly decreases the amount of erosion along the steep dry beach. This is expected as EPS increases the rate of erosion along steep parts of the profile.

The sensitivity of SBEACH to the mean grain size is shown in Figure 5-15. As expected a larger grain size results in less erosion of the dry beach and a steeper profile. Figure 5-15 also indicates that SBEACH is relatively sensitive to the grain size as a 0.08 mm difference in the grain size results in a dry beach retreat difference of 10 ft. The sensitivity of SBEACH to the input wave height is shown in Figure 5-16. Relative to the impact of the sediment grain size, the sensitivity of SBEACH to a 10% increase in the wave height is very small. The sensitivity of the profile response to the input wave height is largest at the offshore bar were the waves are breaking. The sensitivity of SBEACH to the input water level is shown in Figure 5-17. Relative to the impact of the sediment grain size, the sensitivity of SBEACH to a 10% increase in the water level is very small. A noticeable difference exists between the sensitivity of the dry beach to a large increase in wave

height versus a large increase in the water level. Significantly more dry beach erosion occurs if the water level is doubled than if the wave height is doubled. However, more erosion of the submerged profile occurs when the wave height is doubled. This sensitivity exercise suggests that dry beach erosion is more sensitive to an increase in water level, whereas submerged profile erosion is more sensitive to an increase in the wave height.

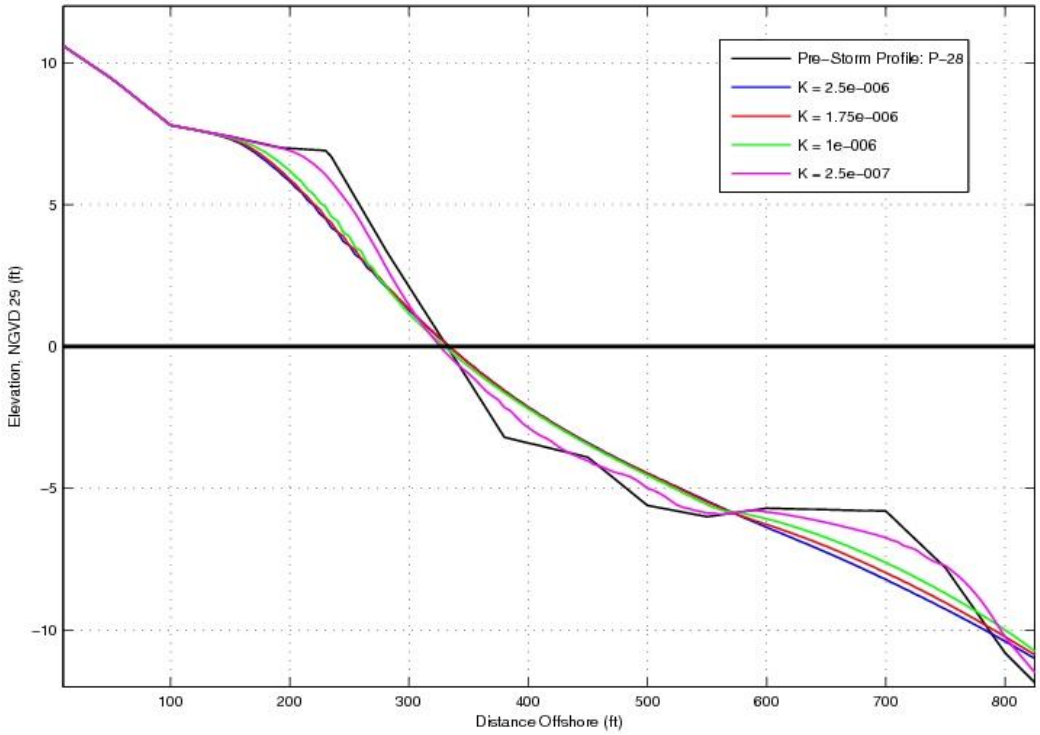


Figure 5-13: SBEACH sensitivity to sediment transport rate coefficient (K)

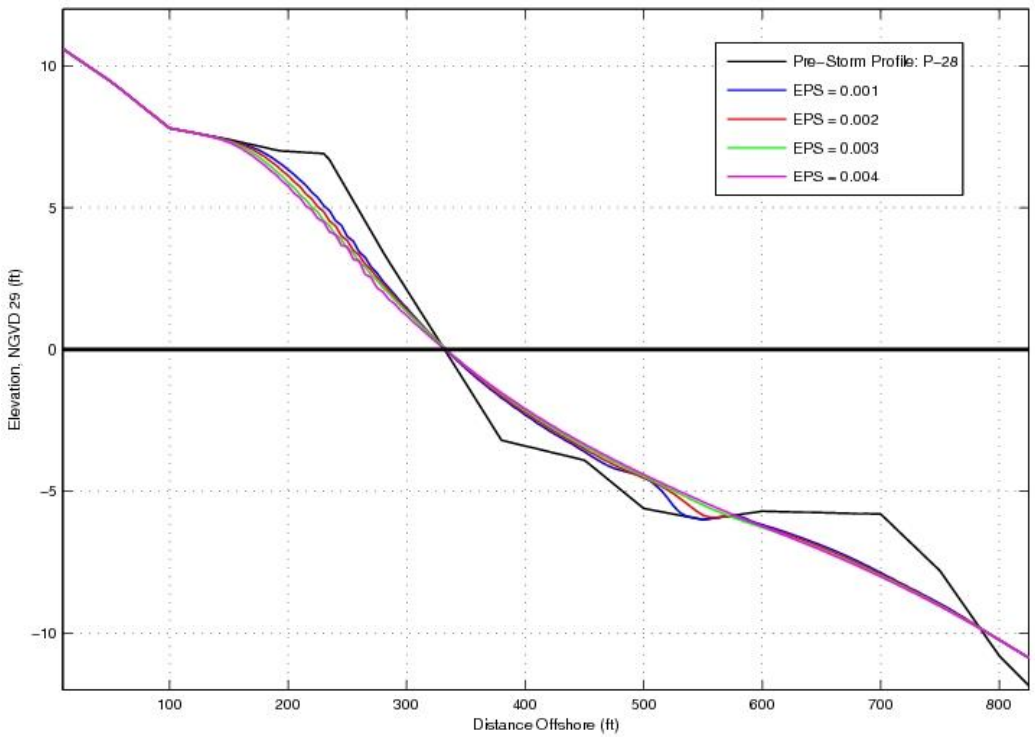


Figure 5-14: SBEACH sensitivity to coefficient for slope-dependent transport (EPS)

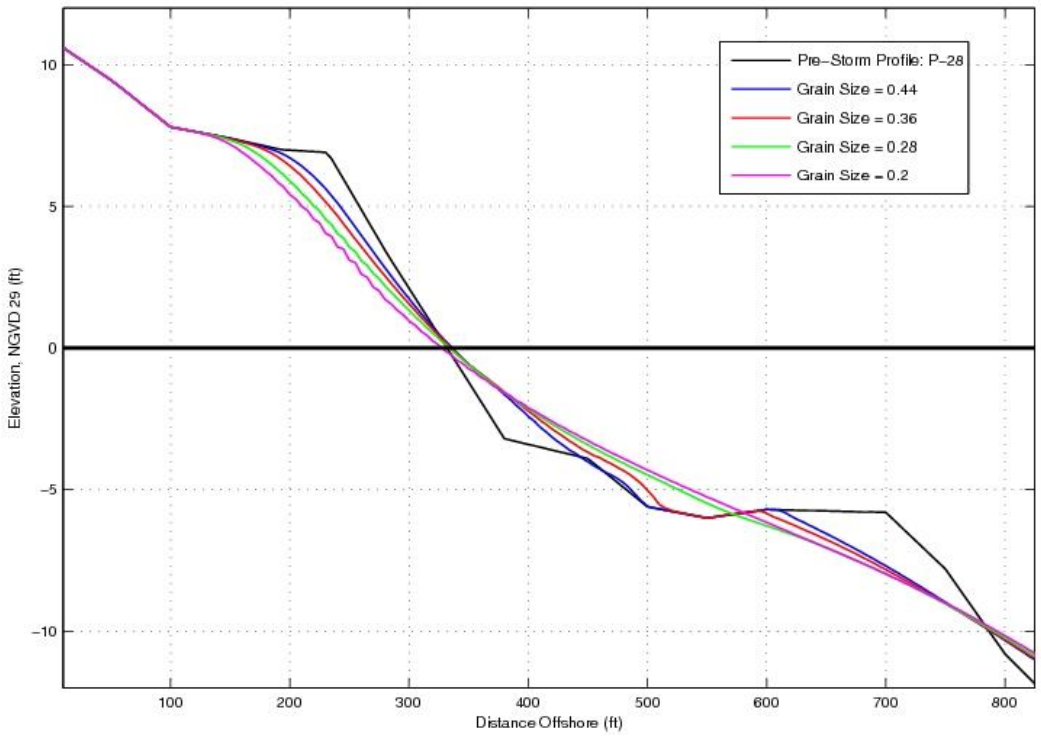


Figure 5-15: SBEACH sensitivity to mean sediment grain size

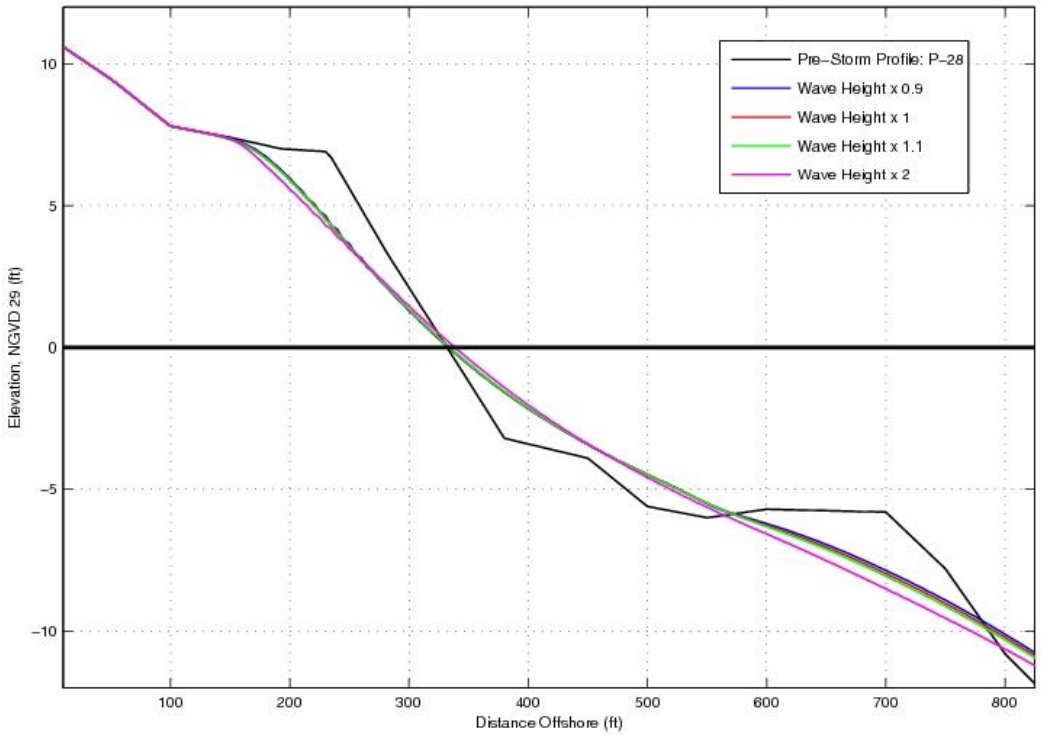


Figure 5-16: SBEACH sensitivity to magnitude of the significant wave height (Hs)

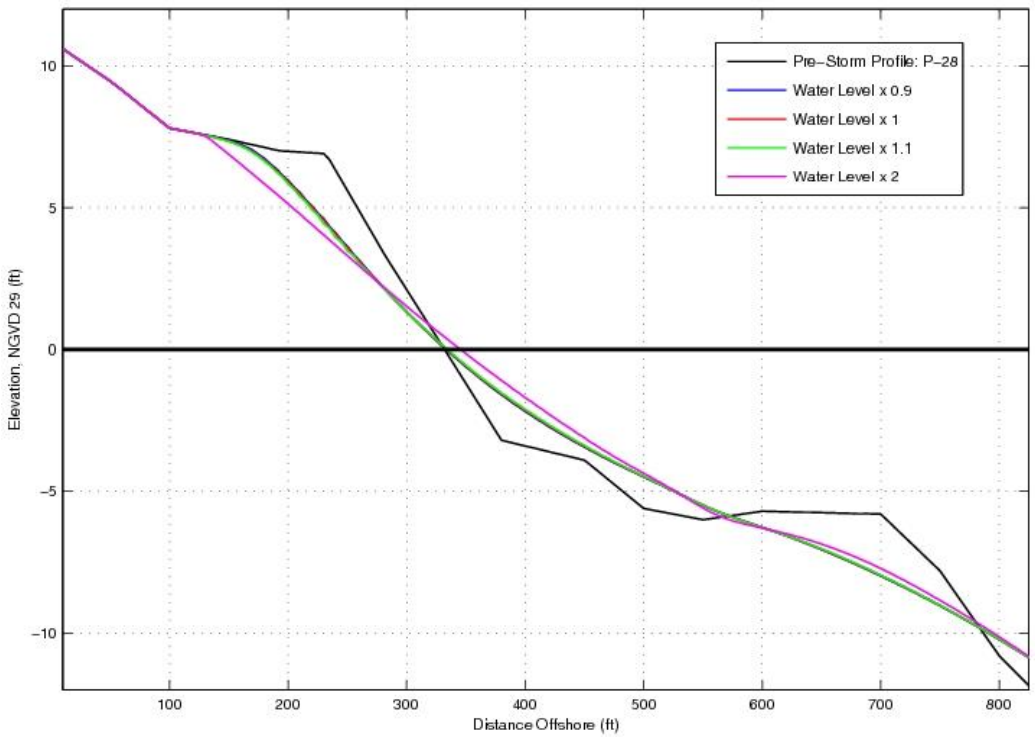


Figure 5-17: SBEACH sensitivity to magnitude of the water level

5.2.3.2. Sensitivity to Model Grid Size and Time Step

During existing conditions model simulations it was observed that dune response to large storms was sensitive to the model grid size and time step. In instances where dune overtopping and erosion occurs the profile response can be very unstable and appear jagged if long time steps and/or small grid cells are used. However, if shorter time steps and/or larger grid cells (in the dry beach) are used the dune response is smoother and more stable. The response of the submerged profile is insensitive to small changes in the grid resolution and time step. Additionally, an increase in the grid size in the submerged profile has minimal impact on the response of the upper profile.

A small sensitivity test was conducted to highlight the observations discussed above. The sensitivity test simulated one profile using 3 different grid cell sizes (5 ft, 10 ft, and 15 ft), and a single storm (October 1954 Hurricane) using 3 different time steps (1 min, 2 min, and 3 min). Table 5-5 shows the 3 profile configurations, 3 storm configurations, and whether the profile response visually appears to be stable or unstable. Figure 5-18 presents the results of profile with 10 ft grid spacing and all the 3 time steps. It is apparent in Figure 5-18 that both the 2 min and 3 min time steps results in jagged and unstable model results. Figure 5-19 presents the results of all 3 grid cell sizes and the most stable time step (1 min). Figure 5-19 indicates that larger grid cells in the dry beach are more stable.

The results of the sensitivity analysis confirm the observations from the existing conditions simulations; small grid sizes and large time steps can cause unstable model results. This analysis was used to determine appropriate grid cell sizes and time steps for the existing conditions simulations.

Table 5-5: SBEACH Sensitivity to Time Step and Grid Spacing

Grid Spacing	Time Step		
	3 min	2 min	1 min
5 ft	Unstable	Unstable	Medium
10 ft	Unstable	Unstable	Stable
15 ft	Medium	Stable	Stable

5.2.4 Calibration Conclusions for Hurricanes Bell and Emmy

SBEACH calibration and sensitivity tests were performed for a set of profiles measured before and after Hurricane Belle and Hurricane Emmy. This was the only available data set with measurements taken before and after a major storm event. Unfortunately significant volumetric accretion occurred in the majority of the profiles between measurements. It is believed that accretion was the result of longshore processes and the placement of over 3.5 million cubic yards of sediment in Rockaway Beach, just east of the surveyed profiles. However, calibration to the data set was still possible and the model was able to reproduce erosion of the dry beach. The calibration parameters that provided the best results for Rockaway Beach was scenario Cal-4 (Table 5-2). Comparison between the observed and modeled volumetric dry beach erosion, recession of the MHW, and landward storm intrusion yielded acceptable results and are comparable to the level of calibration obtained previously for FIMP (Gravens et al., 1999).

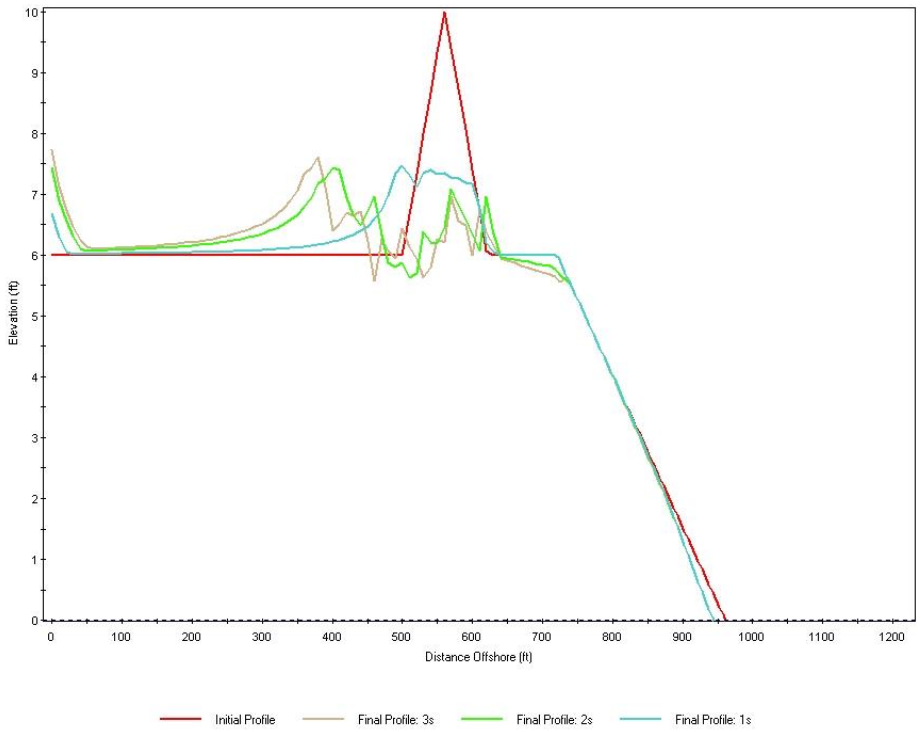


Figure 5-18: SBEACH sensitivity to model time step (grid spacing 10 ft)

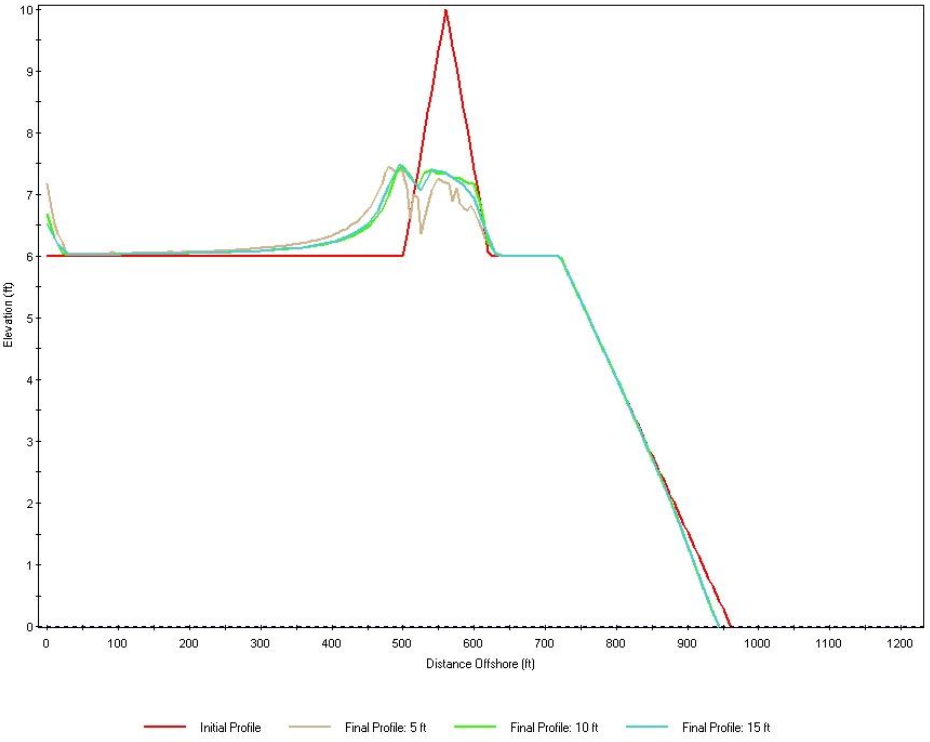


Figure 5-19: SBEACH sensitivity to model grid size (time step of 1 min)

5.2.5 Updated Model Calibration for Overwash Parameter

This appendix documents the calibration of the overwash transport parameter (K_B) in SBEACH. Overwash is defined as "the flow of water over the crest of the beach or dune that does not directly return to the originating water body" (Wamsley and Kraus 2004). Washover is the sediment deposited landward as a result of overwash.

The need to perform this calibration arose from the preliminary "with-project" simulation results where unexpected dune overwash was observed using the default K_B value of $5e^{-3}$. The issue was encountered when simulating profiles with low-crested dunes (relative to the upland elevation) under medium-sized storms that generated run-up induced overwash (i.e., the still water elevation did not overtop the dune). The top plot in Figure 5-20 exemplifies this scenario, showing the formation of a large overwash deposit landward of the pre-storm, 11 ft dune. The bottom plot of this figure shows an example of "inundation overwash" in which the dune becomes completely submerged. The geometry of the overwash deposit under "inundation overwash" is much flatter and broader. In instances where overwash does not occur, then the model results are not affected by K_B.

In view of these results, a reduction in the default value of K_B was deemed appropriate to reduce the excessive overwash. Figure 5-21 shows the results obtained for a range of K_B values equal to and smaller than the default value. The top plot illustrates that, under a medium-sized storm, the reduction in K_B translates into a significant reduction in the amount of dune overwash and dune retreat. Under a storm of Hurricane Sandy's intensity, the bottom plot shows a similar dune response, with the higher K_B values spreading more sediment landward. Note that in both plots the beach erosion is practically the same for all values of K_B.

Similar to Figure 5-21, Figure 5-22 illustrates the results obtained for a range of K_B values on a 20 ft dune under Hurricane Sandy. While consistent with the previous observations, it is evident in this figure that a significant reduction in K_B may lead to severe underestimation of dune erosion, as seen by the remaining dune "trunk" for the lowest tested K_B value. This figure also shows that changes in K_B have very little impact on berm erosion.

Generalizing, the overwash sensitivity analysis indicates that two unfavorable situations may arise if the default value or a very small value for K_B is chosen:

1. If the default value is used, the overwash deposit created by runup-induced overwash may form a dune of significant size that would reduce damages in future storm events during Beach-fx simulations.
2. If K_B is reduced, a flatter overwash deposit is obtained; however, a very small value may severely under-predict dune erosion, offering undesired protection to the upland area in future storm events during Beach-fx simulations.

In this light, a K_B value of $1e^{-3}$ was deemed to be a reasonable middle ground between these constraints. Personal communication with Mark Gravens (USACE CHL) suggested that this value is within a suitable range.

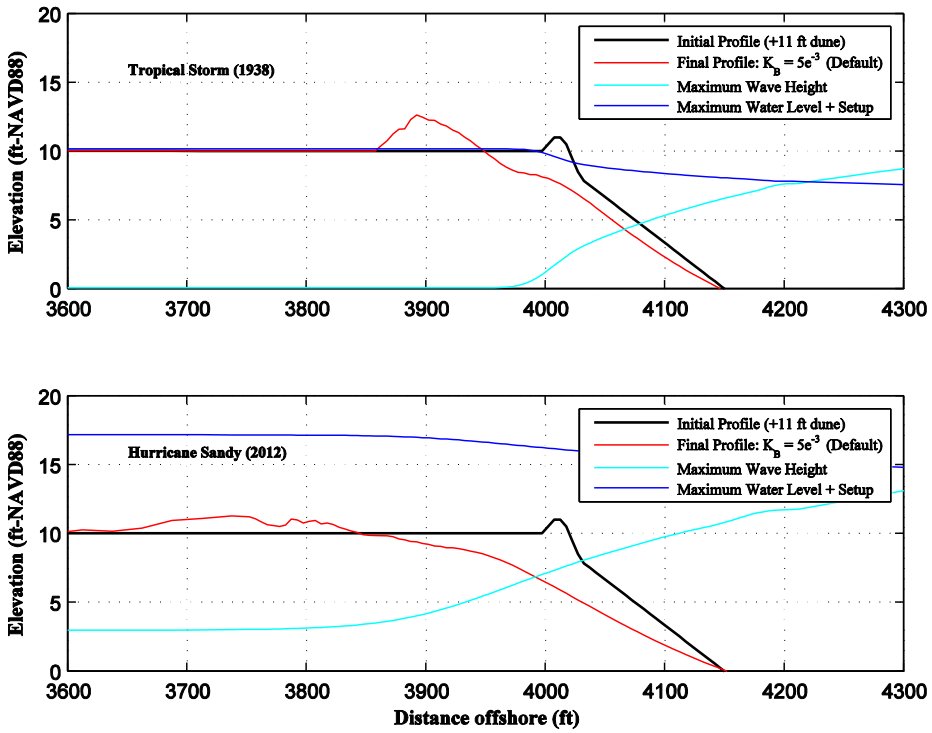


Figure 5-20: SBEACH dune overwash with default overwash transport parameter

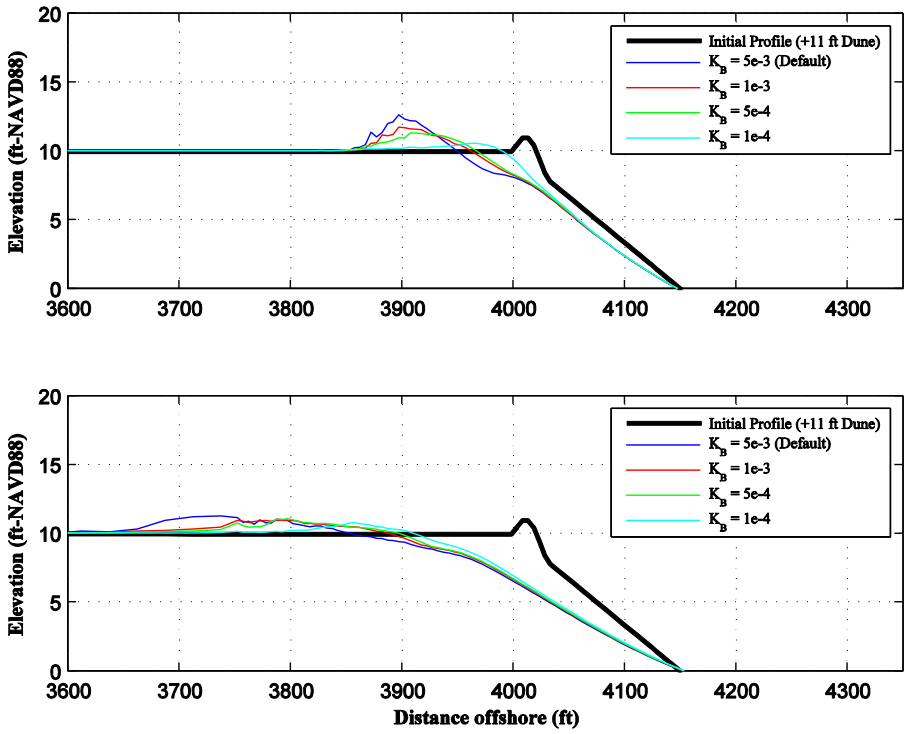


Figure 5-21: SBEACH dune overwash sensitivity to overwash transport parameter (K_B)

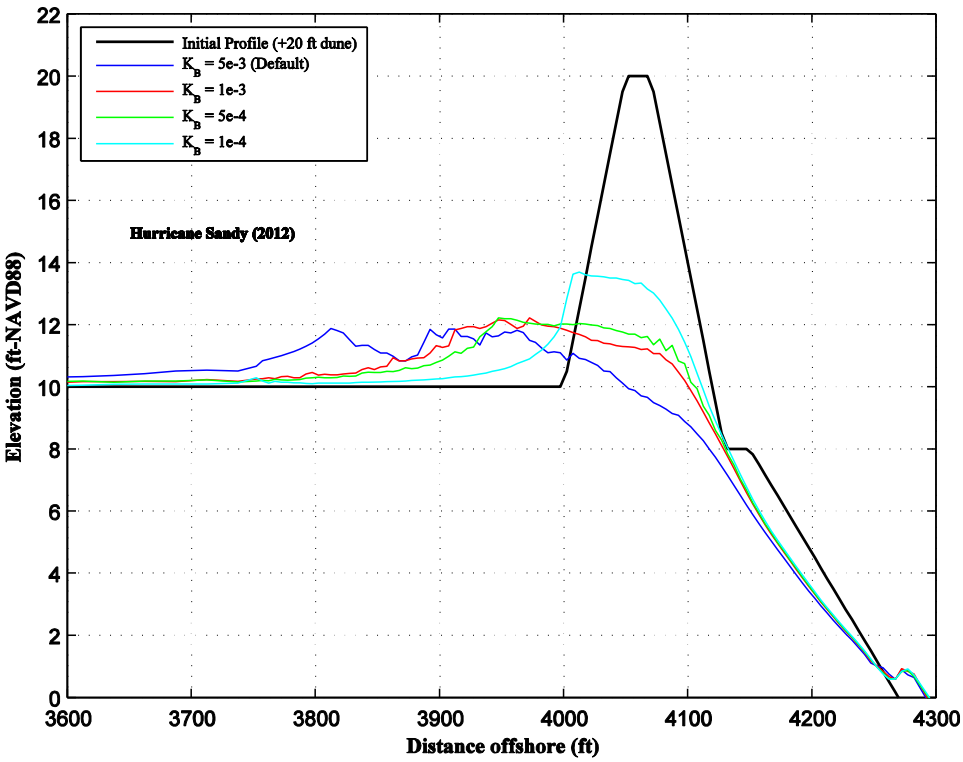


Figure 5-22: SBEACH dune erosion sensitivity to overwash transport parameter (KB)

In a previous Task Order, SBEACH was calibrated to observed morphological changes at Long Beach, NY, following Hurricane Belle and Hurricane Emmy (1976). This calibration defined the SBEACH sediment transport and beach parameters used in the present Task Order. In order to ensure that changes in K_B would not affect the other parameters, the original calibration was revisited. The results indicated that K_B was independent of the other parameters and no further adjustments were required.

Subsequently, the Hurricane Sandy validation was revisited, with emphasis on Reach 1 where most of the dunes in Rockaway are present. Some limitations were present from the start as this reach is absent of post-Irene profile data and the available (2010) profile data is, in general, considerably less eroded than the post-Sandy profile data. Figure 5-23 show the results for profiles 3 (Reach 1) and 73 (Reach 5) for the default and proposed K_B values. The latter profile is the only profile with a dune outside Reach 1.

As observed in these figures, it is difficult to determine whether the proposed K_B value can be justified based on the Hurricane Sandy validation results. Nonetheless, the results are consistent with the previous sensitivity analysis, i.e.: the reduction in the K_B value tends to underestimate dune erosion and reduce the landward spreading of sediment.

Based on the sensitivity analysis and calibration runs, M&N proposes to use a K_B value of $1e^{-3}$. Table 5-6 provides a summary of the parameters that have been adopted for the SBEACH production runs.

Table 5-6: SBEACH Final Model Calibration Parameters

SBEACH Parameter	Value
Landward surf zone depth (ft)	0.91
Effective grain size (mm)	0.29
Maximum slope prior to avalanching (deg)	30
Transport rate coefficient (m^4/N)	$1e^{-6}$
Overwash transport parameter (K_B)	$1e^{-3}$
Coefficient for slope-dependent term (m^2/S)	$1.5e^{-3}$
Transport rate decay coefficient multiplier	0.5
Water temperature (°C)	13

The sensitivity analysis of K_B leads to the following conclusions:

- For profiles with low-crested dunes relative to the upland elevation, the default K_B value can induce the formation of an unrealistically large washover deposit landward of the pre-storm dune as a result of runup-induced overwash.
- The reduction of K_B from its default value limits the excessive landward washover. However, if K_B is significantly reduced, the model tends to underestimate dune erosion.
- A good compromise between avoiding excessive landward washover and underestimating dune erosion is to use a K_B value of 1e-3. This value has been used by other SBEACH experts (Mark Gravens, personal communication).
- Berm and beach erosion were found to be unaffected by changes in K_B.
- K_B is independent of the other sediment transport and beach parameters; therefore, reducing its value does not affect the original calibration.

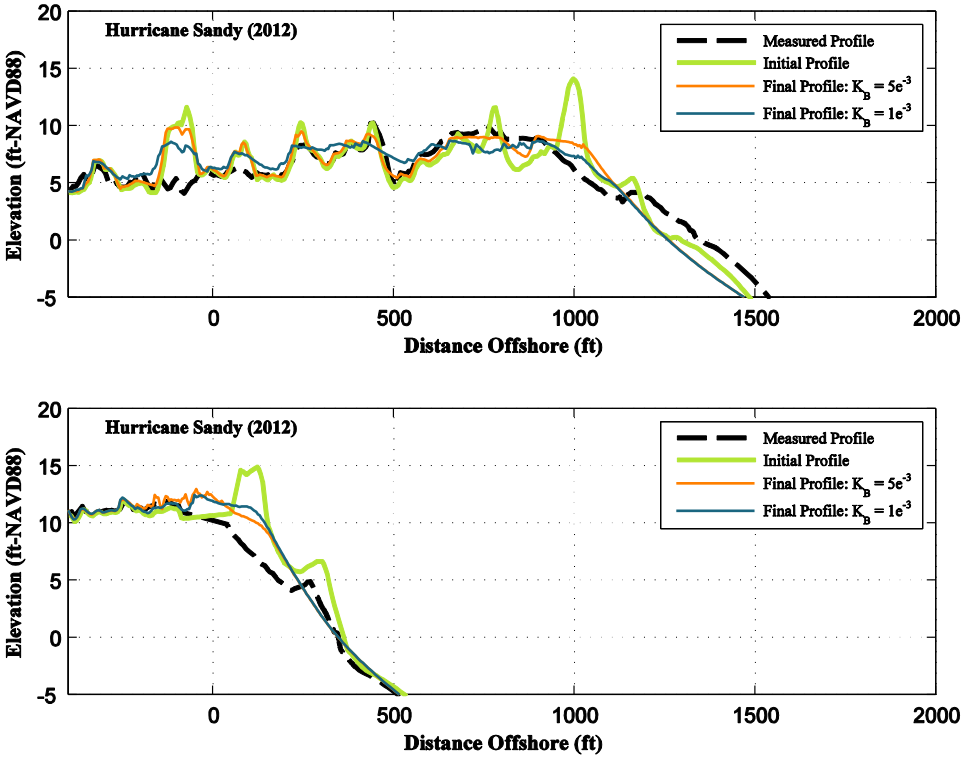


Figure 5-23: SBEACH Hurricane Sandy validation for Profile 03 and Profile 73

5.2.6 Hurricane Sandy Model Validation

SBEACH model validation was performed to observed subaerial beach profile changes during Hurricane Sandy. Unfortunately long-profile surveys with data below MHW are sparse and the majority of the observations are limited to subaerial beach changes. In addition, the time period between the pre-storm profiles and actually occurrence of Hurricane Sandy is 1 to 2 years. Therefore, the observed profile changes represent a much longer period of time than just Hurricane Sandy. Nonetheless, the model validation provides an useful and reassuring comparison of the predicted profile changes by SBEACH and observed post-storm conditions.

Pre-storm beach profiles were constructed using 2011 surveyed profiles and 2010 LIDAR data at locations without a 2011 survey. The post-sandy subaerial beach conditions are based on a 2012 LIDAR survey. The submerged profile for all pre- and post-storm profiles is based on the representative submerged profile (Section 5.3.1). The final SBEACH calibration parameters shown in Table 5-6 are used in the model validation. Figure 5-24 shows the profile locations (in yellow) used in the Hurricane Sandy SBEACH model validation.

Model boundary conditions for Hurricane Sandy are based on the conditions in the Historical Storm Suite (Section 2.1).

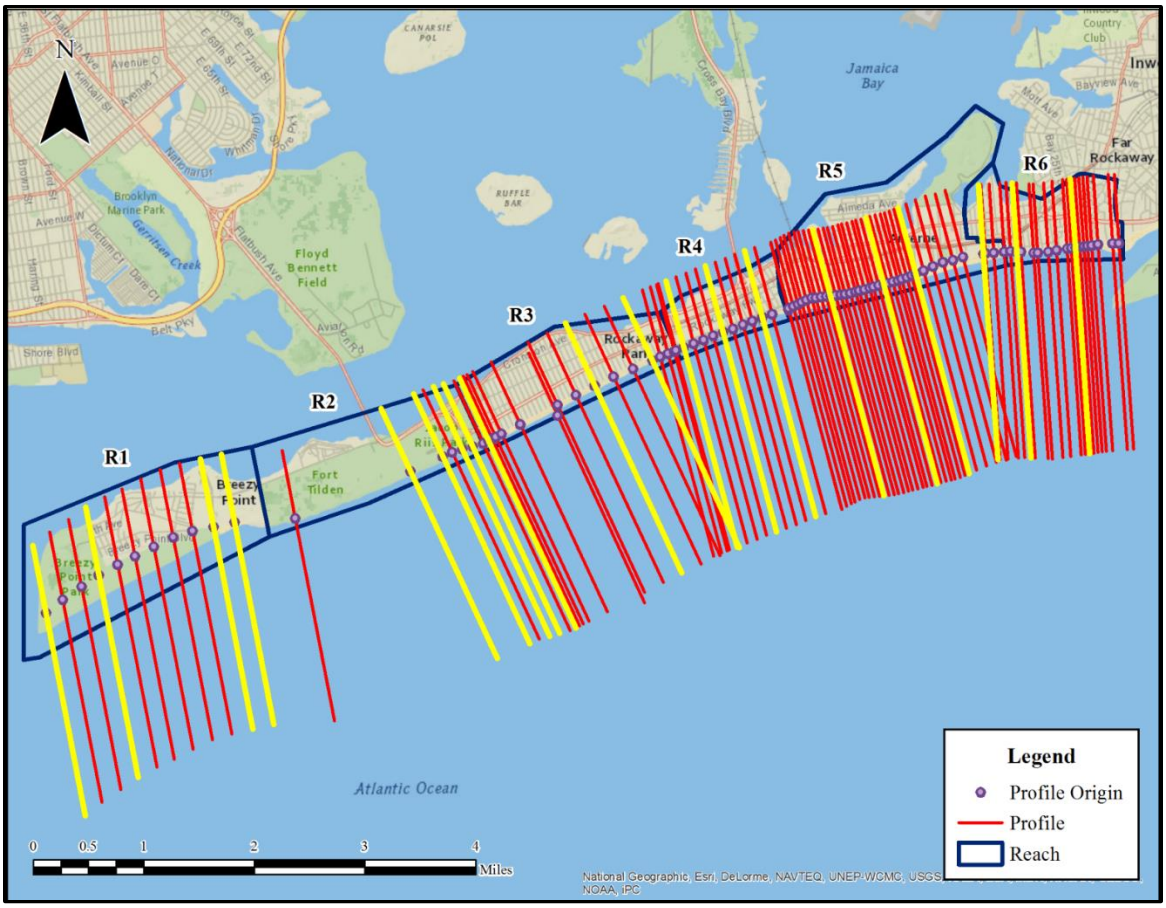


Figure 5-24: SBEACH Hurricane Sandy Validation Profile Locations

Overall the SBEACH validation results for Hurricane Sandy, Figure 5-25 to Figure 5-29, show that the dry beach erosion predicted by SBEACH was in satisfactory agreement with the observed changes, especially in Reaches 3 and 5. The validation analysis found that dunes at Breezy Point were effectively flattened by Hurricane Sandy. Reach 2 experienced very little erosion between 2012 and 2012, and the model overestimated erosion in Reach 2. However, the 2010 data may not be representative of the pre-Sandy conditions in this Reach. Validation comparison at Reach 6 is limited by the post-Sandy nourishment that is already present in the post-Sandy LIDAR data. Potential sources of error in the model calibration are attributed to alongshore sediment not capture by SBEACH and beach profiles changes occurring between the pre- and post-Sandy data as a result of wave conditions and storm events other than Hurricane Sandy.

R1
R2
R3
R4
R5
R6
N
Legend
Profile Origin
Profile
Reach

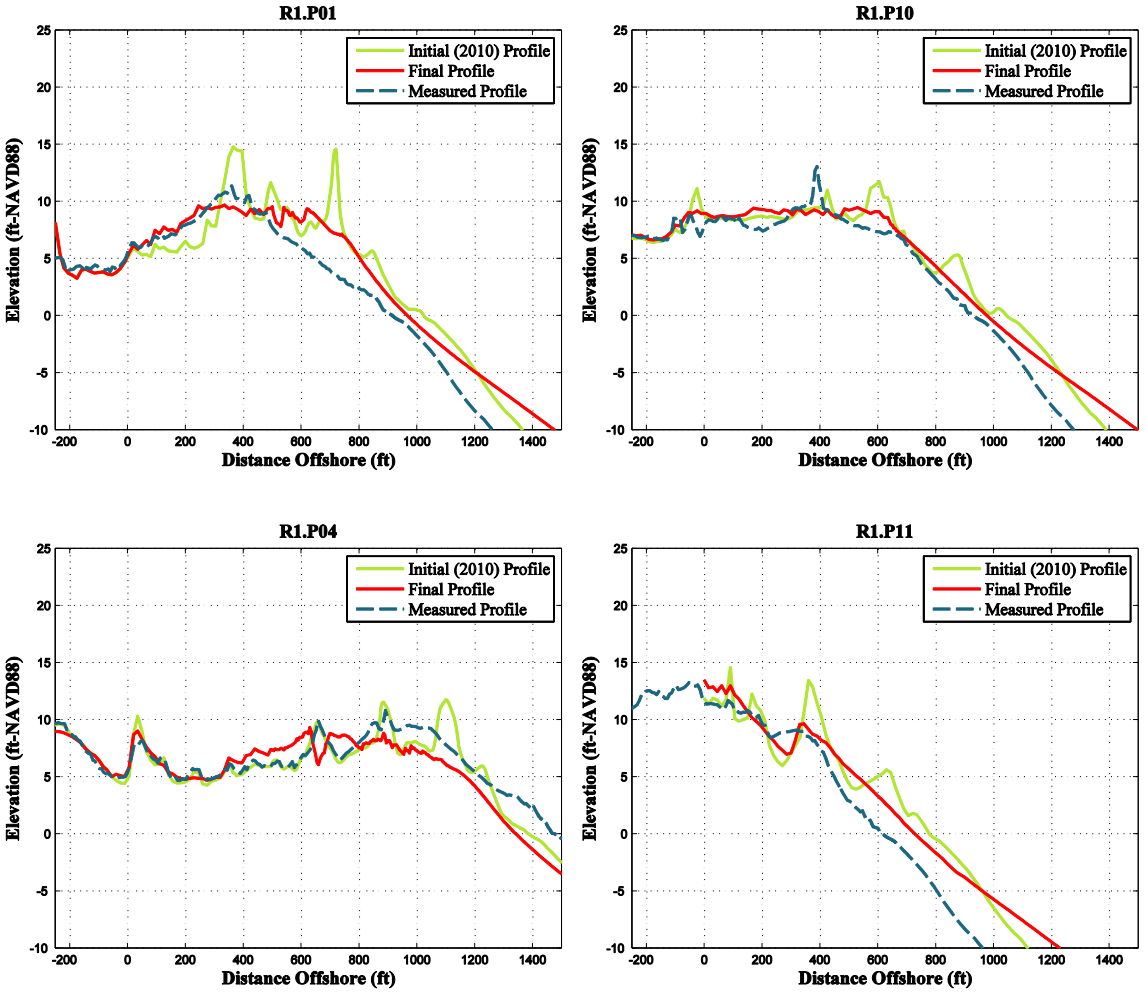
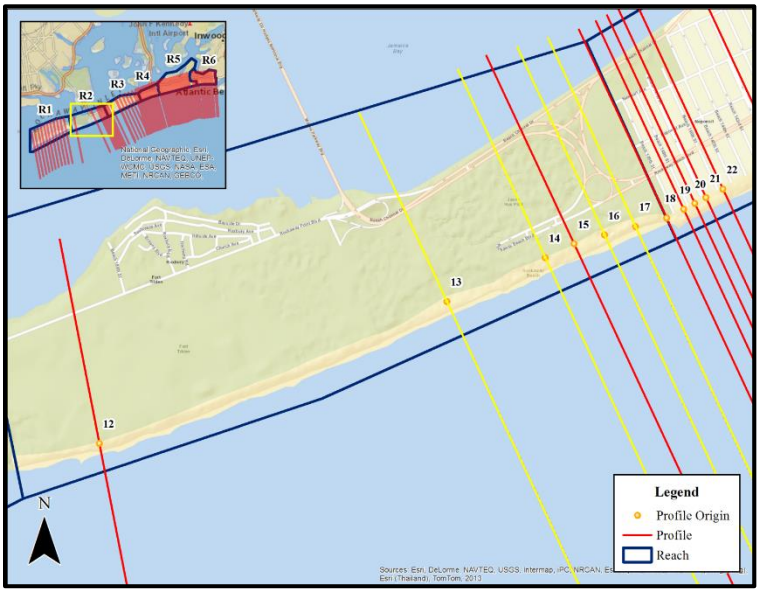
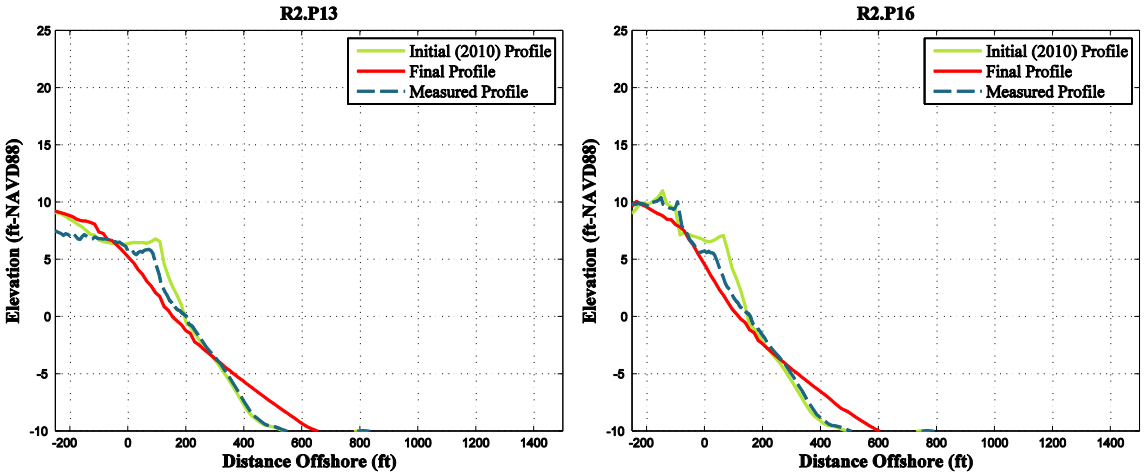

R1.P01
R1.P10
R1.P04
R1.P11
Initial (2010) Profile
Final Profile
Measured Profile
Elevation (ft-NAVD88)
Distance Offshore (ft)

Figure 5-25: SBEACH Hurricane Sandy Validation Results – Reach 1





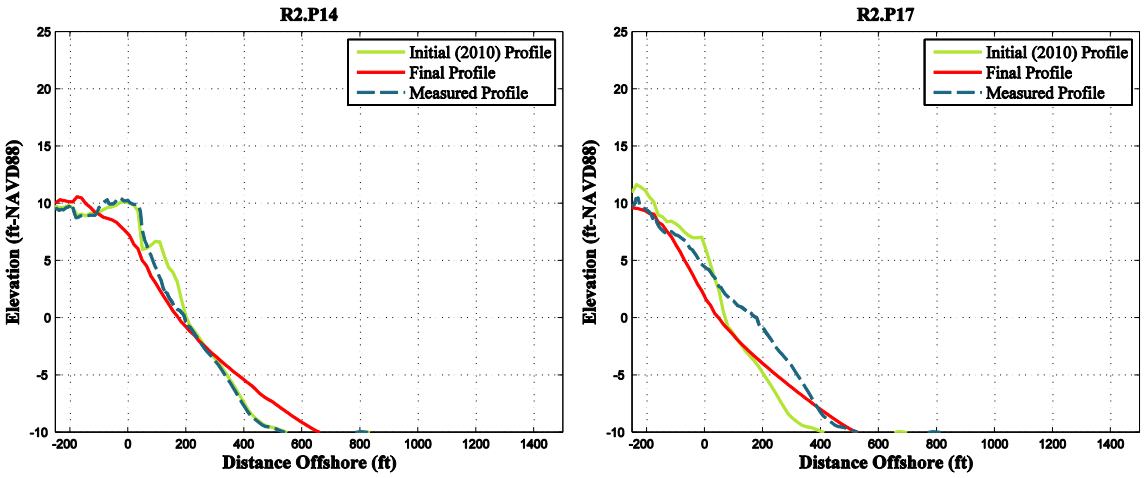
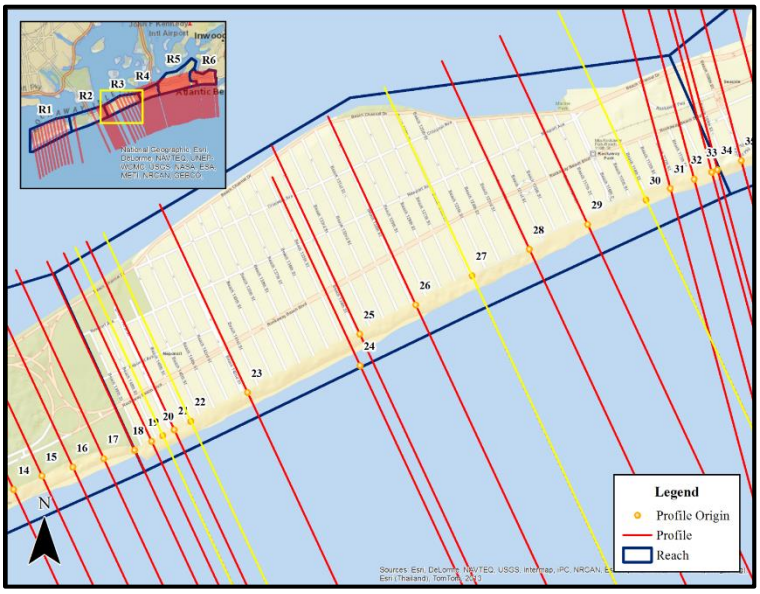


Figure 5-26: SBEACH Hurricane Sandy Validation Results – Reach 2



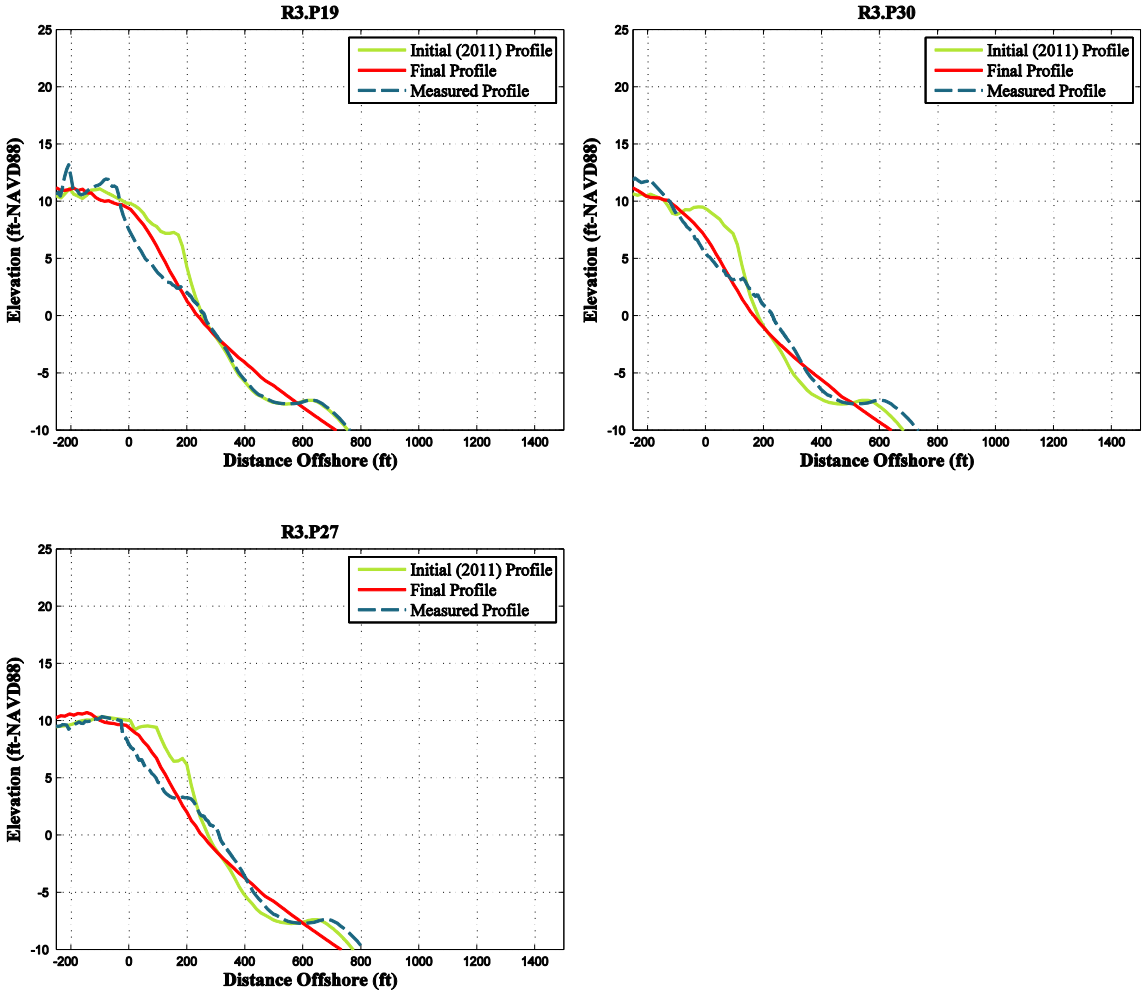
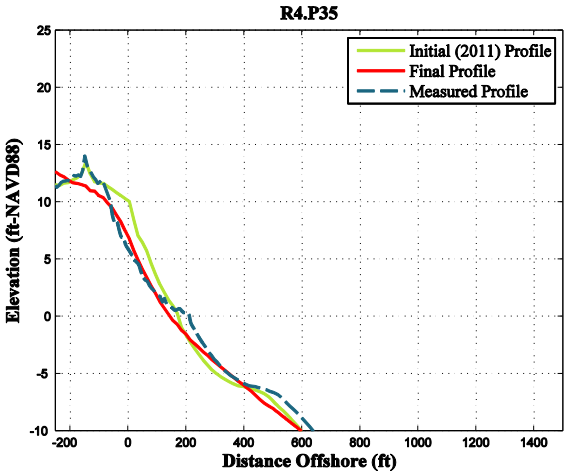
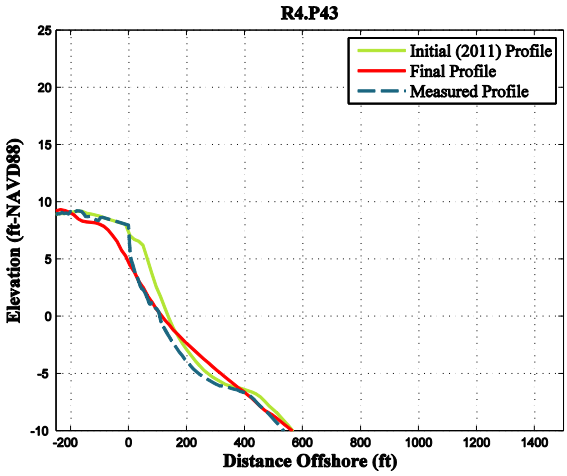


Figure 5-27: SBEACH Hurricane Sandy Validation Results – Reach 3

R1
R2
R3
R4
R5
R6
Legend
Profile Origin
Profile
Reach
N


R4.P35
Initial (2011) Profile
Final Profile
Measured Profile
Elevation (ft-NAVD88)
Distance Offshore (ft)


R4.P43
Initial (2011) Profile
Final Profile
Measured Profile
Elevation (ft-NAVD88)
Distance Offshore (ft)

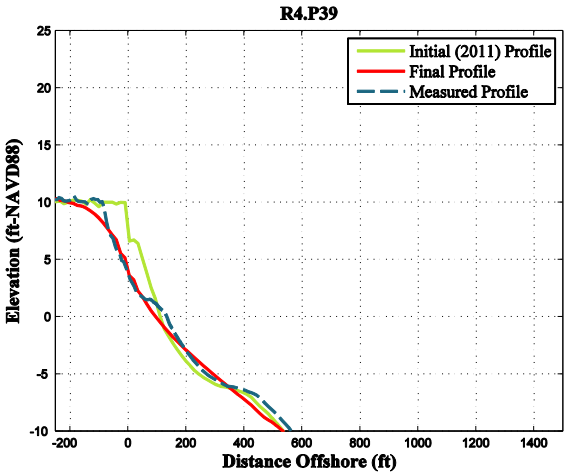
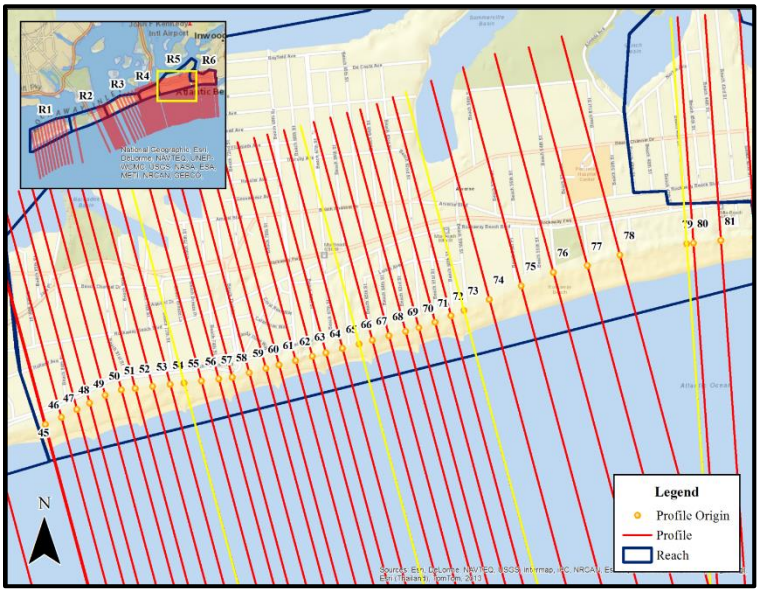
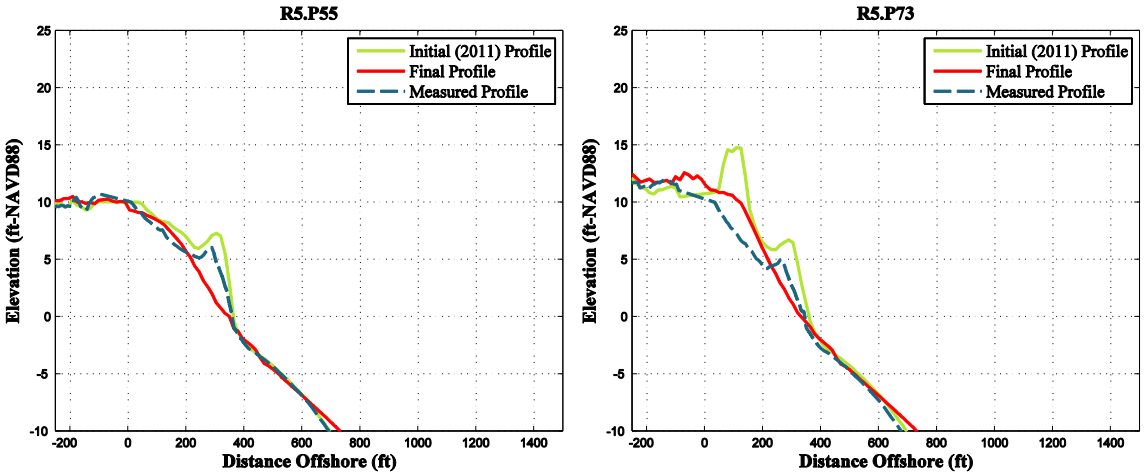

R4.P39
Initial (2011) Profile
Final Profile
Measured Profile
Elevation (ft-NAVD88)
Distance Offshore (ft)

Figure 5-28: SBEACH Hurricane Sandy Validation Results – Reach 4





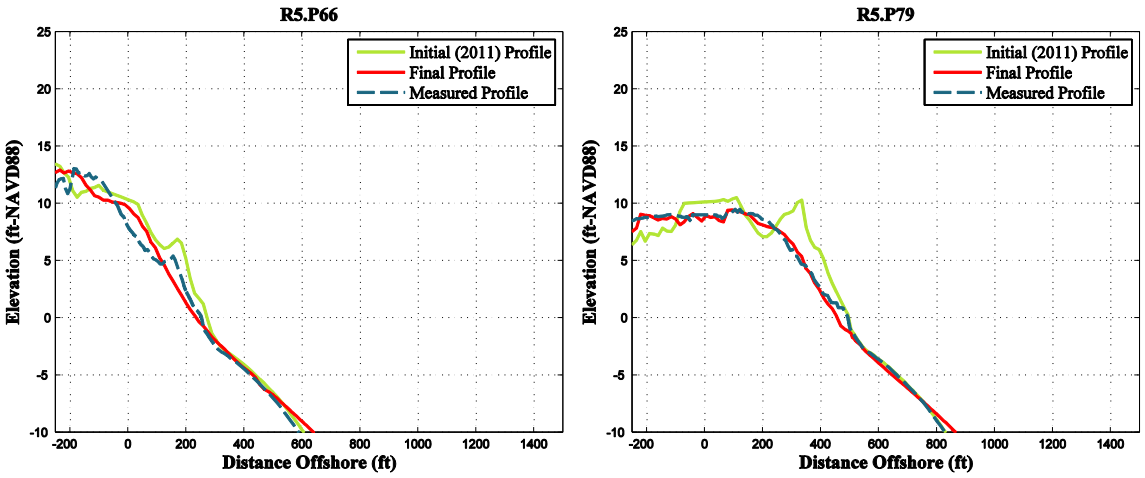


Figure 5-29: SBEACH Hurricane Sandy Validation Results – Reach 5

5.3 SBEACH Without- and With-Project Simulations

The engine behind the Beach-fx Monte Carlo simulations is the Storm Response Database (SRD). The SRD is a lookup table that stores the morphological profile responses (i.e. change in berm width and dune) and damage driving parameters (i.e. wave height, water level, and vertical erosion). The SRD must include SBEACH results for all storm and profile combinations. The storm suite is based on a training set of 38 historical storms, which expands to 456 total events when all twelve possible tidal combinations are added. Approximately 900 unique profiles are required to capture the range of possible existing and with-project profile combinations for R1T1 and R2T1. As a result 410,400 (900 x 456) SBEACH simulations are required to construct the SRD.

5.3.1 Typical Beach Profiles

Twelve (12) simplified profiles, two for each reach were developed based on surveyed profile data sets measured from 1996 through 2003 by the Atlantic Coast of New York Erosion Monitoring Program (ACNYMP). Each survey repeated measurements from an established profile origin. Only measurements taken during the spring of each year were included for seasonal consistency and to capture the post-winter beach conditions. The delineated reaches for Rockaway Beach are shown in Figure 4-1. In order to develop simplified profiles for each reach to be used in Beach-fx model, representative profiles from temporally and spatially averaging profiles within each reach were created. The following steps were used to create the simplified profiles:

1. Compile all existing long range profile data for the project area and import into RMAP (Regional Morphology Analysis Package). Long range profiles extend from the upland origin point to a minimum of 2500 ft offshore;

2. At each profile station, align measured profiles at Mean High Water (Figure 4-2). Only spring measurements are used here;
3. At each profile station, average aligned profiles to determine the representative station profile (Figure 4-3). Temporal averaging at each individual profile station is performed prior to determining reach representative profiles to eliminate unfair weighting due to variations in the total number of surveys available at each profile station;
4. Separate shoreline into reaches and sub-reaches based on general profile morphology and shoreline characteristics (orientation etc.);
5. Align all representative station profiles within each reach at Mean High Water;
6. Compute the representative profile for each reach by averaging all the aligned representative station profiles (Figure 4-4). Spatial averaging of all stations within the sub-reach is used to produce the 'reach representative profile'.

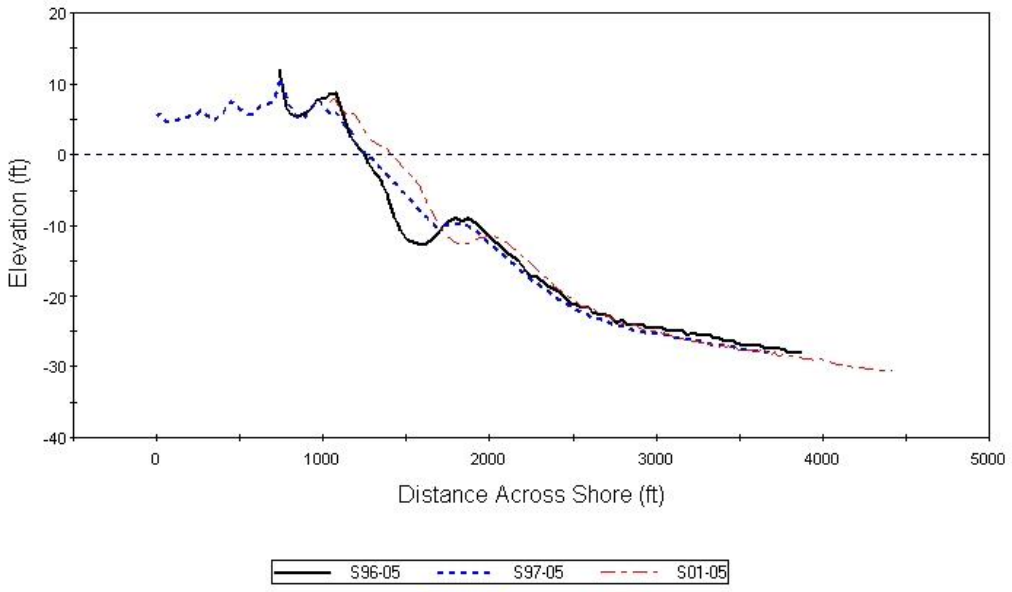


Figure 5-30: Measured profiles at Station 5. S96-05 stands for Profile 5, surveyed in the spring of 1996

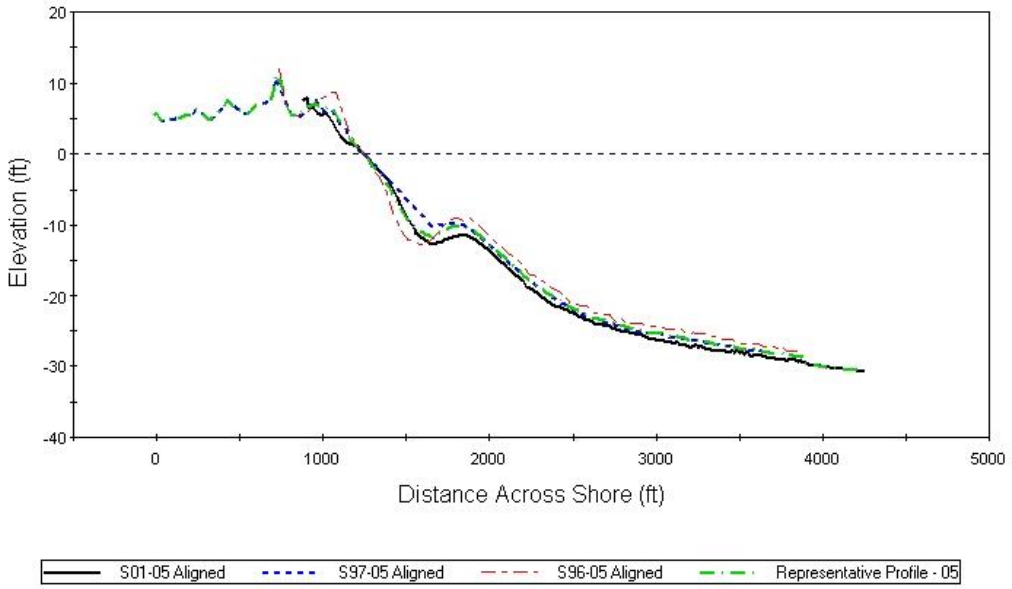


Figure 5-31: Aligned profiles at Station 5. The Representative Station Profile is the average of the aligned (at MHW) profiles

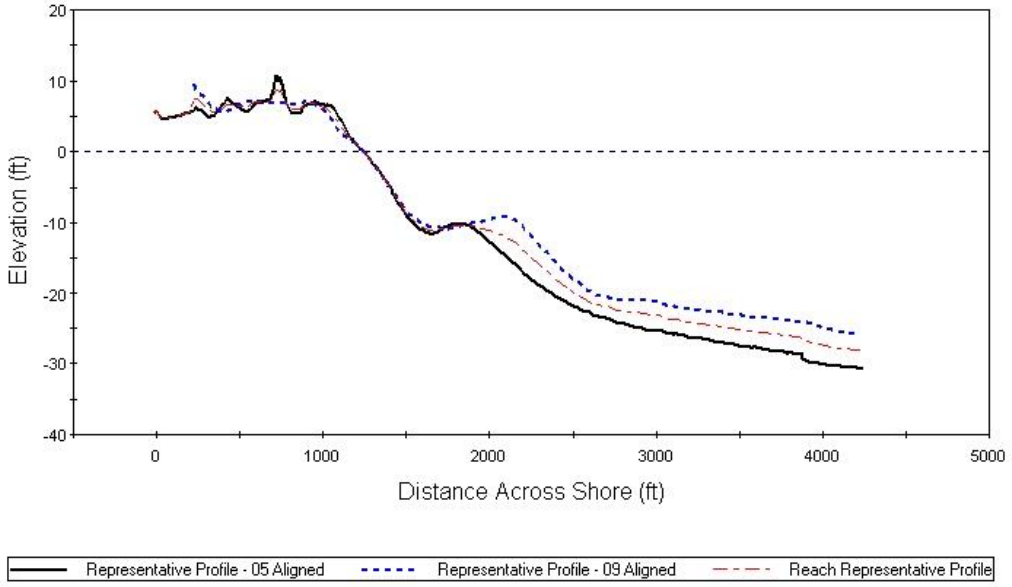


Figure 5-32: Both Representative Station Profiles in this Reach have been aligned at MHW. The Reach Representative Profile is the average of the aligned representative profiles

5.3.2 Beach-fx Simplified Profiles

The representative profile for each reach was further simplified to develop the simplified profiles required for Beach-fx. Each simplified profile in Beach-fx is represented by a single trapezoidal dune (constant dune slope), horizontal berm, constant foreshore slope, and a detailed submerged profile. Figure 4-5 shows the key features in a simplified Beach-fx profile. The existing conditions simplified beach profile configurations are shown in Table 4-2. A single berm height of 6 ft (NAVD88) is used throughout, and all the profiles, except R1T1, do not contain a "physical" dune feature. Specifically, even though all the reaches have a defined dune elevation, and width, only profile R1T1 contains a dune elevation above the upland elevation. All the other dunes are really just an extension of the upland elevation.

The submerged portion (below 0 NAVD88) of each "reach representative profile", developed in step 6, was used as the detailed submerged profile for each reach. In addition to defining the "existing conditions" simplified profile for each sub-reach, a range of pre-defined profiles for each sub-reach, expressed by variations in berm width, dune width, and dune elevation are required for the SRD. It is necessary that the profile variations span all the possible profile configurations during the lifetime of the project (50 years). In order to reduce the number of required profiles in the SRD, it is assumed in Beach-fx that some of the characteristic features of the profile are constant throughout the lifetime of the project (i.e. they do not vary with the storm response). The constant profile features are the upland elevation, dune slope, berm, foreshore slope, and shape of the submerged profile. The profile characteristics that change in response to storms are the dune width, dune elevation, and berm width. Therefore, the pre-defined profiles for each sub-reach only contain changes to the profile characteristics that change in response to storms.

Even though upland erosion may occur in response to a storm in Beach-fx, it is not necessary to run SBEACH simulations for profile variations with reduced upland widths. This is because all such profiles have identical storm responses except translated landward/seaward. Within Beach-fx a translation of the SBEACH results is performed, eliminating the need for profile configurations with reduced upland widths. Furthermore, if the dune elevation and upland elevation are the same it makes no difference in Beach-fx or SBEACH if the high upland morphology is defined including a dune width. Consequently, in cases where the dune elevation and upland elevation are the same, possible profile configurations do not include reduced dune widths either.

The predefined profile configurations were generated using a program, "SBEACHGenerator.exe", provided by USACE-CHL. The program is capable of generating all possible profile permutations at specified dune width, berm width, and dune height increments. The dune and berm widths were modified in 5 ft and 10 ft increments respectively and dune heights were modified in 1 ft increments. A sample of profile configurations for R1 is shown in Figure 28-30. The naming convention used for the profiles is based on previous Beach-fx projects and insures a smooth transition from SBEACH to Beach-fx. An example of a profile name generate by

SBEACHGenerator.exe is R1T1_10.0_001_260, where R1T1 is the profile name (this must match the profile description in Beach-fx), 10.0 is the dune height, 001 is the dune width, and 260 is the berm width.

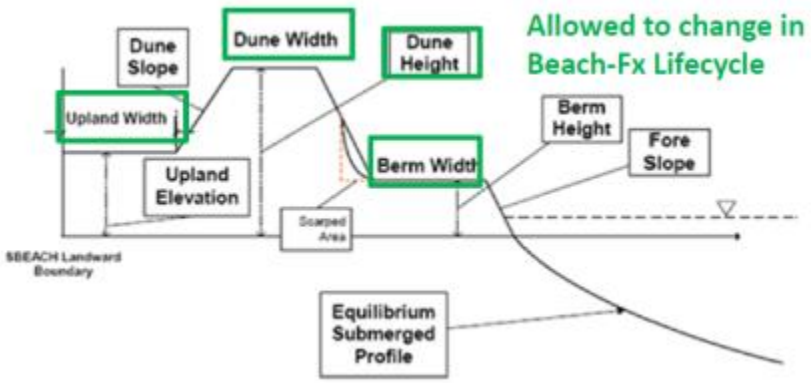


Figure 5-33: Beach-fx Simplified Profile

All possible dune and berm configurations anticipated in the existing and with-project Beach-fx simulations were identified and included in the Storm Response Database (SRD). A Sensitivity analysis indicated that the profile responses for berm widths greater than or equal to 210 feet were nearly identical, and therefore it is not necessary to include berm widths greater than 210 feet in the SRD. An overview of the profile combinations identified for inclusion in the SRD is presented below for R1T1 and R2T1.

R1T1 – Reach 1 (Breezy Point)

Fixed Parameters

Upland Elevation = +6 ft NAVD

Berm Elevation = +6 ft NAVD

Dune Slope = 1:5

Fore Slope = 1:25

Submerged Profile = R1

Variable Parameters

Dune Elevations (ft, NAVD) = 6, 7, 8, 9, 10

Dune Widths (ft) = 5, 10, 15, 20, 30, 40

Berm Widths (ft) = 0, 10, 20, 30, 40, 50, 60, 80, 100, 120, 150, 180, 210

R2T1 - Reach 2 to Reach 6

Fixed Parameters

Upland Elevation = +10 ft NAVD

Berm Elevation = +8 ft NAVD

Dune Slope = 1:5

Fore Slope = 1:15

Submerged Profile = R4

Variable Parameters

Dune Elevations (ft, NAVD) = 10, 11, 12, 13, 14, 15, 16, 18, 20, 22

Dune Widths (ft) = 5, 10, 15, 20, 25

Berm Widths (ft) = 0, 10, 20, 30, 40, 50, 60, 80, 100, 120, 150, 180, 210

5.3.3 Reinforced Dunes

Two reinforced dune alternatives have been proposed for Rockaway Beach. The first alternative is a buried seawall designed to protect inland areas from erosion and wave damages during severe storm events such as Hurricane Sandy. The second alternative is a composite seawall designed to limit storm surge inundation and cross-island flooding in addition to erosion and wave damages during severe storm events. This appendix provides an overview of the approach applied to the East Rockaway to Rockaway Inlet and Jamaica Bay Reformulation Study to integrate the reinforced dune alternatives in the economic analyses (i.e. Beach-fx).

Presently, Beach-fx is capable of simulating seawalls that prevent landward erosion, but not seawalls that reduce upland wave heights and upland flood elevations. SBEACH is used in this study to generate the Beach-fx Storm Response Database (SRD) also has limitations in how it treats seawalls. Due to the limitations of these two models a new approach is applied in this study to evaluate the reinforced dune alternatives.

In general, the approach involves “offline” wave transmission and wave overtopping calculations, which are then used to estimate wave heights and flood elevations landward of the reinforce dunes. The offline calculations use the SBEACH model results as inputs to the empirical formulas (e.g. water level, wave heights, etc.). The wave transmission coefficients and wave overtopping rates are used to adjust the SBEACH results landward of the structures and write new modified SBEACH output files. The modified SBEACH output files are identical to the original SBEACH output files except landward of the reinforced dunes where wave heights and flood depths have been altered.

The following sections briefly describe the approach for the two reinforced dunes and compare the original and revised SBEACH output. A comparison of the SBEACH output for the three design beachfill profiles and two reinforced dunes is also provided at the end.

5.3.3.1. SBEACH Standard Treatment of Seawalls

This section describes how seawalls are treated in SBEACH. Seawalls may be incorporated in SBEACH by specifying the seawall location in the profile and a set of failure triggers (the seawall can also be set to never fail). The seawall crest elevation cannot be specified in SBEACH, which treats the seawall as an infinitely high wall; thus, wave transmission, wave overtopping, or landward flooding is simulated in SBEACH (unless the seawall fails). Seawall failure may be incorporated based on the following three failures triggers:

- Maximum allowable vertical erosion;
- Maximum allowable total water elevation (including wave setup);
- Maximum allowable wave height.

If any one of these conditions is exceeded at the seawall during the simulation, the seawall "fails" (e.g. instantly disappears). The failure triggers must be applied at the same location as the seawall. When the seawall fails, SBEACH completely removes the structure from the simulation, allowing for waves and water to freely penetrate. Conversely, when the seawall does not fail, the structure completely prevents water, waves, and erosion landward of the seawall. As a result seawall protection and failure can be quiet unrealistic, selecting too low or too high failure triggers may significantly over-predict or under-predict storm-induced damages landward of the seawall.

In this study SBEACH simulations with seawalls (no failure allowed) are performed to capture the morphological changes with a seawall. Offline wave transmission and wave overtopping calculations are performed to estimate the wave and water level conditions landward of the seawalls.

5.3.3.2. Buried Seawall Approach

Buried seawalls are dunes with a reinforced rubble mound core. Buried seawalls were originally developed as an alternative to larger standalone seawalls / massive dunes and are designed to function in conjunction with beach restoration projects. The primary advantage of buried seawalls over traditional dunes is the additional protection against erosion and wave attack provided by the stone core. The buried seawall has a permeable core and will therefore not prevent inland flooding.

The approach applied to incorporating Buried Seawalls in SBEACH is as follows:

7. Perform SBEACH simulations for regular dune conditions (D-Runs)
8. Perform SBEACH simulations for regular dune with seawall (S-Runs)

9. Calculate wave transmission coefficient based on local water level (including wave setup) and wave height from S-runs.
10. Replace water level profiles from S-Runs with D-Runs (e.g. structure is permeable).
11. Replace wave height profiles from S-Runs with D-Runs, apply wave transmission coefficient to waves landward of structure.
12. Re-write SBEACH output file from the S-runs with the changes described above.

The wave transmission coefficient is calculated based on the simplified prediction method from CIRIA (2001) which relates the relative crest height of the structure to the wave transmission coefficient is used here to estimate the wave transmission. The CIRIA wave transmission relationship indicates that roughly a 50% decrease in the transmitted wave height occurs if the structure freeboard (Rc) is zero. Therefore, the crest elevation of the structure must be roughly equal to the local water level at the toe of the structure (including wave setup) to achieve a 50% reduction in the wave transmitted wave height. The primary inputs to the wave transmission formula are shown in Table 5-7.

Table 5-7: Wave Transmission Inputs

Parameter	Value/Definition	Comments
Crest elevation	16 ft NAVD	Fixed value
Seawall toe location	100 ft seaward from seawall	Defined by ~1/2 wavelength in front of seawall
Local Water Level	Still water level plus wave setup	Extracted from SBEACH results
Crest Freeboard, R_c	Crest elevation minus local water level	Calculated from SBEACH results
Wave height at toe	Maximum significant wave height during storm, at the toe position	Extracted from SBEACH results

5.3.3.3. Composite Seawall Approach

The second reinforced dune concept is a composite seawall with an impermeable core (i.e. steel sheet pile). The composite seawall is designed to limit storm surge inundation and cross-island flooding as well as erosion and wave attack. The composite seawall may also be compatible with a comprehensive storm surge barrier for Jamaica Bay. In contrast to the buried seawall, it is assumed that the wave transmission coefficient is zero due to the impermeable core. Wave overtopping and subsequent inland flooding is calculated as described below.

The approach applied to incorporating Composite Seawalls in SBEACH is as follows:

1. Perform SBEACH simulations for regular dune with seawall (S-Runs)
2. Calculate wave overtopping rate based on structure freeboard and wave height from S-runs.

3. Calculate corresponding upland flood depth based on wave overtopping rate and uniform open channel flow theory (Manning's formula).
4. Modify water levels in S-Runs landward of structure to reflect upland flood depth.
5. Re-write SBEACH output file from the S-runs with the changes described above.

The composite seawall is treated as a rubble mound structure from a wave overtopping perspective and the methods in the EurOtop Overtopping Manual (2007) were applied. The primary inputs to the wave overtopping formula are shown in Table 5-8.

Table 5-8: Wave Overtopping Inputs

Parameter	Value/Definition	Comments
Crest elevation	17 ft NAVD	Fixed value
Seawall toe location	100 ft seaward from seawall	Defined by ~1/2 wavelength in front of seawall
Still Water Level	Maximum water level at 40 ft depth	Extracted from SBEACH boundary conditions
Crest Freeboard, Rc	Crest elevation minus still water level	Calculated from SBEACH results
Wave height at toe	Maximum significant wave height during storm, at the toe position	Extracted from SBEACH results
Peak wave period	Maximum peak wave period	Extracted from SBEACH boundary conditions
Roughness factor, γ_f	0.55	Rocks (2 layers, impermeable core)

The upland flood depth is calculated based on the wave overtopping rate and uniform open channel flow theory (Manning's formula). A composite roughness coefficient of 0.065 was estimated based on the weighted average of the surfaces landward of the reinforced dune (e.g. asphalt, bare earth, short grass, light brush and trees, medium brush and trees, and buildings). A surface slope of 1V:666H is applied in the open channel flow calculations.

Since SBEACH does not simulate wave overtopping, there may be some instances in the sand-only alternative simulations where minor wave overtopping is not captured by the model. In order to provide a "apples to apples" comparison of the sand-only and composite seawall alternative, upland flooding is only incorporated for storms that result in a wave overtopping rate greater than 20 l/s/m, corresponding to a flood depth of approximately 0.5 feet.

Upland Flood Depth

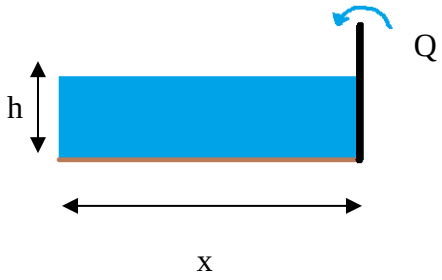
The flood depth on the leeside of the structure is estimated by applying uniform open channel flow theory (Manning's formula). Although wave overtopping during a storm is typically not uniform,

this approach provides a simple way to estimate the flooding landward of the seawall caused by high rates of wave overtopping.

Manning's formula is:

$Q = AV = (1.49/n)R_h^{2/3}S_e^{1/2}$ (U.S. Customary Units) (1)

where:



Q = discharge

A = area = hx

V = velocity

h = water (flood) depth

R_h = hydraulic radius = area/wetted perimeter = A/x

S_e = bed slope (landward of seawall)

n = Manning (roughness) number

The design wave overtopping rate (q) calculated with the EurOtop Manual is a discharge per unit width *x* (i.e. q = Q/x). Substituting into Equation 1 and solving for the flood depth *h* results in (Bedient and Huber, 1992):

$h = (nq/1.49S_e^{1/2})^{3/5}$ (U.S. Customary units) (2)

Hence, for this application, the flood depth is a function of the wave overtopping discharge, bed slope, and Manning's number. As explained previously, the wave overtopping rate was calculated at the toe of the seawall, determined to be 100 ft seaward from the structure. The bed slope on the leeside of the wall was defined as 1/666, thus giving a decrement of 3 ft over the upland width of about 2000 ft. The Manning's number, however, had to be estimated based on the land cover across Reaches 3 to 6 where the seawall would be located.

Estimation of Manning's Number

Aerial imagery of Rockaway suggests that the area to be protected by the seawall is in general highly developed with buildings, streets, and parking lots. However, the variations in building density as well as the presence of vegetation and undeveloped areas make it difficult to identify an appropriate Manning number for the entire area. The selection of a representative Manning's number is important, as the sensitivity of the flood depth to the Manning's number is high (Figure 5-34).

A composite Manning's number was estimated for each reach by examining the alongshore land cover characteristics within 1000 ft landward of the proposed seawall location. The composite value was calculated in the following manner (USGS 1984):

$n_{composite} = (n_1d_1 + n_2d_2 + \ldots n_nd_n)/(d_1 + d_2 + \ldots d_n)$ (3)

where *d* is the distance covered by a surface of Manning's number *n*. The type of surfaces that were found to primarily cover the area of interest and their corresponding Manning's number are listed in Table 5-9. With the exception of the building category, the source of these values is Chow (1959). A value of 0.12 was adopted for buildings based on guidance from URS, and this was found to be within other ranges found for buildings in the literature.

Table 5-9: Manning's number for main surfaces covering Reaches 3 to 6

Surface Type	Manning's Number
Asphalt (rough) / Concrete	0.016
Bare earth	0.025
Short grass	0.03
Light brush and trees	0.06
Medium brush and trees	0.08
Building	0.12

Figure 5-35 illustrates the application of this approach to a segment in Reach 3 and Table 5-10 shows the composite *n* values estimated for each reach. These values appear to be consistent with the building and vegetation densities observed in each reach. Given the small difference between these values and based on the sensitivity analysis shown in Figure 8, a Manning's number of 0.065 is proposed to be applied to all reaches.

Table 5-10: Composite Manning's number for each reach

Reach	Composite Manning's Number
3	0.076
4	0.057
5	0.056
6	0.064
Overall (apply to all reaches)	0.065

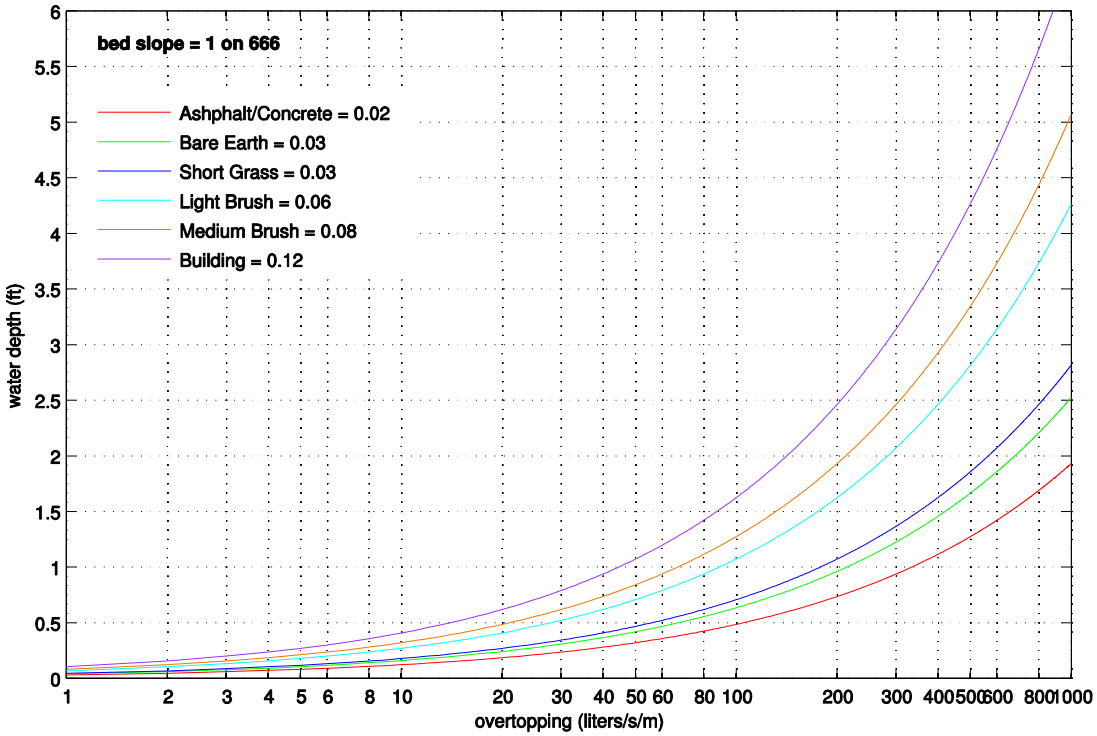


Figure 5-34: Sensitivity of flood depth (h) to Manning's number (n)

Figure 5-35: Illustration of composite Manning's number approach for Reach 3

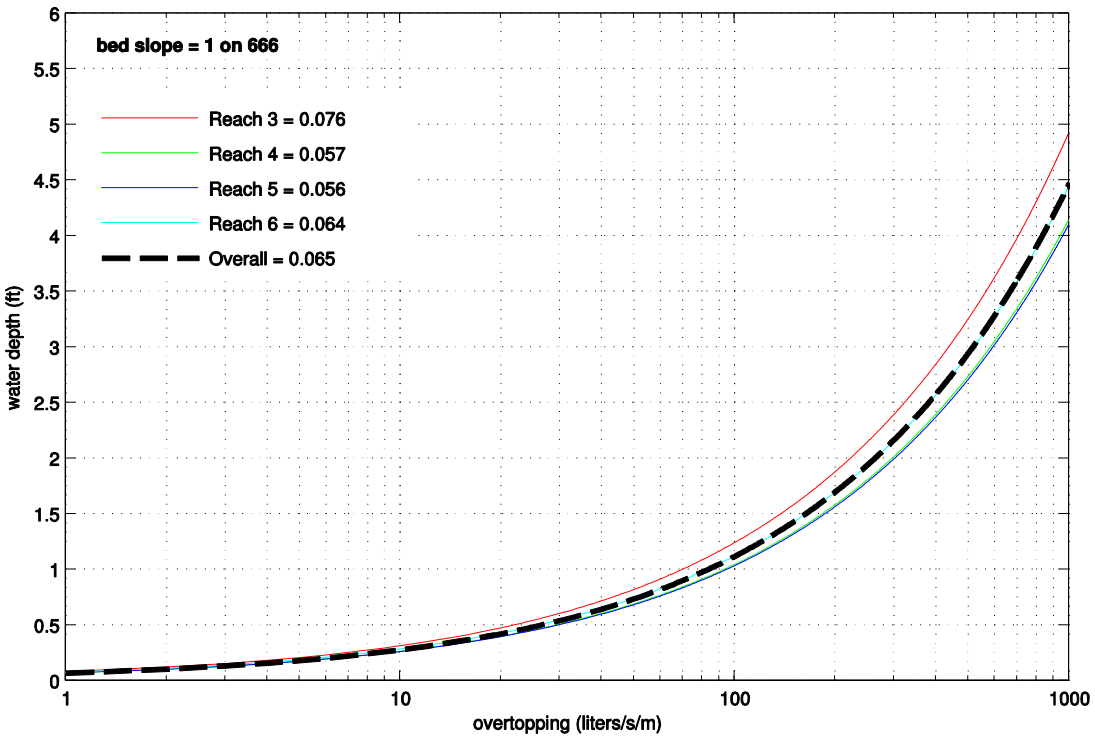


Figure 5-36: Sensitivity of flood depth to the various composite Manning's numbers

Incorporation of Flood Depth

Once calculated, the flood depth was incorporated into the original SBEACH output file from the location of the seawall to the extent of the upland elevation (~2000 ft). Figure 5-37 depicts the final product. The flood depth was sloped down using a 1/666 slope so its maximum is on leeside of the seawall and then decreases away from the structure.

Since SBEACH does not simulate wave overtopping, there may be some instances in the sand-only alternative simulations where minor wave overtopping is not captured by the model. In order to provide a fair evaluation of the sand-only and seawall alternatives wave overtopping and flood depths will only be incorporated for storms that result in a wave overtopping rate exceeding a threshold of 20 l/s/m, which yields a flood depth of approximately 0.5 feet. Figure 5-38 shows the number of storm events that exceed the wave overtopping threshold for each dune crest scenario.

In some cases where the seawall was not fronted by a dune and the overtopping threshold was exceeded, the flood depth on the leeside of the seawall was calculated to be higher than the ocean side water level. In these instances, the flood depth was set equal to the water level at the seawall on the ocean side and sloped down as described before. None of the storms were observed to generate a water level (including setup) greater than the seawall crest elevation (+18 ft NAVD).

However, if lower seawalls are considered than the local water level (including setup) for some storms will exceed the structures crest elevation.

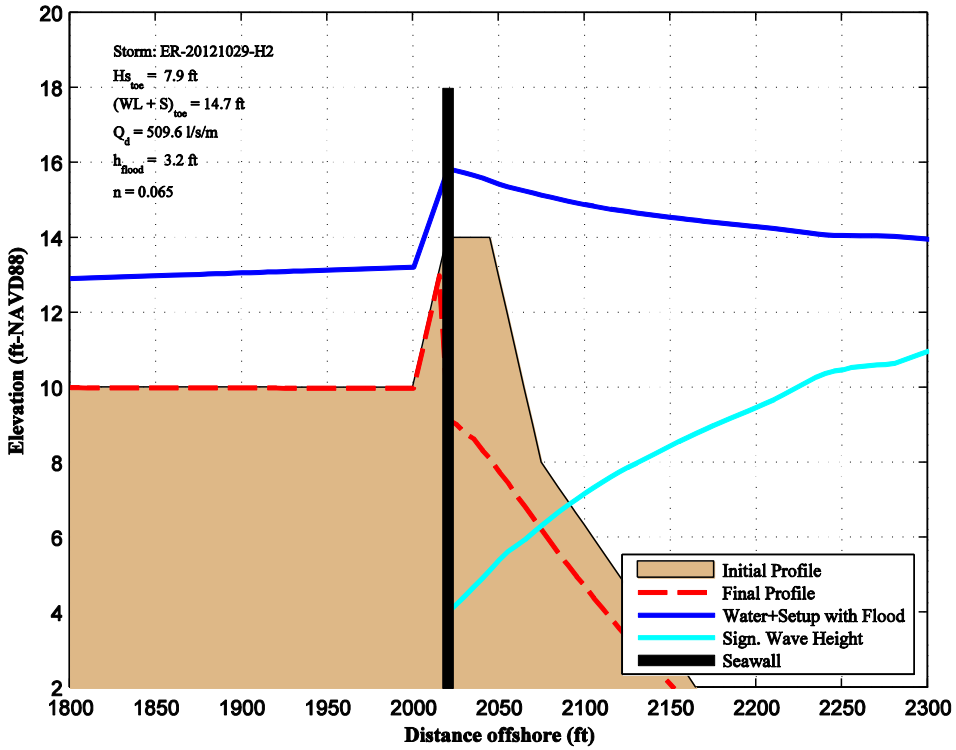


Figure 5-37: SBEACH output with flooding behind seawall

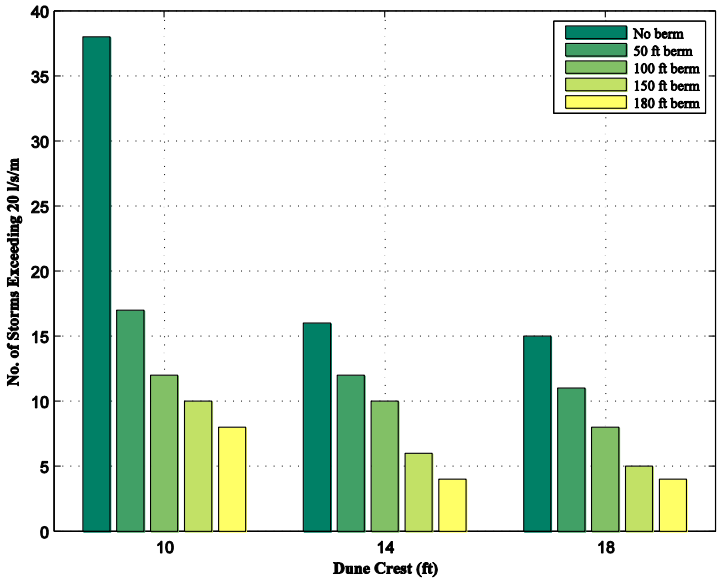


Figure 5-38: Number of storms to be modeled based on overtopping threshold

5.3.4 SBEACH Model Results

Over 410,400 (900 x 456) SBEACH simulations were required to construct the SRD for Beach-fx. A sample set of the SBEACH results for the following profiles and all 456 storms are provided in Enclosure A "SBEACH Model Results":

- R1T1_06.0_000_000
- R1T1_10.0_040_180
- R2T1_10.0_000_060
- R2T1_13.0_025_060
- R2T1_16.0_025_060
- R2T1_18.0_025_080
- R2T1_20.0_025_100
- R2T1_18.0_025_060 – Buried Seawall
- R2T1_18.0_025_060 – Composite Seawall

The naming convention "R2T1_20.0_025_180" indicates the profile (R2T1), dune height (20.0), dune width (025), and berm width (180).

6.0 EMPIRICAL SIMULATION TECHNIQUE (EST)

The Empirical Simulation Technique (EST) is used here to define frequency of occurrence relationships for important design parameters such as nearshore wave height, wave setup, wave overtopping, and beach and dune erosion.

6.1 Important Probability Concepts

To develop design parameter vs. frequency relationships, probability methods must be applied based on peak design parameter records (historical or simulated). The probability that an event, X, will occur and be equal to some prescribed value, x, is given by $P(X=x)$. Probability of exceedance, $P(X \geq x)$, is the probability that an event, X, will occur, in some prescribed time interval, and exceed x. Probability of exceedance, $P(X \geq x)$, is equal to the sum of all probabilities, $P(X=xi)$, where $xi \geq x$. For example, if a peak wave height of 10 ft has a probability of exceedance of 0.9, there is a 90% chance that peak wave height will exceed 10 ft. Conversely, the probability of nonexceedance, $P(X \leq x)$, is equal to $1-P(X \geq x)$ and is the probability that no event, X, will occur and exceed some prescribed value, x. For this study, probability of exceedance is analogous to frequency. Typically, engineers present design parameter vs. frequency relationships in terms of return period. Return period, Tr, is the reciprocal of the probability of exceedance ($Tr(x)=1/P(X \geq x)$).

To associate probability with a given event, it is necessary to assume the population of events follows some defined probability distribution. A cumulative distribution function (CDF), F(x), is a function that describes the probability of nonexceedance, such that $F(x)=P(X \leq x)$. The probability density function (PDF), f(x), is defined as the derivative of the cumulative distribution function, $f(x)=d/dx(F(x))$. The most well-known PDF is the normal (Gaussian) distribution function, or bell curve.

In this study univariate EST and multivariate EST are applied to determine frequency-of-occurrence relationships. Furthermore, the population of storms was divided into two distinctly different sets: extratropical and tropical.

6.1.1.1. Peak-Over-Threshold Analyses

Peak-over-threshold methods involve analyses of historical records to extract a subset of peak values, N values, exceeding some prescribed cutoff criteria, such as a maximum expected annual tide or similar. This subset is then ranked, with rank n, in order of magnitude and assigned a probability, P. In this study a training set of storms has already been developed and is assumed to represent the peak wave height and wave setup events for Rockaway.

For peak-over-threshold analyses, the probability of a wave event occurring during a particular interval along with the probability of that event exceeding a certain value must be determined. The EST is used to determine the cumulative distribution, F(x), values that correspond to the

probability of an event causing a wave height at or below a specified value, given that an event occurs. The EST method is detailed in Section 6.2. In the EST, the number of storms in a time interval, t, is modeled with the Poisson distribution. The Poisson distribution is:

$$F(M = m) = \frac{e^{-\lambda t}(\lambda t)m}{m!} \qquad \text{(Equation 6-1)}$$

where:

λ is the average rate of occurrence (ex. 14 storms in 72 years gives λ=14/72=0.194), P(M = m) is the probability of M=m occurrences in the interval t.

Then, the return period for a particular event is:

$$T_r(x) = \frac{1}{\lambda(1 - F(x))} \qquad \text{(Equation 6-2)}$$

The storm training set contains 22 extratropical events over 49 years and 14 tropical events over 72 years. This corresponds to $\lambda_{tropical}$=0.194 and $\lambda_{extratropical}$=0.449.

6.1.1.2. Combined Storm Populations

Two distinct storm populations were considered for this study: extratropical events, characterized by extratropical weather patterns and durations on the order of days, and tropical events, characterized by cyclonic weather patterns and durations on the order of hours. The combined return period, including both extratropical and tropical events, is defined as:

$$T_{combined}(x) = \frac{1}{\left(\frac{1}{T_{tropical}(x)} + \frac{1}{T_{extratropical}(x)}\right)} \qquad \text{(Equation 6-3)}$$

6.2 Empirical Simulation Technique (EST)

EST is a nonparametric method for determining frequency-of-occurrence relationships. Parametric methods assume that the storm population follows some prescribed probability distribution, for example a normal (Gaussian) distribution. In contrast, nonparametric methods do not presume a distribution; instead the distribution is computed from the available data (i.e. it is assumed the future events will be statistically similar in magnitude and frequency to past events). When selecting a method for use with a particular data set, it is important to realize that nonparametric methods are more appropriate when the population distribution is unknown, while parametric methods are more appropriate when the distribution is known beforehand. As such, nonparametric methods are more appropriate for determining the extreme wave heights and wave setup at Rockaway.

EST begins with an analysis of historical events that have impacted a specific location. In this study these events are the storm training set. The selected database of events is then parameterized based on event characteristics and the impacts of each event. Parameters that define the storm are referred to as input vectors (e.g. wave period, storm surge, etc.). Response vectors define storm related-impacts such as wave setup and shoreline erosion. These input vectors are then used as a basis for generating life-cycle simulations of storm-event activity.

The probability of a storm event occurring in a given year in the life-cycle simulation is modeled by the Poisson distribution (Equation 6-1). When a storm event(s) occurs during a life-cycle simulation a realistic storm event is generated from the historical events using the nearest neighbor interpolation, bootstrap, resampling technique developed by Borgman et al. (1992). The response vectors for each simulated storm event are obtained from 1-D (Univariate EST) or multi-dimensional (Multivariate EST) interpolation between generated storm event and input vectors. Events that are output by the EST are similar to those in the training set with some degree of variability from the historic events.

Each life cycle simulation represents a realistic prediction, albeit with a degree of variability, of the frequency and magnitude of storm events that might occur over a real life cycle. Simulating many life-cycle simulations, as in EST, allows statistical quantification of response parameter vs. frequency-of-occurrence relationships with definable confidence limits. For theoretical details associated with the EST life-cycle simulation procedure the reader is referred to Scheffner et al. (1999).

6.2.1 Univariate EST

Univariate (1-D) EST is any EST simulation with one input vector. In 1-D EST simulations the response parameters are obtained from 1-D interpolation between the input vector and response vector(s). Generally the input and response parameter are the same (e.g. wave height). This approach is used for determining the frequency-of-occurrence relationships for the offshore wave and nearshore wave heights. In this study 500 500-year life-cycle simulations for tropical and extratropical storms to determine the offshore and nearshore wave height vs. frequency-of-occurrence relationships.

6.2.2 Multivariate EST Methods for Determining Probability Distributions

Multivariate EST is a statistical procedure used to develop frequency relationships of occurrence relationships for design parameters as a function of the input parameters (i.e. wave, tide, and surge) that are descriptive of the storm event but have unknown joint probabilities.. The multivariate EST approach used here for SBEACH model results is the same as used for FIMP (Gravens et al., 1999). Details of the approach, as applied to wave setup along Rockaway, are provided below from Gravens et al. (1999).

Multivariate EST requires specifying a set of parameters that describe the dynamics of some physical system – nearshore wave setup in response to tropical and extratropical storms in this case. The response parameter, wave setup, must be descriptive of both the process being modeled and the effects of that process. The parameters that describe only the physical attributes of the process are referred as input vectors.

Input vectors are specific parameters describing those characteristics of the storm which have a first-order effect on the magnitude of the modeled response. Nine input parameters, the same as in FIMP, are defined:

6.2.2.1. Storm Surge Parameters

- Peak surge
- Duration of storm surge (length of time surge exceeds 0.3 m)[3]
- Average value of surge over the storms duration

6.2.2.2. Tide Parameters

- Tide amplitude (spring, average, or neap)
- Tide phase at peak surge (high, mid, or low tide)
- Slope of tide at peak surge (needed to distinguish between high tide occurring before and after peak surge)

6.2.2.3. Storm Wave Parameters

- Peak wave height.
- Duration of storm waves (length of time wave height exceeds 1 m).
- Average value of wave height over the storm's duration.

The second class of vectors involves some selected response resulting from the input-vector-parameterized storm. Originally Graves et al. (1999) evaluated 19 specific response vectors, three new response vectors (#20, #21, and #22) have been added to help characterize the performance of the dune and seawall alternatives. The 22 responses are as follows:

1. Erosion Distance – Distance from 0 NAVD on initial beach profile to the landward-most point of 0.3 m (1 ft) vertical erosion/accretion.
2. Eroded Volume above 0 NAVD.

[3] It is worth to highlight the storm duration as an import storm characteristic besides the surge elevations, since it is sometimes overlooked. A prolonged duration of moderate storm conditions can have similar impacts as a shorter more severe storm condition.

3. Eroded Volume above +3 m (10 ft) NAVD.
4. Vertical Erosion of Dune Crest.
5. Landward Translation of Dune Crest.
6. Maximum Runup Elevation – relative to NAVD.
7. Maximum Runup Height – magnitude of runup relative to instantaneous still water level.
8. Maximum Wave Height – highest wave at offshore boundary of model domain (~10 m depth).
9. Wave Period – wave period associated with maximum wave height.
10. Maximum Tide and Surge – relative to NAVD.
11. Maximum Wave Setup Elevation – relative to NAVD.
12. Maximum Wave Setup Magnitude – relative to instantaneous still water level.
13. Maximum Nearshore Wave Crest Elevation – elevation of wave crest at the shoreline, relative to NAVD.
14. Maximum Nearshore Wave Height – wave height at the landward edge of the inner surf zone.
15. Active Profile Distance – distance from 0 NAVD on initial profile to landward limit of profile change.
16. Recession of 0 NAVD contour.
17. Recession of 1.5-m (5-ft) NAVD contour.
18. Recession of 3.0-m (10-ft) NAVD contour.
19. Recession of 4.6-m (15-ft) NAVD contour.
20. Maximum Upland Flood Depth – height of water above ground on leeward side of dune/seawall
21. Maximum Upland Wave Height – wave height on leeward side of dune/seawall
22. Maximum Wave Overtopping Rate – peak (mean) wave overtopping rate in liters per second per meter during storm event. Calculated outside of SBEACH.

The results for response vector #20 (Upland Flood Depth) and vector #21 (Upland Wave Height) are shown in Figure 6-1.

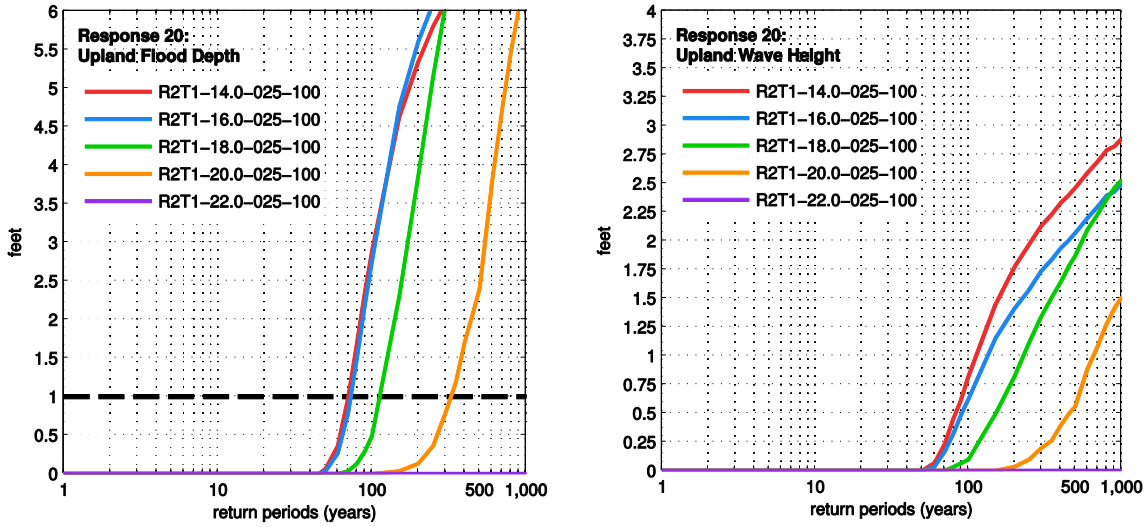


Figure 6-1: EST Results for Upland Flood Depth and Wave Height

7.0 CROSS-ISLAND FLOODING MODELING (XBEACH)

7.1 XBEACH Overview

The purpose of the XBeach modeling effort is to evaluate cross-island flooding during severe coastal storms at Rockaway Beach, NY. XBeach resolves long wave motions (e.g. infragravity waves) and is well suited to predict surfbeat, wave breaking, wave setup, surf and swash zone processes, overwash, inundation, and cross-island flooding during storm events. The primary difference between XBeach and other hydrodynamic models is that XBeach includes wave group driven motions. Studies have shown that nearshore hydrodynamics and morphodynamics are often dominated by time scales associated with wave groups during storm conditions (Roelvink et al. 2009).

XBeach modeling results are used to characterize cross-island flooding during a range of extreme storm conditions (10, 25, 100, and 500-year return period) in Without Project Future Conditions (WOPFC). The modeled water levels across the peninsula are being used as inputs to a HEC-FDA economics model to calculate WOPFC damages to non-shorefront infrastructure.

Unlike many coastal shorelines, Rockaway Beach does not have a natural dune system. The high point along most of the shoreline is a broad coastal ridge with elevations between +10 ft and +12 ft NAVD. Urban development has occurred along the ridge, which is located at the seaward edge of the developed neighborhoods. Landward of the ridge, the ground slopes gradually down towards Jamaica Bay. Figure 7-1 shows pre- and post-Sandy photos along a representative section of Rockaway Beach (Neoponsit). Debris and sand deposits provide evidence of the strong waves and currents capable of transporting large quantities of sand across the peninsula.

The photos also show that the storm did not cause any substantial changes in the bed elevations apart from lowering of the beach berm. If a dune had been present prior to the storm, the post-storm photo would likely have shown substantial dune erosion and depending on the size of the dune, complete flattening of the dune. Not surprisingly, in the absence of a dune sediment transport and morphological processes appear to only play a minor role in cross-island flooding at Rockaway Beach.

It is acknowledged that the Army Corps of Engineers is in the process of placing 3.5 million cubic yards of sand and building a dune with a crest elevation of +16 feet NAVD88. However, in the absence of a continued renourishment it is unclear how long the constructed beach and dune will last. Historical records indicate that substantial quantities of sand have been required (approximately 350,000 to 400,000 cubic yards) to maintain the beach at Rockaway. Therefore, it is likely that over the 50-year project evaluation period that WOPFC will best be described by beach conditions with a narrower beach and no dune. The XBEACH simulations assumed that the post-Sandy bed elevations (e.g. no dune / narrow beach) are representative of the WOPFC.

XBeach is also well suited to calculate sediment transport and morphology changes during storm events. However, in this study sediment transport and morphology processes were not included in the model simulations to simplify and streamline the study. It is also believed that sediment transport and morphology processes play a minor role in evaluating cross-island flooding in WOFPC (e.g. no dune).

It is beyond the scope of the present study to complete a full model calibration for the XBeach model. Instead a desk top validation analysis was performed to compare the model response to Hurricane Sandy conditions.

Figure 7-1: Pre- and Post-Hurricane Sandy Comparison at Rockaway Beach (USGS)

7.2 XBEACH Model Setup

7.2.1 XBeach Description

XBeach (eXtreme Beach behavior) is a two-dimensional model for short wave envelope propagation, nonstationary shallow water equations, sediment transport and bed update. XBEACH is a public-domain model that has been developed with funding and support by the US Army Corps of Engineers, by a consortium of UNESCO-IHE, Deltares, Delft University of Technology, and the University of Miami.

XBeach uses an innovative time-dependent wave action balance solver, which solves the wave refraction (bottom and current) and allows variation of wave action in x, y, time, and over the direction space (Roelvink et. al, 2010). The wave action balance solver is used to simulate the propagation and dissipation of wave groups (infragravity waves). The directional distribution of the action density is taken into account, whereas the frequency spectrum is represented by a single representative frequency. Several wave dissipations models are available for use in the nonstationary wave action balance.

XBeach uses the Generalized Lagrangean Mean (GLM) approach to solve the nonstationary shallow water equations. This approach was implemented to represent the depth-averaged undertow and its effect on bed shear stresses and sediment transport.

XBeach also includes sediment transport, morphology, and many other advanced features (i.e. groundwater flow, non-hydrostatic waves, etc.) that are not included in this study. A complete description of the XBeach is available in *"Modelling storm impacts on beaches, dunes and barrier islands"* (Roelvink et. al, 2009) or the "*XBeach Manual"* (Roelvink et. al, 2010).

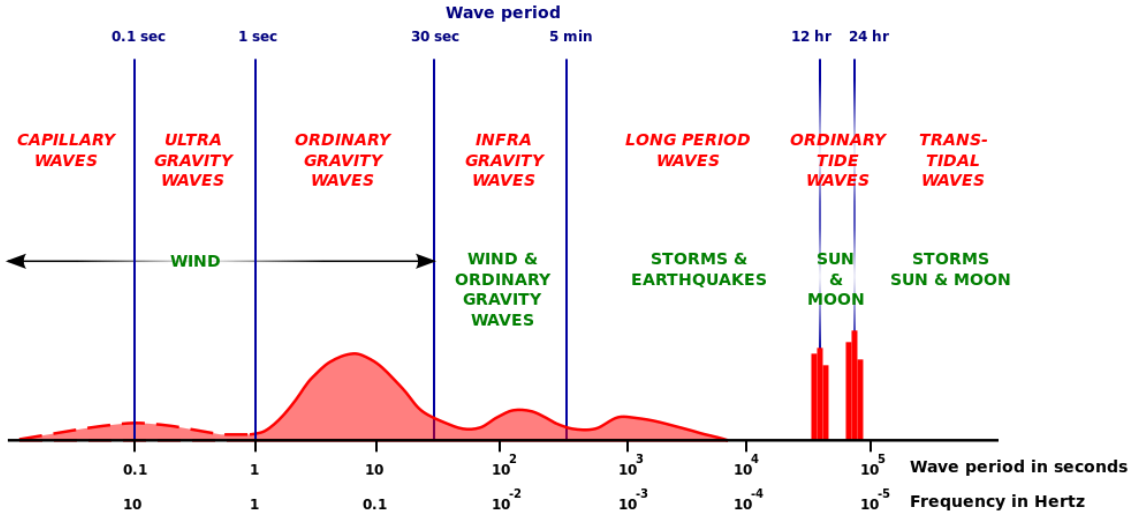


Figure 7-2: Ocean Wave Spectrum Classification (Munk, 1950)

7.2.2 XBeach Model Grid & Bathymetry

A rectilinear model grid encompassing the entire Rockaway peninsula and part of Long Beach was developed for the study. The model extends offshore beyond the seaward edge of the surf zone and includes a portion of Jamaica Bay and Hempstead Bay.

The modeling domain does not include Rockaway Inlet and therefore does not include the complex processes at this inlet. The selected modeling approach simplifies the boundary conditions and allows greater flexibility and control over the Jamaica Bay water elevations. One of the limitations of this approach is that the Jamaica Bay water elevations are uniform along the boundary.

Preliminary modeling simulations were performed with a separate and larger modeling grid that included Rockaway Inlet, however such a modeling domain would need to be calibrated to ensure that the tide and surge propagation into Jamaica Bay were correctly predicted by the model. A larger modeling domain would have been inefficient with too much burden on computational resources

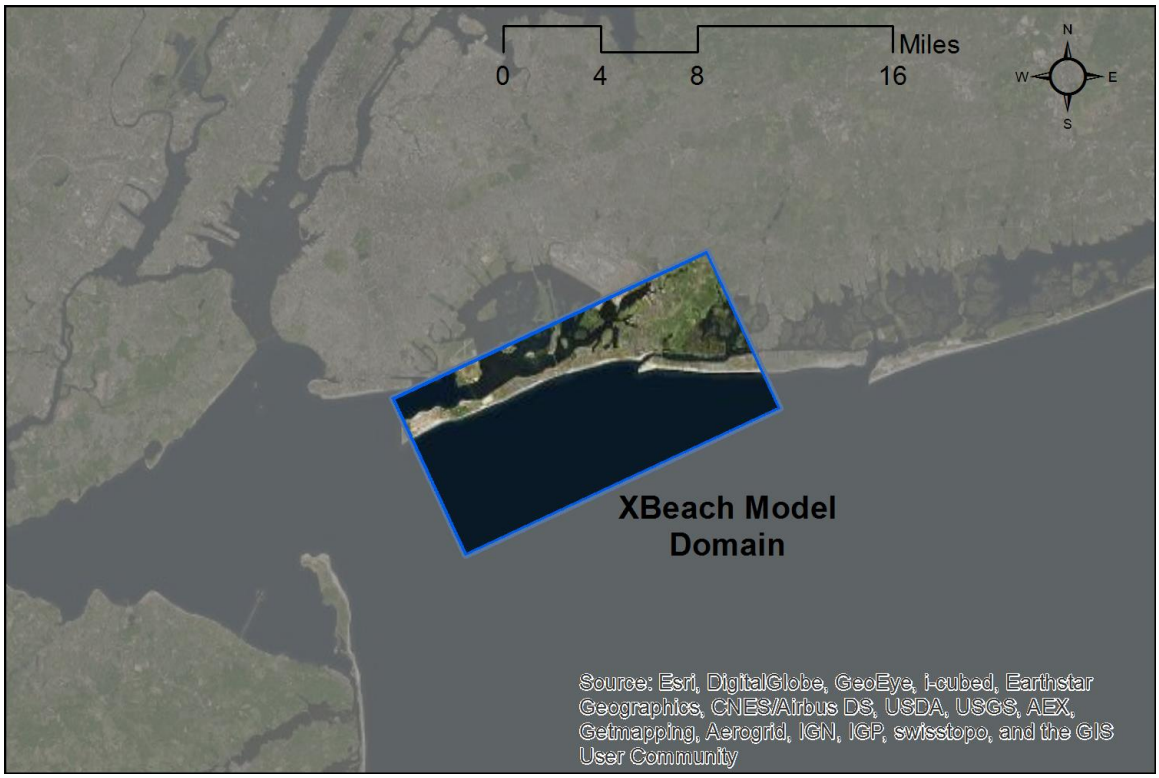


Figure 7-3: XBeach Model Domain

The model grid resolution ranges between 48 meters offshore to up to 12 meters along the shoreline and upland areas. Several data sources were used to create the model bathymetry:

- LIDAR data collected by the USACE on 2012-11-16 and New York State over several weeks in the winter of 2012;

- ACNYMP Beach Profiles;
- Multibeam survey of East Rockaway Inlet performed by Rogers Surveying in 2005.
- FEMA ADCIRC Modeling Grid.

All the bathy data was converted to a consistent spatial coordinate system (UTM 18N) and vertical datum (meters NAVD) prior to use. In addition, the "bare earth" LIDAR data was modified to remove debris piles in areas such as Jacob Riis Park, boardwalk debris, and locations where the LIDAR data picked up the elevation of the overpasses.

All the bed elevations in Jamaica Bay were set to -15 ft NAVD effectively removing the marshes and small islands in the bay. This simplification of the bed elevations in the bay allows the application of a simple boundary condition along the bay. The model bathymetry along the offshore boundary was also adjusted to ensure a uniform depth along the boundary. These adjustments do not significantly impact the solution in the area of interest, Rockaway Beach.

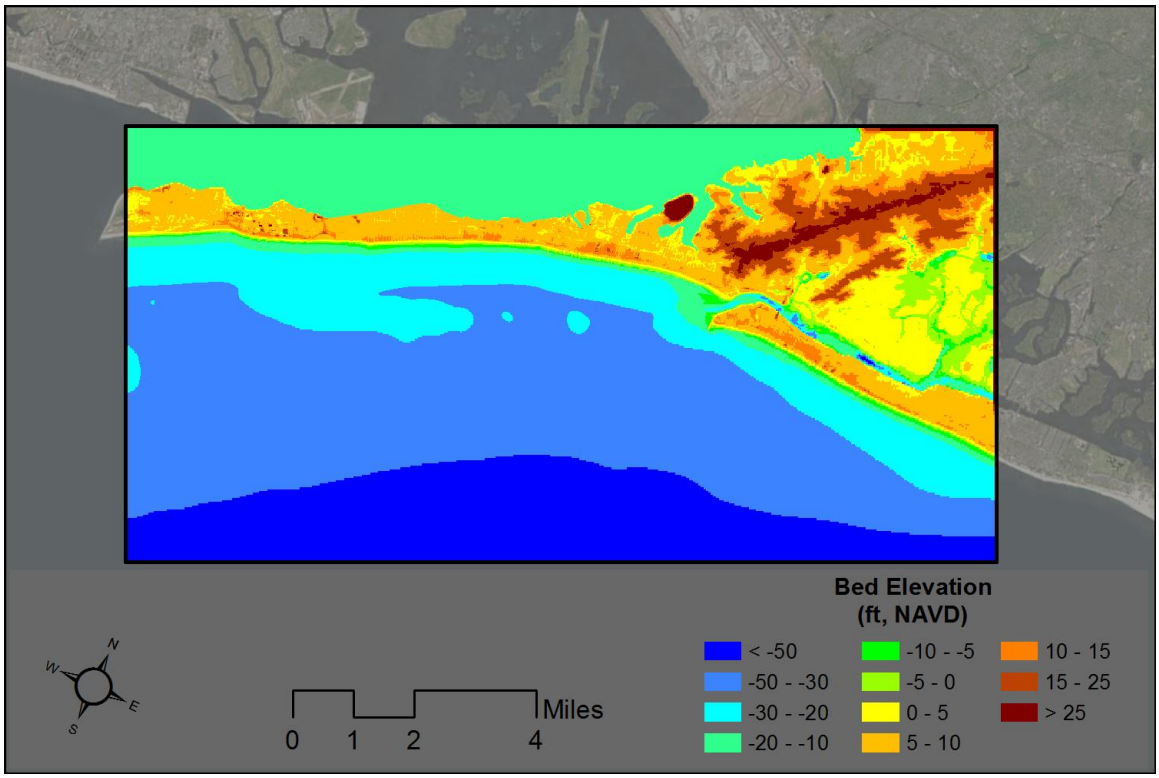


Figure 7-4: XBeach Model Bathymetry

7.2.3 XBeach Boundary Conditions

7.2.3.1. Flow

The flow boundaries for the model are the offshore, bay, and lateral boundaries. Weakly-reflective boundaries (absorbing boundary) are applied on the offshore and bay boundaries with a separate

time series of water elevations applied uniformly along each boundary. The lateral flow boundaries are prescribed as Neumann or "no-gradient" boundaries. The Neumann boundary preserves the alongshore gradient in the water level and longshore currents.

7.2.3.2. Waves

Two types of offshore wave boundaries are applied in the model simulations. In the Hurricane Sandy validation simulations time-varying directional spectrum output from SWAN simulations at single location near the center of the offshore boundary are prescribed. Details of the SWAN model are provided in a Memorandum for Record titled "Task 2 – Incorporate Sand Scale Storm in the Evaluation" prepared by Hampson & Jimenez and dated December 4, 2013. In the production simulations of synthetic storm events the wave conditions are specified by the bulk parameters (significant wave height, peak wave period, mean wave angle, peak enhancement factor for the JONSWAP spectrum, and direction spreading coefficient). In both instances the wave conditions are specified in 1 hour blocks with a slight taper (100 seconds) between the blocks.

7.2.4 XBeach Model Settings

With the exception of the bed roughness, the default settings for the XBeach model are applied. A spatially varying map of the bed roughness (Chezy coefficient) was used in the model to capture the change in the roughness over land due to vegetation and urban infrastructure. Over water a Chezy coefficient of 55 $m^{1/2}/s$ is used and over land a value of 15 $m^{1/2}/s$. The over land Chezy value was selected based on previous work for Reformulation Study which calculated a composite Manning Number of 0.065 (unitless) based on the roughness from vegetation and urban development (*"Seawall Overtopping and Flooding"*). A Manning Number of 0.065 is equivalent to Chezy value of 15.4 $m^{1/2}/s$ in 1-meter of water depth.

7.3 XBEACH Validation

7.3.1 XBeach Validation Boundary Conditions

The flow boundary conditions (water level) for Hurricane Sandy are obtained from two temporary USGS storm tide stations deployed prior to the storm: Sea Gate (SSS-NY-KIN-001WL) and Broad Channel (SSS-NY-QUE-005WL). The Sea Gate storm tide sensor is used to define the ocean water levels and the Broad Channel sensor is used to define the bay water levels. Figure 7-5 shows the locations of the two stations and Figure 7-6 shows the recorded water levels during the storm event. A 1 hour running average filter was applied to the water elevations to remove oscillations caused by waves.

The wave boundary conditions (directional frequency spectrum) are obtained from SWAN spectral wave model output at a location approximately 2 miles offshore of Rockaway. Figure 7-7 presents

the bulk parameters (H_{m0}, T_p, wave direction) obtained from the XBEACH boundary conditions (direction spectrum) for Hurricane Sandy.

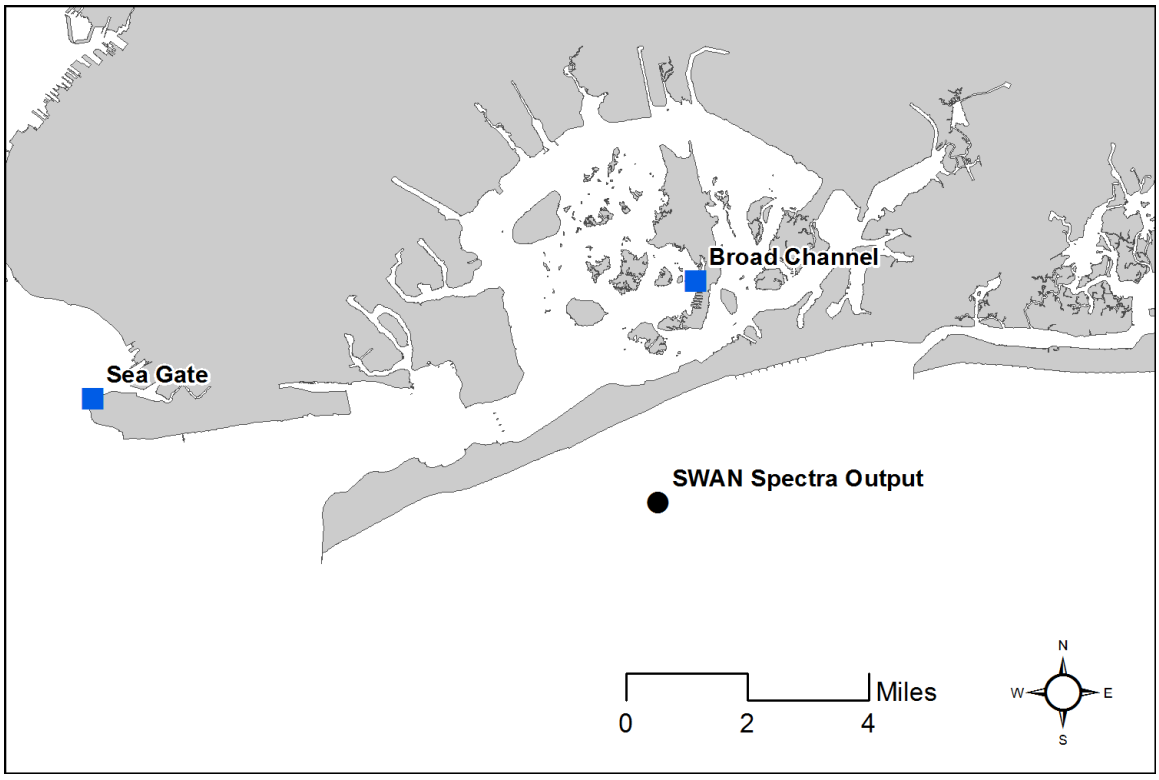


Figure 7-5: Hurricane Sandy Tide and Wave Stations

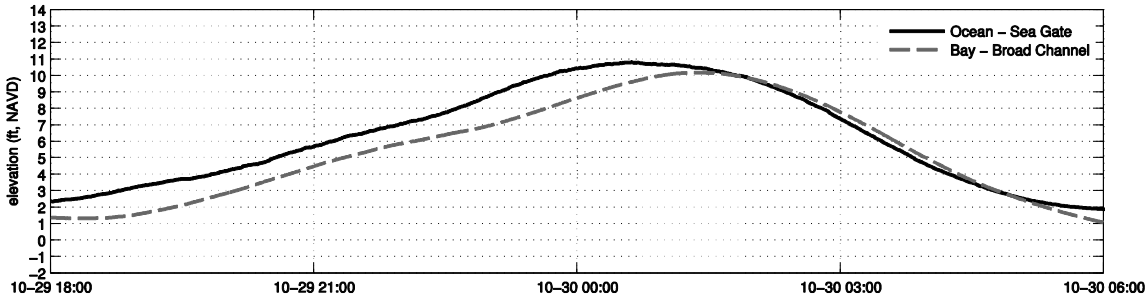


Figure 7-6: XBEACH Storm Tide Boundary Conditions – Hurricane Sandy

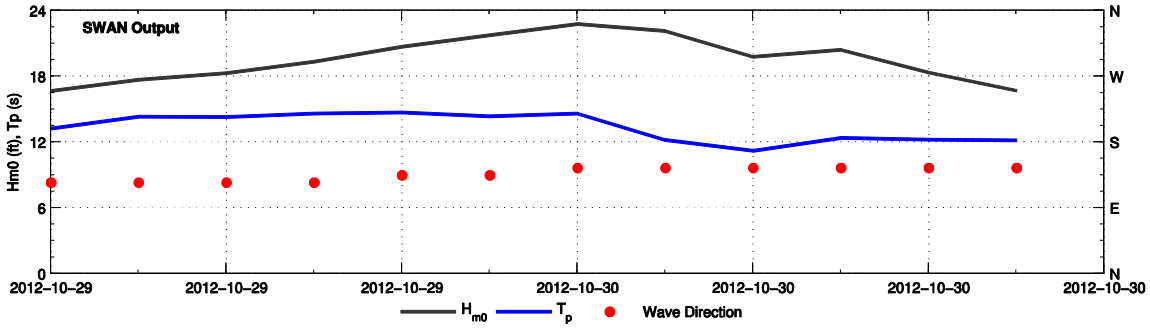


Figure 7-7: XBEACH Wave Boundary Conditions – Hurricane Sandy

7.3.2 XBeach Model Validation Results

Instantaneous snapshots of the water surface and bed elevation during the Hurricane Sandy simulation are shown in Figure 7-8. Only a small portion of the modeling domain, near Jacob Riis Park, is shown in the snapshot. The top panel shows the conditions about 4 hours before the peak of storm, before any noticeable overwash or cross-island flooding has occurred. The bottom panel shows the conditions 1 hour before the peak of the storm, at which time inundation and cross-island flooding has already begun to occur.

The ocean water levels are several feet higher than the bay water levels due to: 1) higher ocean side storm surge, 2) nearshore wave setup. The island is also characterized by a high coastal ridge (+10 ft to +12 ft NAVD) along the shoreline. Landward of this coastal ridge, the ground slopes gradually back towards the bay. Therefore, once the high coastal ridge is overtopped, water flows across the island towards the bay. In instances when nearly the whole peninsula is inundated (e.g. Hurricane Sandy) a gradient in the water level develops between the ocean and bay. Figure 7-9 presents a map of the maximum modeled water elevations during Sandy and Figure 7-10 shows the maximum inundation depths (height above ground) along Rockaway. These maps capture the extent of flooding during Sandy as well as the gradient in the water levels across the peninsula.

The map of maximum water elevations, Figure 7-9, also shows a comparison of the observed and modeled High Water Marks (HWM). Most of the HWM are located near the bay, and thus controlled by the bay water levels. However, there are two HWM located closer to the ocean, both of which had much higher flood elevations (12.7 ft NAVD). The model is able to reproduce the water elevations at these two locations (12.9 ft and 13.4 ft NAVD). This provides confidence that the model is able to reproduce the gradient in water elevations across the peninsula.

A time series of the modeled water elevation at two of the HWM (QUE-729 and QUE-730) is presented in Figure 7-11. One of the HWM (QUE-729) is located in an area exposed to ocean waves and the other (QUE-730) is not. The light grey line is the instantaneous water elevation at 1 minute intervals and the black line is the filtered water elevation (1-hour running average).

Oscillations from long waves are visible in the time series of the water level at the HWM exposed to ocean waves. This variation is not present in the bay side HWM.

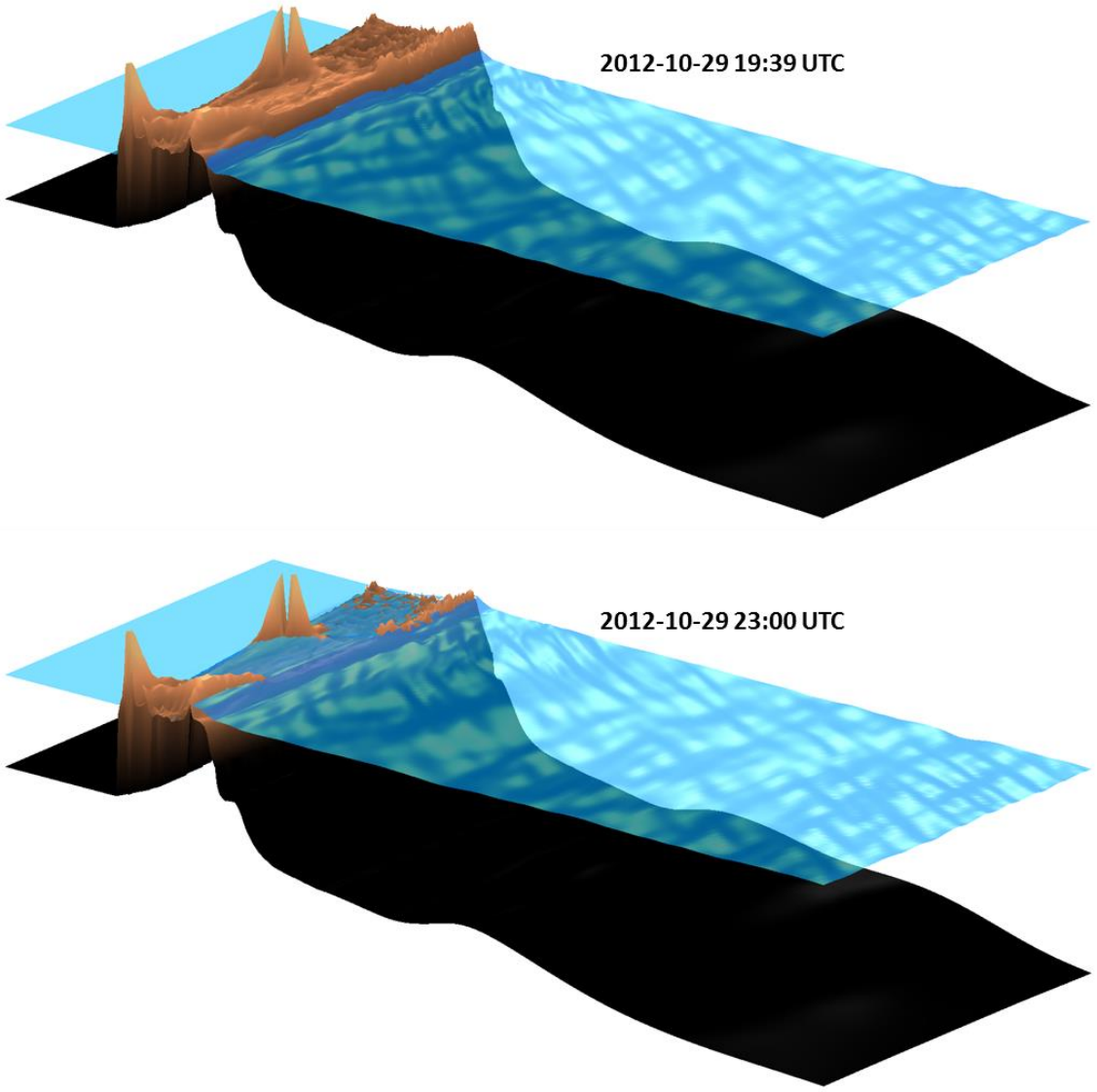


Figure 7-8: XBEACH Snapshot of Water Level near Jacob Riis Park

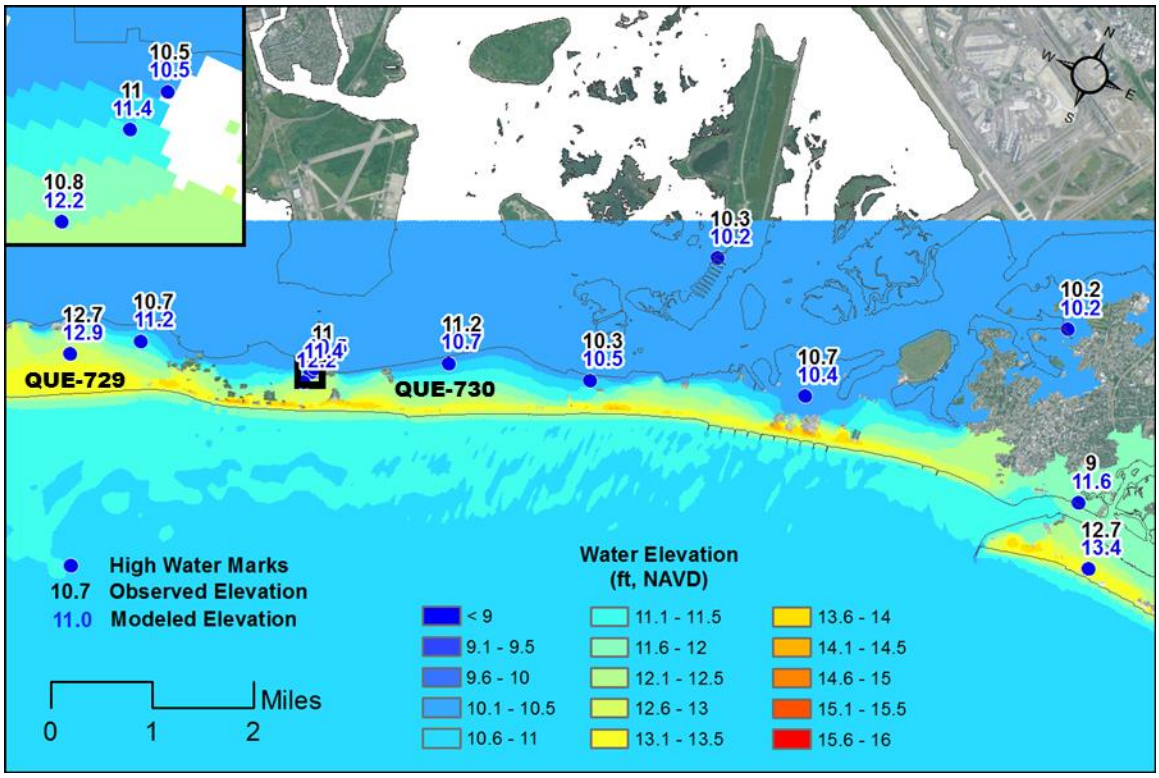


Figure 7-9: XBEACH Modeled Maximum Water Elevations – Hurricane Sandy

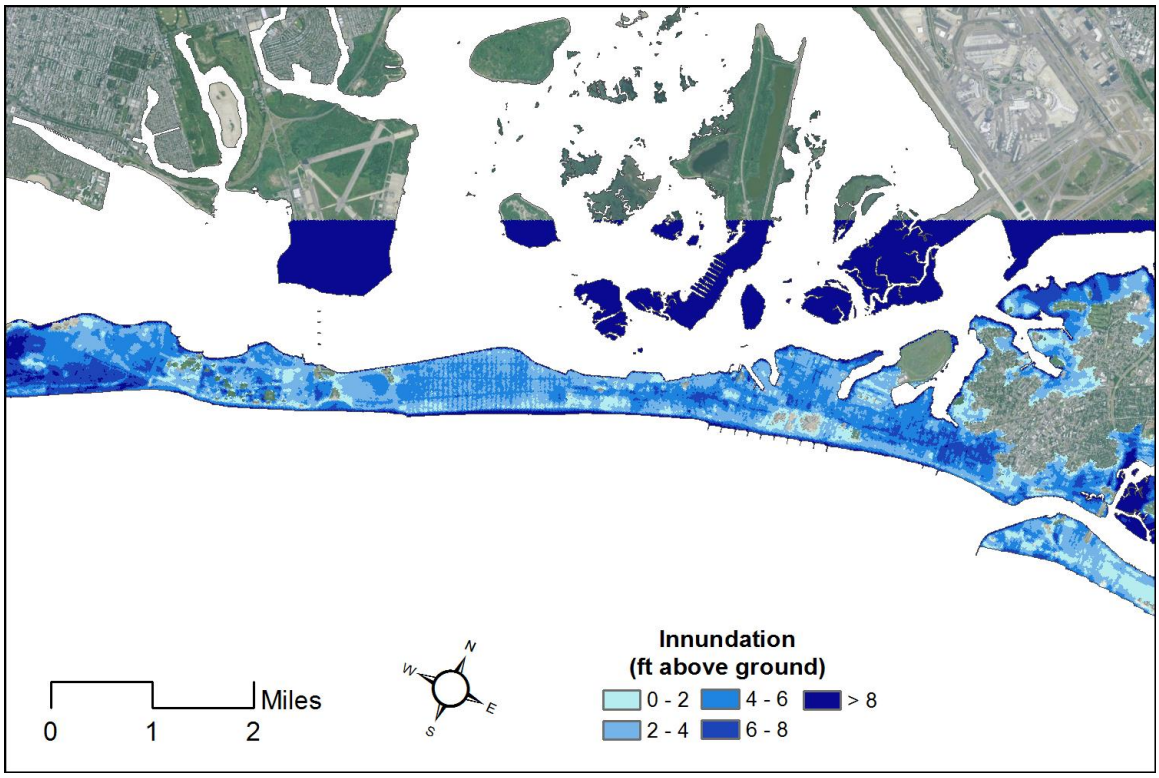


Figure 7-10: XBEACH Modeled Maximum Inundation – Hurricane Sandy

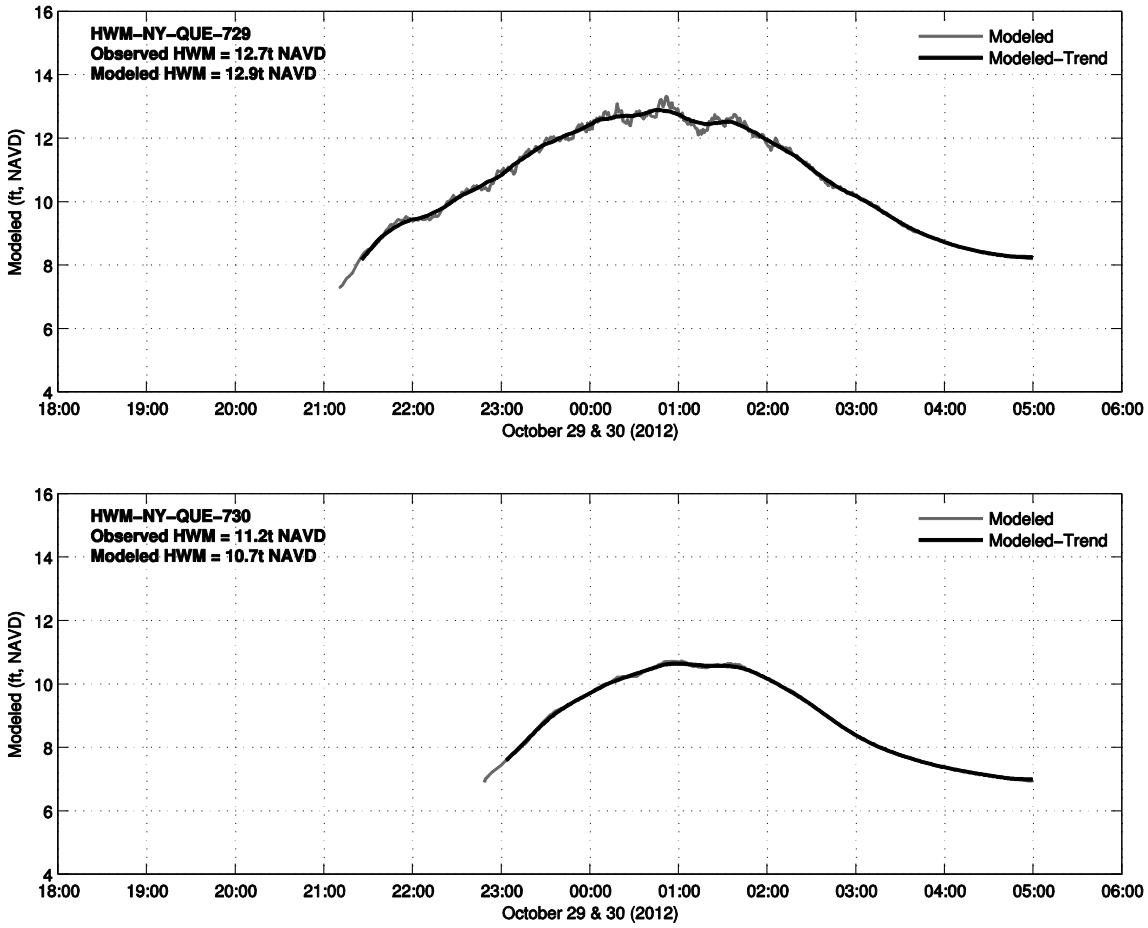


Figure 7-11: XBEACH Time Series of Modeled Water Elevations – Hurricane Sandy

7.4 XBEACH Without Project Simulations

7.4.1 XBeach Without Project Boundary Conditions

XBEACH simulations were performed for four synthetic storm events representing the 10, 25, 100, and 500 year return periods. The shape of the synthetic storm hydrographs is developed following the same approach applied by Larson & Kraus (1989) and utilized mathematical functions to represent the evolution of the surge during hurricanes and nor'easters. The basic premise is that Hurricanes have relatively short storm surge durations when compared to nor'easters. The 10 and 25 year events were simulated as Nor'easters and the 100 and 500 year events were simulated as Hurricanes. Synthetic surge and wave boundary conditions were developed such that the maximum still water level and maximum significant wave height and wave period corresponded to the design conditions as described above and shown in Table 7-1. The development of the design water levels and wave conditions has been documented in earlier reports. Figure 7-12 presents an example of the boundary conditions for a Nor'easter and

Hurricane. Since only the peak 12 hours of the storm are simulated in XBEACH, the significant wave height and peak wave period were held constant during the 12-hour simulations. Only the ocean and bay water levels varied during the simulations.

Table 7-1: XBEACH Boundary Conditions – Synthetic Storms

Return Period (years)	Ocean SWL (feet, NAVD)	Bay SWL (feet, NAVD)	T_p (s)	H_{m0} (feet)
10	6.5	6.6	14	15.3
25	7.9	7.9	14	18.6
100	10.5	9.8	14	23.9
500	14.7	12.3	14	29.3

Ocean and Bay Still Water Levels obtained from FEMA (2013)

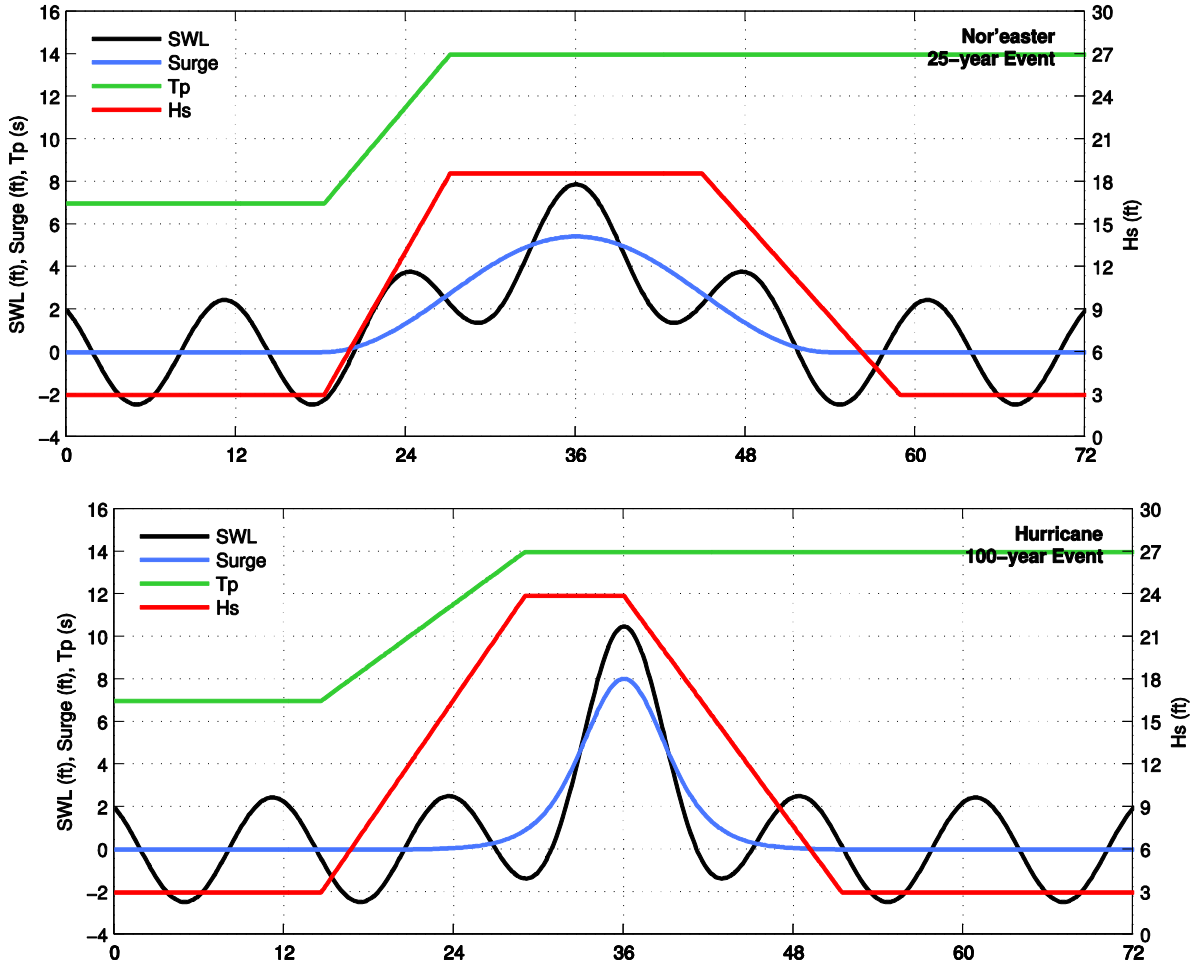


Figure 7-12: XBEACH Synthetic Nor'easter and Hurricane Boundary Conditions

7.4.2 XBeach Without Project Model Results

Results for the four synthetic storm simulations are presented in Figure 7-13. Each panel shows the maximum modeled water elevation during the simulation. The four storm events (10, 25, 100, and 500 year return period) capture four very different levels of flooding. The model results show what areas are most vulnerable as well whether the flooding is caused by the ocean or bay.

During the 10-year event, only a few areas of Rockaway are flooded, most notably Breezy Point, Roxbury, the center of the peninsula, and the eastern end of the peninsula. It appears that both Breezy Point and the center of the peninsula are flooded from the ocean side. However, Roxbury and the eastern end of Rockaway appear to be flooded from the bay. These are the most vulnerable areas along Rockaway and are most likely to flood first during storm events.

During the 25-year event flooding is much more prevalent along the peninsula. Nearly all of Breezy Point is inundated as well as large portions of the heavily developed neighborhoods along the center of the peninsula.

During the 100-year and 500-year events nearly the entire peninsula is inundated, with distinct gradients in the water elevations between the ocean and bay.

The model results, maximum modeled water surface elevation, have been saved as rasters (GeoTiff file) compatible with ArcGIS. These results will be used as inputs to the Non-Shorefront economics model.

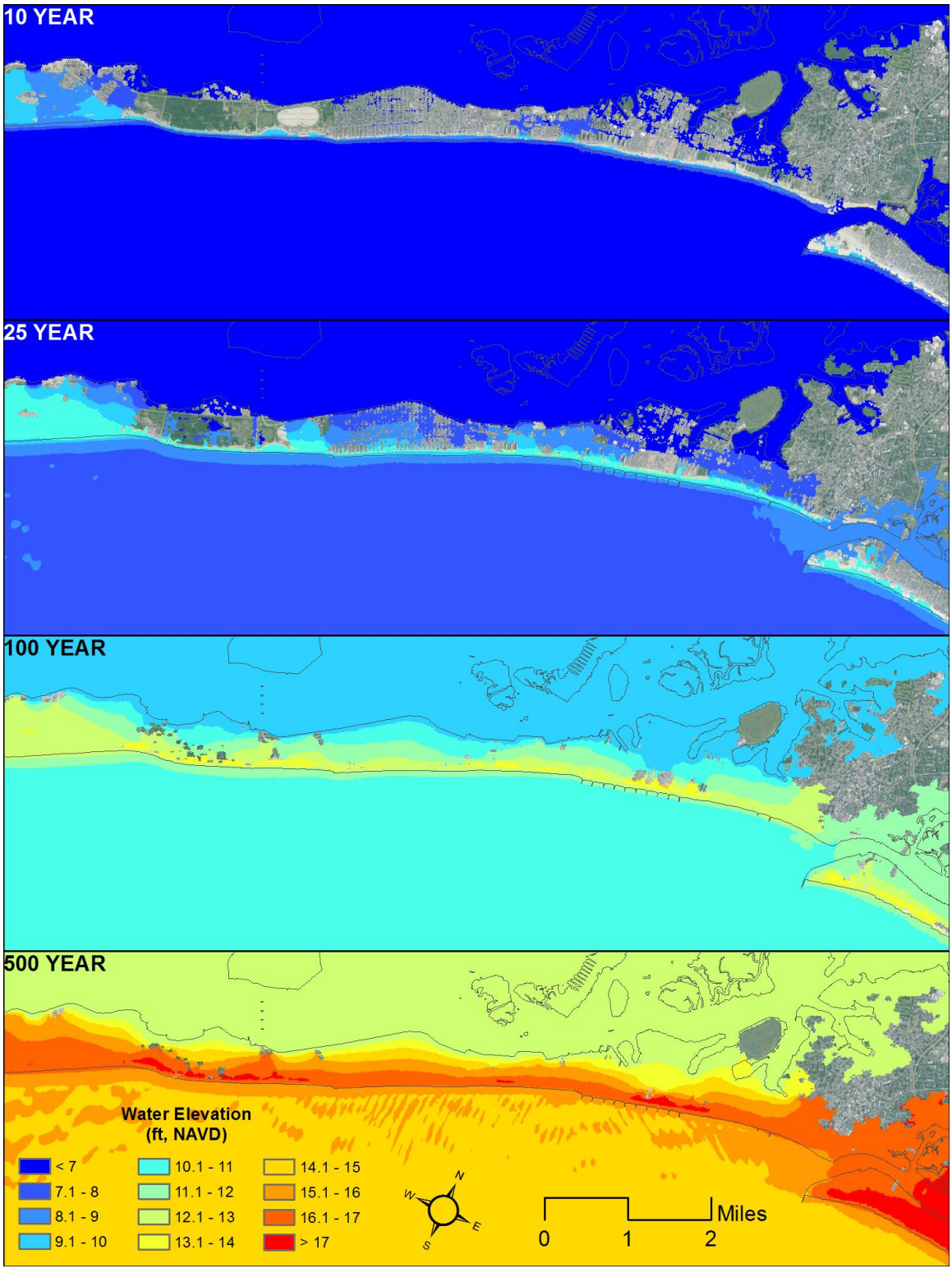


Figure 7-13: XBEACH Modeled Maximum Water Elevations – Synthetic Storms

7.5 XBEACH With Project (Seawall) Simulations

XBeach model simulations were also performed to better understand the potential flooding behind the seawall if the dunes or seawalls are not tied in to high ground. The Hurricane Sandy validation simulation was repeated with an impermeable barrier along shore shoreline from Reaches 3 to Reach 6. However, flood waters are able to flank the impermeable barrier and flood the areas around the seawall. The model results provide insight into the increase in flood elevations, above the Jamaica Bay flood elevations, that could be attributed to the ocean flooding flanking the dunes or seawall. Figure 7-14 shows the flood elevations during Hurricane Sandy if an impermeable barrier is present along the shoreline. Figure 7-15 shows a comparison of the flood elevations above the Jamaica Bay flood elevation under the without-project and with-project conditions.

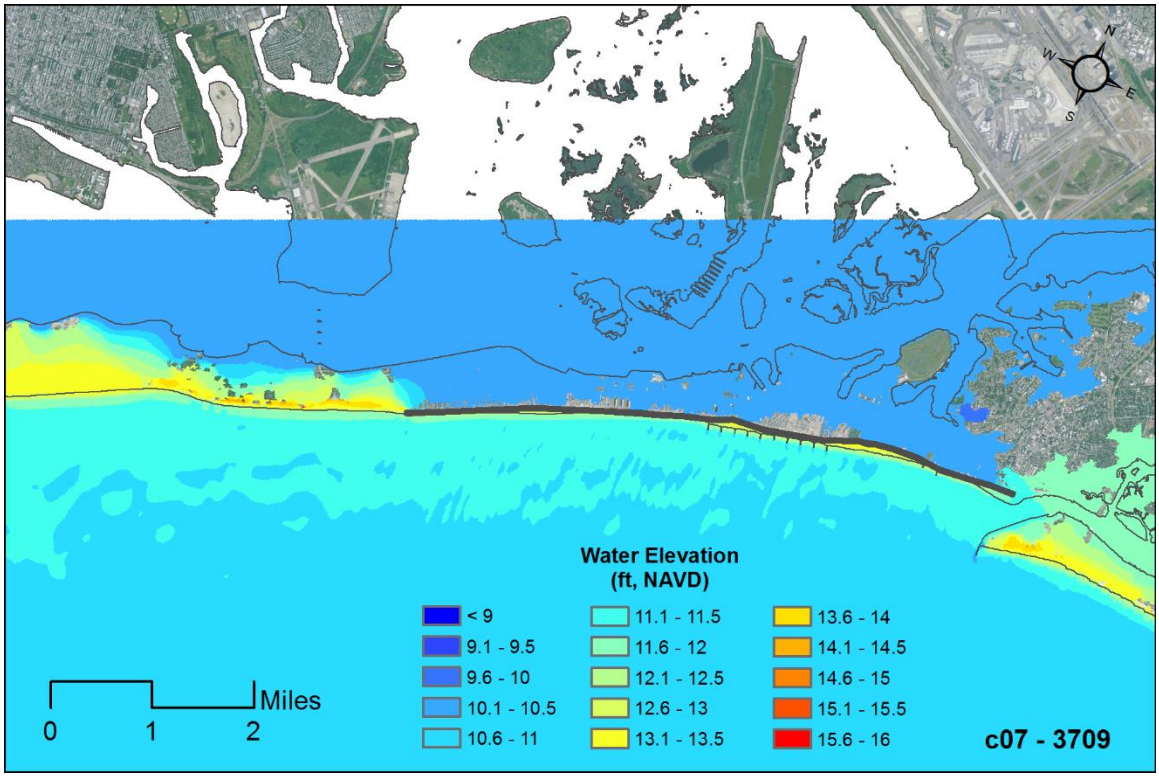


Figure 7-14: XBEACH Water Levels during Hurricane Sandy with Seawall

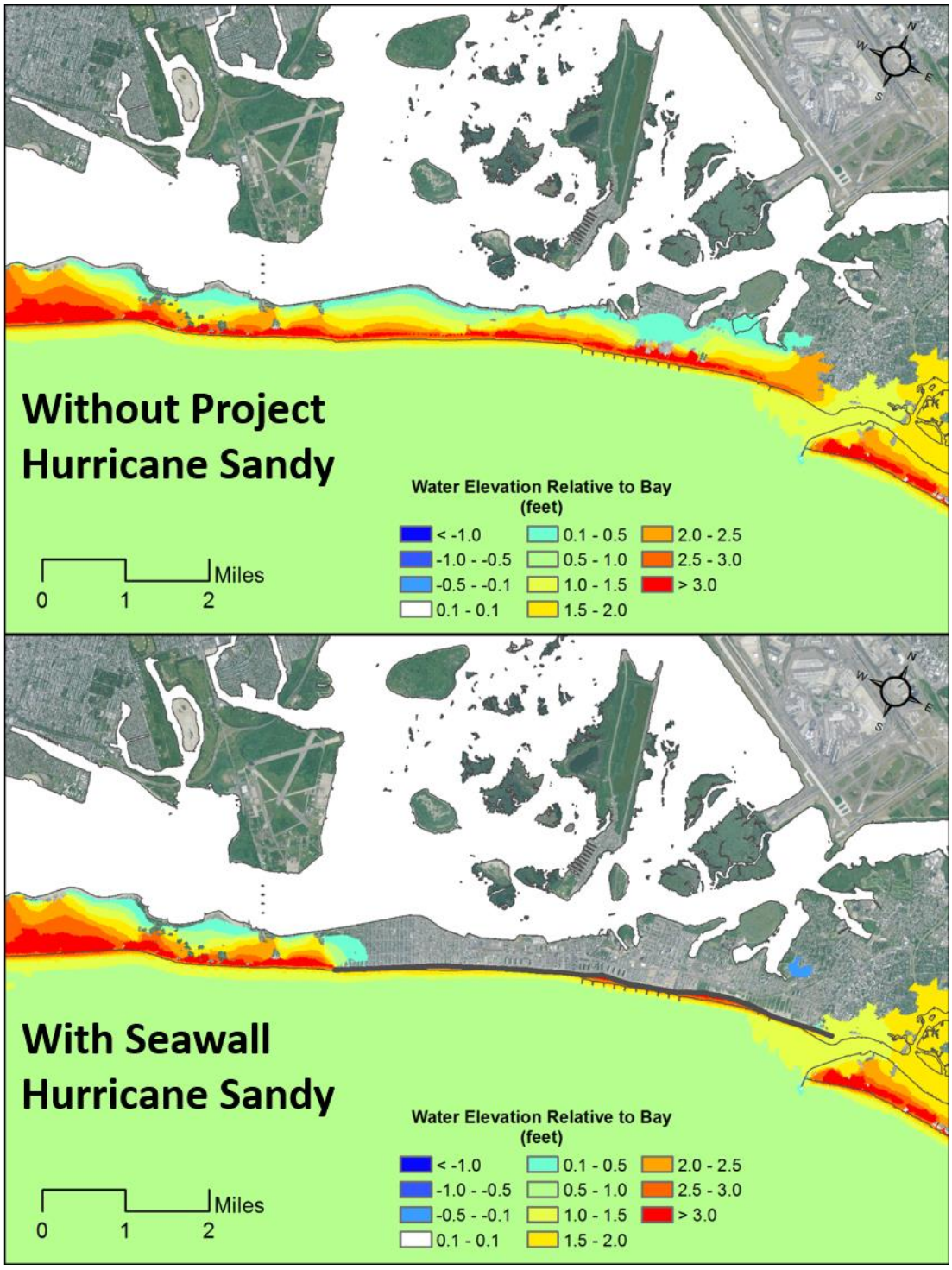


Figure 7-15: XBEACH Water Elevation Relative to Bay during Hurricane Sandy

8.0 SHORELINE CHANGE MODELING (GENESIS)

The GENESIS-T model was applied to better understand the historical longshore sediment transport and erosional patterns along the Rockaway Study Area and to evaluate numerous shoreline stabilization and restoration alternatives.

Shoreline, survey, sediment, and engineering activities data was compiled and studied to understand the history of the Study Area and develop inputs for the GENESIS-T model. Wave data from multiple sources was also compiled to develop a long-term wave climate for use in GENESIS-T.

To establish the appropriate model parameters for the existing system, the GENESIS-T model was calibrated for an April 1996 to August 2010 time period using historical shoreline positions and coinciding wave data. Model parameters established during the calibration were then used to determine the future without project conditions as well as the impact of various shoreline stabilization and restoration alternatives (with project conditions), helping to determine the best solution to the erosion problems along the Rockaway shoreline.

The GENESIS-T model coverage extends from the terminal groin at Rockaway Inlet east to East Rockaway Inlet, covering approximately 10.5 miles along the Rockaway shoreline. This area has typically been divided into 6 reaches based on shoreline change patterns and engineering structures. Figure 8-1 shows the GENESIS-T model extent and reaches along the study area.

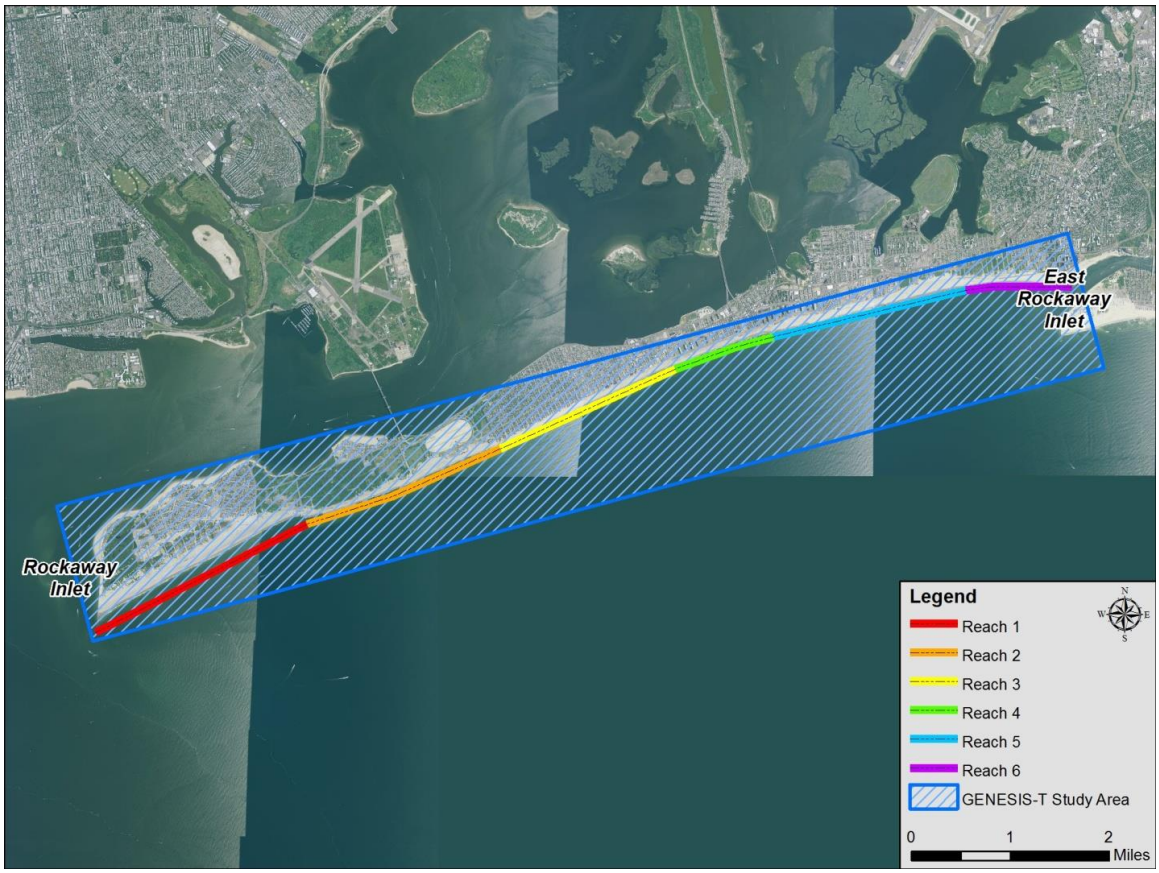


Figure 8-1: GENESIS-T Model Extent

8.1 GENESIS Overview

GENESIS (Generalized Model for Simulating Shoreline Change) is designed to simulate long-term shoreline change based on spatial and temporal differences in longshore sediment transport induced primarily by wave action. The GENESIS modeling system allows for a number of user-specified inputs including wave inputs, initial shoreline positions, coastal structures and their characteristics, and beach fills; all of which aid in the calculation of sediment transport and shoreline change. This model was developed at the U.S. Army Corps of Engineers (USACE), Engineer Research and Development Center (ERDC), Coastal & Hydraulics Laboratory (CHL). For a more detailed description of the GENESIS model, the reader is referred to the User's Manual and Technical Reference published on the model (Hanson and Krauss, 1989, Gravens et al, 1991).

GENESIS-T is a more recent release that expands on the modeling capabilities of GENESIS, allowing for the formation of tombolos at detached breakwaters and/or T-groins. After a comparison of GENESIS and GENESIS-T, it was decided to use GENESIS-T for this study due to the possible alternatives to be studied. It was determined in previous studies by M&N that GENESIS and GENESIS-T results yield almost identical predicted shorelines in the absence of tombolo formation.

GENESIS-T operates within the Coastal Engineering Design and Analysis System (CEDAS), a suite of tools developed by Veri-Tech, based on various numerical models and codes developed at CHL. GENESIS and GENESIS-T run through the Nearshore Evolution Modeling System (NEMOS), which is designed to ease in the preparation of data inputs, analysis, and manipulation for a number of related coastal models.

The GENESIS-T model has potential for many applications in the coastal environment, including evaluation of longshore sediment transport, analysis of beach fill performance, or the analysis of the impact of coastal structures on shoreline change.

The main inputs to the GENESIS-T model include:

- Shoreline Position Data – one-dimensional description of the shoreline position relative to a straight baseline position,
- Wave Data – long-term time dependent description of wave heights, periods, and directions applicable to the Study Area,
- Coastal Structures – position and characteristics of coastal structures (breakwaters, groins, jetties, or seawalls) acting along the Study Area,
- Beach Fill – starting and ending dates and location of beach fill defined by an added berm width,
- Bypassing – starting and ending dates and location of bypassing defined by the quantity in cy/hr
- Sediment and Beach Characteristics – effective grain size, average berm height, and closure depth for the Study Area,
- Sediment Transport Parameters – used to characterize longshore sediment transport and calibrate the model,
- Boundary Conditions – seaward boundary conditions for the input wave data and lateral boundary conditions for the shoreline (left and right), and
- Regional Contour – an offshore contour to account for bathymetry which may affect wave direction/energy

While GENESIS-T can be a very useful tool for predicting future shoreline change due to the impacts of engineering activities (i.e. beach nourishment, structures, etc.), there are some limitations to the model, making it best to follow up with additional modeling or analytical techniques. The main limitations include:

- Longshore Transport Only – The one dimensional model does not account for cross shore transport when predicting shoreline change and shoreline position, forcing the user to assume all change is based on longshore transport, and

- Performance around Inlets – Coastal processes which occur around inlets are very complex and not able to be modeled with a one dimensional model. In addition to the lack of cross shore transport in the model, there is also no "sink" component whereby sediment that may deposit in the inlet shoals is removed from the system.

8.2 GENESIS Calibration

The GENESIS-T model was calibrated to reflect the historical trends of longshore sediment transport and the resulting shoreline change over the Study Area. The overall calibration time period was based on the availability of shoreline data, wave data, and knowledge of engineering activities (i.e. beach nourishment, structure construction, etc.) in the area. The calibration period was chosen, based on the coincidence of the above mentioned data, from April 1, 1996 to August 13, 2010. The model was setup with a 60 ft grid spacing over 55,260 ft of shoreline (921 grid cells).

For this study, the general calibration procedure involved:

- Establishing known model inputs including shoreline position, waves (height, period, and direction), locations of structures, sediment and beach characteristics (grain size, berm height, depth of closure), beach fills, bypassing, and boundary conditions,
- Establishing initial sediment transport parameters and adjusting these parameters until the relative shoreline response (erosion/accretion) and sediment transport rate matched historical trends,
- Adjusting the groin permeability until the shoreline response better matched historical trends around the structures, and
- Adjusting the regional contour to account for bathymetric influences on sediment transport and coastal processes near the inlets

Over 100 model runs were completed during the model calibration process. The input data for the calibration and calibrated model settings will be presented in the following sections, along with a discussion of the results and issues encountered during the calibration process.

8.2.1 Shoreline Position Data

For shoreline input, GENESIS-T requires the shoreline be specified in a station-offset formulation whereby the station represents a position along a landward baseline and the offset is the perpendicular distance from this baseline to the shoreline. The initial shoreline used in the GENESIS-T model was the Spring 1996 wet/dry shoreline, digitized from aerial photography. An exact date was not known for the aerial photography so it was assumed to be April 1, 1996. The final reference shoreline to which the model was calibrated was the August 13, 2010 shoreline, based upon a MHW contour derived from LiDAR data. It should be noted that the two shorelines

were derived from different sources, thereby introducing some uncertainty to the calibration process. The initial and reference shoreline positions used in the GENESIS-T calibration model can be seen in the calibration results.

8.2.2 Wave Data

GENESIS-T requires a continuous record of wave conditions (wave height, wave period, and wave direction) at one or more stations along the modeling domain to drive the long-term shoreline changes. The wave conditions may be defined in relatively deepwater and transformed to nearshore using the GENESIS-T internal wave model or transformed to multiple nearshore stations using an external wave model. The latter approach (external wave model) was applied in this study to capture the alongshore variation in the wave conditions.

The first step in defining the wave conditions, is constructing a continuous record of the offshore wave conditions. Wave data in the study area was available at two NDBC wave buoys in addition to the USACE Wave Information Studies (WIS) wave hindcast:

- WIS 123 (1980-01-01 to 1999-12-31)
- NDBC 44025 (1991-04-29 to 2013-10-24)
- NDBC 44065 (2008-10-30 to 2013-10-05)

All three stations contained information about the wave height, wave period, and wave direction at 3-hour (WIS) or hourly (NDBC) intervals. As shown in Figure 8-2 the locations of the NDBC wave buoys and WIS station differ. The wave conditions at NDBC 44025 buoy were transformed to the closer buoy location, 44065, with a spectral wave model (SWAN). The WIS data was combined with the transformed wave data at the 44065 station to create a continuous record of the wave conditions from 1980-2013.

The next step was to transform the offshore wave conditions to 58 nearshore wave stations along the Rockaway shoreline, typically around the depth of closure (~25 ft). Figure 8-3 shows an example of the nearshore wave stations used along the eastern end of the GENESIS-T modeling domain. A nearshore wave model (SWAN) was used to build a look-up table that establishes relationships between nearshore wave conditions and offshore wave conditions.

The purpose of using multiple wave stations along the Rockaway shoreline was to capture the impact of changing wave conditions along the study area. Figure 8-4 shows annual wave roses at the offshore wave station and two nearshore stations near East Rockaway Inlet. It is apparent that the waves near East Rockaway Inlet (GENESIS 002) are of a different direction and magnitude than those away further away from the inlet (GENESIS 008). Capturing the alongshore variability in the wave conditions in this area was critical to reproducing a nodal point in the sediment transport that exists within Reach 6 of the Study Area.

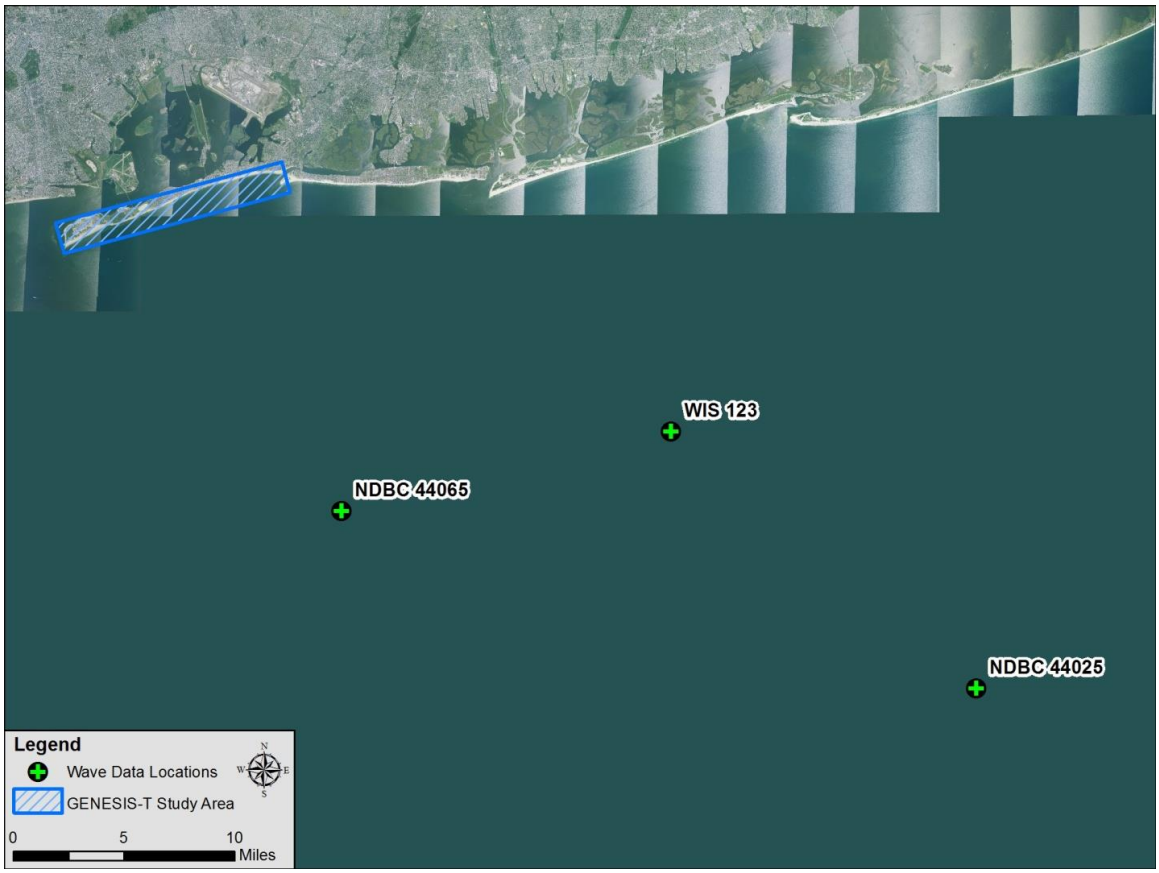


Figure 8-2: GENESIS-T Offshore Wave Data Locations

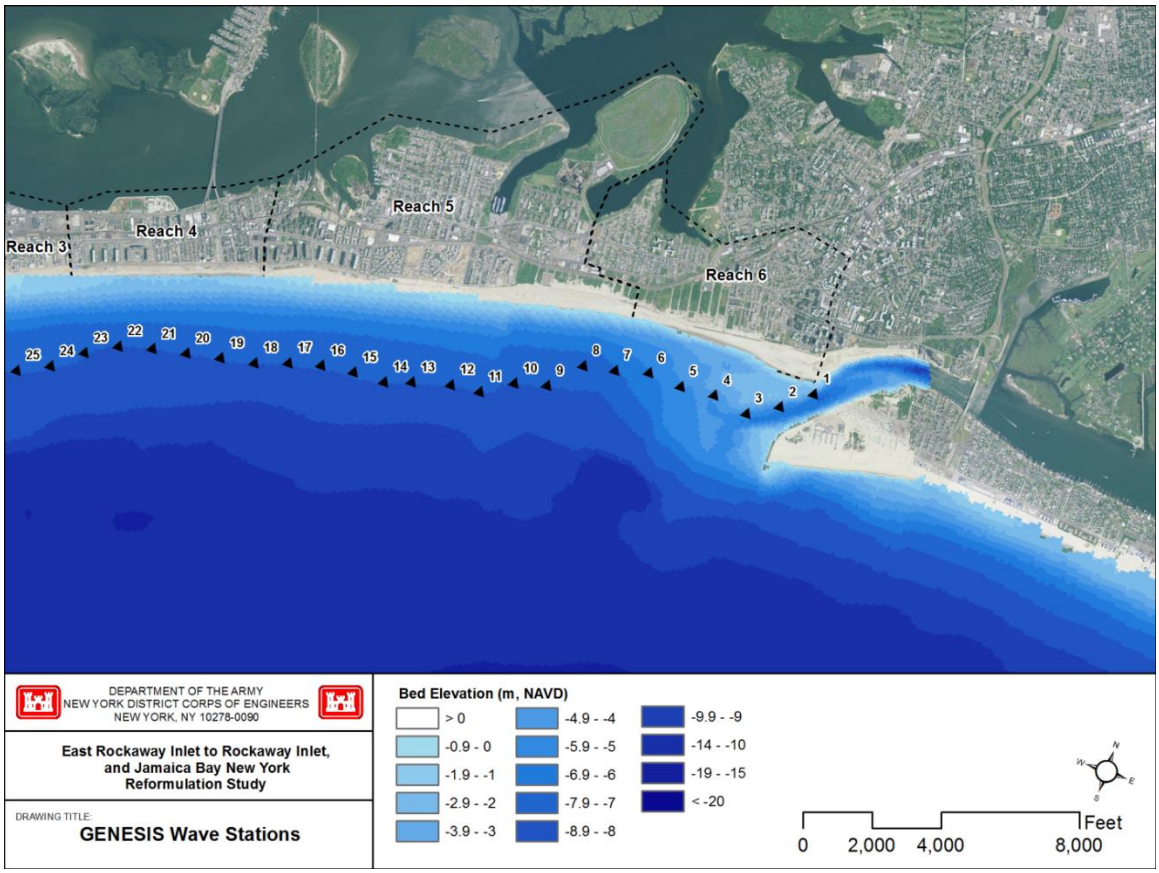


Figure 8-3: GENESIS-T Nearshore Wave Stations

WIS 123 GENESIS Station 2 GENESIS Station 8

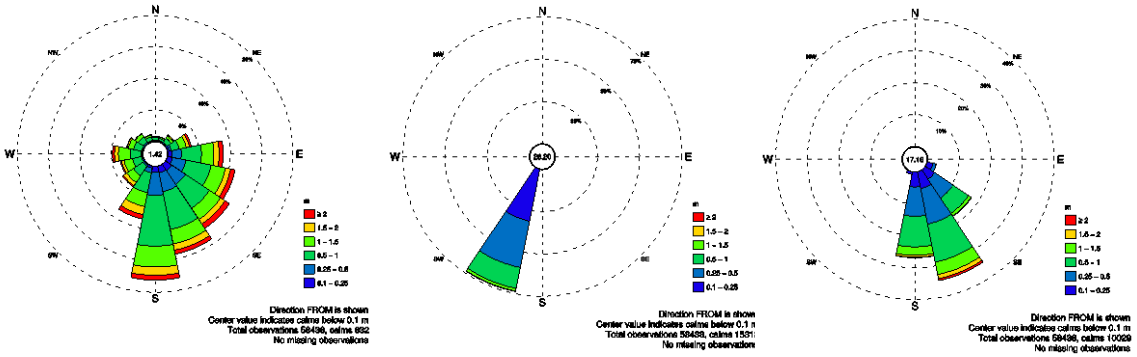


FIGURE 8-4: GENESIS-T REPRESENTATIVE WAVE ROSES

8.2.3 Coastal Structures

GENESIS-T requires the locations and characteristics of nearshore structures as input. The coastal structures are incorporated in the GENESIS-T model by a station-offset formulation, similar to the shoreline position. Allowable structures include non-diffracting groins/jetties, diffracting groins/jetties, seawalls, and/or detached breakwaters. Each structure is modeled uniquely with respect to longshore transport and shoreline change. In general, structures exert two direct effects on the shoreline change modeling:

- Structures extending into the surf zone block a portion, or all, of the longshore transport from their updrift sides and may reduce the transport of sand towards the downdrift side. This effect may be induced by a groin or jetty.
- Structures which have seaward ends extending well beyond the surf zone, including jetties or detached breakwaters, induce wave diffraction which causes the local wave height and direction to change.

Wave transmission through and over breakwaters is controlled by the user-specified transmission coefficient (K_t). The transmission coefficient is defined as the ratio of wave heights on the shoreward side of the breakwater to the incident wave heights on the seaward side of the breakwater and may range from 0 (no transmission) to 1 (complete transmission).

Similar to detached breakwaters, a non-diffracting or diffracting groin implemented in GENESIS-T must have a defined permeability coefficient which controls the transmission of sand over and through the structure. The permeability can range from 0, implying an impermeable structure to 1, implying a completely transparent structure. The literature indicates that the range of permeability coefficients for a groin that has gaps or is overtopped during parts of the tidal cycle is often between 0.1 and 0.5.

The Rockaway calibration model includes 37 existing rock groins within the Study Area (see Figure 8-5). Each groin was assigned a permeability coefficient. Both structure condition and relative permeability to other structures are taken into account but the final number is based on observed shoreline change near each structure during calibration. There are also several dilapidated timber groins that were not included in the model as they are not believed to have an impact on the shoreline. Table 8-1 shows the permeability coefficient determined for each of the 37 groins included in the calibration model. As can be seen, most of the structures have permeability coefficients ranging from 0.2 – 0.5. The rock groins are in fairly good condition, so this matches well with the chosen permeability coefficients and ranges suggested in the literature. The only structure with a differing value was the terminal groin at Rockaway Inlet (0.8). This is the result of trying to match shoreline change processes near an inlet in GENESIS-T and not an indication that the groin is not functional.

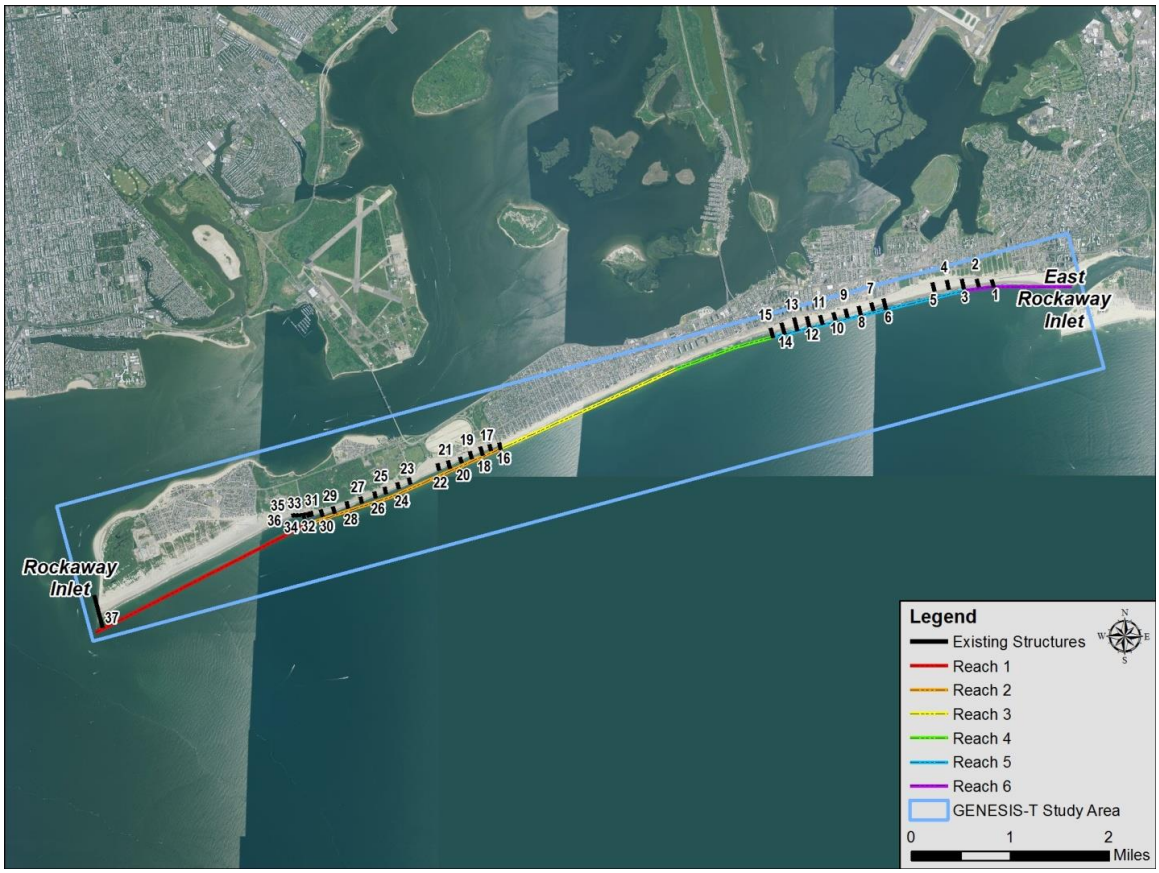


Figure 8-5: GENESIS-T Calibration (Existing) Structures

Table 8-1: GENESIS-T Groin Permeability Coefficients

Groin	K_t	Groin	K_t	Groin	K_t	Groin	K_t
1	0.2	**11**	0.2	**21**	0.3	**31**	0.5
2	0.2	**12**	0.2	**22**	0.3	**32**	0.5
3	0.2	**13**	0.2	**23**	0.3	**33**	0.5
4	0.2	**14**	0.2	**24**	0.3	**34**	0.5
5	0.2	**15**	0.2	**25**	0.3	**35**	0.5
6	0.2	**16**	0.25	**26**	0.3	**36**	0.5
7	0.2	**17**	0.3	**27**	0.3	**37**	0.8
8	0.2	**18**	0.3	**28**	0.3		
9	0.2	**19**	0.3	**29**	0.3		
10	0.2	**20**	0.3	**30**	0.3		

Notes: K_t – groin permeability, 0 (no transmission) to 1 (complete transmission)

8.2.4 Beach Fill Projects

Multiple beach nourishment projects took place during the calibration period from April 1996 to August 2010, including inlet maintenance dredging from East Rockaway Inlet in addition to multiple renourishment projects. GENESIS-T requires, as input, the lateral extents of the nourishment as well as an added berm width. The added berm width was determined based on the active profile height (depth of closure to berm elevation), project length, and volume of nourishment. Table 8-2 shows the beach fill activities that took place during the calibration time period and were included in the calibration simulation. Figure 8-6 displays the location and quantities of each of the nourishment projects.

Table 8-2: GENESIS-T Calibration Beach Fill Data

Year	Authorization	Project Name	Source of Fill	Area of Placement	Total Fill Placed (cy)	Length (ft)	Added Berm Widths (ft)
1996	Section 934 of WRDA 1986	Renourishment #6	Borrow area 1B	B110th St. to B46th St.	1,485,800	15,720	82
1996	Section 934 of WRDA 1986	Renourishment #6	Borrow area 1B	B149th St. to B110th St.	592,800	9,720	53
1998	Rivers and Harbors Act of 1930	Navigation/Operations & Maintenance Dredging	Dredged Material From East Rockaway Inlet	B27th St. to B39th St.	218,000	3,050	62
2000	Rivers and Harbors Act of 1930	Navigation/Operations & Maintenance Dredging	Dredged Material From East Rockaway Inlet	B27th St. to B39th St.	241,000	3,050	69
2000	Section 934 of WRDA 1986	Renourishment #7	Borrow Area 2	B59th St to B74th St	333,075	3,750	76
2000	Section 934 of WRDA 1986	Renourishment #7	Borrow Area 2	B90th St. to B118th St.	676,260	7,800	75
2002	Rivers and Harbors Act of 1930	Navigation/Operations & Maintenance Dredging	Dredged Material From East Rockaway Inlet	B27th St. to B39th St.	140,000	3,050	40
2004-2005	Rivers and Harbors Act of 1930	Navigation/Operations & Maintenance Dredging	Dredged Material From East Rockaway Inlet	B28th St. to B36th St.	221,002	2,100	92
2004	Section 934 of WRDA 1986	Renourishment #8	Borrow Area 2	B118th St. to B110th St.	94,968	2,050	40
2004	Section 934 of WRDA 1986	Renourishment #8	Borrow Area 2	B110th St. to B46th St.	634,557	15,550	36
2004	Section 934 of WRDA 1986	Renourishment #8	Borrow Area 2	B46th St. to B24th St.	271,953	5,400	44
2007	Rivers and Harbors Act of 1930	Navigation/Operations & Maintenance Dredging	Dredged Material From East Rockaway Inlet	B28th St. to B38th St.	260,000	2,600	87
2009	Rivers and Harbors Act of 1930	Navigation/Operations & Maintenance Dredging	Dredged Material From East Rockaway Inlet	B28th St. to B39th St.	285,000	2,850	87
2010	Rivers and Harbors Act of 1930	Navigation/Operations & Maintenance Dredging	Dredged Material From East Rockaway Inlet	B92nd St. to B103th St.	137,000	3,150	38

Figure 8-6: GENESIS-T Beach Fill Project Map

8.2.5 Inlet Bypassing

It is believed that natural sediment bypassing occurs at East Rockaway Inlet, however the quantity and path of the bypassing is not well understood. Previous studies have estimated that between 70,000 cubic yards (OCTI, 2011) and 170,000 cubic yards (USACE Draft Basis of Design) of bypassing occurs. A range of bypassing amounts from 0 cy/yr to 200,000 cy/yr were tested during model calibration. Based on historical references, sediment budget calculations, and modeled shoreline positions, a bypassing rate of 100,000 cy/year was determined to provide the best model calibration. The attachment point, or location in which the bypassing enters the littoral system, was also determined during model calibration. Bypassing is defined in GENESIS-T as a constant sediment flux (cy/hr) over a defined extent. Figure 8-7 shows the alongshore extent of bypassing determined through model calibration.

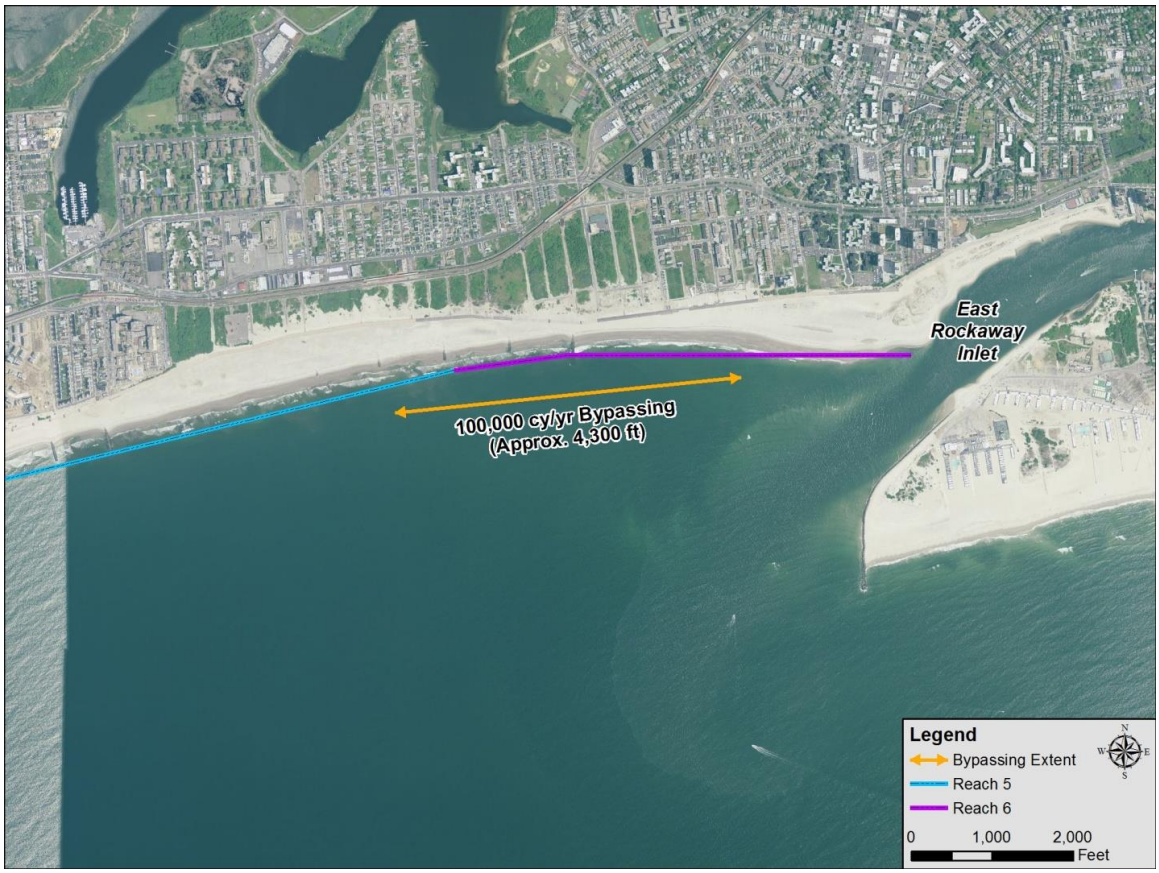


Figure 8-7: GENESIS-T Bypassing at East Rockaway Inlet

8.2.6 Sediment and Beach Characteristics

GENESIS-T requires, as input, the effective grain size (mm), average berm height (ft), and closure depth (ft). The effective grain size assumed was 0.29 mm based on beach sediment samples collected in 1974 (USACE, 2011). The average berm height was set to +6 ft NAVD88 and the closure depth was set to -25 ft NAVD88. These values were determined based on beach profile surveys collected between 1996 and 2003 as part of the Atlantic Coast of New York Monitoring Program (ACNMYP) (USACE, 2011).

8.2.7 Sediment Transport Parameters

An initial calibration run indicated that the nearshore wave stations were properly defining a sediment transport nodal point in Reach 6, moving sediment east of that point into East Rockaway Inlet and west of that point towards Rockaway Inlet. With sediment transport going in the correct direction, the magnitude of the transport was adjusted based on the transport parameters K1 and K2 in GENESIS-T. The transport rate coefficient, K1, is used to control the time-scale and magnitude of the simulated shoreline change, while K2 is used to control shoreline change and longshore sand transport in the vicinity of structures. Although the values of K1 and K2 have been

empirically estimated, these coefficients are treated as calibration parameters in GENESIS-T and range in value from 0 to 1.0 with higher K values producing higher transport rates in the model.

The final calibration transport coefficient values were chosen to be K1 = 0.2 and K2 = 0.2 after applying a range of values from 0.1 to 0.3. These K values allowed for the correct magnitude of sediment transport along the Rockaway shoreline based on historical sediment transport rate studies, sediment budget calculations, and modeled shoreline position. Figure 8-8 shows the resulting transport rates from the GENESIS-T calibration model, with the nodal point occurring midway through Reach 6.

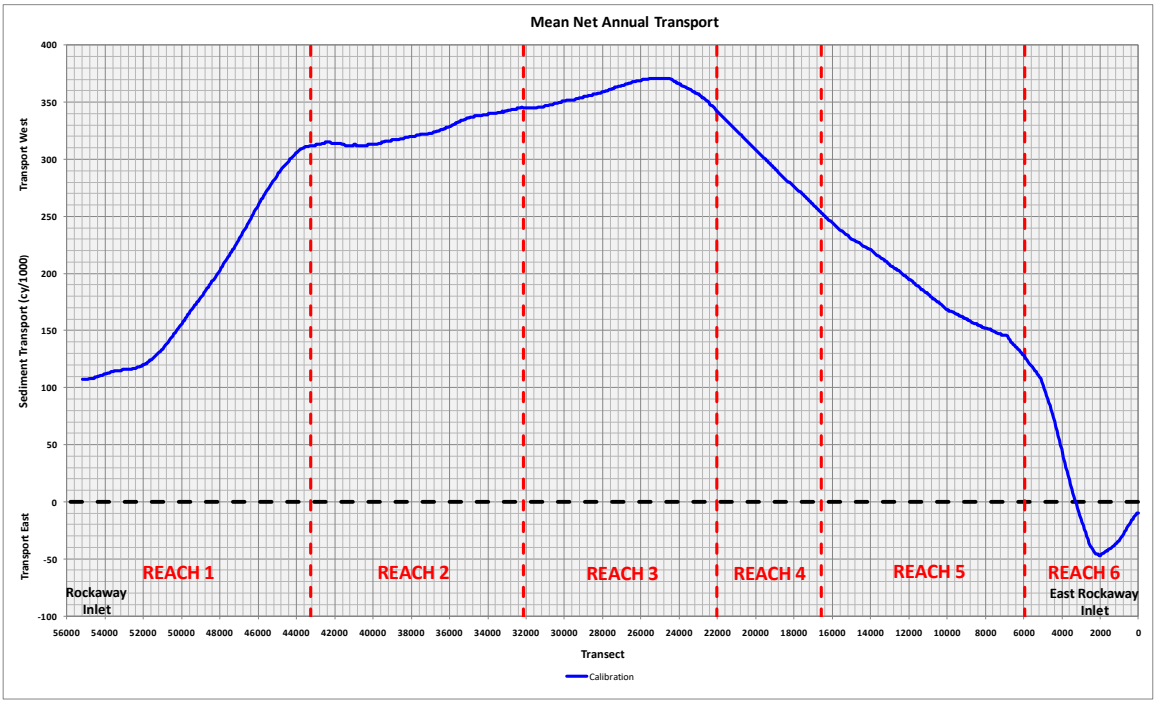


Figure 8-8: GENESIS-T Calibration - Sediment Transport Rate

8.2.8 Boundary Conditions

The required boundary condition inputs for GENESIS-T include the seaward wave data boundary conditions and the lateral boundary conditions at the left (west) and right (east) ends of the shoreline, as described in the following section.

8.2.8.1. Seaward Boundary Conditions

Within the seaward boundary conditions, the user may modify the input wave conditions (wave height and direction) to analyze the impact changes in modeled wave conditions have on the resulting shoreline response. The user may also define an offshore regional contour to account for variations in nearshore bathymetry (landward of the depth of closure) which may cause a change

in wave energy/direction, altering sediment transport patterns along the shoreline from what they might be if these features didn't exist.

During calibration it was determined that the input wave height and direction was representative of nearshore conditions and were not modified by any factors. It was determined that inlet influences near the east and west boundaries of the model were causing shoreline change responses that were not being captured correctly in GENESIS-T. Therefore, the regional contour was used to match the observed shoreline change behavior at the inlets. The regional contour was determined by starting with an actual offshore contour near the depth of closure. Slight adjustments were made to capture any bathymetry features landward of the depth of closure that may impact the shape of the shoreline. Larger adjustments were made near the inlets to help capture the inlet effects on shoreline change processes. Figure 8-9 shows the final regional contour used in the model. As can be seen, the regional contour is parallel to the shoreline along most of the study area, indicating that it does not play a large part in manipulation of the shoreline in the model calibration. The areas nearest the inlets that are not shore parallel are where the regional contour has the greatest impact on the model calibration, helping to better reflect historical shoreline change patterns in these areas.

Figure 8-9: GENESIS-T Regional Contour Location

8.2.8.2. Lateral Boundary Conditions

The west boundary of the model was located at the terminal groin structure adjacent to Rockaway Inlet. A gated (groin) boundary was used at this location. The east boundary of the model was established at the mouth of East Rockaway Inlet where a pinned boundary was established based on the absence of difference between the initial (1996) and reference (2010) shoreline position data at that location.

8.2.9 Calibration Model Results

Figure 8-10 shows a plot of the final shoreline resulting from the GENESIS-T calibration modeling against the initial shoreline position (April 1996) and the comparable measured shoreline position (August 2010). Enclosure B shows the results from the GENESIS-T model calibration overlaid on aerial photography.

As shown in Figure 8-10, the model output matched the measured reference shoreline position fairly well in most areas. It appears to slightly over predict the erosion in Reaches 4, 5, and 6 (eastern portion of the study area) and slightly over predict accretion in Reaches 1, 2, and 3 (western portion of the study area). These differences will be taken into account when assessing the performance of various alternatives. Figure 8-11 shows the measured and modeled shoreline change for comparison. It is apparent that the modeled data closely follows the trends of the measured data even though the modeled shoreline position does not exactly match the measured shoreline position.

Figure 8-12 shows the difference in position between the 2010 measured shoreline and 2010 modeled shoreline. This figure shows the modeled shoreline being landward of the measured shoreline in Reaches 4-6 and seaward of the measured shoreline in Reaches 1-3. Again, these differences will be considered when assessing the performance of various alternatives. Table 8-3 contains some statistics per reach related to the difference in measured and modeled shoreline position results. It is important to note that the amount of change seen in the shoreline from year to year is very considerable. The maximum measured change from 1996 to 2010 was 381 ft (26 ft/yr) and the average measured change was 69 ft (5 ft/yr). Therefore, a calibration model error on the order of 1 to 4 ft/yr, depending on the reach, is considered very reasonable.

Table 8-3: GENESIS-T Measured vs. Modeled Shoreline Error Analysis

Reach	Avg. Error (ft)	Avg. Error (ft/yr)
Reach 1	+64	+4.4
Reach 2	+47	+3.3
Reach 3	+16	+1.1
Reach 4	-22	-1.5
Reach 5	-31	-2.2
Reach 6	-25	-1.7
Overall	+15	+1.1

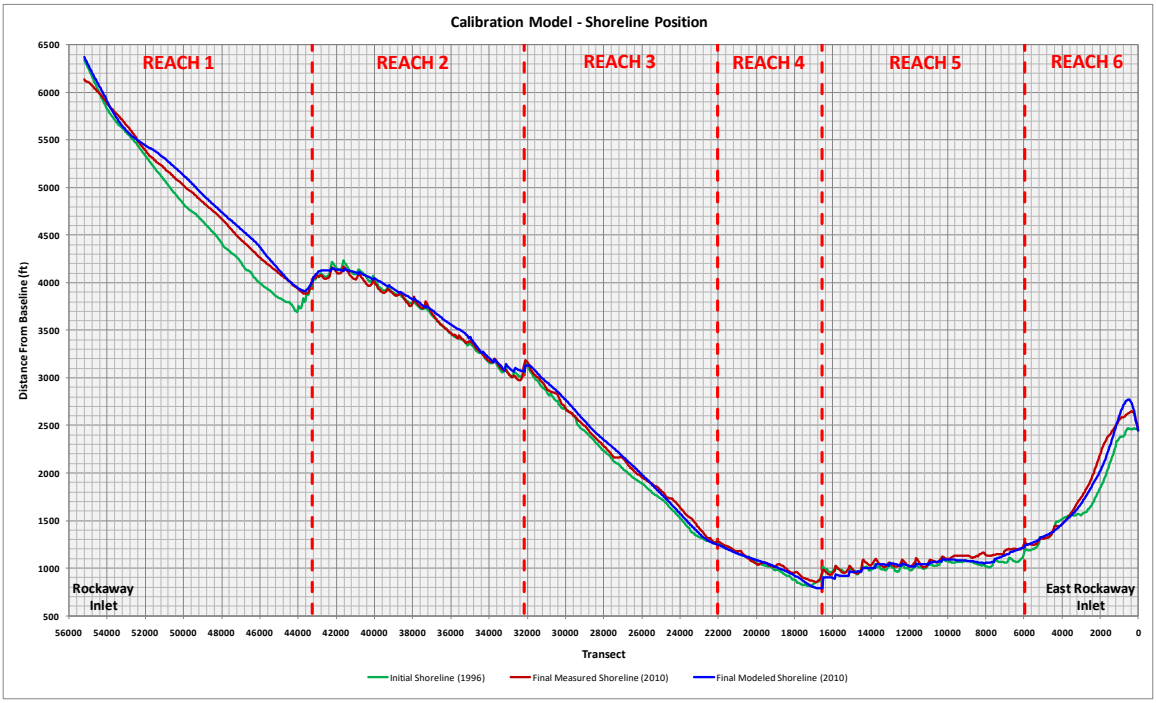


Figure 8-10: GENESIS-T Calibration Results – Shoreline Position Overview

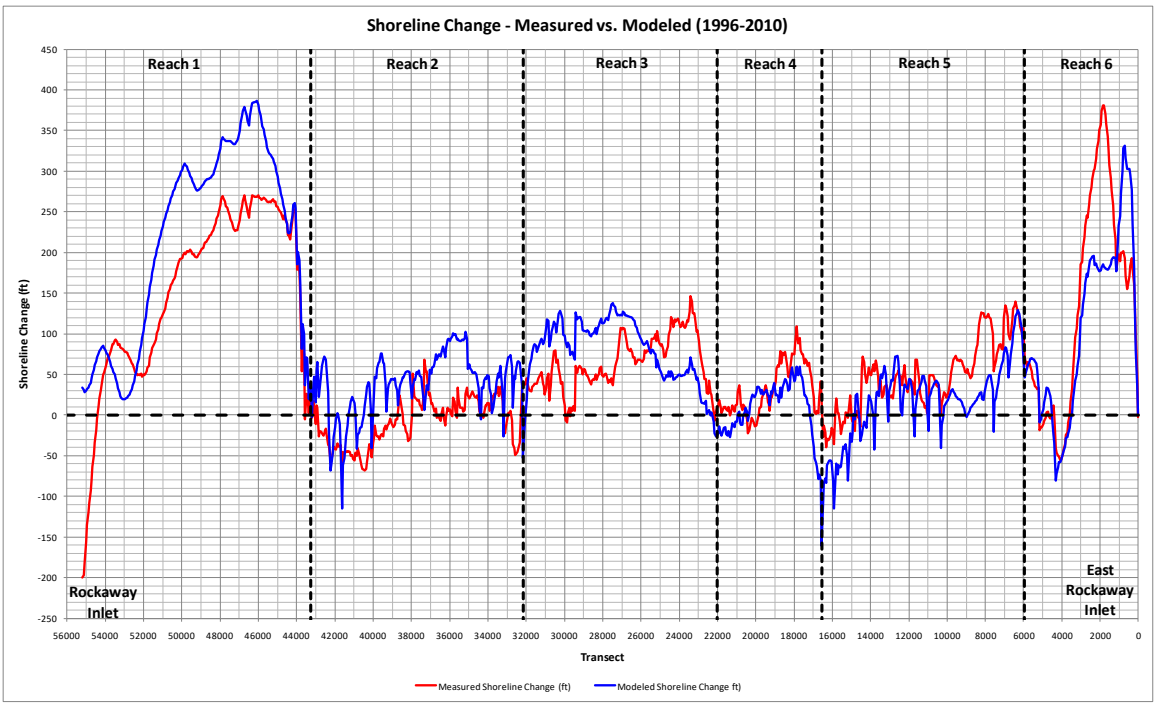


Figure 8-11: GENESIS-T Measured vs. Modeled Shoreline Change

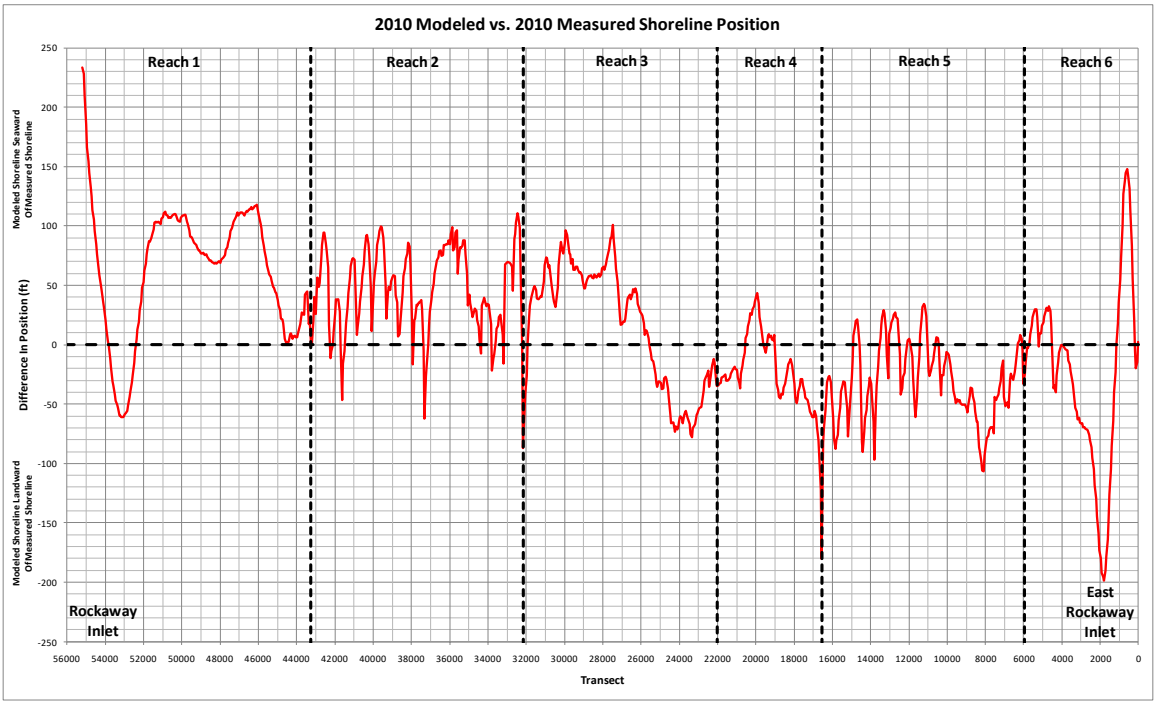


Figure 8-12: GENESIS-T Measured vs. Modeled Shoreline Position Difference

8.3 GENESIS Without Project Simulation

The Without Project Future Condition (WOPFC) is by definition the projection of the most-likely future conditions in the project area if no actions are taken as a result of this study. The WOPFC must be representative of what is most likely to occur in the absence of a federal project, and as such must be based upon historic practice and trends. The WOPFC serves as the base conditions for all the alternative analyses.

Identifying the WOPFC at Rockaway is particularly important and difficult because approximately 18,500,000 cubic yards of beach fill have been place along the shoreline since 1974 under the federal Beach Erosion Control Project. Therefore, historical data may not be used to describe the shoreline and beach conditions if no actions are taken in the project area. Instead, the calibrated GENESIS-T model is used to describe the shoreline changes that are likely to occur in the WOPFC.

In defining the WOPFC, the following assumptions are made to establish the framework of what is likely to occur.

- As defined by existing Federal/State navigation authorities, the existing inlets (Rockaway Inlet and East Rockaway Inlet) and their corresponding approach and Jamaica Bay navigation channels will be maintained near the present widths depths, and locations. Approximately 230,000 cubic yards of material will be dredged from East Rockaway Inlet every 2 years and placed in Reach 6.
- No other major beach fill projects will occur in the project area.

The 50-year study period for the WOPFC and alternative analyses is from June 2018 to June 2068. A 3.5 year GENESIS-T simulation was performed from January 2015 to June 2018 to create a realistic starting shoreline that would serve as consistent starting point for the WOPFC and alternative With Project Future Condition (WPFC) simulations. After developing the initial shoreline a 16-year simulation from June 2018 to June 2034 was performed in GENESIS-T to define the WOPFC. The same wave conditions from the calibration time frame (plus 1 extra year) were applied in the 16-year simulation.

The January 2015 shoreline was developed based on the latest available aerial imagery (Spring 2013) and accounts for the expected shoreline changes due to FCCA beach nourishment project currently under construction. Wave data for the 3.5 year GENESIS-T simulation was taken from years 2004-2007, which were considered to be a representative of the average wave climate. It was assumed that no inlet maintenance dredging would occur over the 3.5 year simulation since a substantial amount of material was removed for the FCCA beach nourishment project.

As stated above, the WOPFC does not include any beach fill except for inlet maintenance beach fill as part of the Federal Navigation Project (dredging) at East Rockaway Inlet. Based on the beach nourishment history compiled for the model calibration, it was determined that approximately 230,000 cubic yards of material is dredged from East Rockaway Inlet every 2 years

and placed in Reach 6 (Inlet Maintenance Nourishment). This equated to 66 ft of added berm width over 3,700 feet of shoreline.

Figure 8-13 show the results of the WOPFC simulations. It is important to acknowledge that the GENESIS-T simulation only covers 16 years of the 50-year study period. It is assumed that shoreline change trends would likely continue at similar rates for another 34 years. Starting in Reach 6 it is apparent the inlet maintenance beach fill is not enough to prevent continued shoreline erosion at the hot spot (near the eastern most groin). Although, the inlet maintenance beach fill does significantly reduce the erosion that would likely occur in its absence.

Moving west along the shoreline, significant erosion is expected to occur within the groin field in Reach 5. Erosion increases throughout the groin field and peaks at close to 200 feet in the western most compartment. The erosion in Reach 5 masks the effectiveness of the groin field. As the shoreline recedes, the effective length of the groins increases and the groin fields trapping efficiency also increases. The impact of the groin field is visible downdrift in Reach 4, where the most severe erosion is predicted to occur. Immediately downdrift of the groins shoreline changes on the order of 400 feet are predicted to occur. Severe erosion continuous throughout Reach 4 and extends into the beginning of Reach 3. The shoreline stabilizes in Reach 3 and begins to show accretion starting in Reach 2. Significant accretion is predicted in Reach 1 and Reach 2.

Based on the trends seen in the calibration results, some inferences can be made with respect to the without project conditions results. First, the model may slightly overestimate erosion in Reach 6 and Reach 4. Conversely, the accretion seen in Reaches 1 and 2 may also be overestimated. However, the errors in the model calibration were on the order of 3 feet/year, which is relatively small in comparison to some of the predicted shoreline change rates (-20 feet/year in Reach 4).

Even with these uncertainties, it is important to recognize the overall poor condition of the beach in the WOPFC. The WOPFC provides a baseline to compare the impact of each alternative on the future condition of the beach.

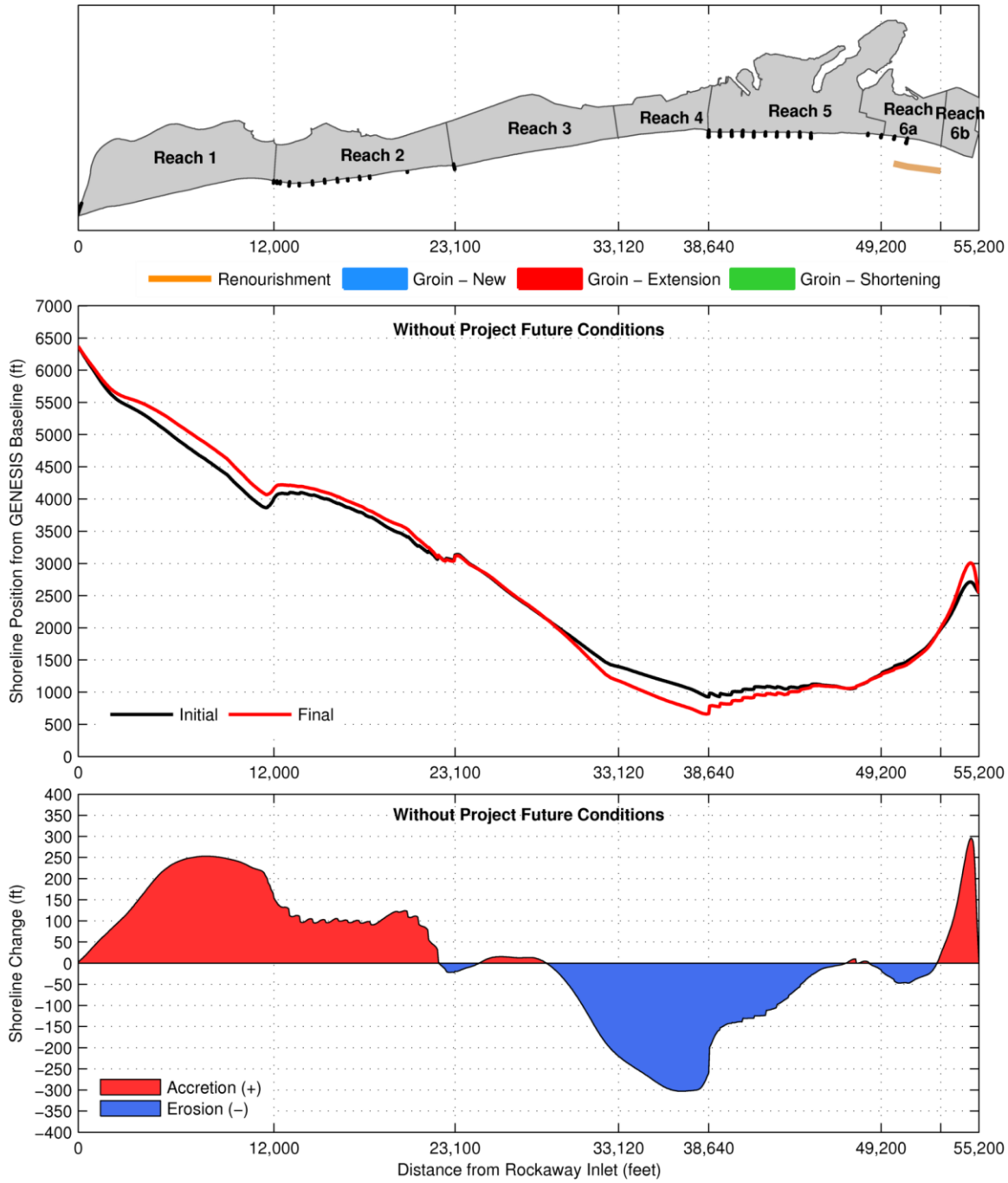


Figure 8-13: GENESIS-T WOPFC Shoreline Changes

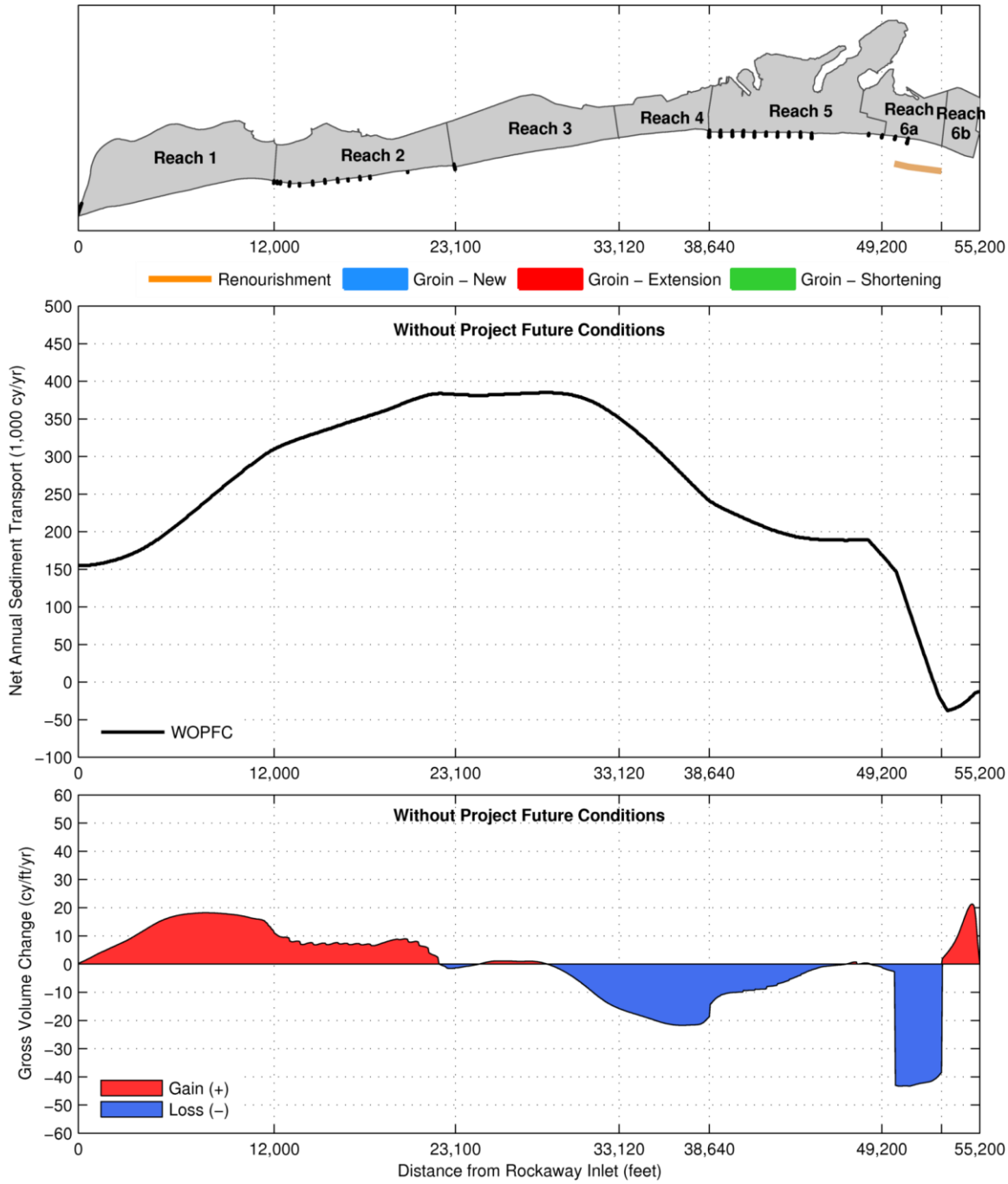


Figure 8-14: GENESIS-T WOPFC Sediment Transport & Gross Volume Changes

8.4 GENESIS Alternative Simulations

This section documents the evaluation of several beach restoration and erosion control alternatives for Rockaway Beach. The alternative evaluation focuses on ways to reduce future renourishment requirements and life-cycle costs. The alternative analysis does not consider storm damage reduction benefits; all of the alternatives provide roughly the same level of protection since the

alternatives have the same design profile (e.g. berm and dune dimensions). Different measures, such as new groins, shortening / lengthening of existing groins, and boardwalk relocation, are evaluated based on their ability to reduce future renourishment requirements and life-cycle costs. The three alternatives evaluated are (Figure 8-15):

- Alternative 1: Beach Restoration
- Alternative 2: Beach Restoration + Reduced Erosion Control
- Alternative 3: Beach Restoration + Increased Erosion Control

The objective of all three alternatives is the same: maintain the design beach profile over the life of the project at the lowest possible cost. The focus of Alternatives 2 and 3 are managing the two historical erosional hot spots in Reach 4 and 6 with either reduced erosion control (groin shortening and boardwalk relocation) or increased erosion control (new groins and extension of existing groins).

The calibrated GENESIS-T model was used to simulate With Project Future Conditions (WPFC) for each short-listed alternative. The same 16-year WOPFC time period (wave conditions from 1996 to 2012) is used to evaluate the alternatives. The GENESIS-T model simulates the impact of beach fill project and coastal structures on shoreline change and longshore sediment transport. The purpose of the GENESIS-T alternative simulations is to 1) confirm that each alternative is able to maintain the design shoreline between renourishment operations, 2) determine the location and quantity of beachfill needed to maintain the design shoreline.

The WPFC modeling was an iterative process requiring several simulations for each short-listed alternative. In particular, Alternatives 2 and 3 required numerous simulations to determine optimal groin configurations (e.g. length and number groins) and extent and density of renourishment fill needed. Each change in the groin configuration and renourishment quantities/extent affected sediment transport rates and shoreline changes. Therefore, it took several iterations to converge to an optimal solution.

In the beginning of the modeling study individual erosion control measures (e.g. new tapered groin field in Reaches 3 and 4) were evaluated separately. After investigating the merit of each individual measure, effective measures were combined to match the original short-listed alternatives. All the WPFC simulations include natural inlet bypassing and inlet maintenance dredging, both of which provide an influx of sediment to Reach 6a which helps reduce shoreline erosion.

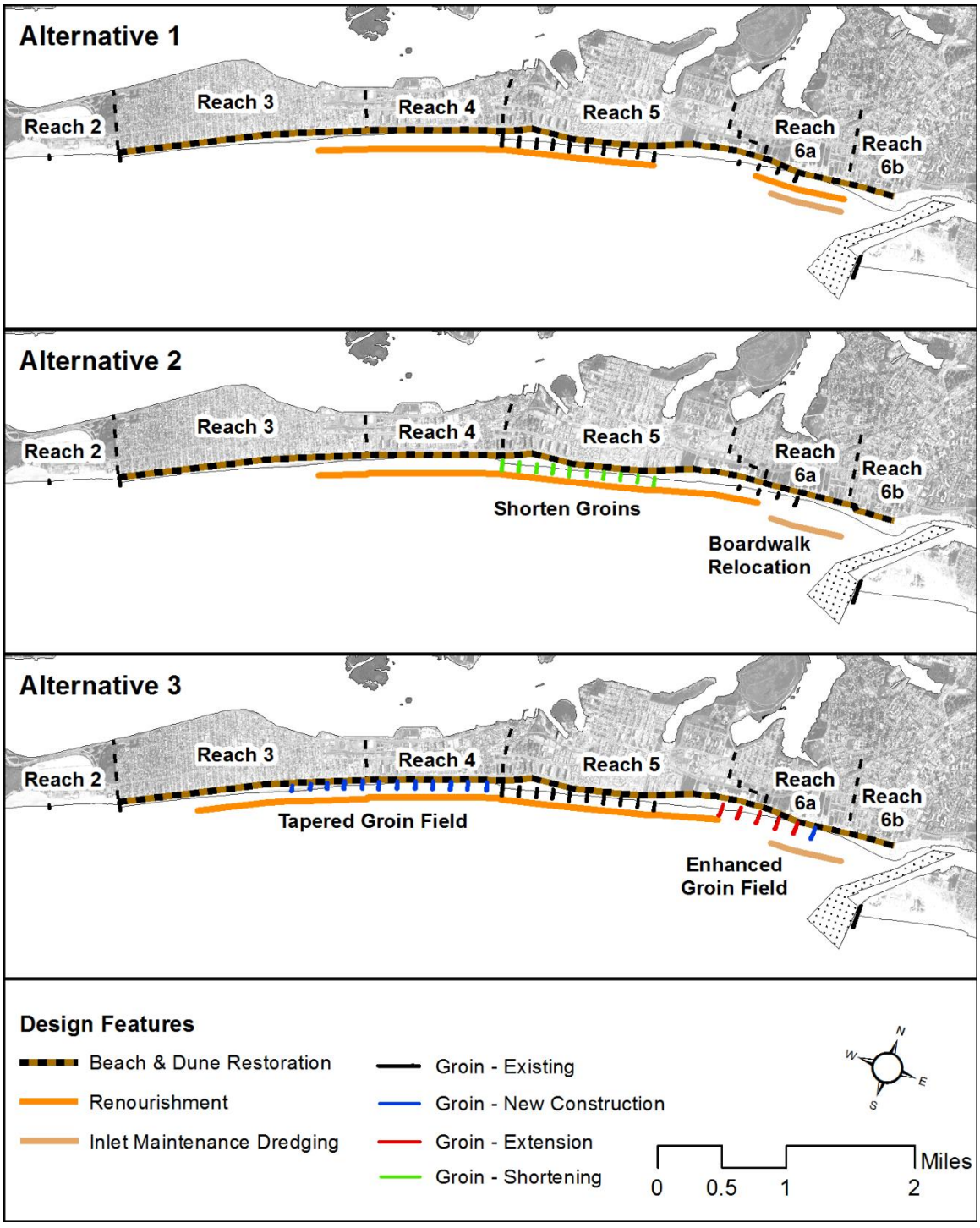


Figure 8-15: GENESIS-T Alternatives

8.4.1 Alternative 1

Alternative 1, Beach Restoration, is similar to the Section 934 Beach Erosion Control Project constructed and maintained from 1996-2004. Alternative 1 includes initial construction, advance

fill, and future renourishment operations. No modification of the existing groins is included in this alternative. Several iterations of Alternative 1 were simulated in GENESIS-T to determine the location and density of renourishment needed to maintain the design shoreline throughout the 16-year simulation. The final renourishment beach fill quantities are shown in Table 8-4.

Table 8-4: GENESIS-T Alternative 1 Renourishment Quantities

Reach	Fill Extent (ft)	Cycle (yr)	Renourishment (cy/yr)	Renourishment (cy per operation)	Fill Density (cy/ft/yr)
Reach 3	1,980	4	30,000	120,000	15.2
Reach 4	5,520	4	120,000	480,000	21.7
Reach 5	6,240	4	65,000	260,000	10.4
Reach 6a	3,660	4	60,000	240,000	16.4
Reach 6a	2,880	2	115,000[1]	230,000	39.9
Total			390,000		

[1]Inlet Maintenance Dredging of East Rockaway Inlet

Two types of figures are used in this document to present the GENESIS-T modeling results. The first type of figure, Figure 8-16, presents modeled net shoreline changes. Net shoreline changes show the difference between the initial shoreline position and final shoreline position. The final shoreline position is at the end of the last renourishment cycle and captures the loss of advance fill. The shoreline change figures illustrate the ability of each alternative to stabilize the shoreline and highlights the areas of the shoreline that require advance fill and periodic renourishment operations. Advance fill is a sacrificial quantity of sand which acts as an erosional buffer against long-term and storm-induced erosion with the goal of preventing erosion of the design profile between renourishment cycles. In general the design shoreline is maintained within the Project Area over the 16-year GENESIS-T simulations. Therefore, shoreline erosion within the Project Area in Figure 8-16 captures the loss of the advance fill volume over the last renourishment cycle. The x-axis, distance from Rockaway Inlet, is the same for all three panels. It is important to note that the shoreline changes are compared to the initial shoreline (i.e. after initial construction of the project with advance fill).

The second type of figure, Figure 8-17, presents modeled net annual longshore sediment transport rates in 1,000 cy/yr (middle panel) and gross sediment volume changes in cy/ft/yr (bottom panel). The bottom panel (gross volume changes) illustrates the total volume of sediment lost or gained along the shoreline. The gross volume changes combines shoreline changes and placed beachfill quantities to capture the true erosive nature of certain areas, highlighting the difficulty in maintaining the design shoreline in these areas.

A third type of figure, which is not included in this appendix, but instead as an enclosure, shows the initial and final shoreline positions from the GENESES-T modeling results in plan-view with

an aerial image of the study in the background. These figures are included in Enclosure B - "GENESIS-T Model Results".

The middle panel of Figure 8-17 shows the net annual longshore sediment transport rates under WOPFC (black) and Alternative 1 (red). The only difference between these two conditions is the initial shoreline positions and placement of beachfill during renourishment operations. It is clear that these two changes result in greater sediment transport rates throughout the project area. The increase in sediment transport rates is attributed to end losses caused by beachfill diffusion and reduced effectiveness of groins (e.g. Reach 5) caused by an increase in the beach width / reduction in effective groin length.

A summary of the performance of Alternative 1 is provided below:

- End losses and background erosion rates make it difficult and costly to maintain the design shoreline in Reach 6a, requiring approximately 175,000 cy/yr of fill.
- A large portion of the beachfill placed in Reach 6a is transported to adjacent shorelines where sediment is accumulated resulting in excess beach widths.
- Periodic renourishment is required in the groin field in Reach 5 and downdrift of the groin field in Reaches 3 and 4 to offset background shoreline erosion.
- A large portion of the beachfill placed in Reach 4 is transported to adjacent shoreline in Reach 3 where sediment is accumulated resulting in excess beach widths.
- The design shoreline in the hot spot in Reach 4 is be maintained by 1) keeping the groin compartments in Reach relatively filled which allows more sediment transported downdrift, 2) providing sufficient advance fill to offset background shoreline erosion.
- The quantity of beachfill required over the life of the project, 390,000 cy/year is consistent with the amount of beachfill placed in the Historical Sediment Budget (398,000 cy/yr).

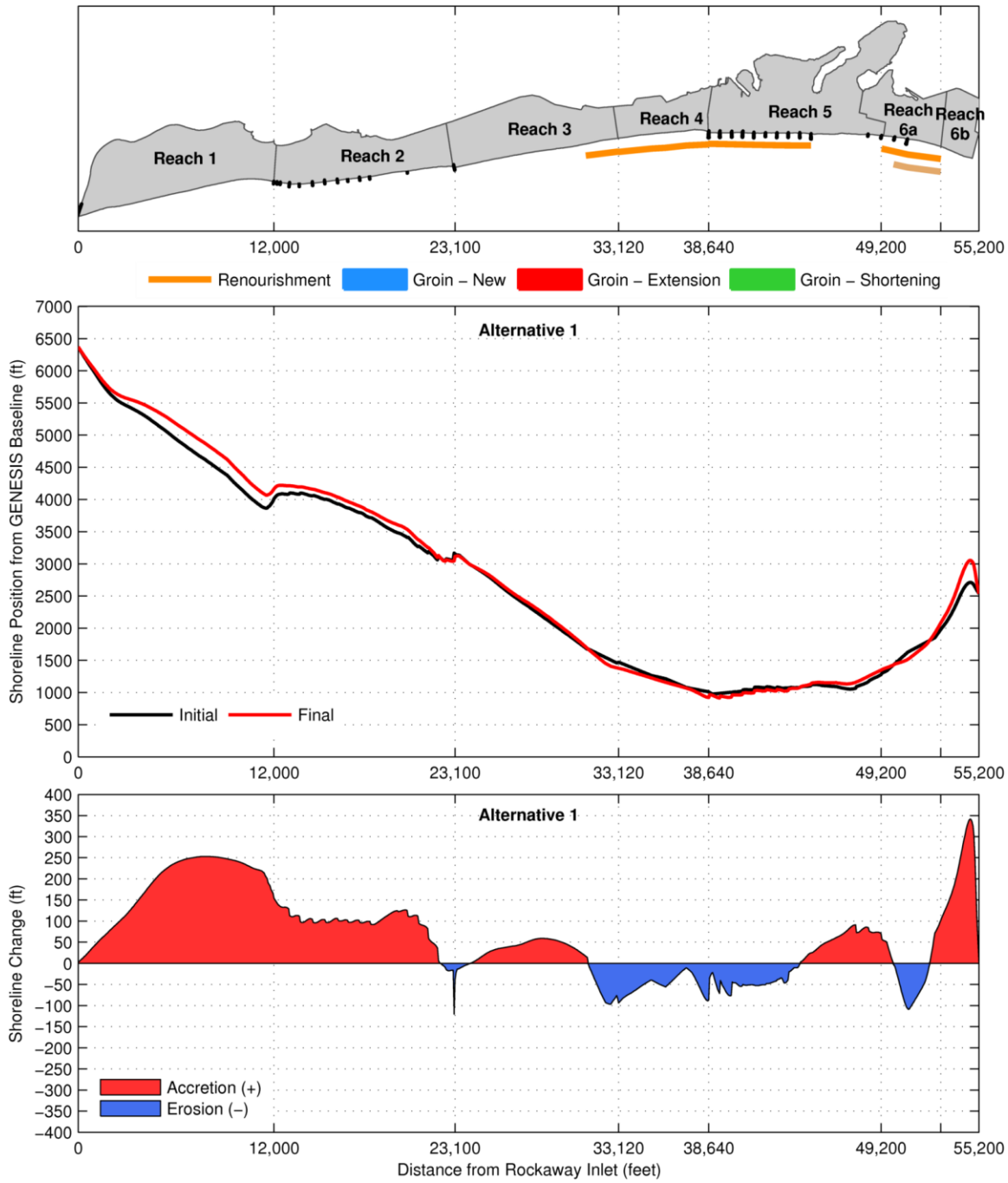


Figure 8-16: GENESIS-T Alternative 1 Shoreline Changes

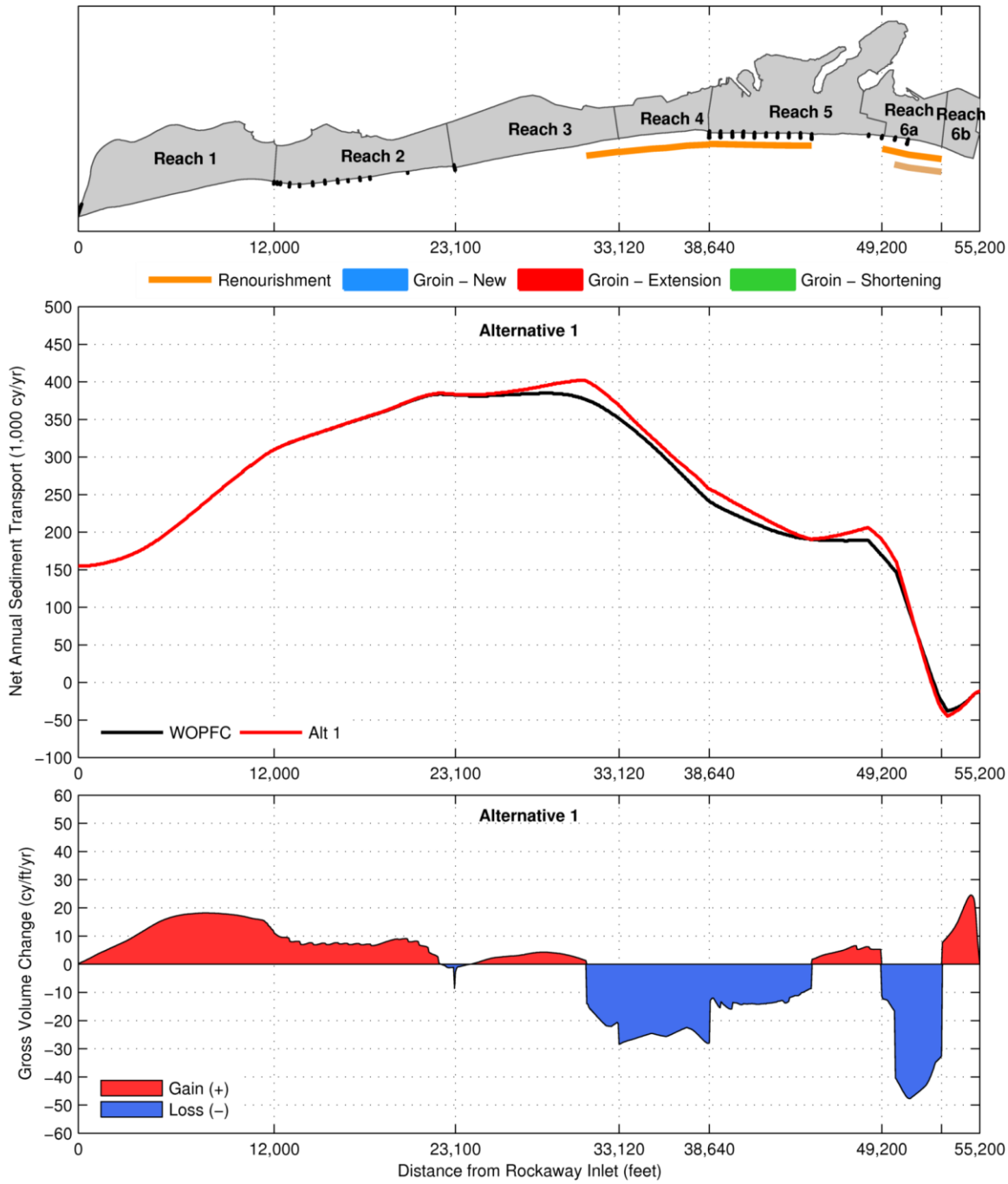


Figure 8-17: GENESIS-T Alternative 1 Sediment Transport & Gross Volume Changes

8.4.2 Alternative 2

Alternative 2, Beach Restoration and Reduced Erosion Control, includes two measures in addition to Alternative 1: 1) boardwalk relocation in Reach 6a with landward relocation of design shoreline,

and 2) groin shortening in Reach 5 to address historic erosional hot spots in Reach 6a and Reach 4. Several iterations of Alternative 2 were simulated in GENESIS-T to determine the location and density of renourishment needed to maintain the design shoreline throughout the 16-year simulation. The final renourishment beach fill quantities are shown in Table 8-5.

Table 8-5: GENESIS-T Alternative 2 Renourishment Quantities

Reach	Fill Extent (ft)	Cycle (yr)	Renourishment (cy/yr)	Renourishment (cy per operation)	Fill Density (cy/ft/yr)
Reach 3	2,000	4	25,000	100,000	12.5
Reach 4	5,520	4	70,000	280,000	12.7
Reach 5	6,240	4	90,000	360,000	14.4
Reach 5	4,320	4	35,000	140,000	8.1
Reach 6a	2,880	2	115,000[1]	230,000	39.9
Total			335,000		

[1]Inlet Maintenance Dredging of East Rockaway Inlet

The modeling results are presented in Figure 8-18 and Figure 8-19. Net shoreline changes are presented in Figure 8-18. Net annual longshore sediment transport rates and gross volume changes are presented in Figure 8-19.

The middle panel of Figure 8-19 shows the net annual longshore sediment transport rates under Alternative 1 (red) and Alternative 2 (blue). The impact of boardwalk relocation is captured by the reduction in sediment transport rates in Reach 6a and the eastern end of Reach 5. Likewise, the effect of shortening the groins in Reach 5 is captured by an increase in the sediment transport rates in this area.

A summary of the performance of Alternative 2 is provided below:

- End losses and background erosion rates in Reach 6a are reduced by relocating the boardwalk in Reach 6a. Inlet maintenance dredging (115,000 cy/yr) is enough to maintain the design shoreline, no additional renourishment is required.
- Due to the boardwalk relocation and associated reduced renourishment quantities there is no longer an excess of sediment accumulating in the adjacent areas of Reach 5.
- Groin shortening in Reach 5 increases sediment transport within the groin field allowing more sediment to be transported downdrift to Reach 4. As a result, renourishment quantities in Reach 4 are reduced. However, this reduction comes at the expense of Reach 5 which now requires higher renourishment volumes.
- Groin shortening evenly redistributes the background shoreline erosion rates between Reach 4 and 5. Groin shortening does not affect the overall renourishment quantities.
- Groin shortening has a negligible effect on sediment transport, shoreline changes, and renourishment quantities in Reach 3 in comparison with Alternative 1.

- 335,000 cy/year of beachfill are required over the life of the project, a reduction of 55,000 cy/yr compared to Alternative 1.The reduction of renourishment quantities is associated with the boardwalk relocation feature.

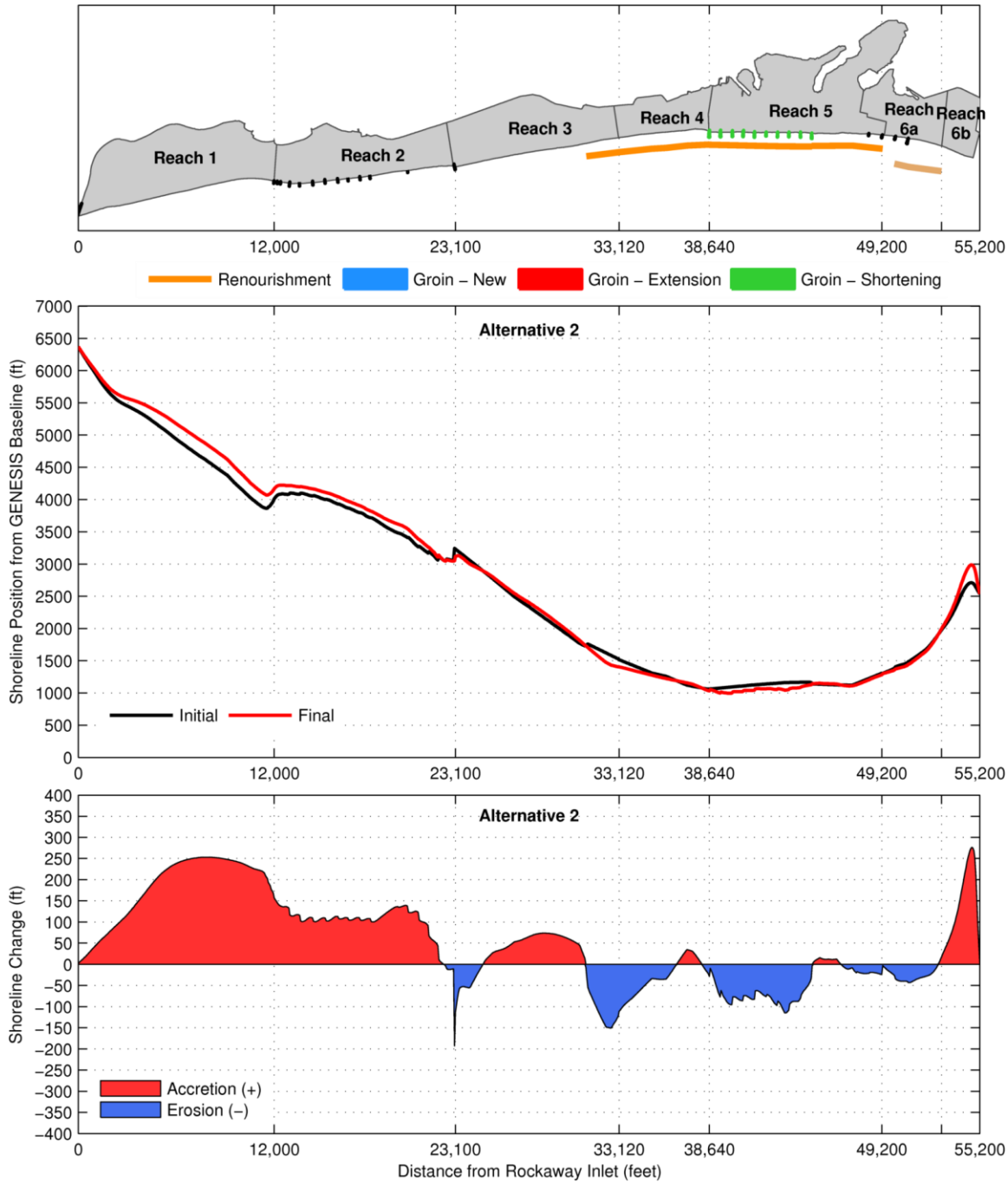


Figure 8-18: GENESIS-T Alternative 2 Shoreline Changes

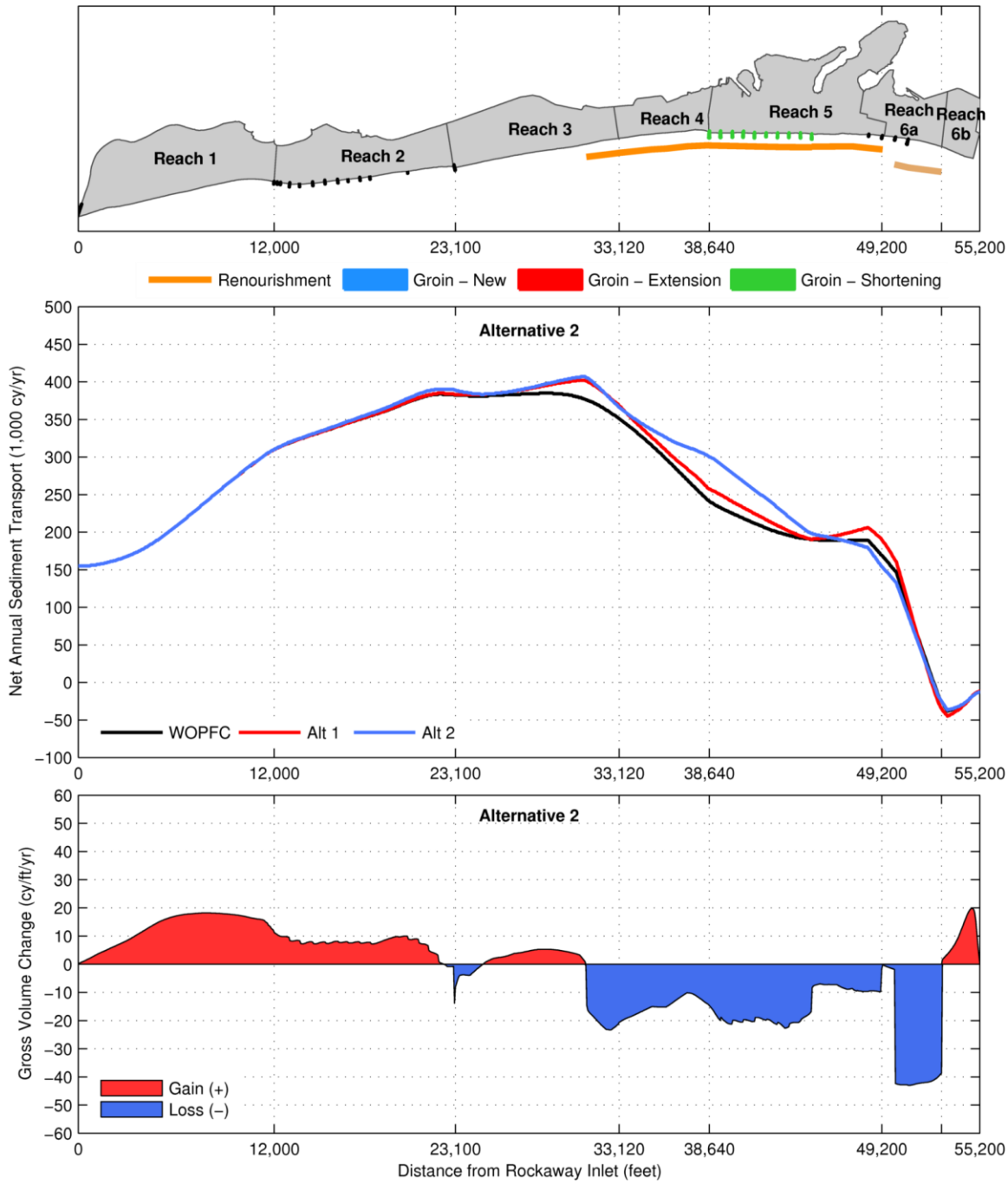


Figure 8-19: GENESIS-T Alternative 2 Sediment Transport & Gross Volume Changes

8.4.3 Alternative 3

Alternative 3, Beach Restoration and Increased Erosion Control, includes two measures in addition to Alternative 1: 1) new groin construction and groin extensions in Reach 6a, and 2) new groin

construction in Reaches 3 and 4 to address historic erosional hot spots in Reach 6a and Reach 4. Several iterations of Alternative 3 were simulated in GENESIS-T to determine the optimal groin configurations as well as the location and density of renourishment needed to maintain the design shoreline throughout the 16-year simulation. The final renourishment beach fill quantities are shown in Table 8-6.

Table 8-6: GENESIS-T Alternative 3 Renourishment Quantities

Reach	Fill Extent (ft)	Cycle (yr)	Renourishment (cy/yr)	Renourishment (cy per operation)	Fill Density (cy/ft/yr)
Reach 3	3,960	4	40,000	160,000	10.1
Reach 3	3,000	4	50,000	200,000	16.7
Reach 4	5,520	4	25,000	100,000	4.5
Reach 5	6,240	4	80,000	320,000	12.8
Reach 5	2,700	4	10,000	40,000	3.7
Reach 6a	2,880	2	115,000[1]	230,000	39.9
Total			335,000		

[1]Inlet Maintenance Dredging of East Rockaway Inlet

The modeling results are presented in Figure 8-20 and Figure 8-21. Net shoreline changes are presented in Figure 8-20. Net annual longshore sediment transport rates and gross volume changes are presented in Figure 8-21.

The middle panel of Figure 8-21 shows the net annual longshore sediment transport rates under Alternative 1 (red) and Alternative 3 (green). The impact of new groin and groin extensions in Reach 6a is captured by the reduction in sediment transport rates in this area. Likewise, the effect of constructing new groins in Reaches 3 and 4 results in a reduction in sediment transport within the groin field.

A summary of the performance of Alternative 3 is provided below:

- End losses and background erosion rates in Reach 6a are reduced by extending the existing groins and adding one new groin. Inlet maintenance dredging (115,000 cy/yr) is enough to maintain the design shoreline, no additional renourishment is required.
- The groin extensions in Reach 6a combined with the decrease in renourishment fill placed, decreases the sediment flux into Reach 5. As a result renourishment quantities in Reach 5 increase.
- Sediment transport rates at the western end of Reach 5 have increased in response to the increase in beachfill (i.e. beachfill diffusion). As a result, the sediment flux into Reach 4 increased.

- The groin field in Reach 4 needed to be extended into Reach 3 to prevent creating a new hot spot.
- The sediment transport rate in within the new groin field in Reaches 3 and 4 is suppressed by the groins.
- The tapered groins lead a smooth transition between the groin field and downdrift shoreline.
- The quantity of beachfill required over the life of the project is 320,000 cy/year, a total reduction of 70,000 cy/yr from Alternative 1 (390,000 cy/yr).
- 35,000 cy/yr of the reduction in renourishment quantities is attributed to the groin features in Reach 6a.
- 35,000 cy/yr of the reduction in renourishment quantities is attributed to the groin features in Reaches 3 and 4.

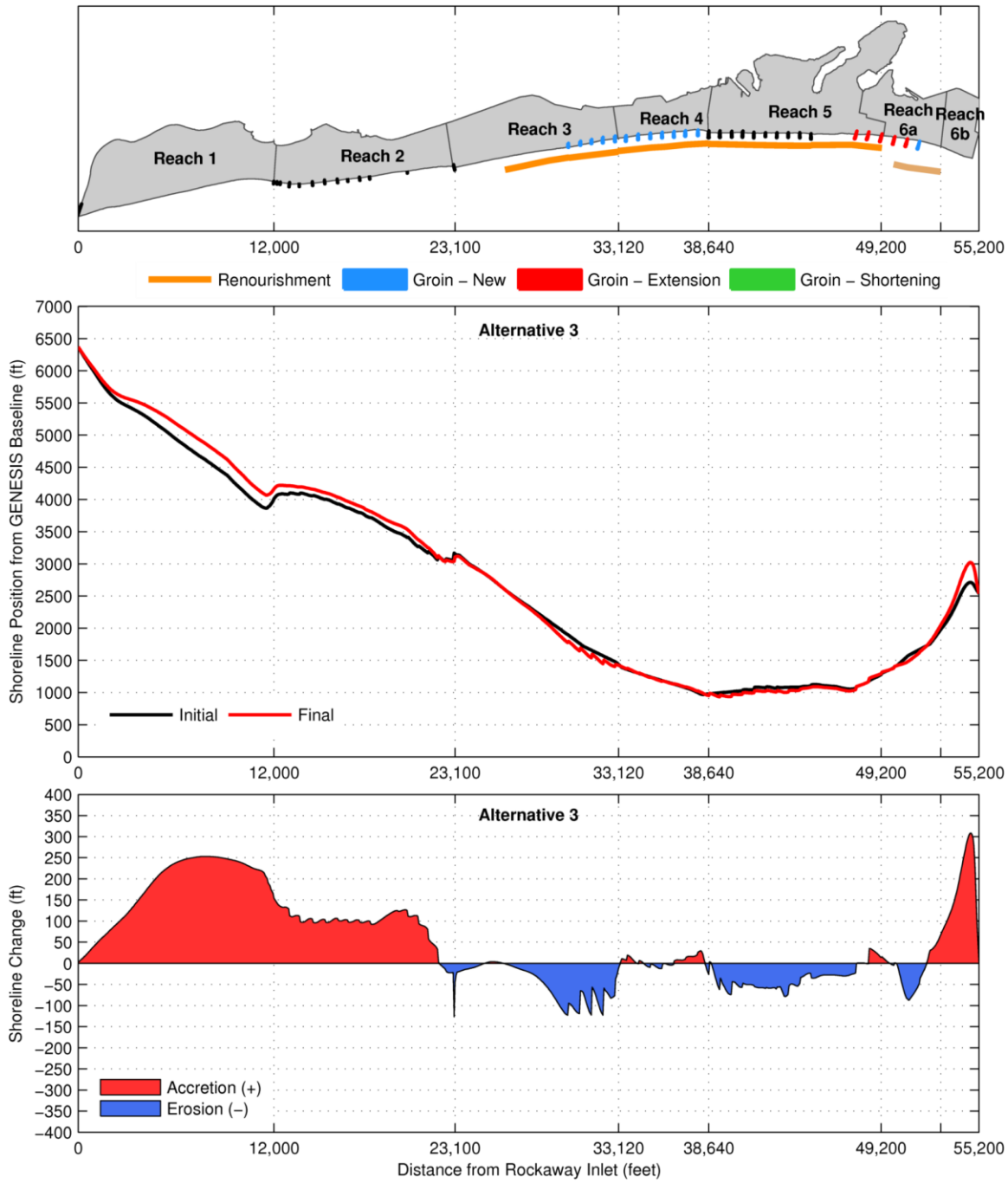


Figure 8-20: GENESIS-T Alternative 3 Shoreline Changes

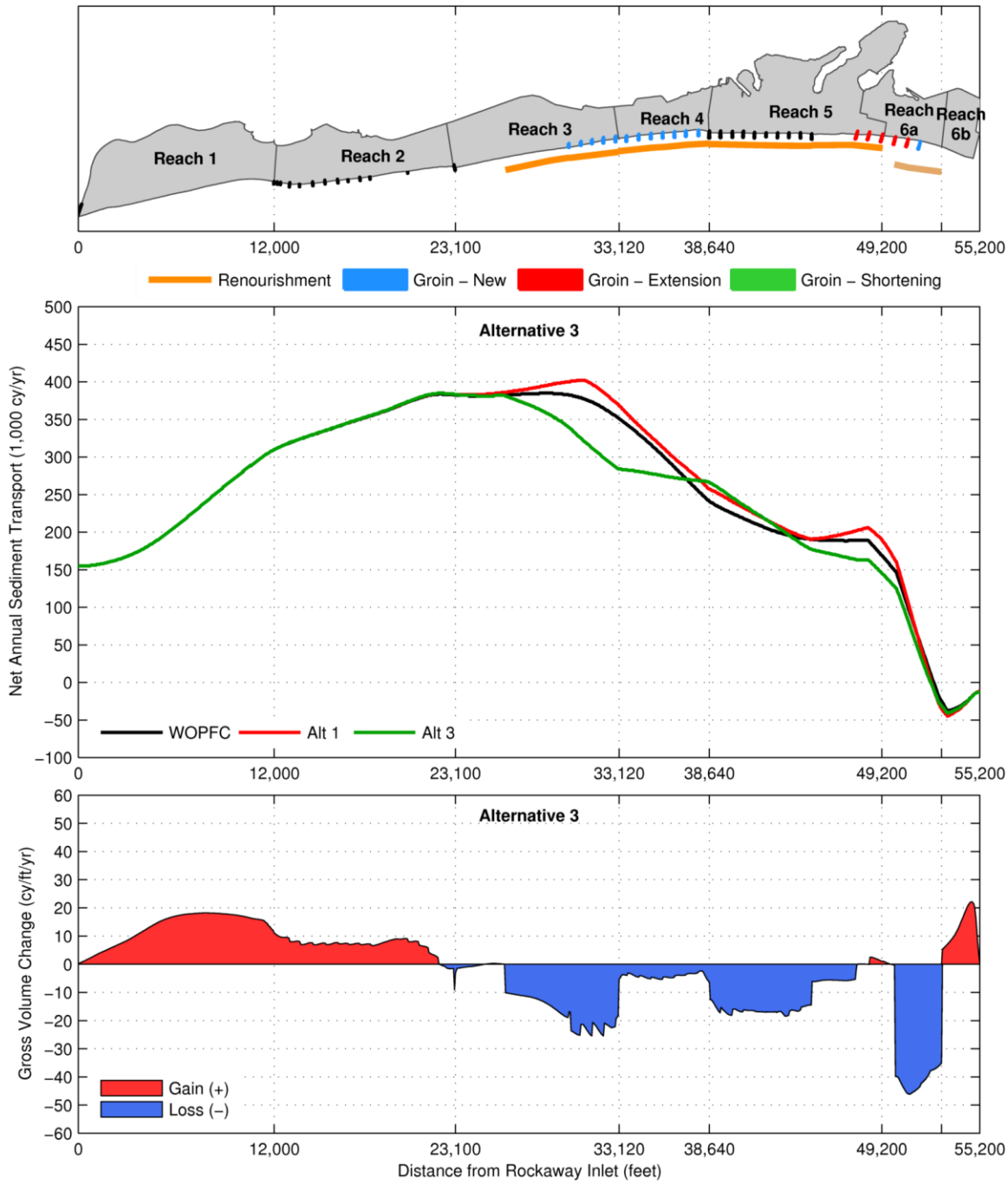


Figure 8-21: GENESIS-T Alternative 3 Sediment Transport & Gross Volume Changes

8.4.4 Other Alternatives

Several other alternatives were evaluated in GENESIS-T before converging to the three alternatives described above. In this case it is just as informative review the GENESIS-T results

for a few of the alternatives that were not carried forward. GENESIS-T results for three additional alternatives are presented here, all of which are variations of Alternative 3:

- Alt A - Alt 3 without any groins in Reach 3 and longer groins in Reach 4;
- Alt B - Alt 3 without any groins in Reaches 3 or 4, but tapering of the last two groins in Reach 5;
- Alt C - Alt 3 with additional groins extending all the way through Reach 2.

The sediment transport results for these 3 additional alternatives are shown in Figure 8-22. The purpose of showing Alt A is to reinforce the point that adding new groins has the potential to just push the "problem" downdrift. A snapshot of the shoreline positions at the end of the 16-year GENESIS simulation for Alternative A is shown in Figure 8-23, which shows that Alternative A has just moved the EHS to Reach 3. Alternative 3 included 5 tapered groins in Reach 3 to avoid creating an EHS equal or worse in this case to the historical EHS in Reach 4.

Alternative B, tapering of the last two groins in Reach 5, does increase the flux of sediment into Reach 4. However, the shoreline in Reach 5 experiences additional erosion (Figure 8-24). This measure could be combined with Alternative 3 with the additional erosion in Reach 5 managed by placing more beachfill in this area. However, the same objective may be achieved by decreasing the effective length of these groins by placing additional sand in the last two groin cell compartments

Alternative C, extending groins from Reach 5 through Reach 2, is included to show that the sediment transport rate could be suppressed over the entire project area if enough groins are constructed. Downdrift impacts in Alternative C would be minimal since Reach 1 is an area that is accreting. Alternative C would reduce renourishment quantities by 50,000 to 100,000 cy per year. However, the cost of building groins along the entire shoreline would likely outweigh the cost savings.

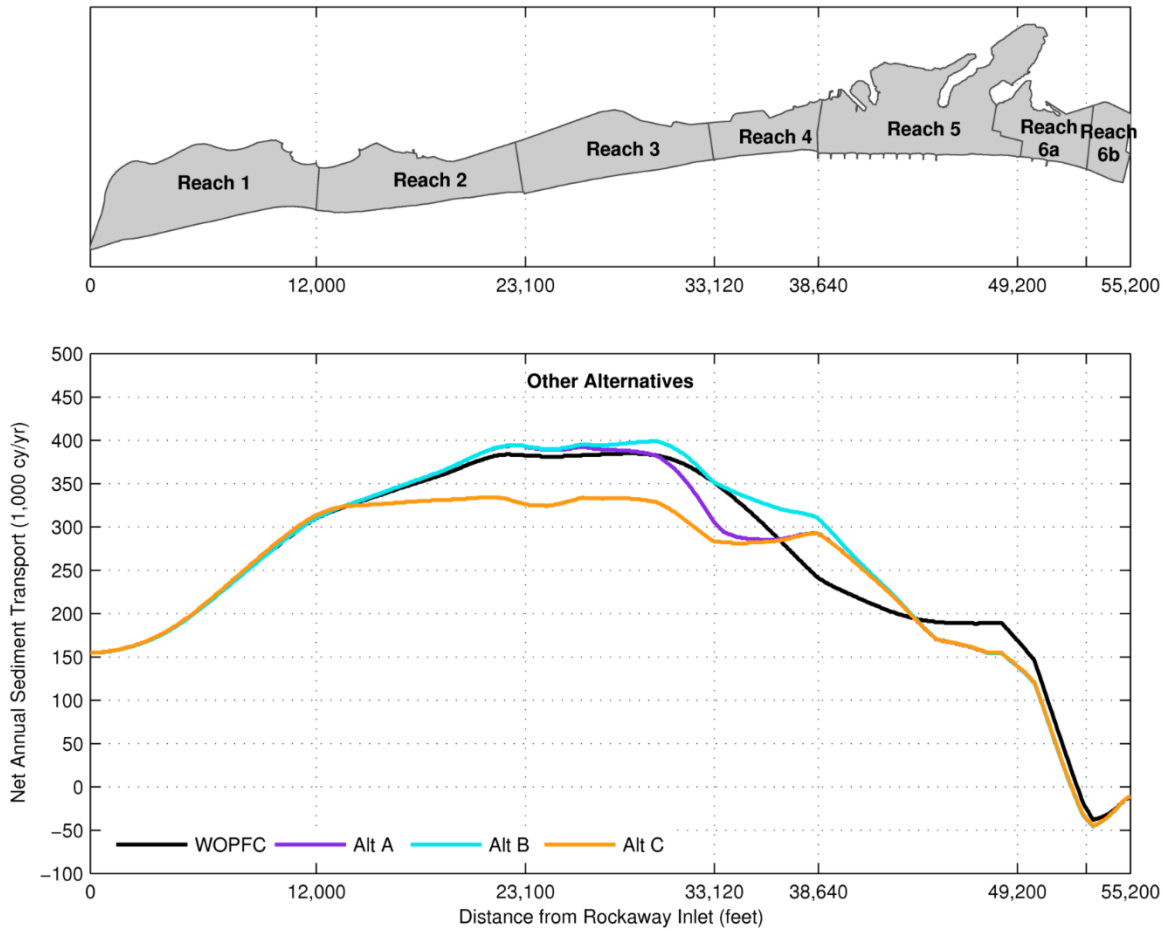


Figure 8-22: GENESIS-T Sediment Transport for Other Alternatives

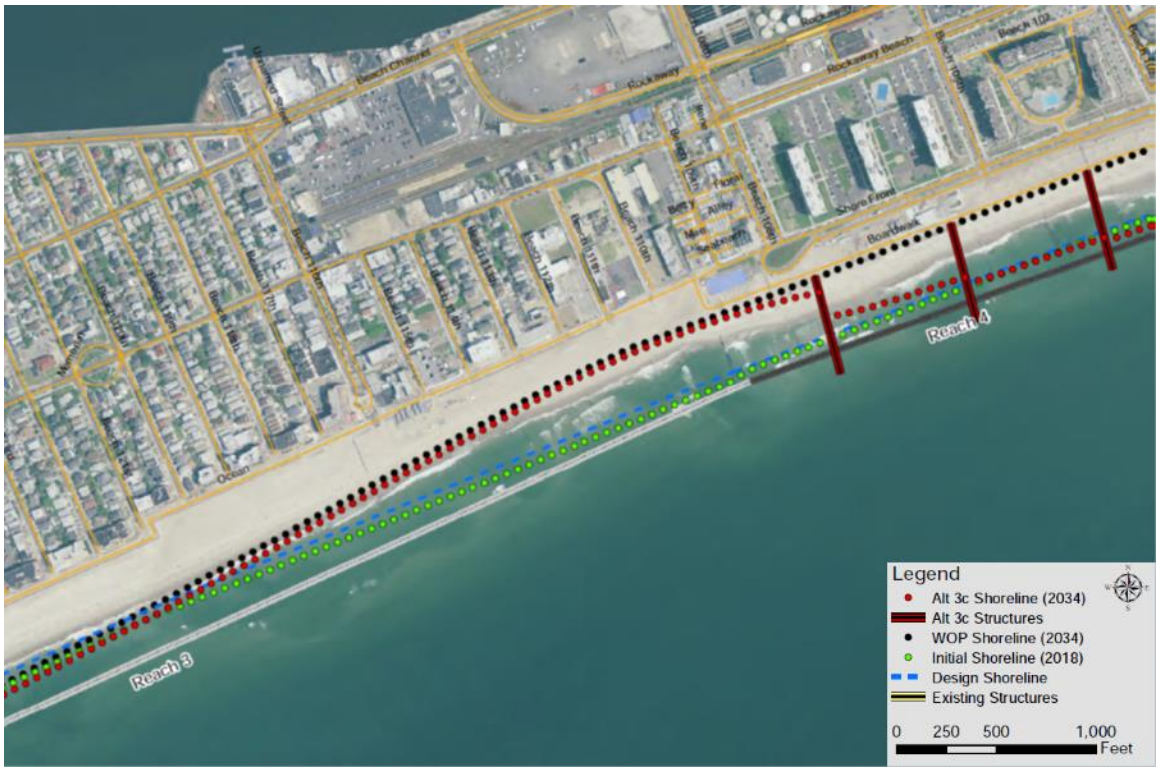


Figure 8-23: GENESIS-T Downdrift Erosion in Alternative A (red dots)

Figure 8-24: GENESIS-T Impact of Tapered Groins in Alternative B (orange dots)

8.4.5 Summary of GENESIS-T Results

GENESIS-T modeling was conducted for the three short-listed alternatives. Several GENESIS-T simulations were performed for each alternative prior to converging to a combination of renourishment fill and erosion control measures that maintained the design shoreline between renourishment operations. A summary of the renourishment quantities is provided in Table 8-7. It is noted that these renourishment quantities do not account for sea level rise or overfill requirements. These factors will be incorporated in the life-cycle cost estimates.

Alternative 1, Beach Restoration, requires 390,000 cy/yr of renourishment to maintain the design shoreline. As a point of comparison, 398,000 cy/yr of beachfill was placed along Rockaway from 1975-2010, and 354,000 cy/yr of beachfill was required during the Section 934 Beach Erosion Control Project.

Alternative 2, Reduced Erosion Control, requires 335,000 cy/yr of renourishment to maintain the design shoreline. A reduction in renourishment quantities of 55,000 cy/yr, all of which is attributed to the boardwalk relocation measure. Groin shortening in Reach 5 does not reduce the overall renourishment quantities. However, groin shortening does address the erosional hot spot in Reach 4 by increasing the flux of sediment into Reach 4, creating a more uniform shoreline erosion rate.

Alternative 3, Increased Erosion Control, requires 320,000 cy/yr of renourishment to maintain the design shoreline. A reduction in renourishment quantities of 35,000 cy/yr is attributed to the new groin and groin extensions in Reach 6a. A reduction of 35,000 cy/yr is attributed to the new tapered groin field in Reaches 3 and 4. The modeling results indicated that the new tapered groin field in Reach 4 needed to be extended into Reach 3 in order to avoid creating a new erosional hot spot downdrift.

Table 8-7: GENESIS-T Summary of Renourishment Quantities

Reach	Renourishment (cy/yr)[1]		
	Alternative 1	Alternative 2	Alternative 3
Reach 3	30,000	25,000	90,000
Reach 4	120,000	70,000	25,000
Reach 5	65,000	125,000	90,000
Reach 6a	175,000[2]	115,000[2]	115,000[2]
Total	390,000	335,000	320,000

Notes [1]Renourishment quantities do not include SLR or overfill

[2]Includes Inlet Maintenance Dredging (115,000 cy/yr)

9.0 REFERENCES

Bedient, P.B., and Huber, W.C. (1992). "Hydrology and Floodplain Analysis (2nd Edition)." Addison-Wesley Publishing Company: Reading, Massachusetts.

Chow, V.T. (1959). "Open-Channel Hydraulics." McGraw-Hill: New York.

EurOtop. (2007). "Wave Overtopping of Sea Defences and Related Structures: Assessment Manual." Eds. T. Pullen., N.W.H Allsop, T. Bruce., A. Kortenhaus, H. Schuttrumpf, and J.W. van der Meer.

Federal Emergency Management Agency (FEMA). (2007). "Guidelines and Specifications for Flood Hazard Mapping Partners." Section D.2.7 Overland Wave Propagation.

Goda, Y. (2000). "Random Seas and Design of Maritime Structures." World Scientific: New Jersey.

M&N. (2001). "Selection of Alternative Design Beach Profiles." Draft Memorandum. Fire Island Inlet to Montauk Point (FIMP) Study.

Smith, J. M., Sherlock, A. R., Resio, D. T., 2001. "STWAVE: Steady-State Spectral Wave Model User's Manual for STWAVE, Version 3.0". ERDC/CHL SR-01-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Smith, J. M. 2007. "Full-plane STWAVE: II. Model overview". ERDC TN-SWWRP-07-05. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Wamsley, V., and Kraus, N.C. (2004). "SBEACH dune lowering sensitivity analysis for the Fire Island to Montauk Point, New York, study." USACE ERDC/CHL TR-05.

U.S. Army Corps of Engineers (USACE).(2004). "Coastal overwash Part1: Overview of processes." USACE ERDC/RSM-TN-14

U.S. Army Corps of Engineers, New York District (USACE-NAN), (2005). "Baseline Conditions Storm Surge Modeling and Stage Frequency Generation: Fire Island to Montauk Point Reformulation Study", U.S. Army Corps of Engineers, New York District.

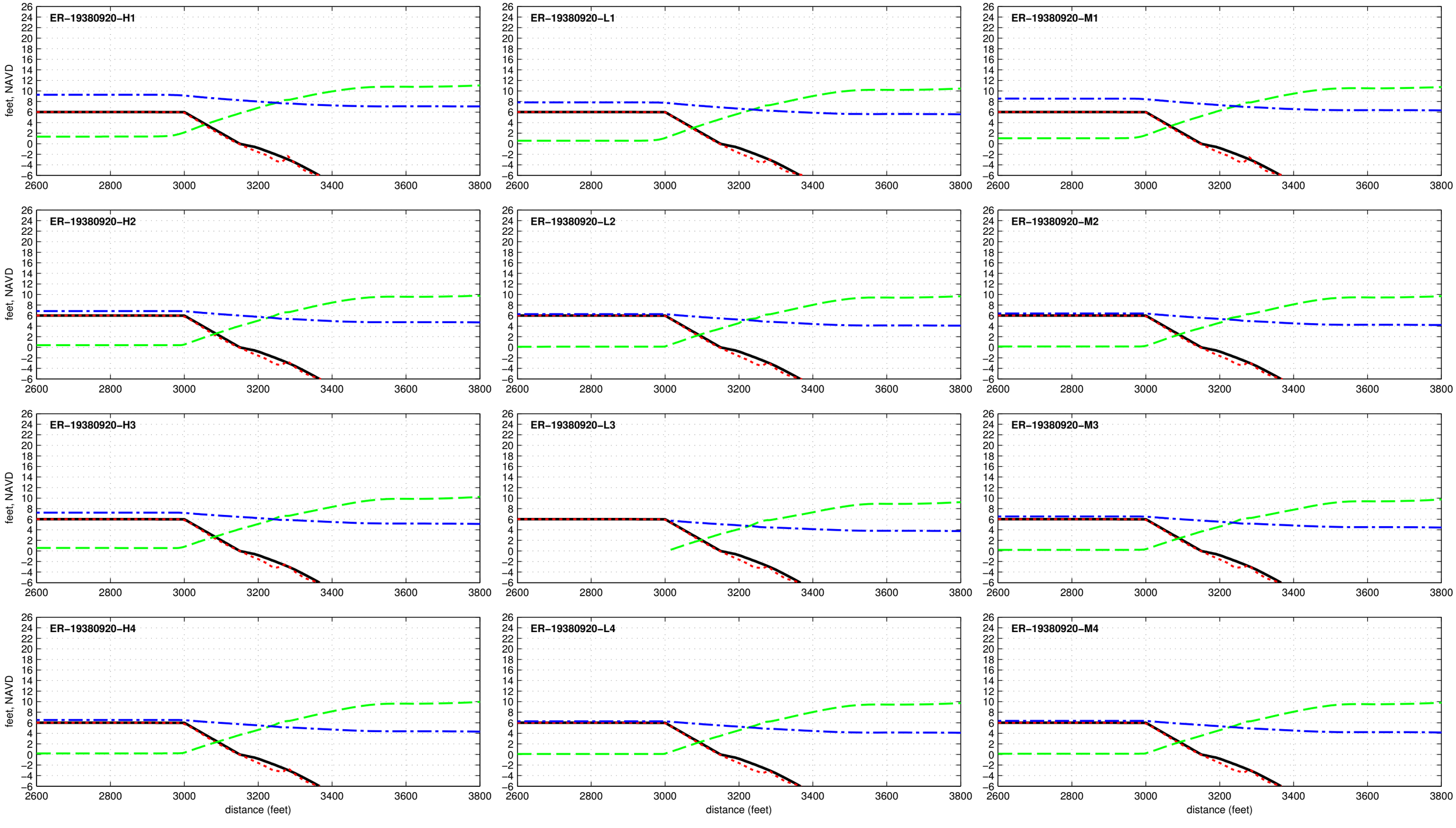
U.S. Geological Survey (USGS) by Arcement, G.J. and Schenider, V.R. (1984). "Guide for Selecting Manning's Roughness Coefficients for Natural Channels ad Flood Plains." U.S. Geological Survey Water-supply Paper 2339.

ENCLOSURE A

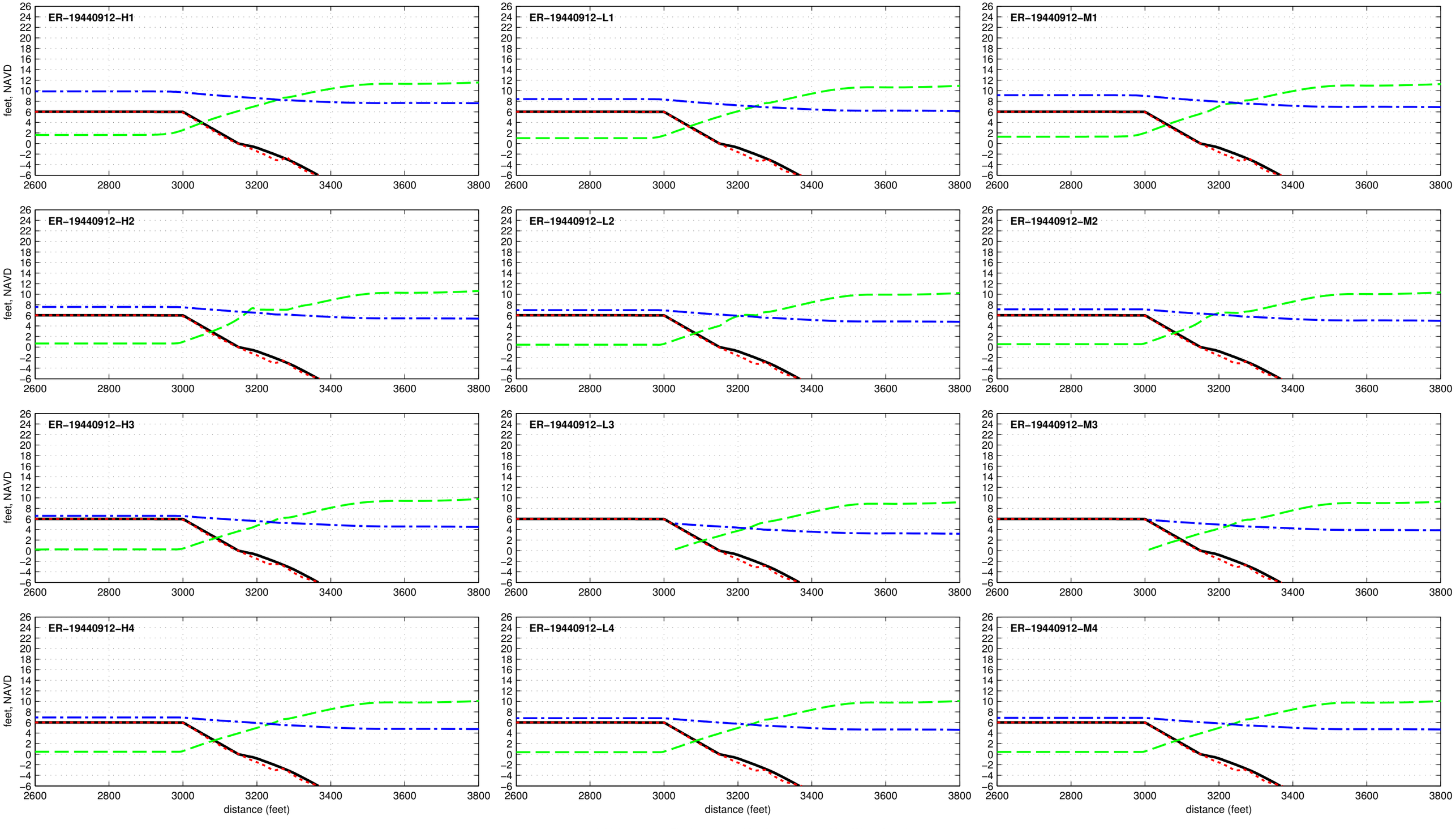
SBEACH MODEL RESULTS

R1T1_06.0_000_000 - DUNE

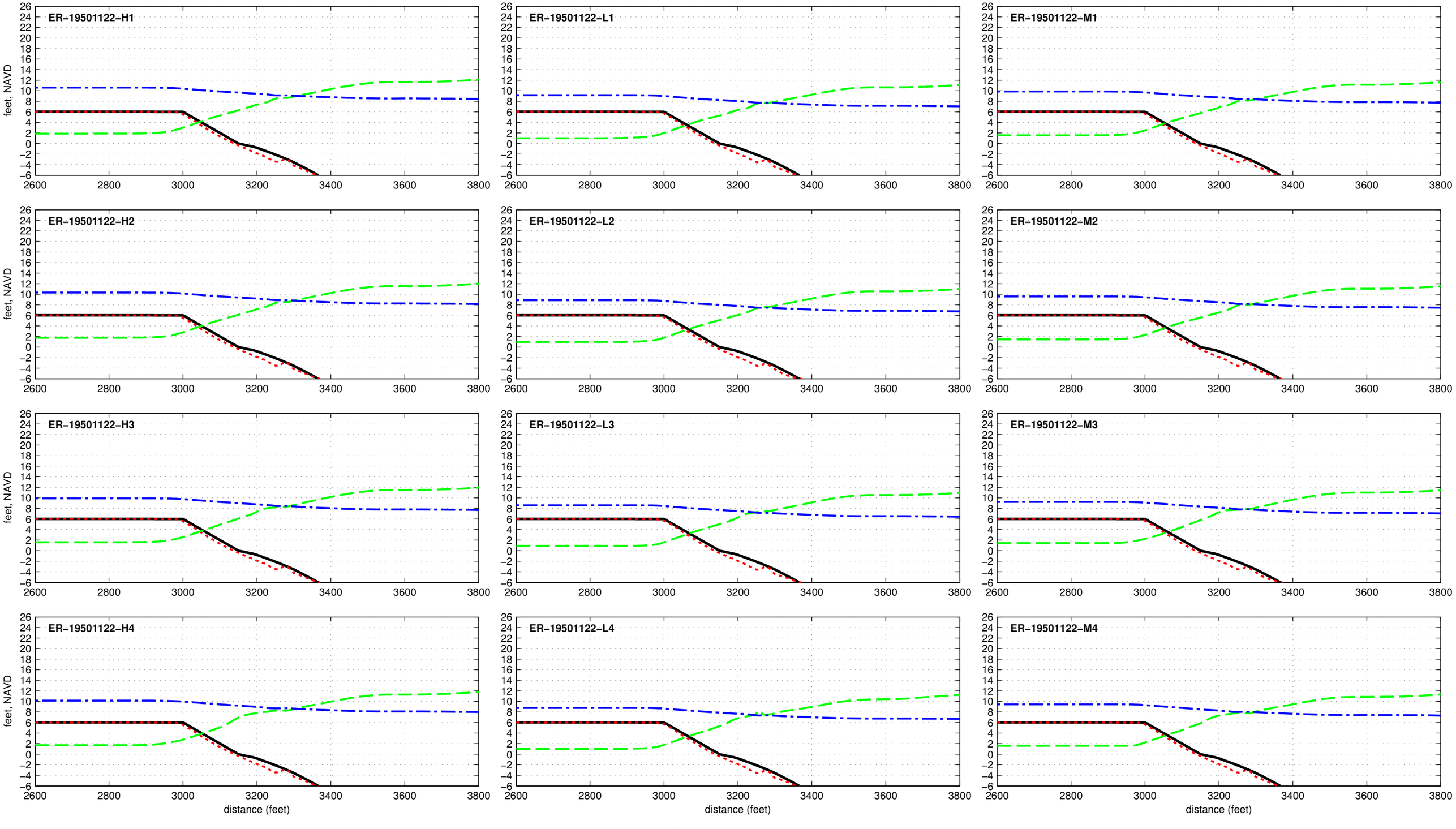
Dune R1T1-6.0-000-000 - ER-19380920



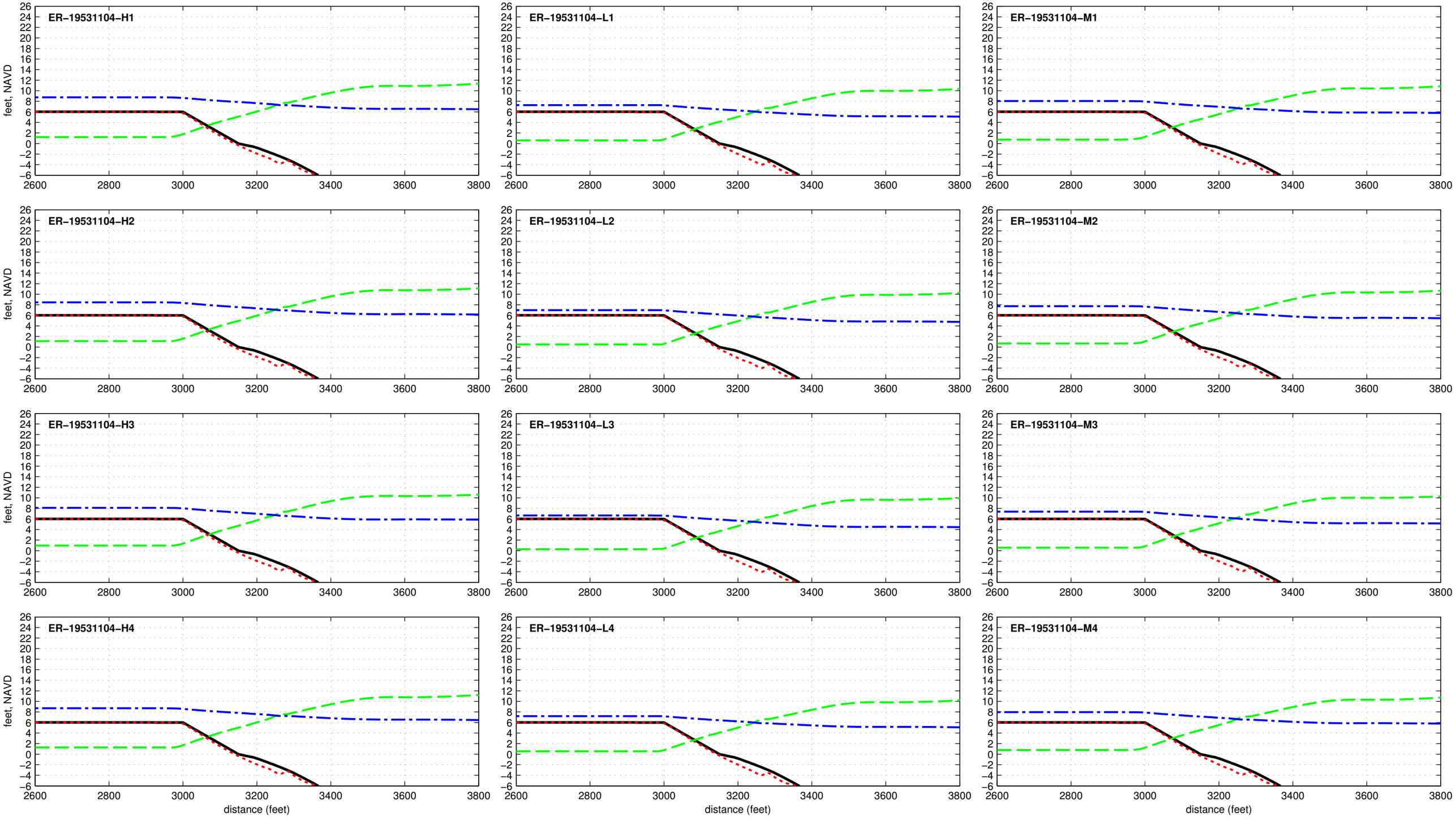
Dune R1T1-6.0-000-000 - ER-19440912



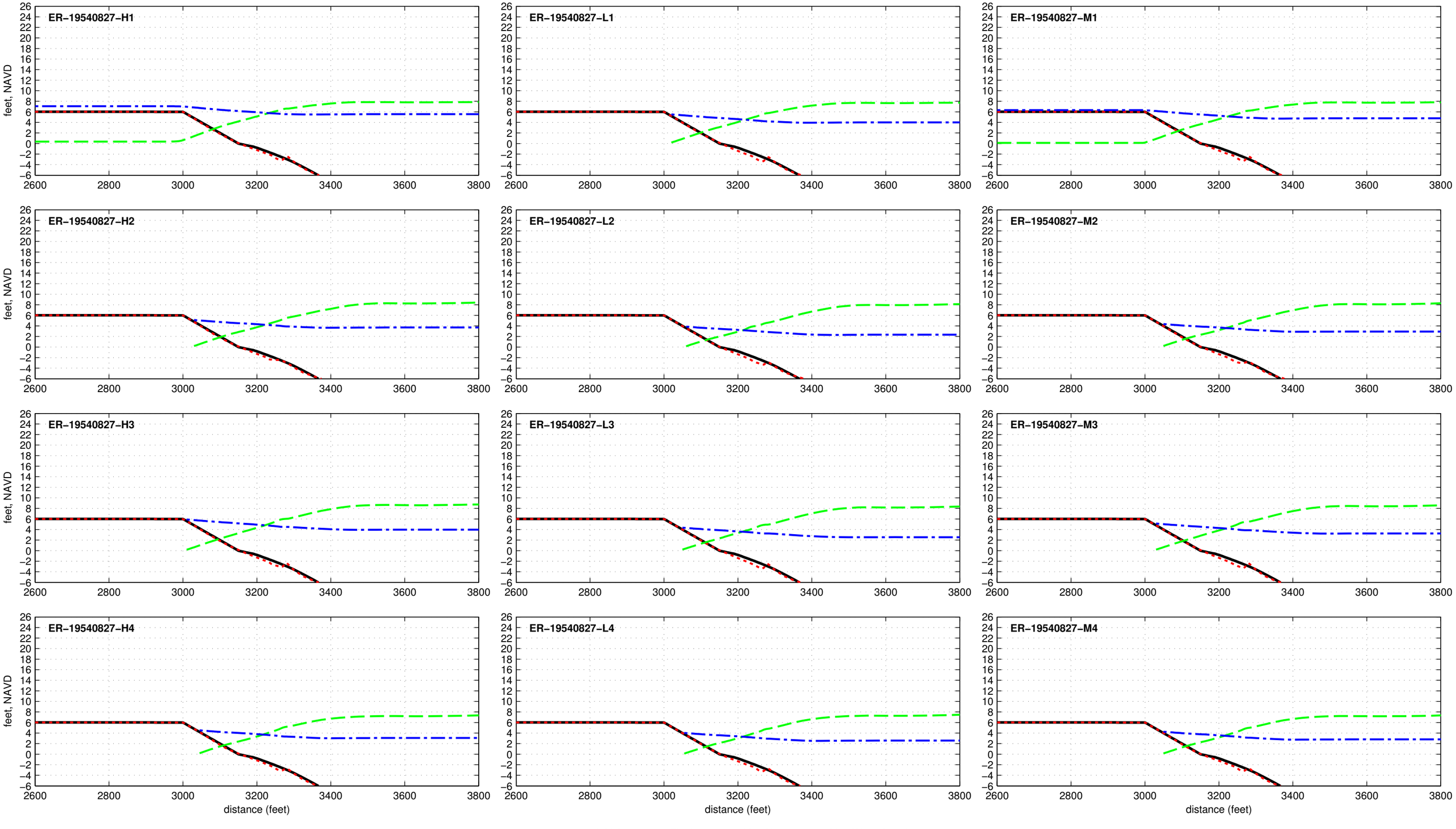
Dune R1T1-6.0-000-000 - ER-19501122



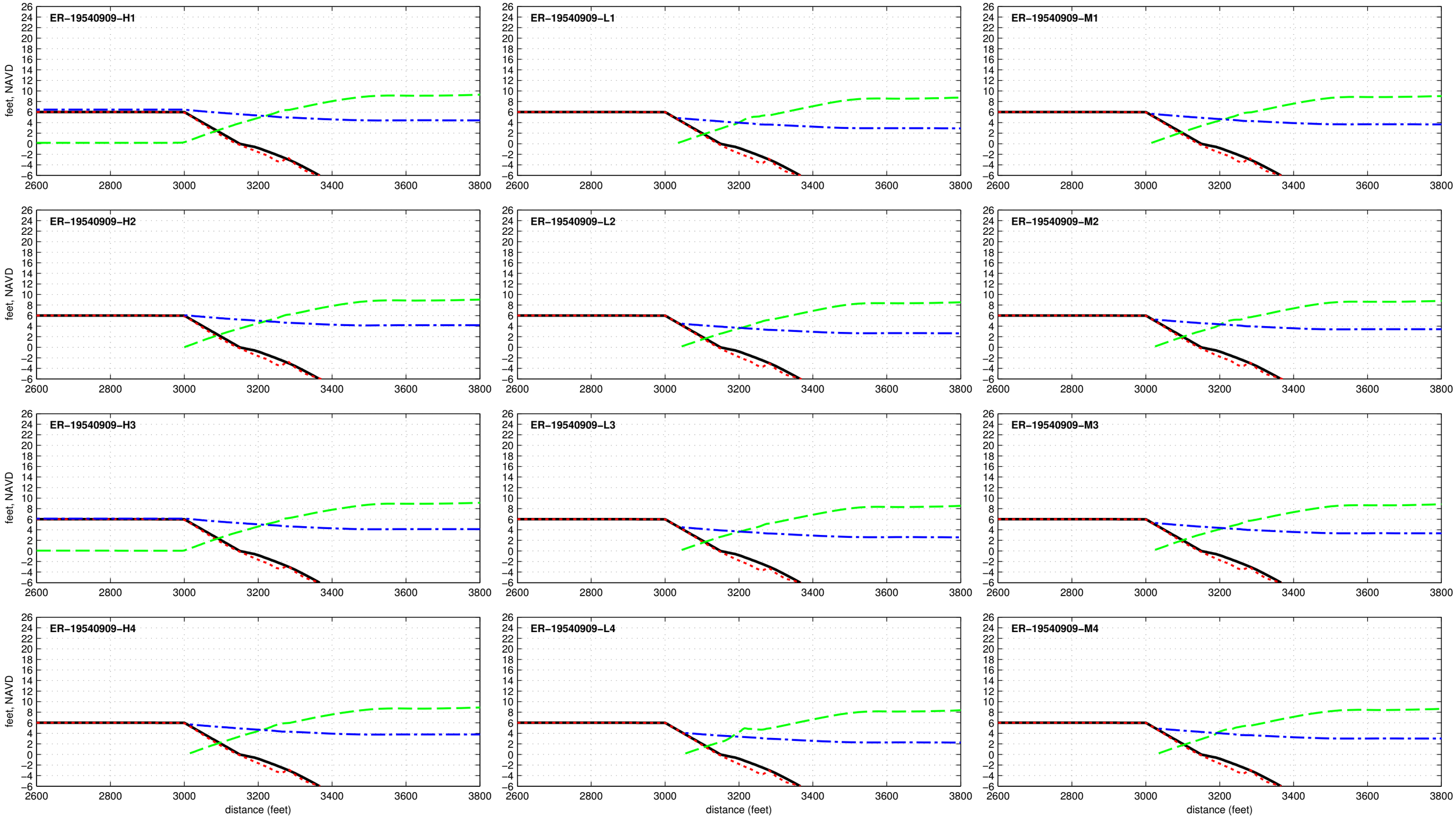
Dune R1T1-6.0-000-000 - ER-19531104



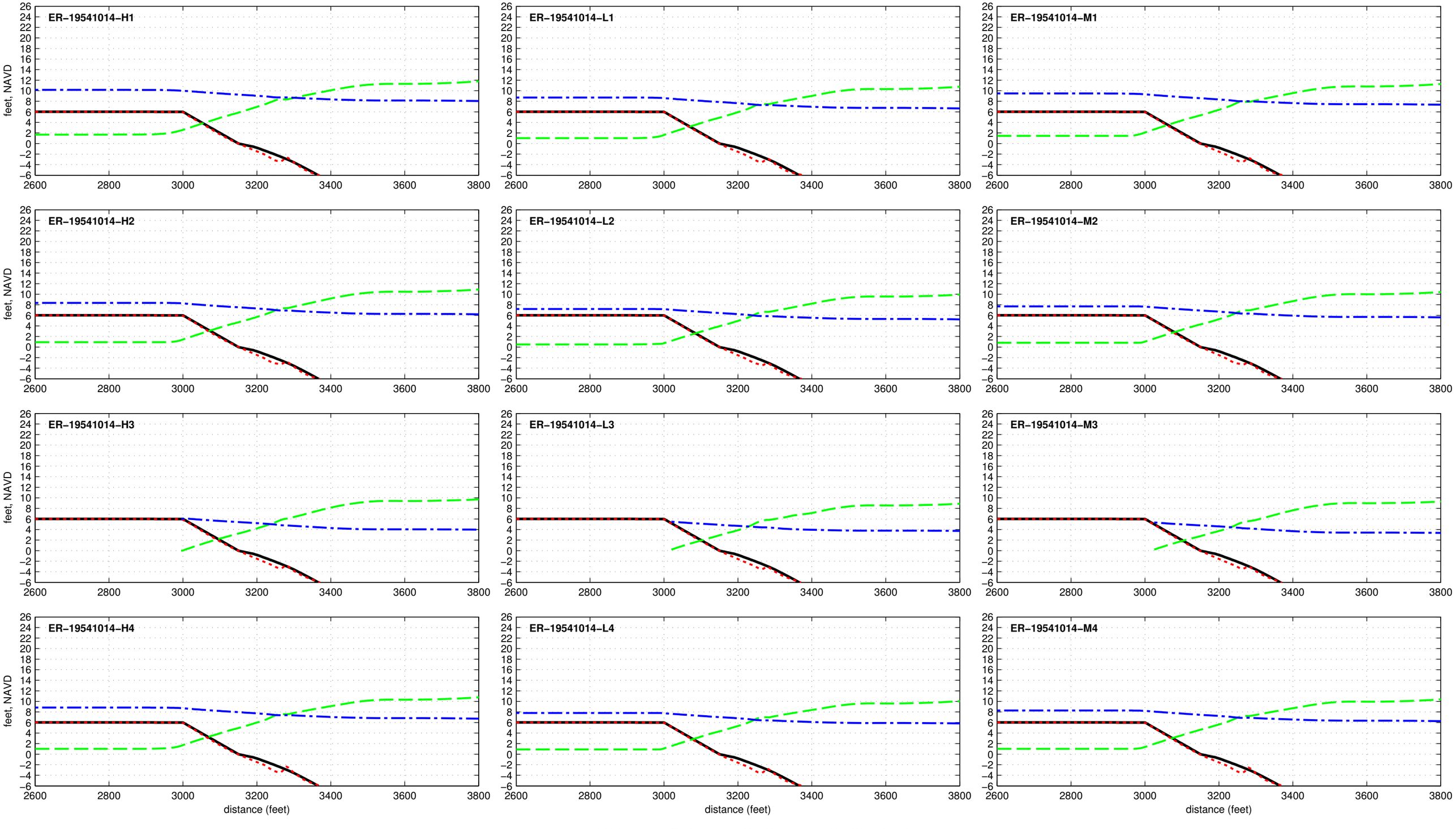
Dune R1T1-6.0-000-000 - ER-19540827



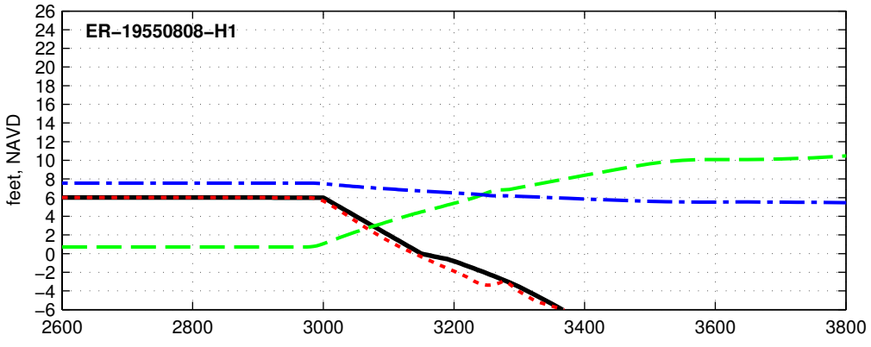
Dune R1T1-6.0-000-000 - ER-19540909

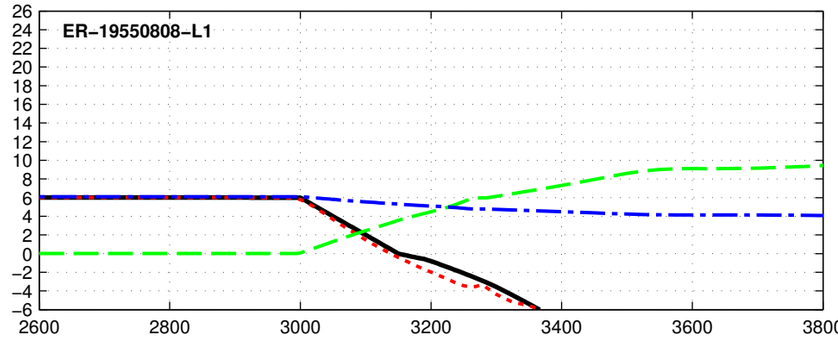


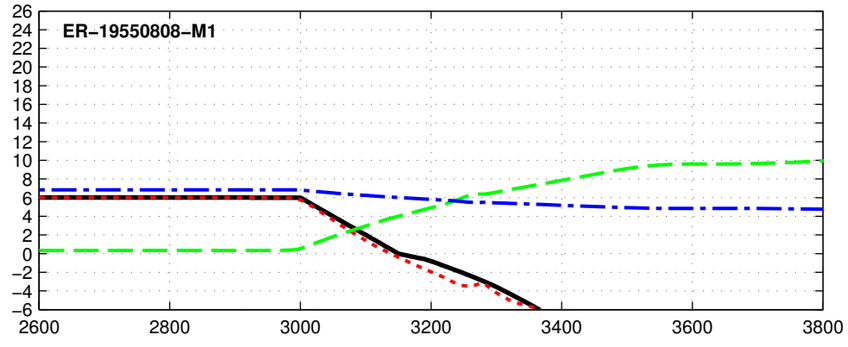
Dune R1T1-6.0-000-000 - ER-19541014

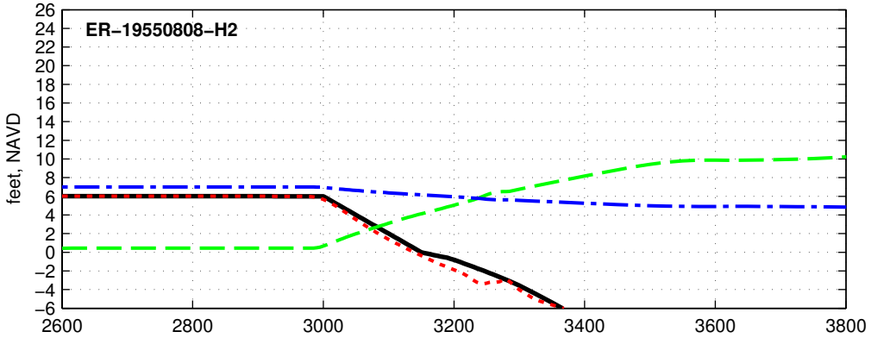


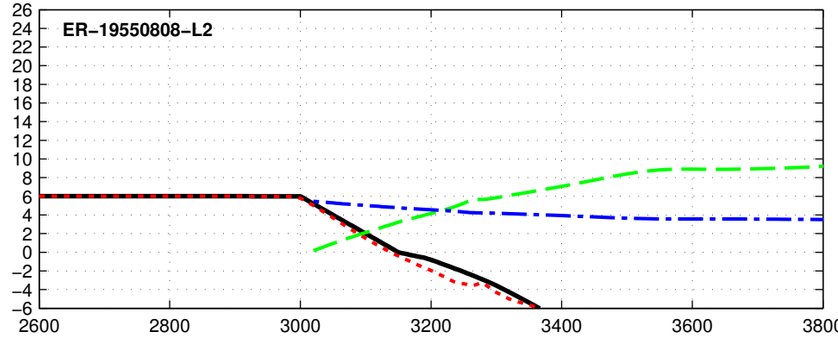
Dune R1T1-6.0-000-000 - ER-19550808

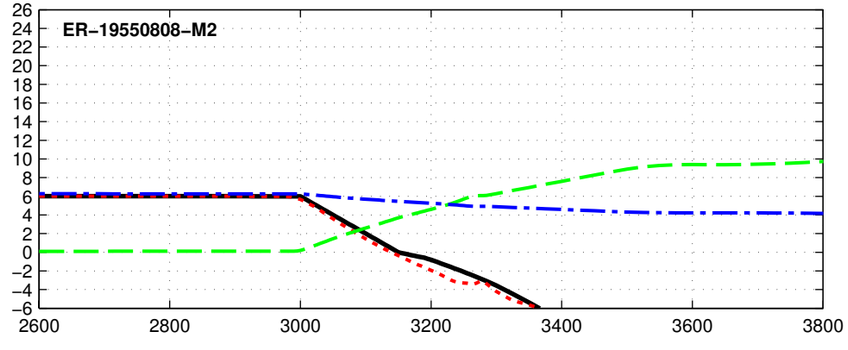


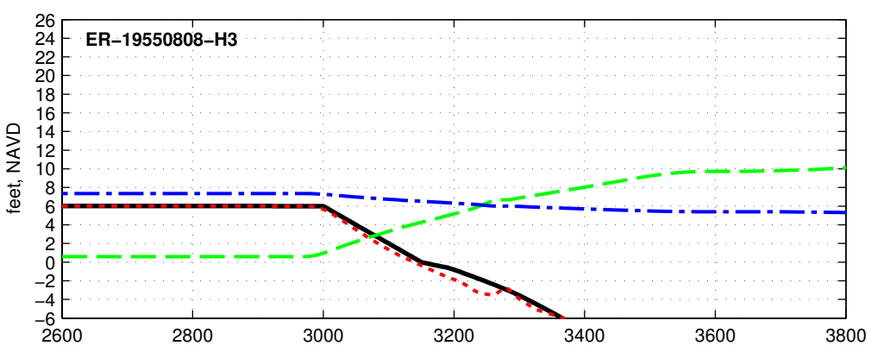


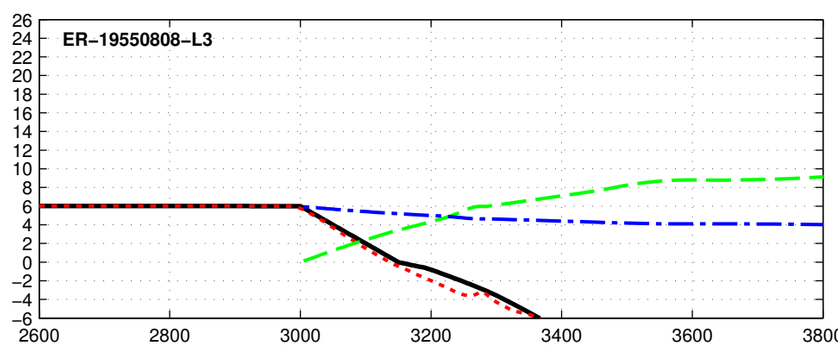


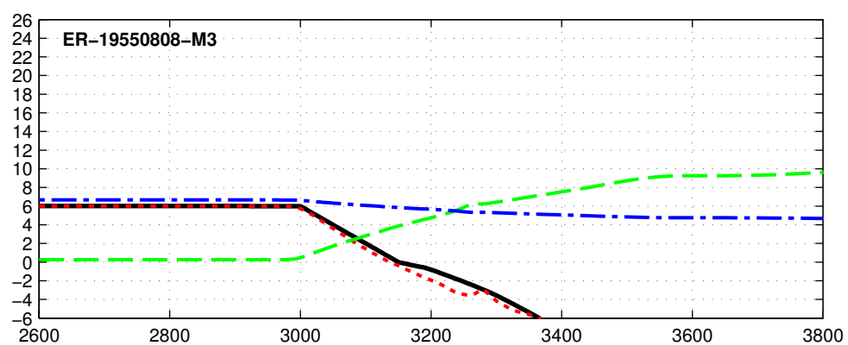


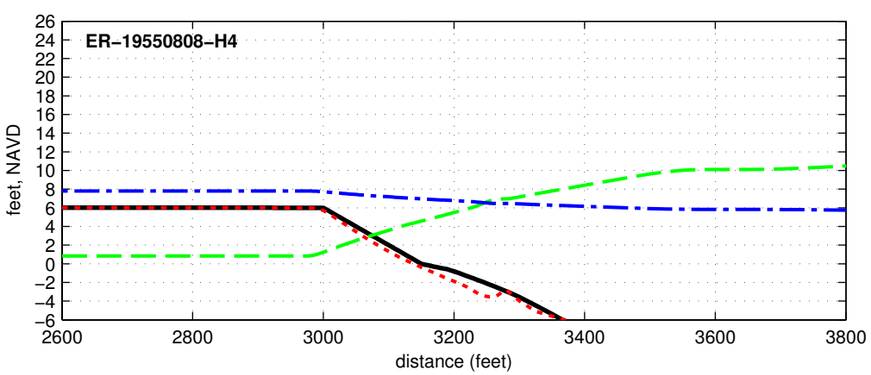


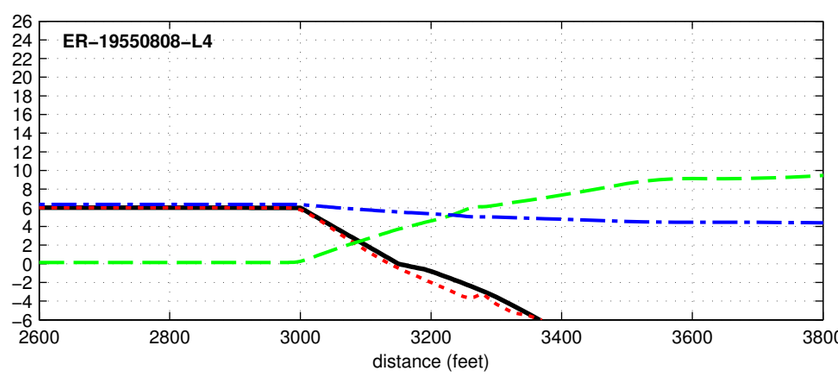


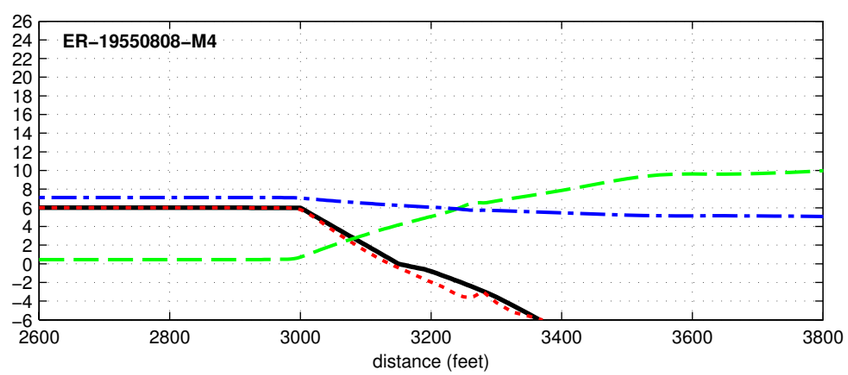






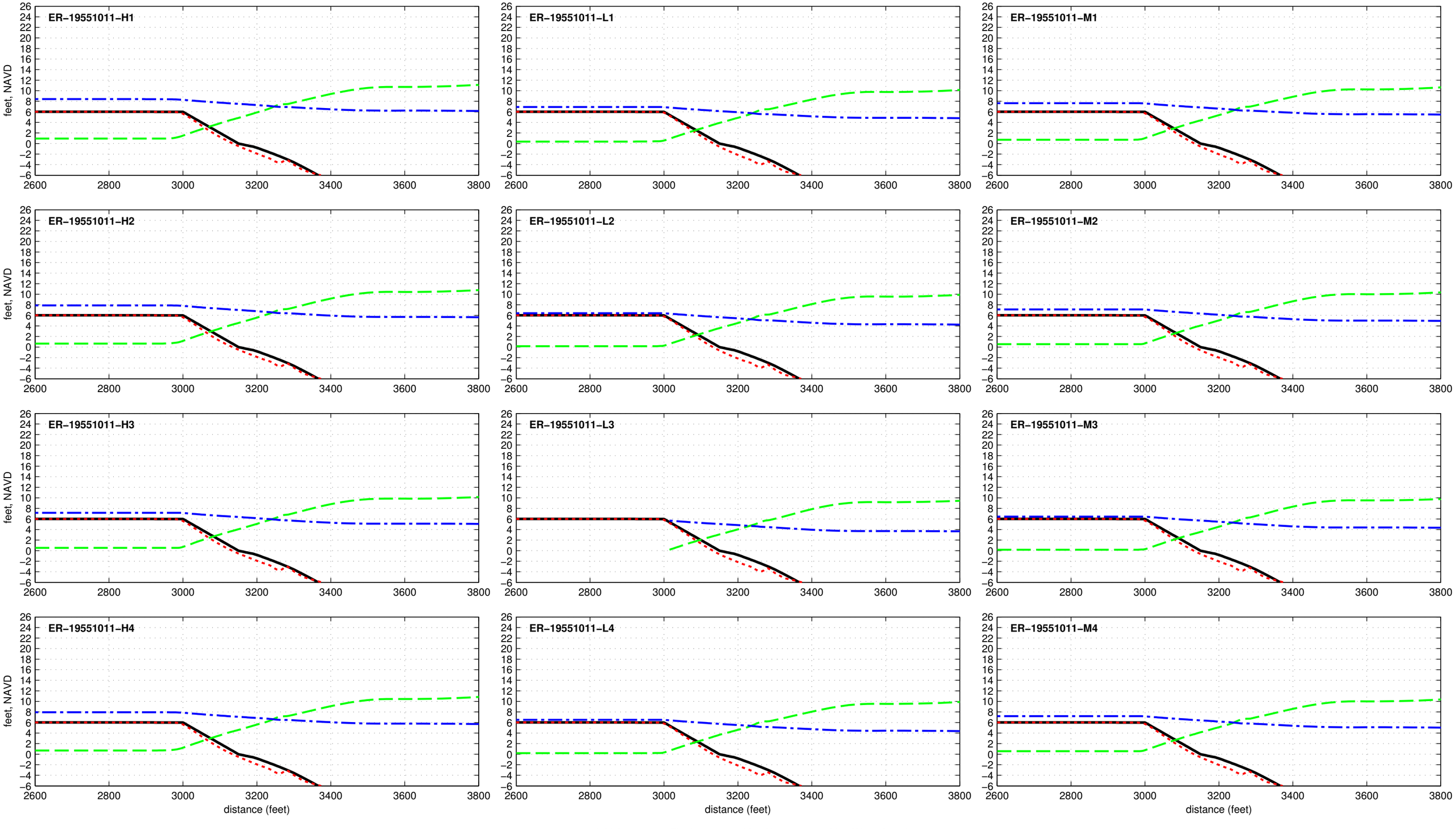




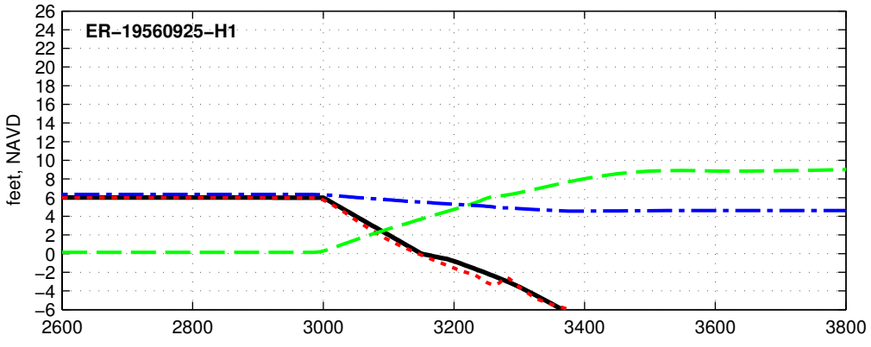


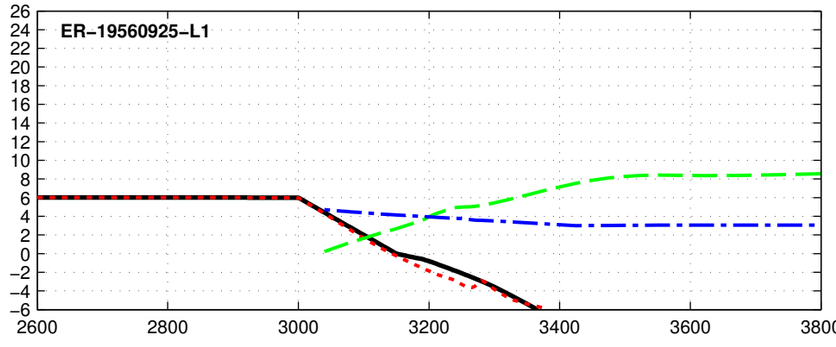
Initial Final Max Hs Max Water Level

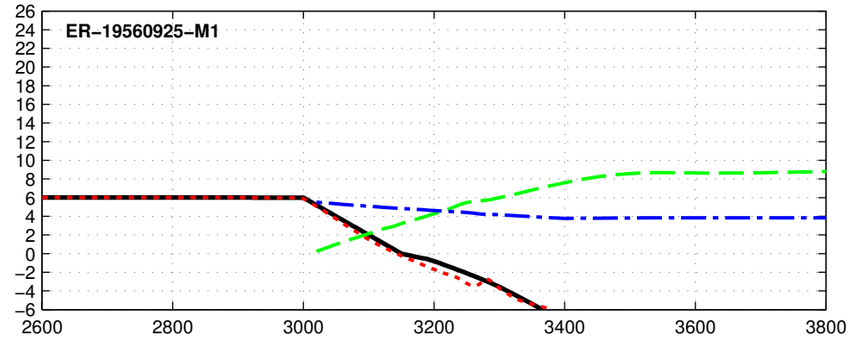
Dune R1T1-6.0-000-000 - ER-19551011

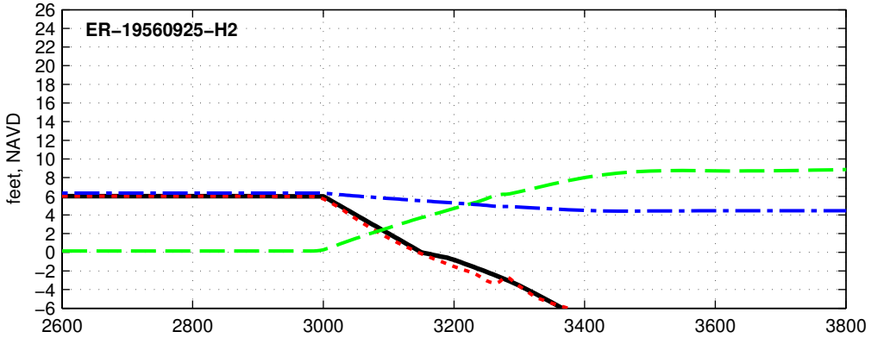


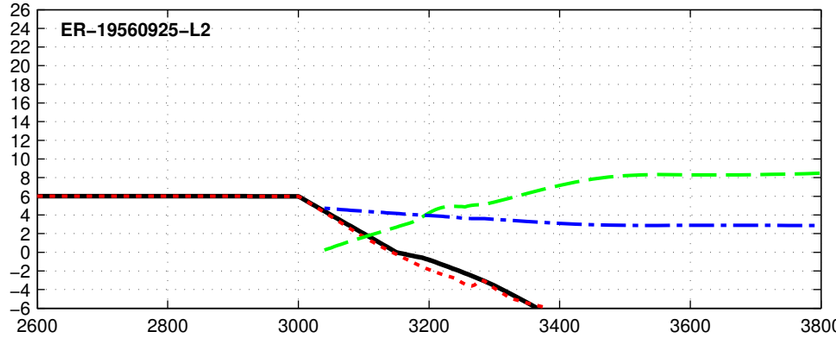
Dune R1T1-6.0-000-000 - ER-19560925

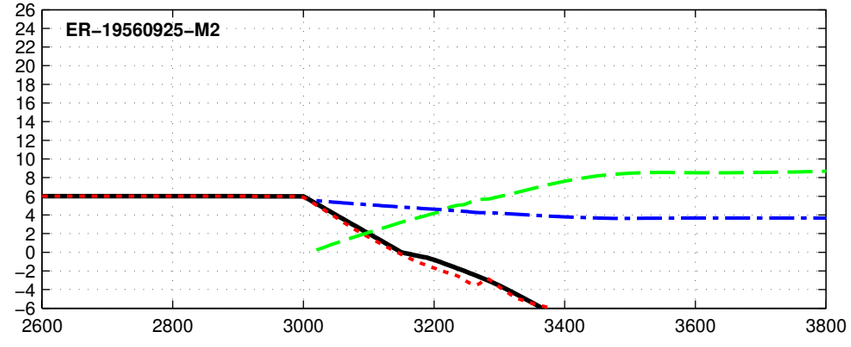


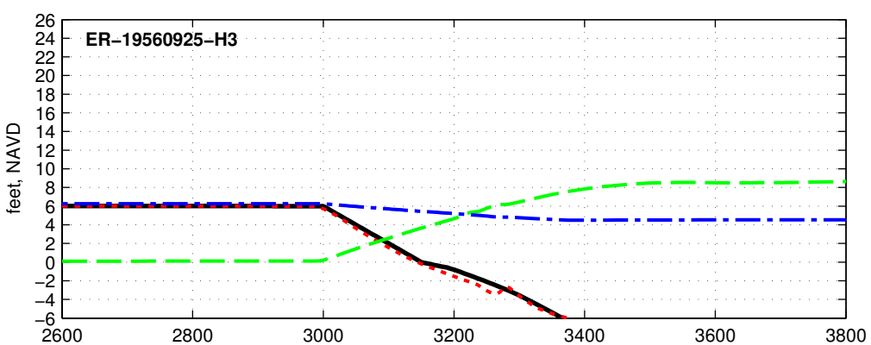


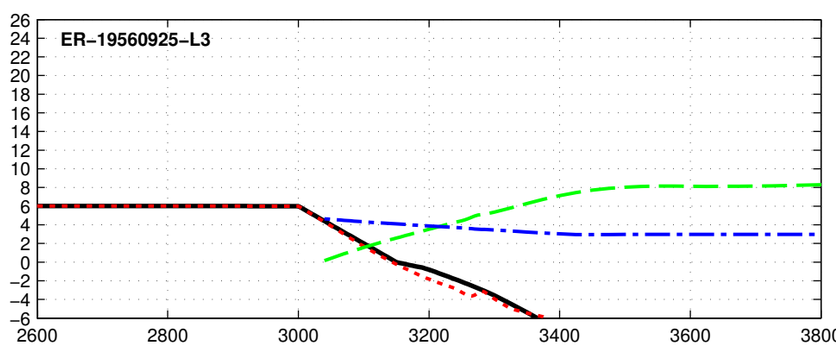


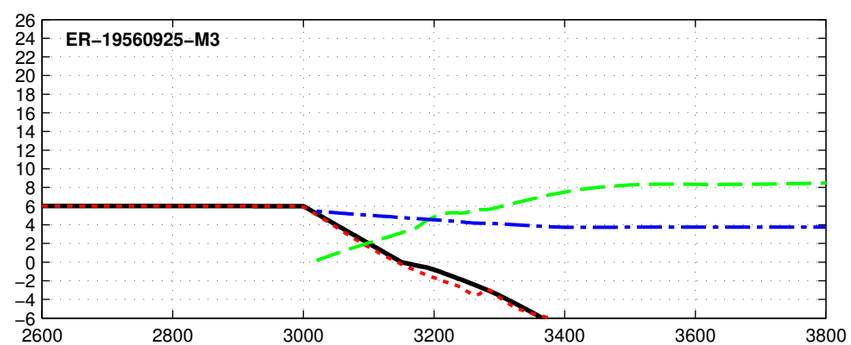


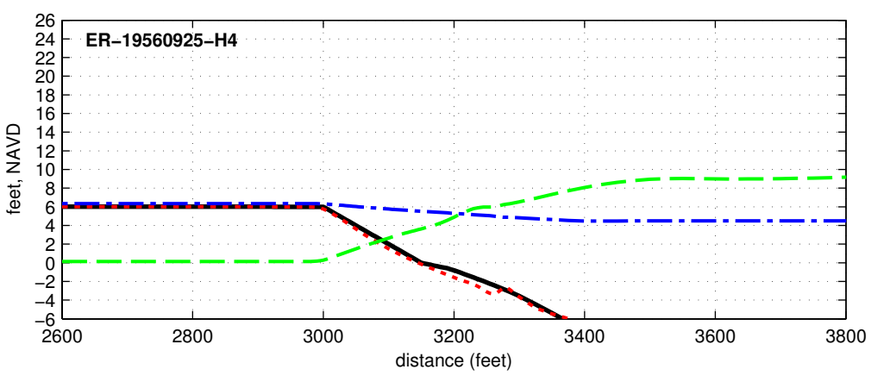


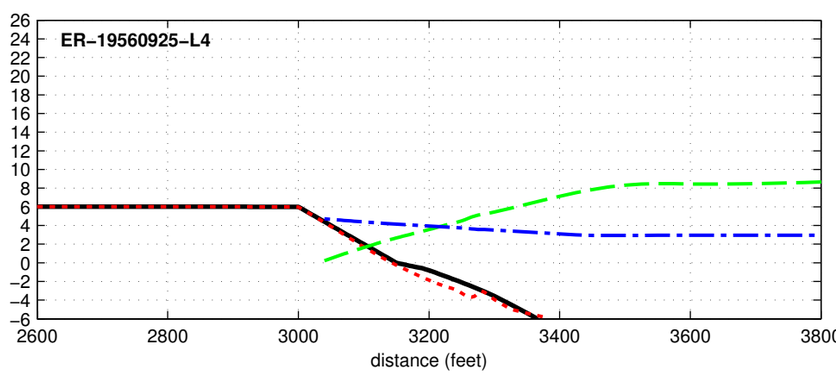


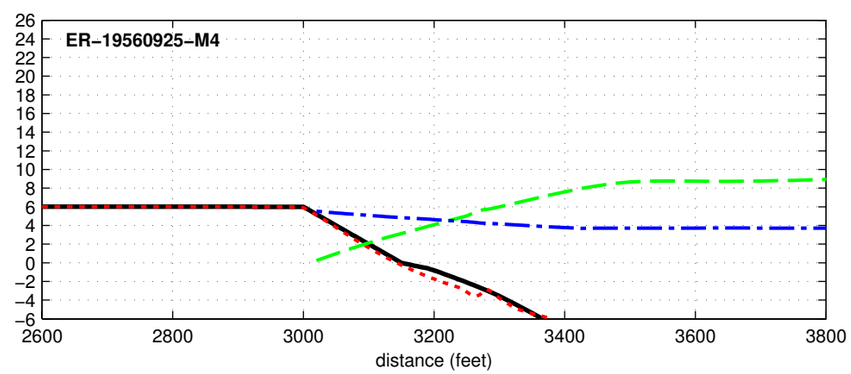






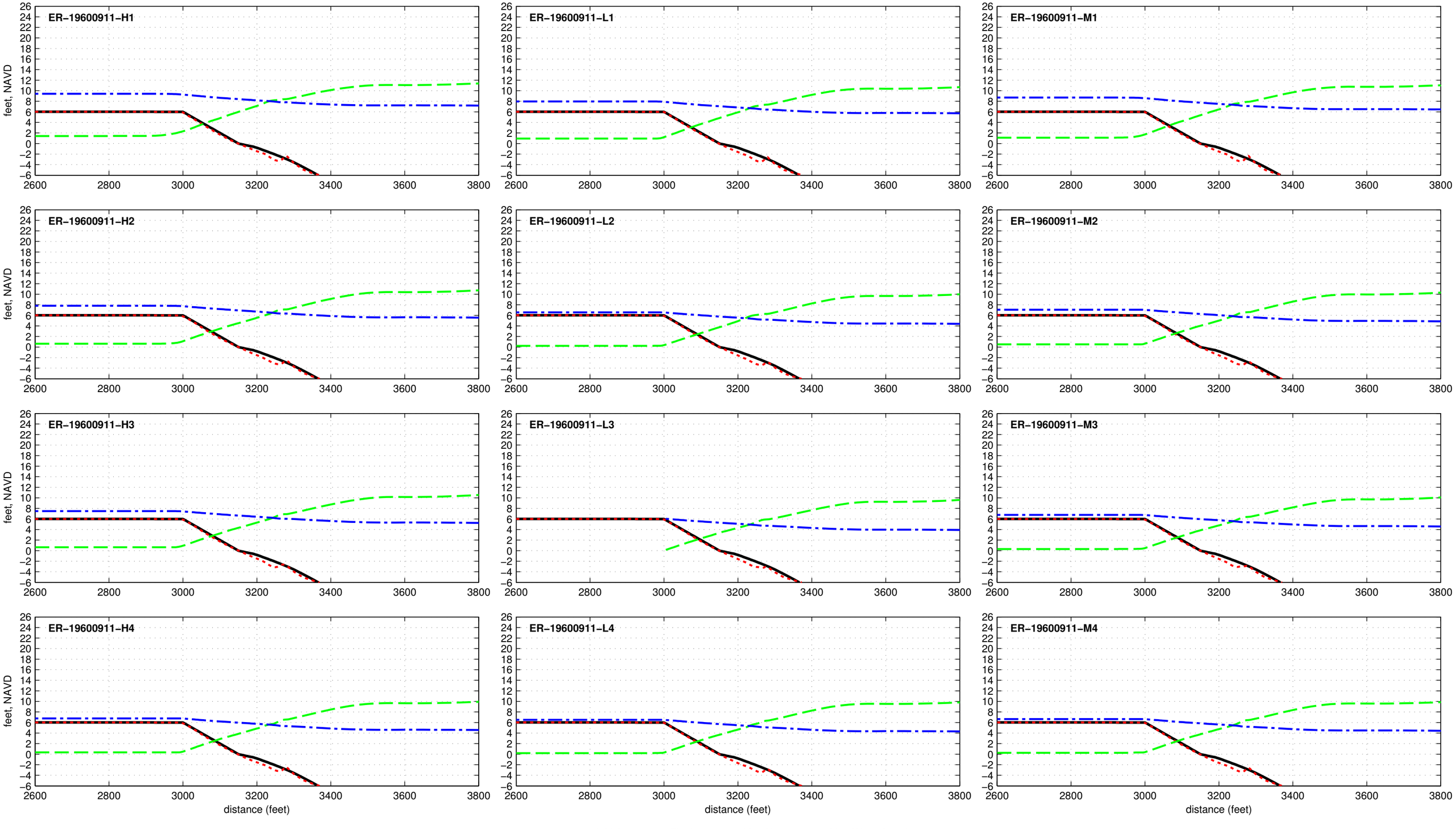




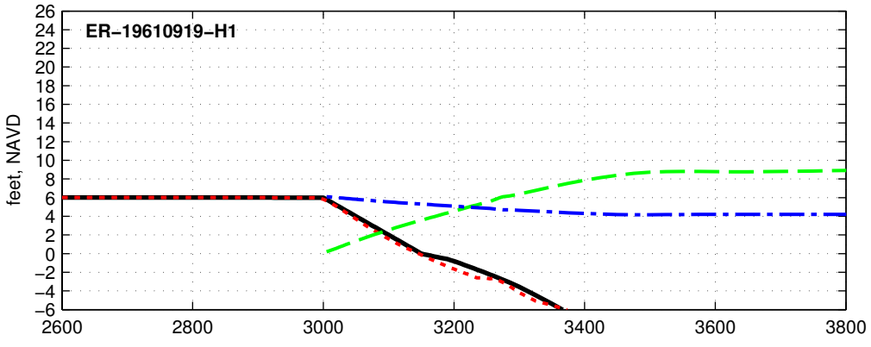


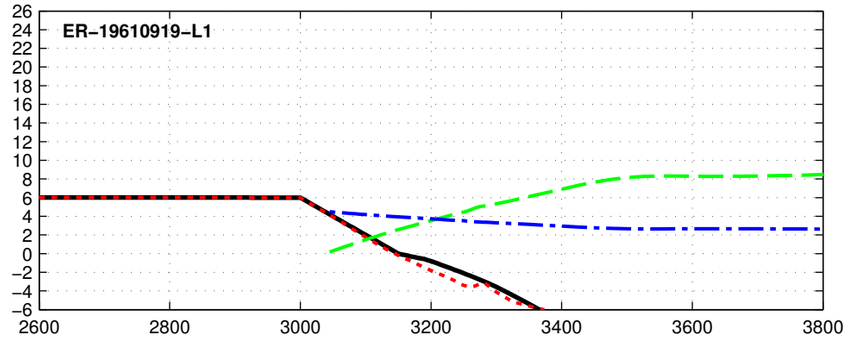
Initial Final Max Hs Max Water Level

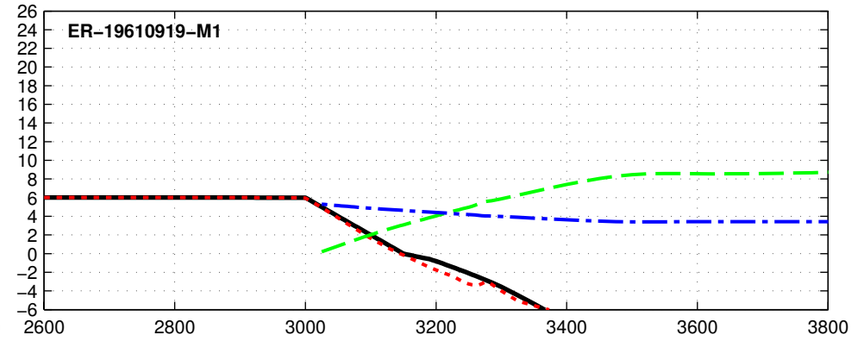
Dune R1T1-6.0-000-000 - ER-19600911

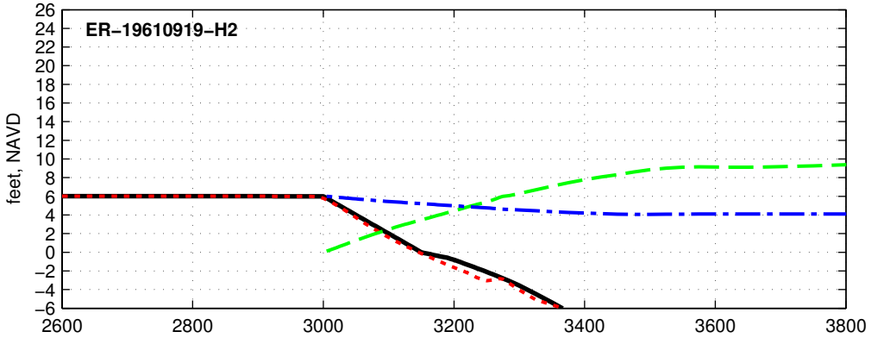


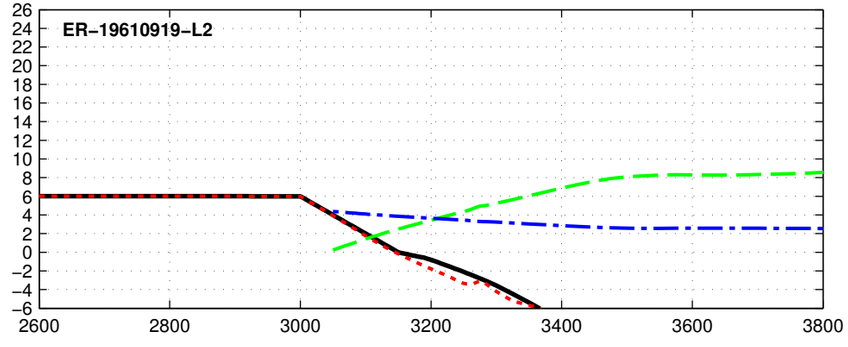
Dune R1T1-6.0-000-000 - ER-19610919

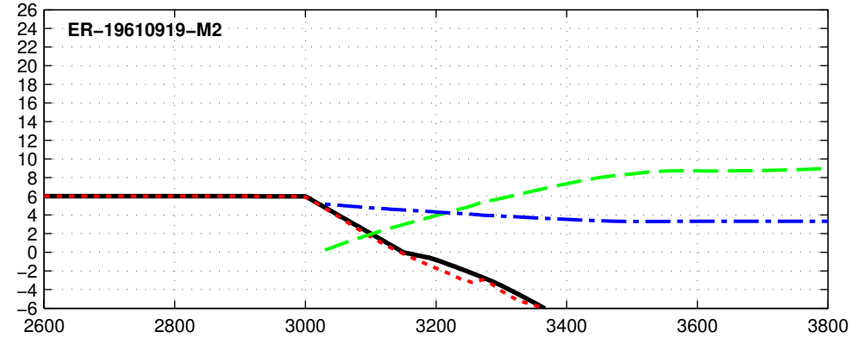


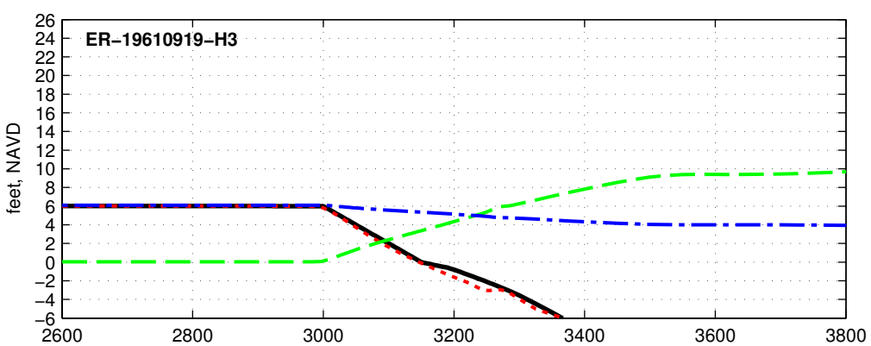


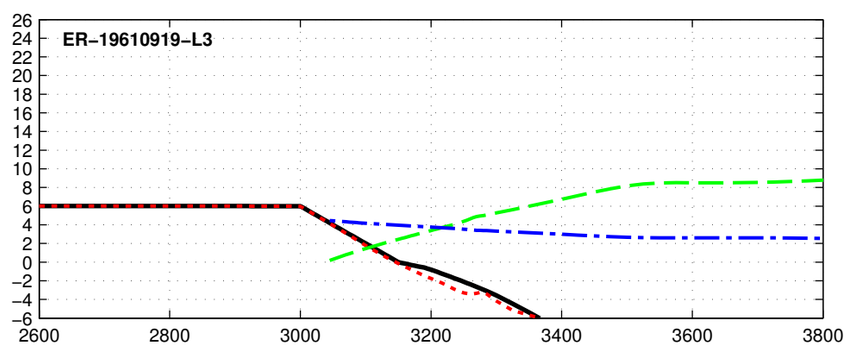


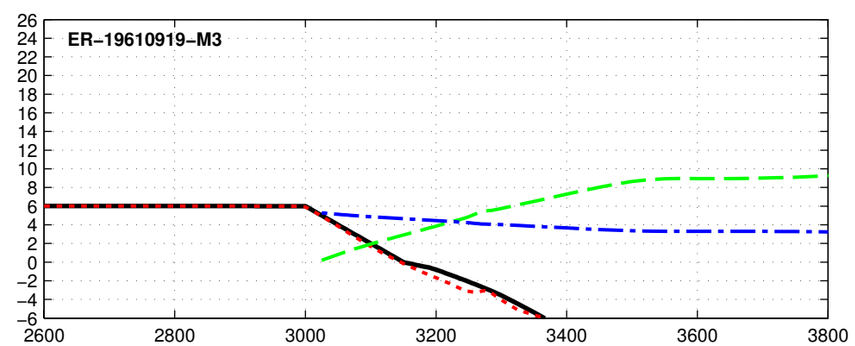


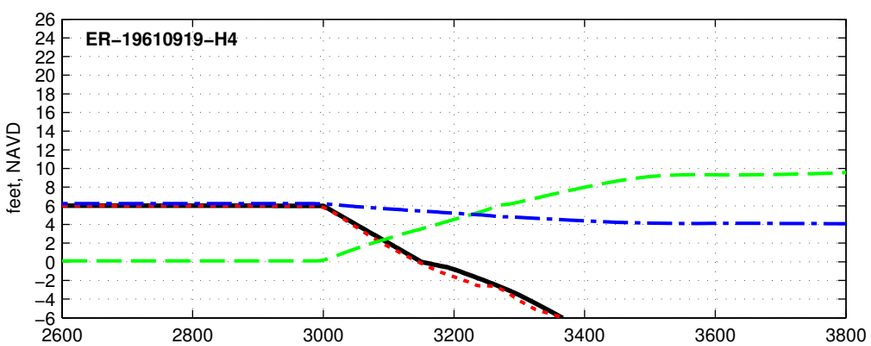


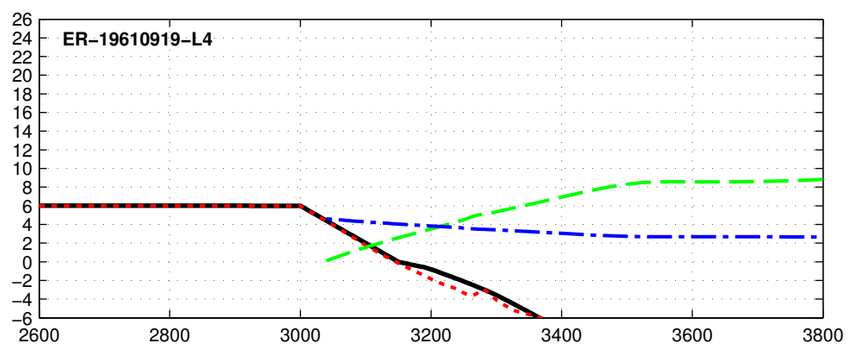


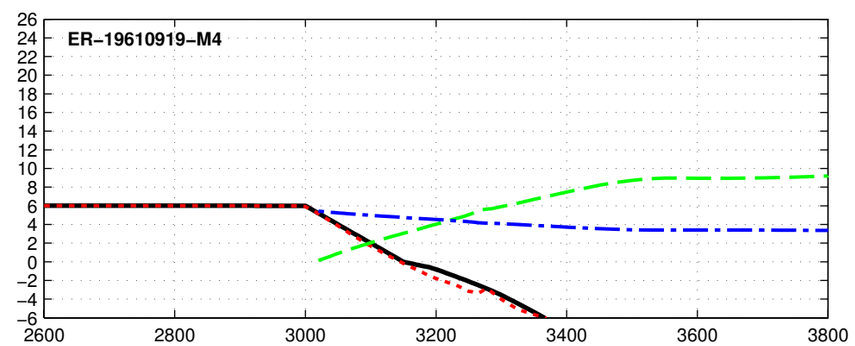






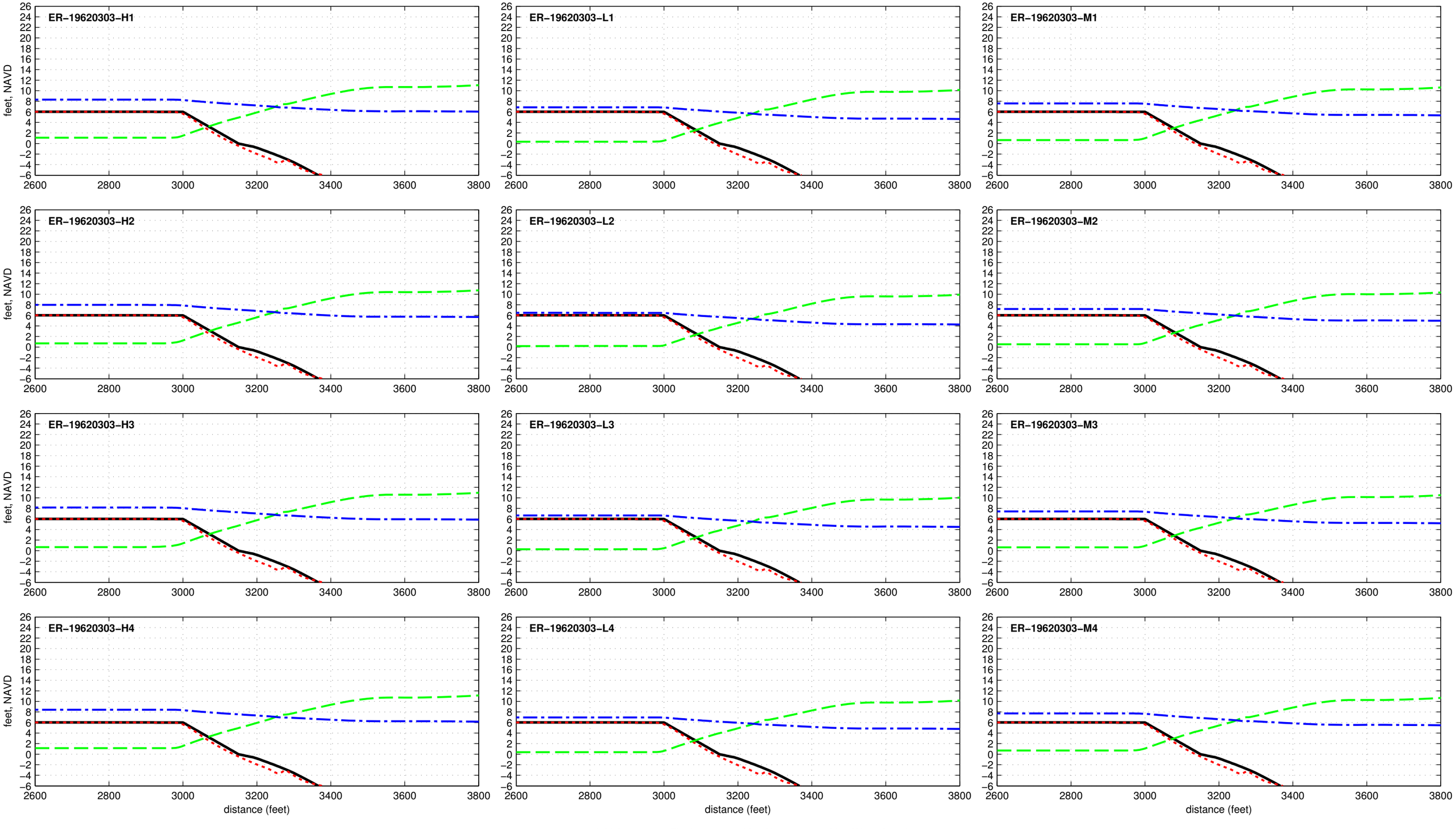




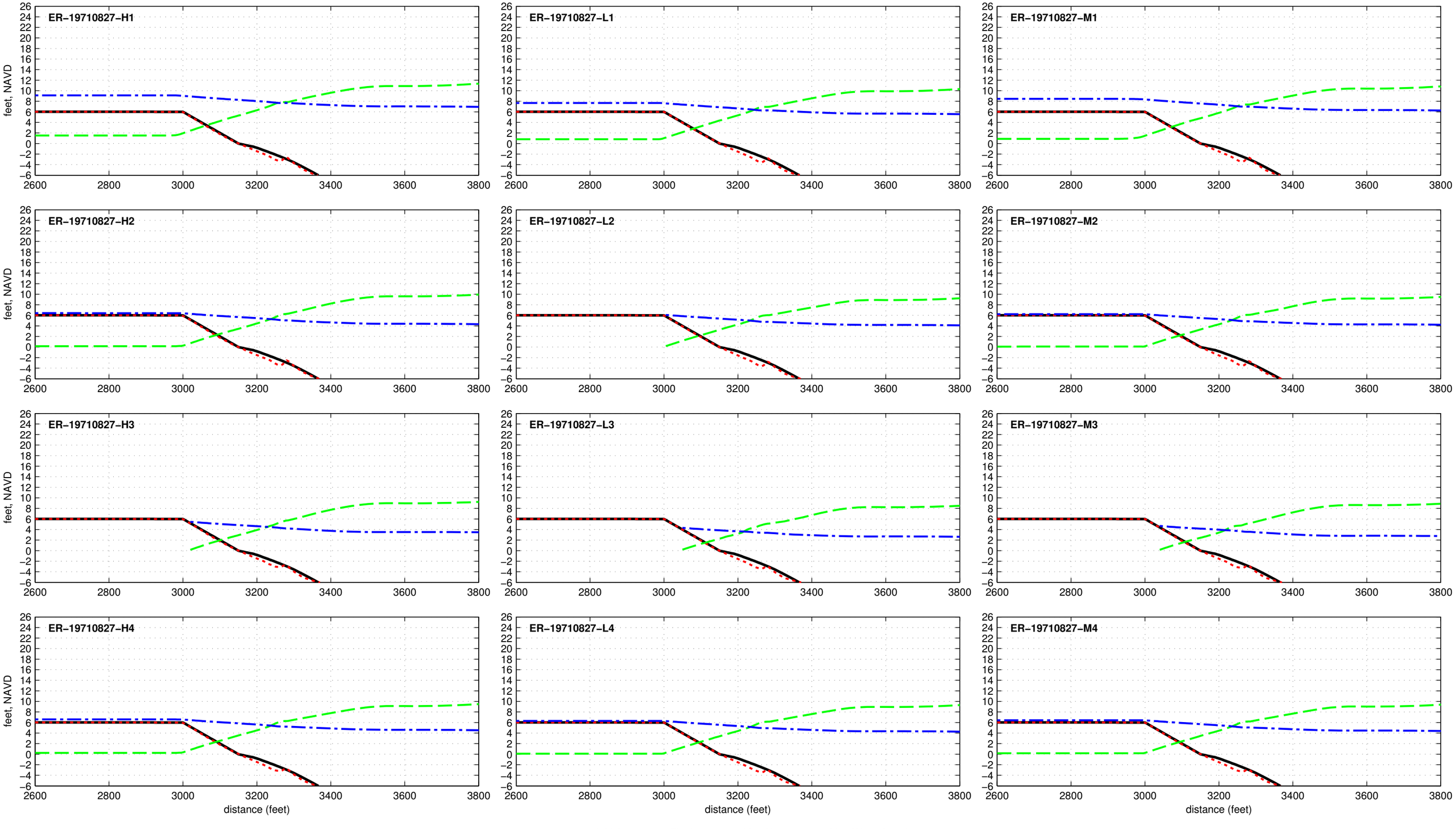


Initial Final Max Hs Max Water Level

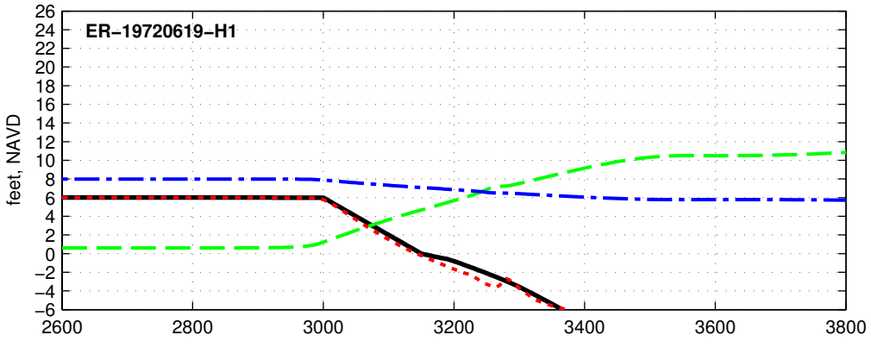
Dune R1T1-6.0-000-000 - ER-19620303

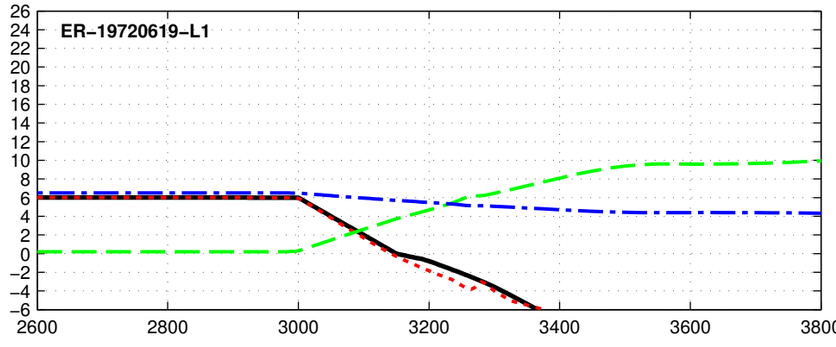


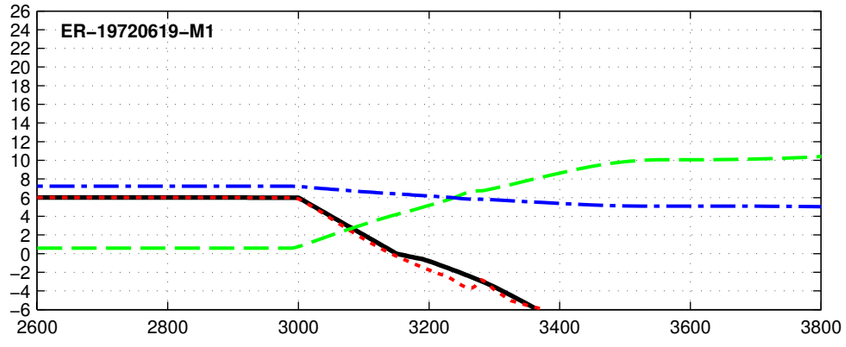
Dune R1T1-6.0-000-000 - ER-19710827

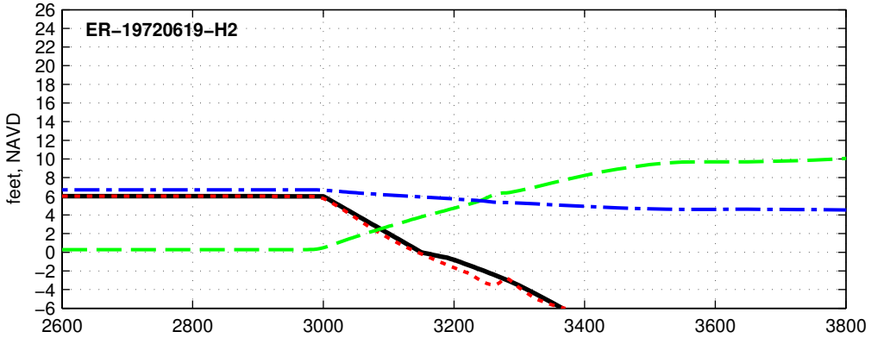


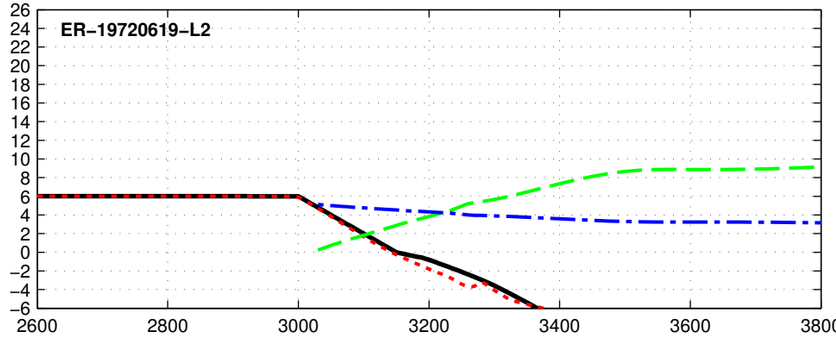
Dune R1T1-6.0-000-000 - ER-19720619

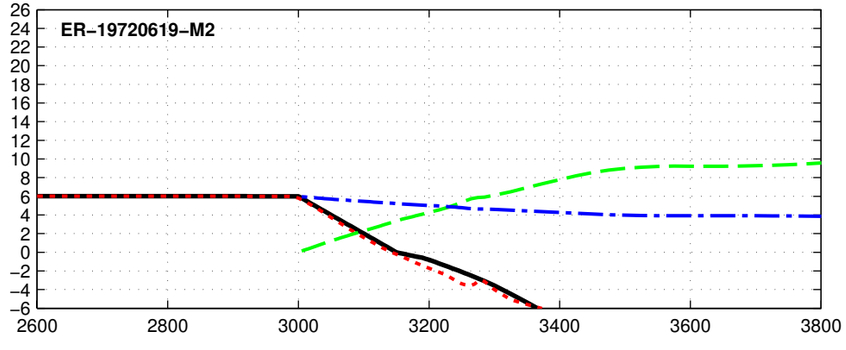


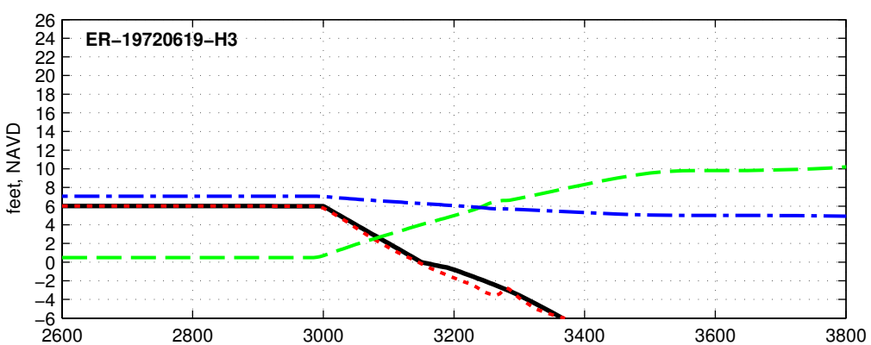


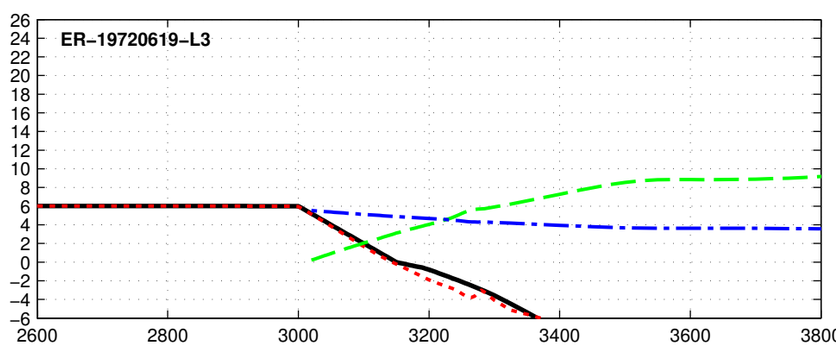


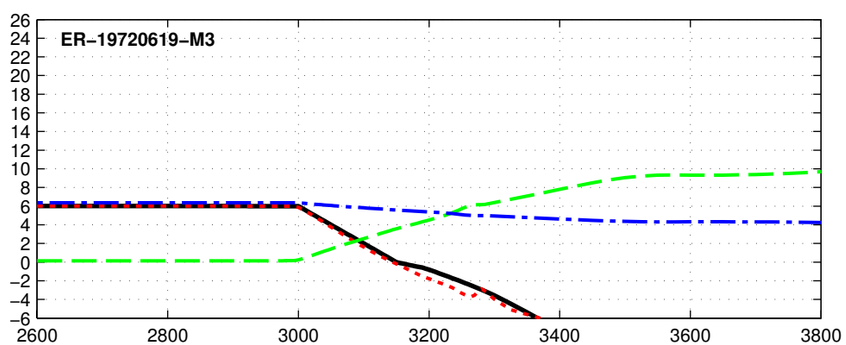


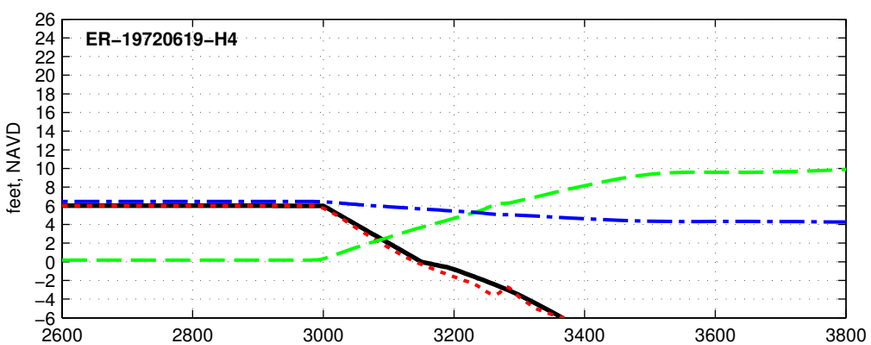


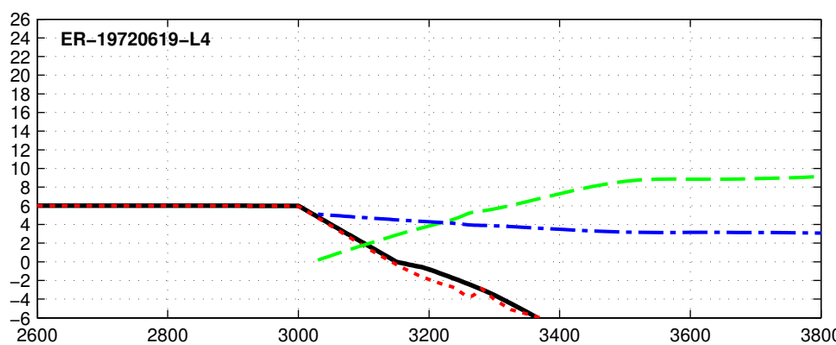


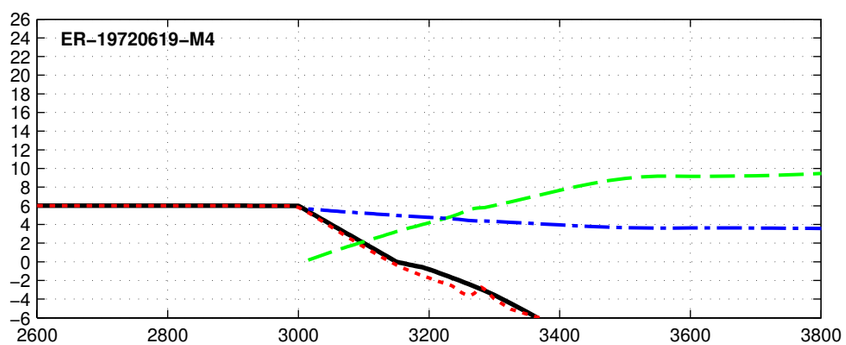










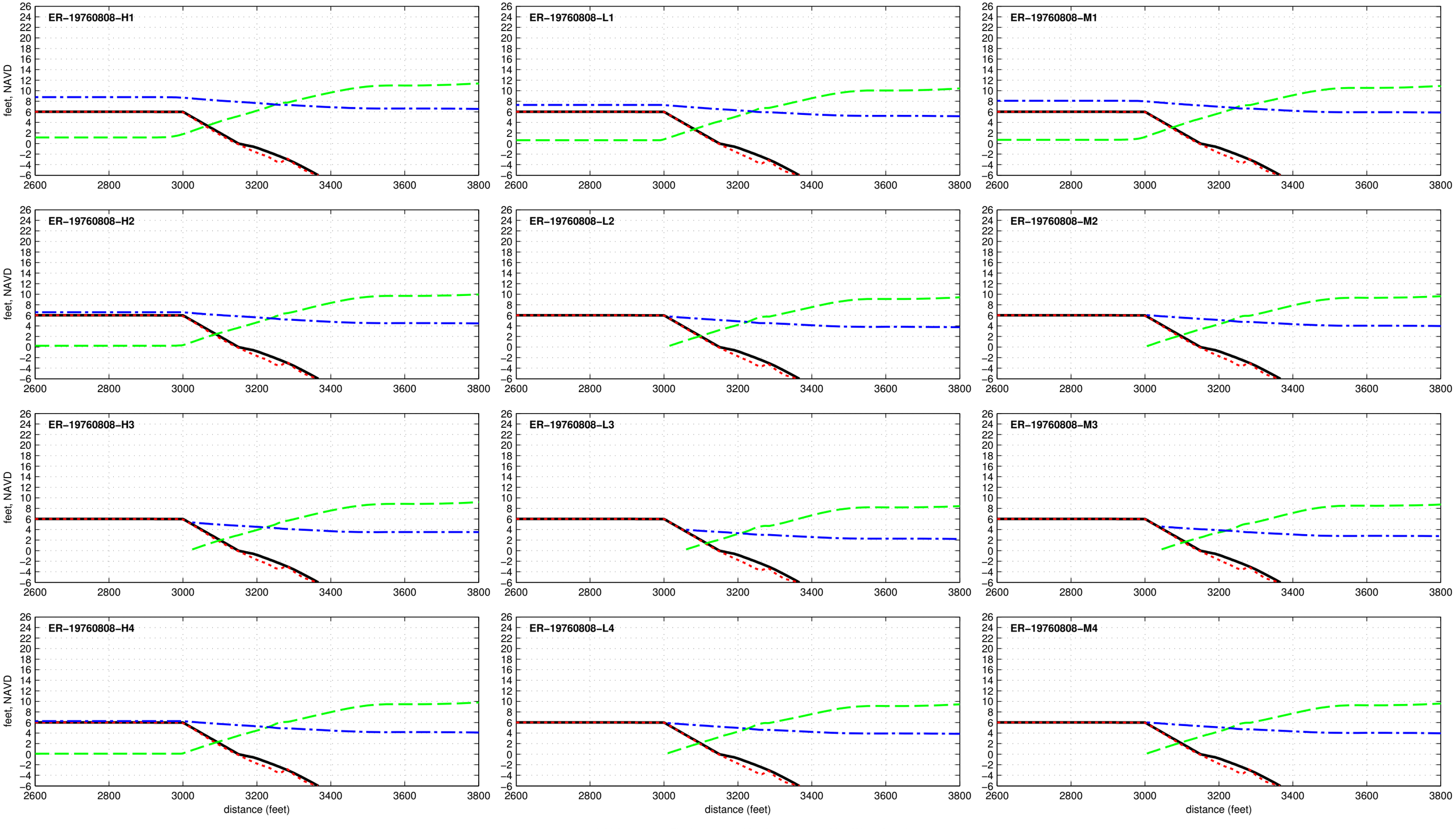


feet, NAVD

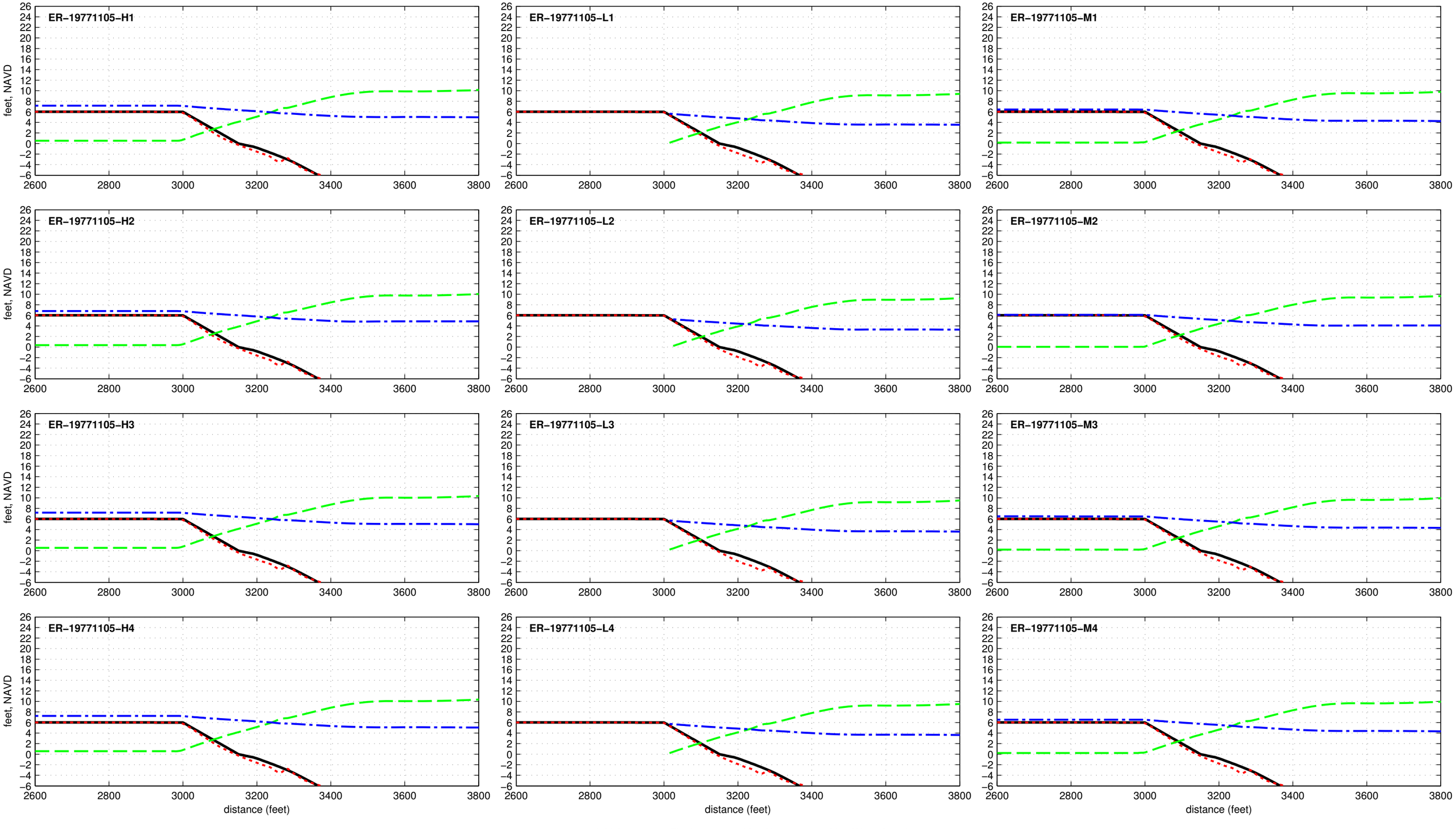
distance (feet)

Initial Final Max Hs Max Water Level

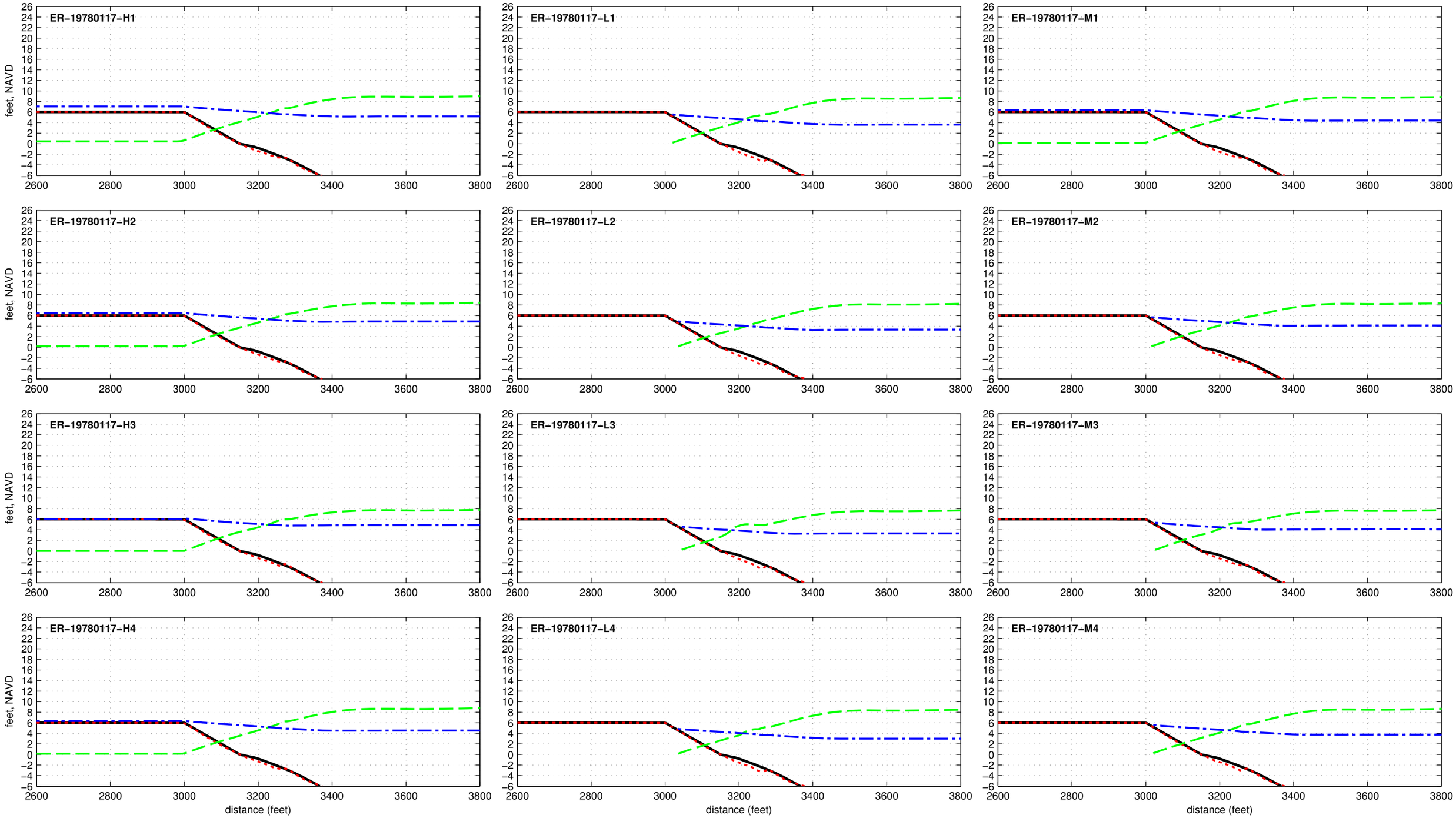
Dune R1T1-6.0-000-000 - ER-19760808



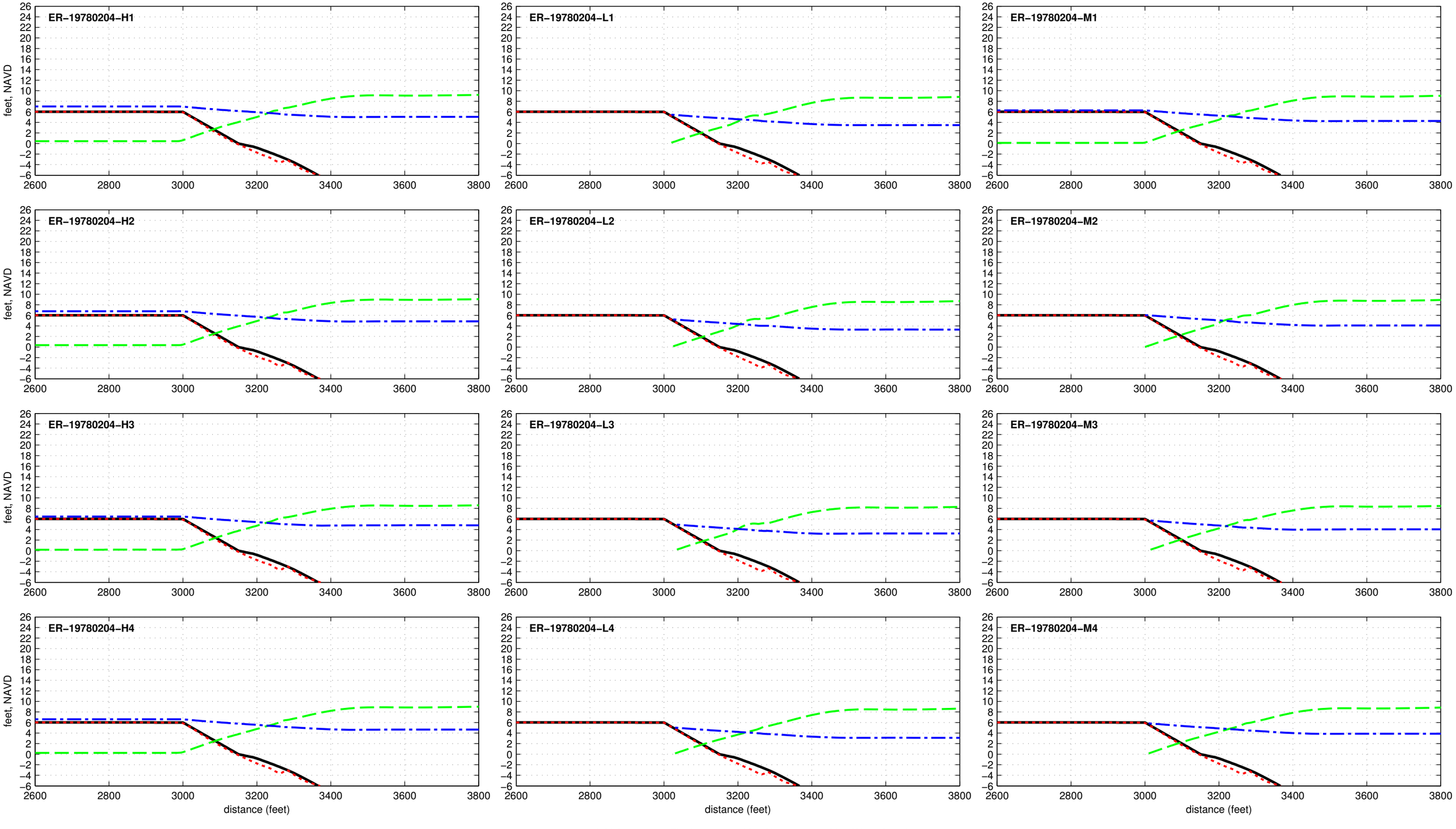
Dune R1T1-6.0-000-000 - ER-19771105



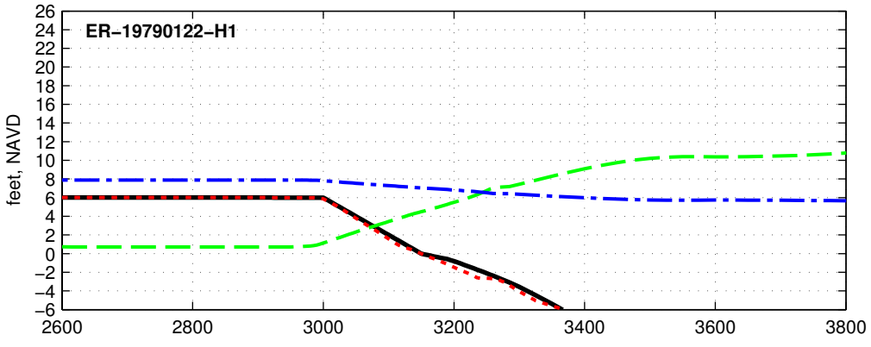
Dune R1T1-6.0-000-000 - ER-19780117

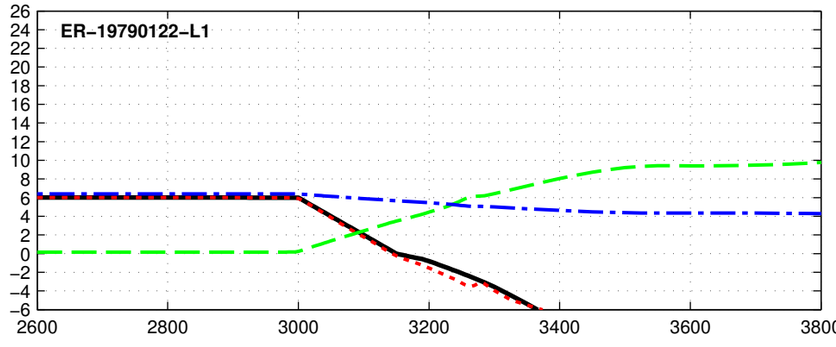


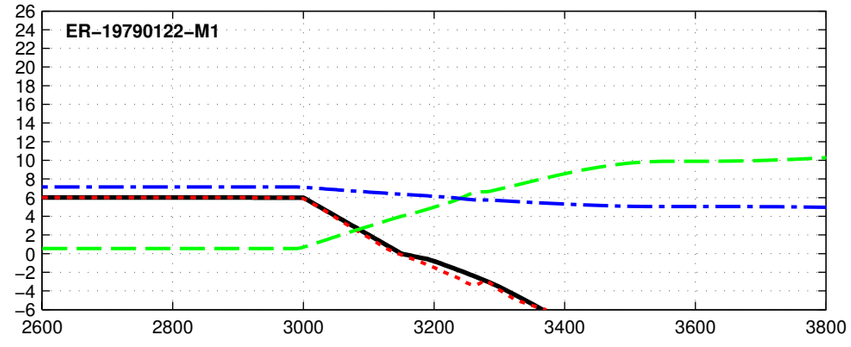
Dune R1T1-6.0-000-000 - ER-19780204

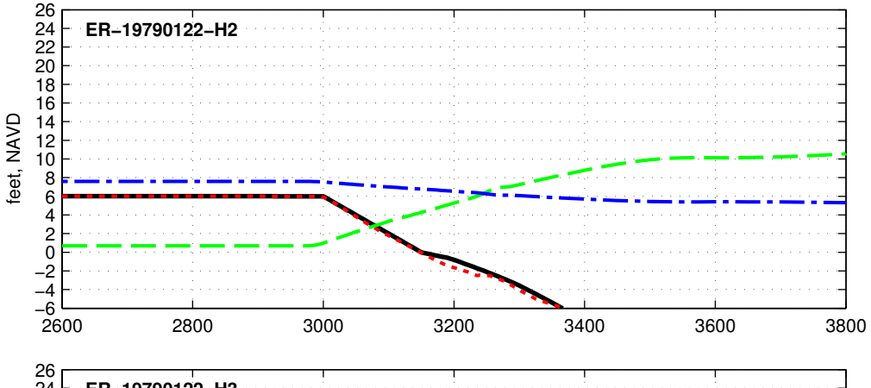


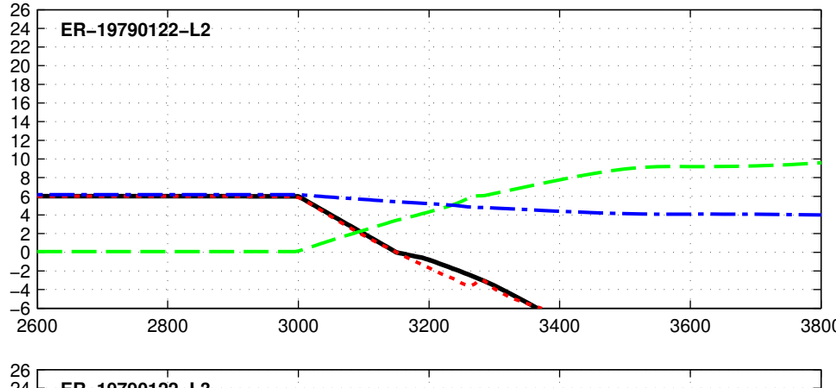
Dune R1T1-6.0-000-000 - ER-19790122

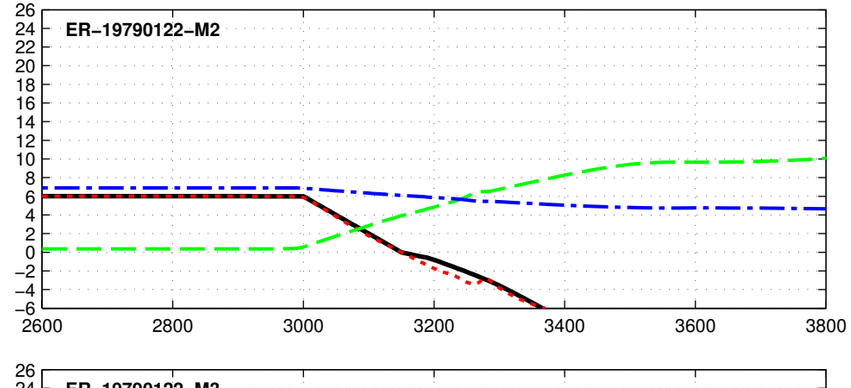


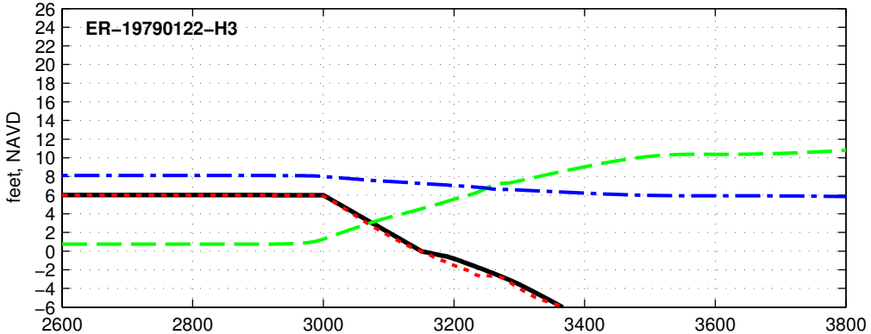


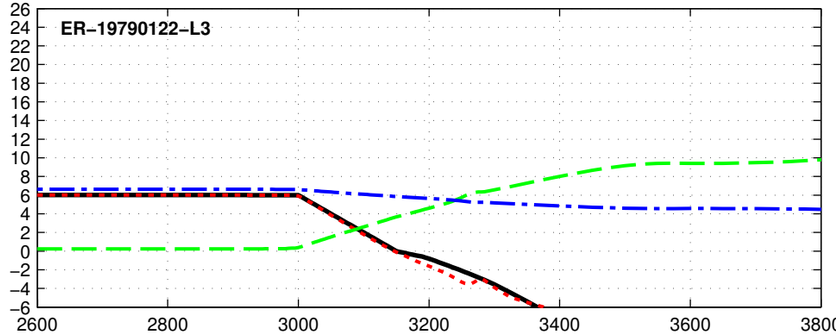


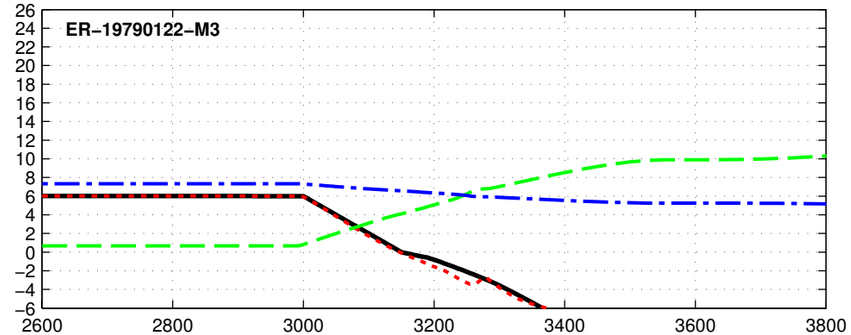


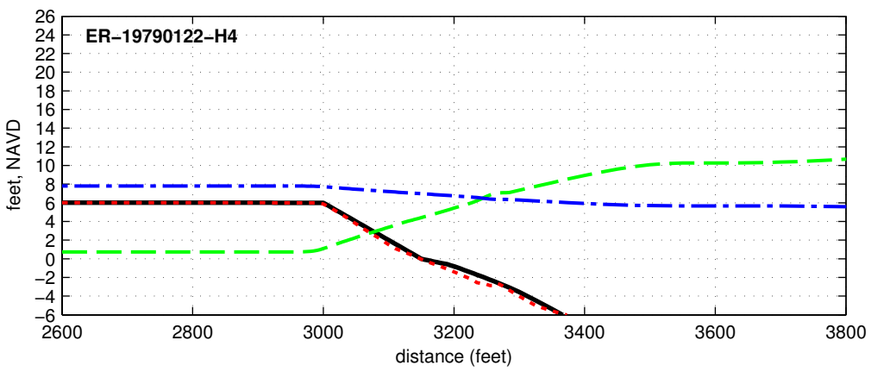


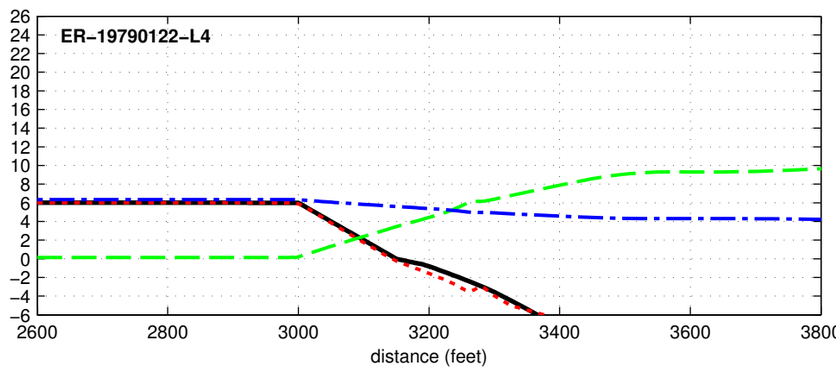


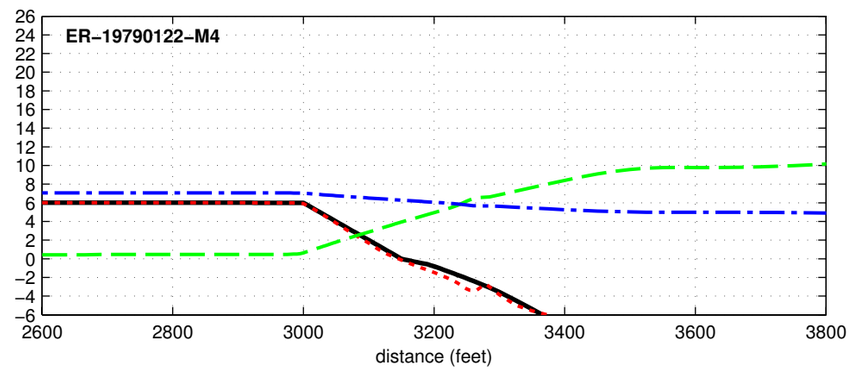






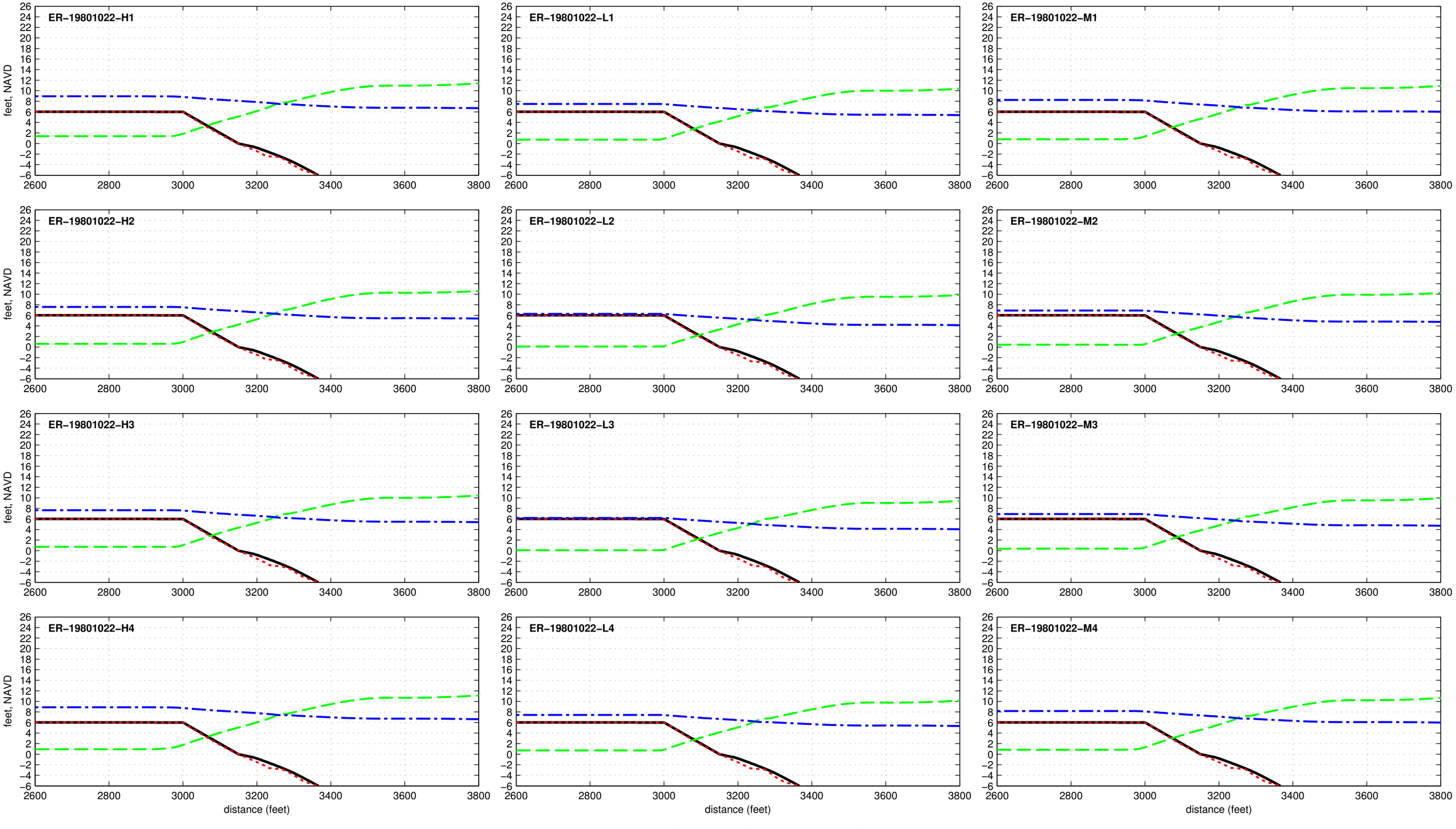




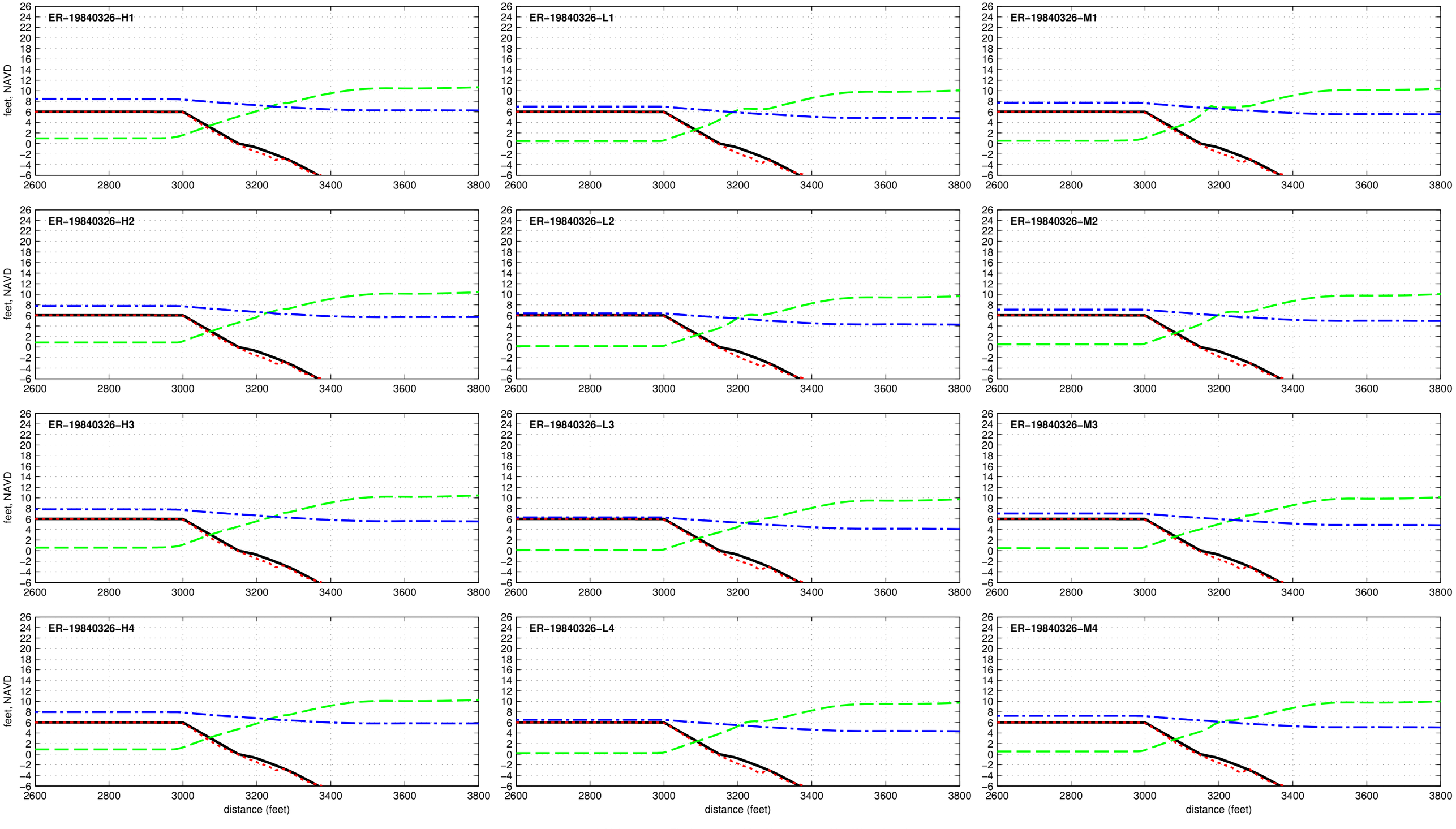


Initial Final Max Hs Max Water Level

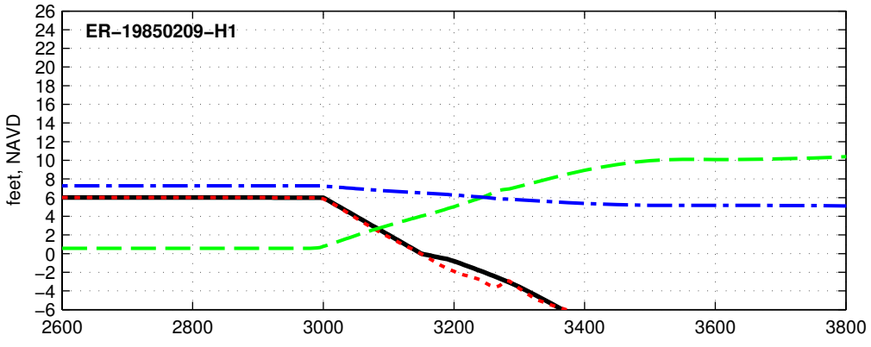
Dune R1T1-6.0-000-000 - ER-19801022

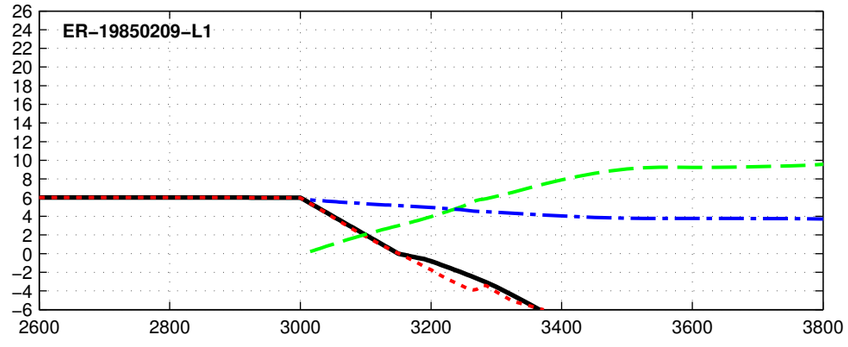


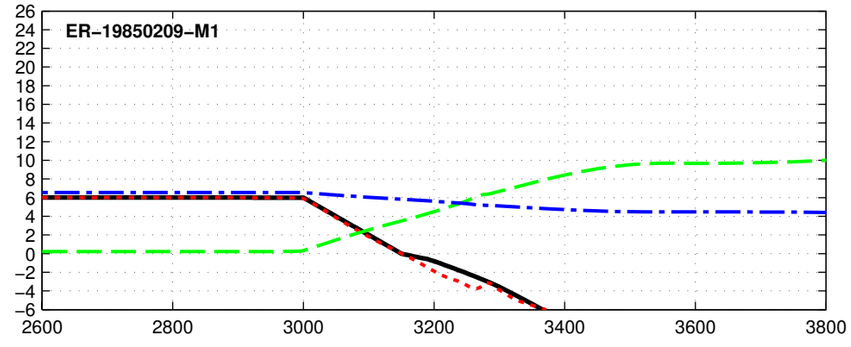
Dune R1T1-6.0-000-000 - ER-19840326

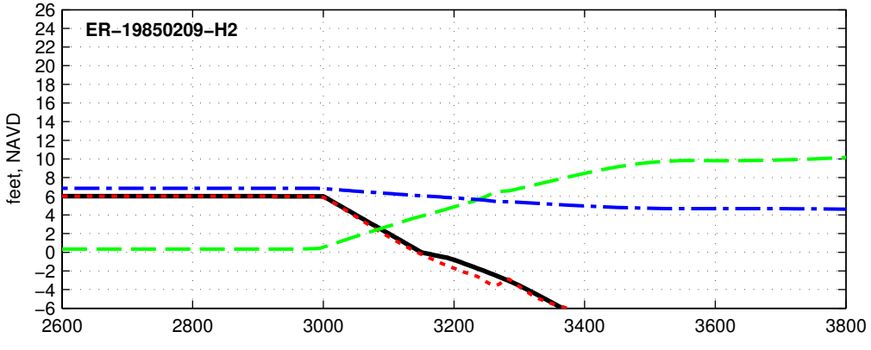


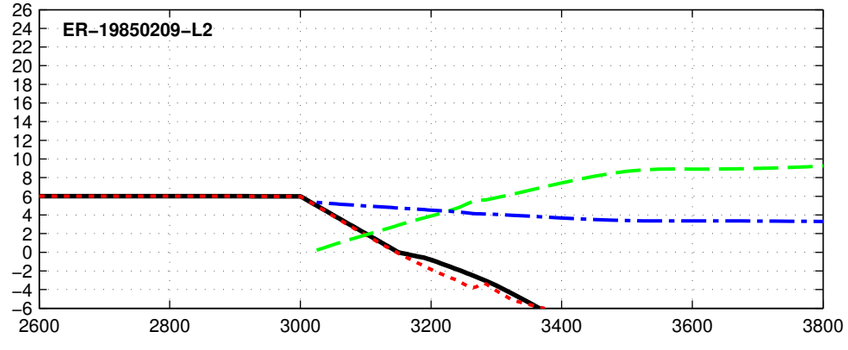
Dune R1T1-6.0-000-000 - ER-19850209

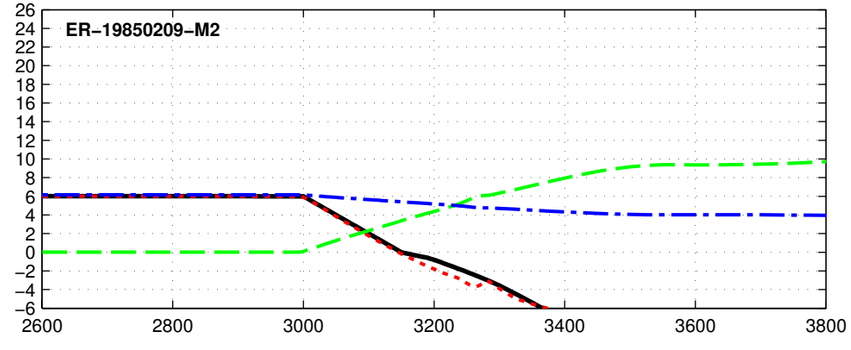


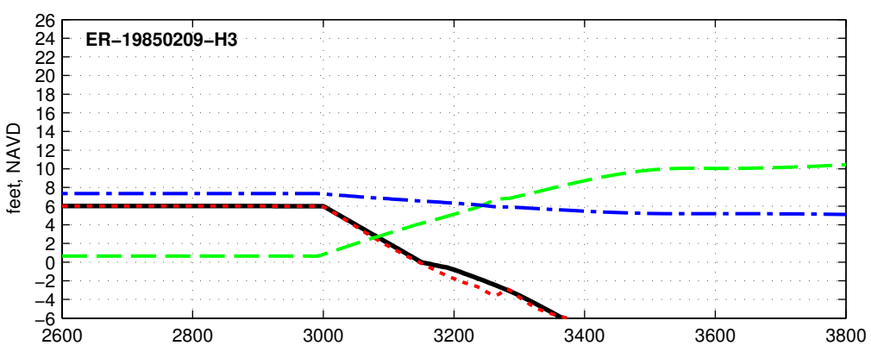


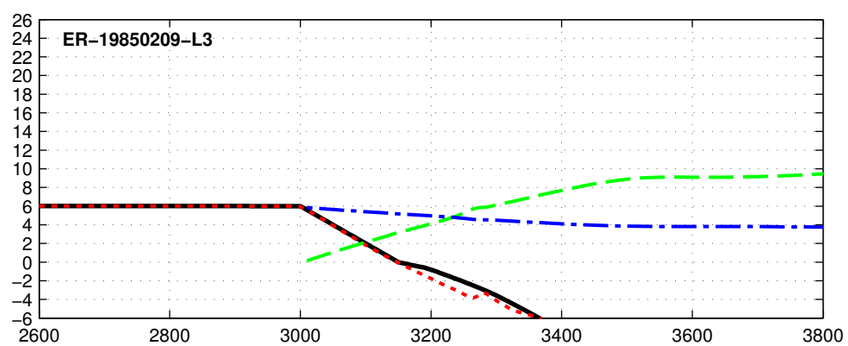


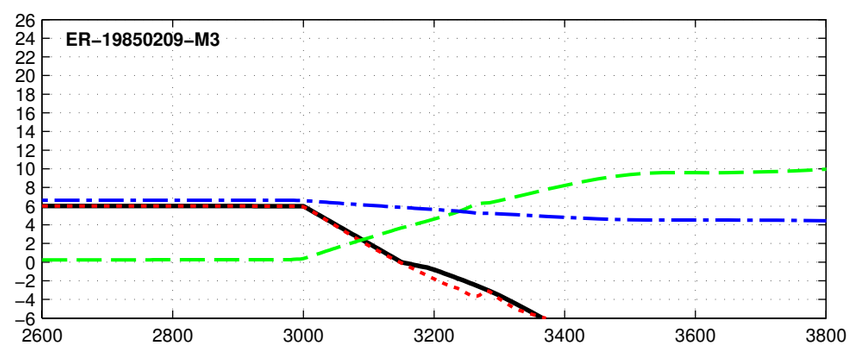


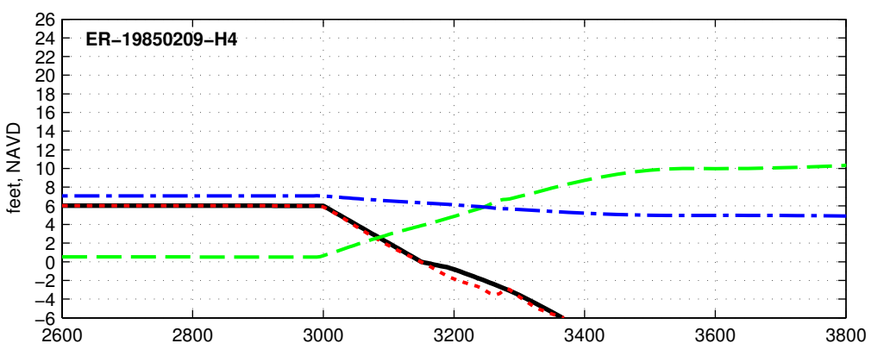


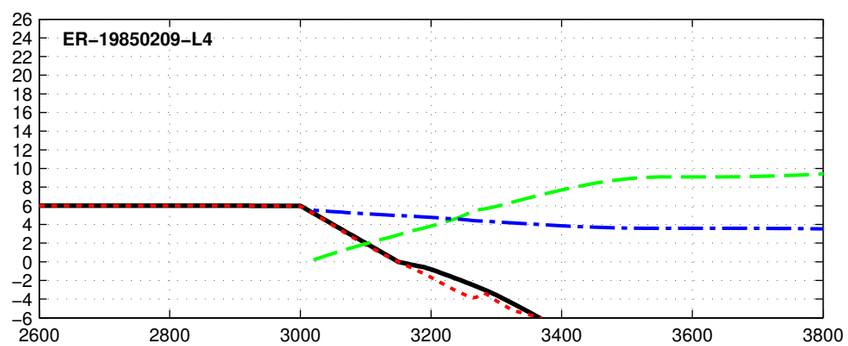


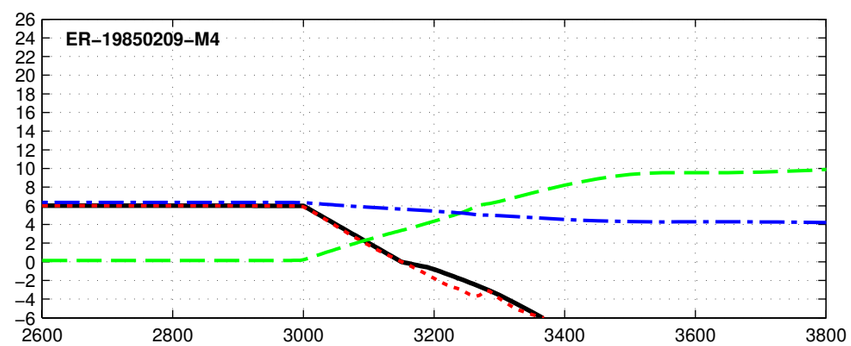






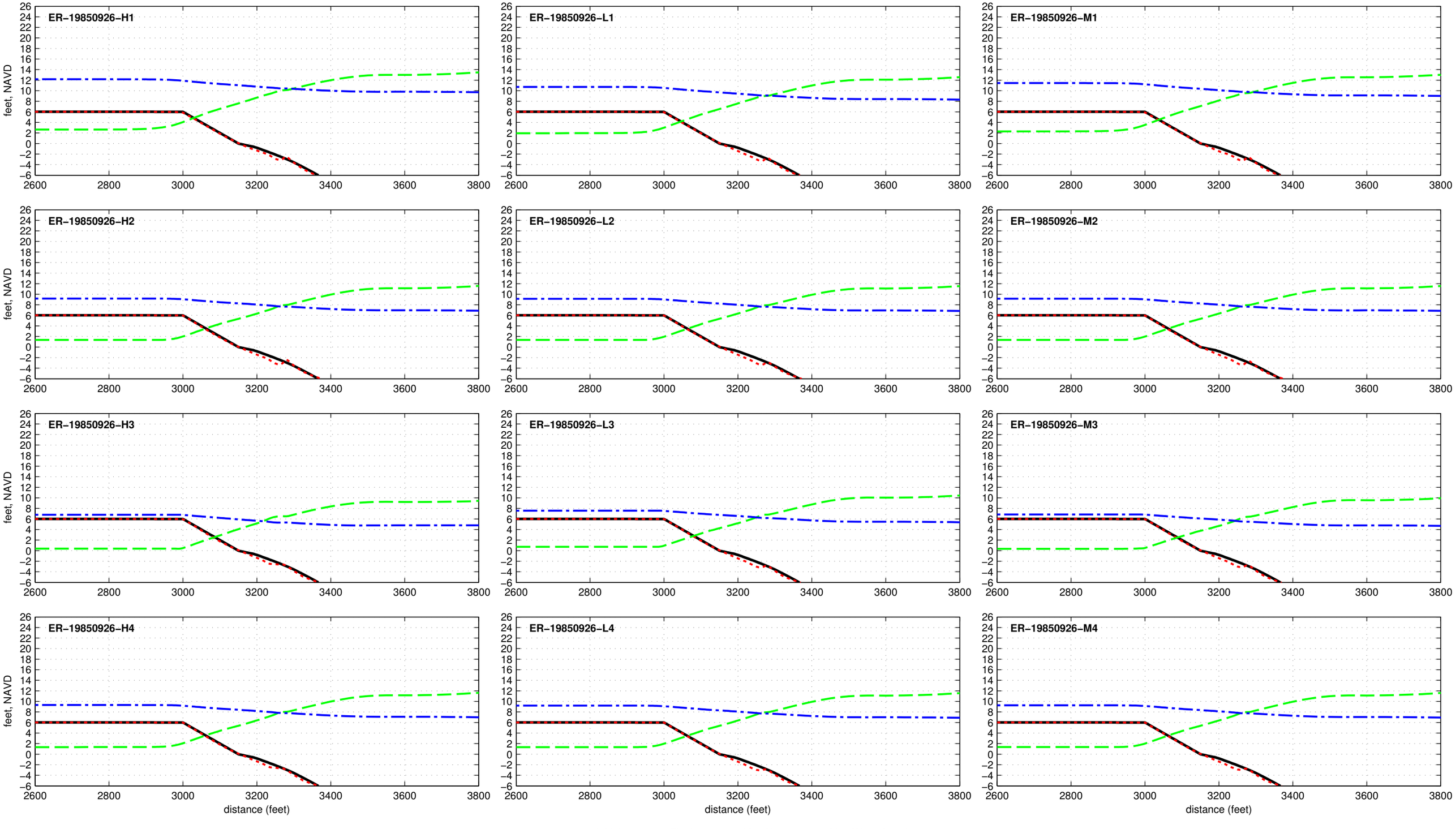




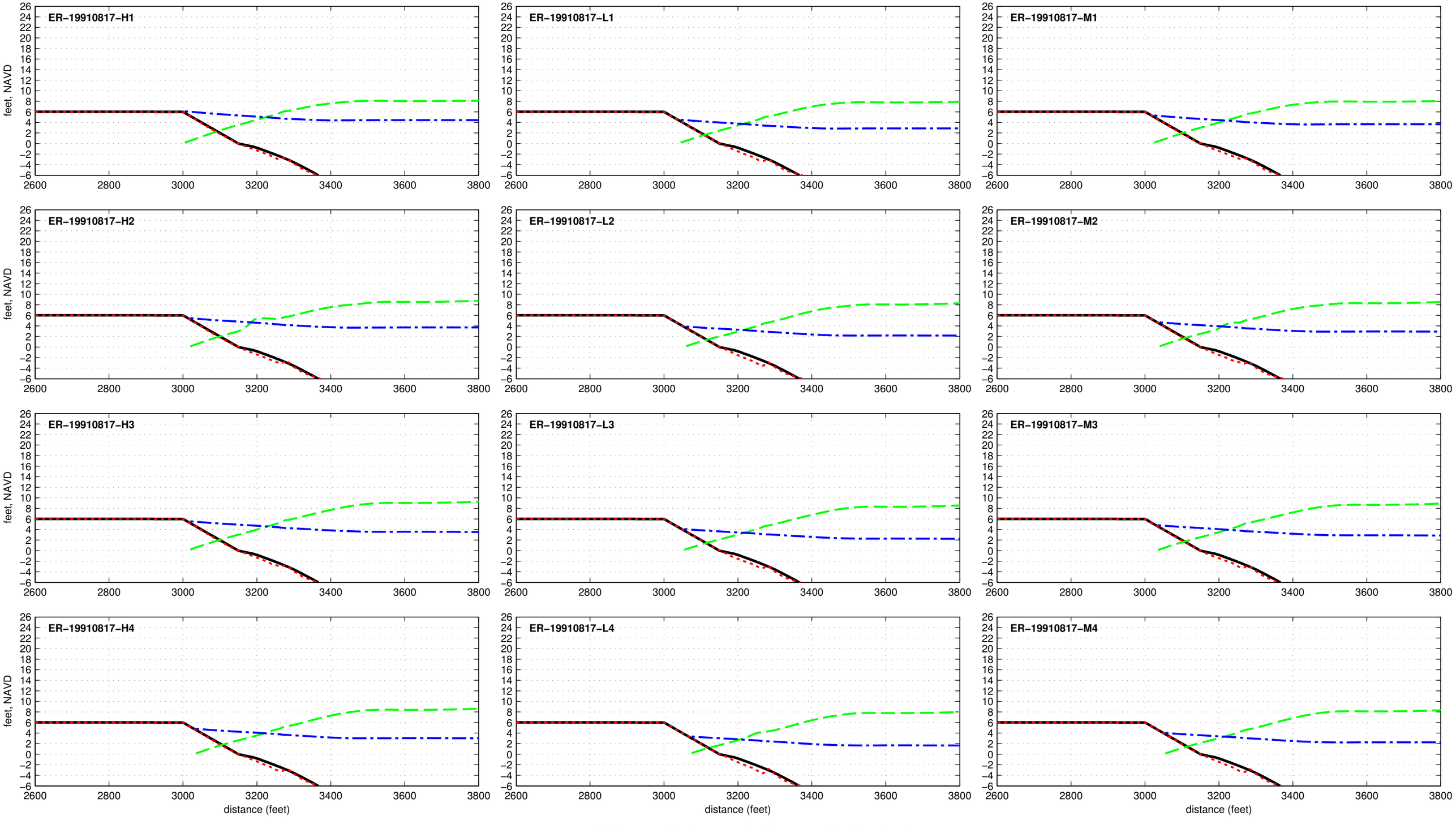


Initial Final Max Hs Max Water Level

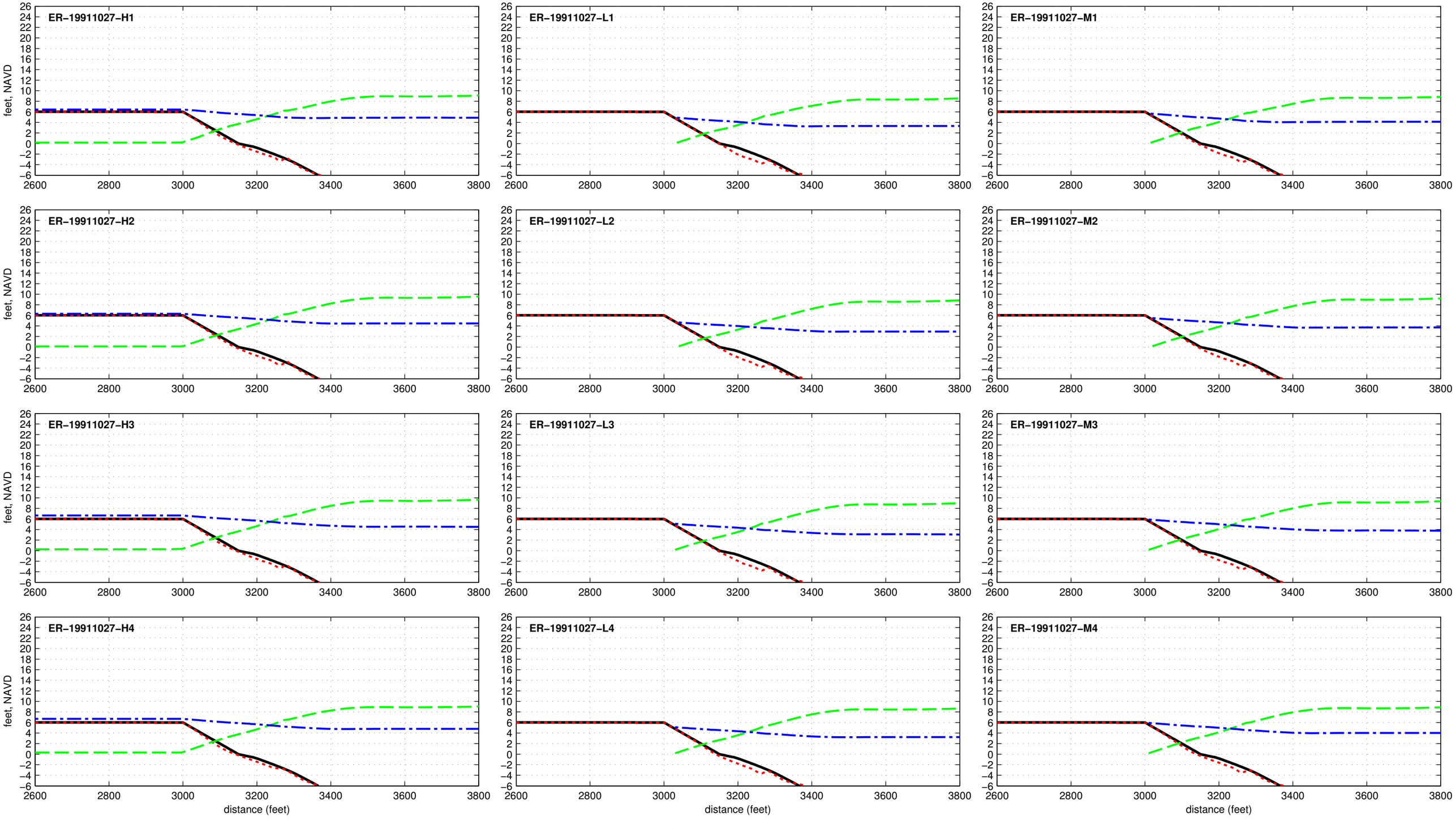
Dune R1T1-6.0-000-000 - ER-19850926



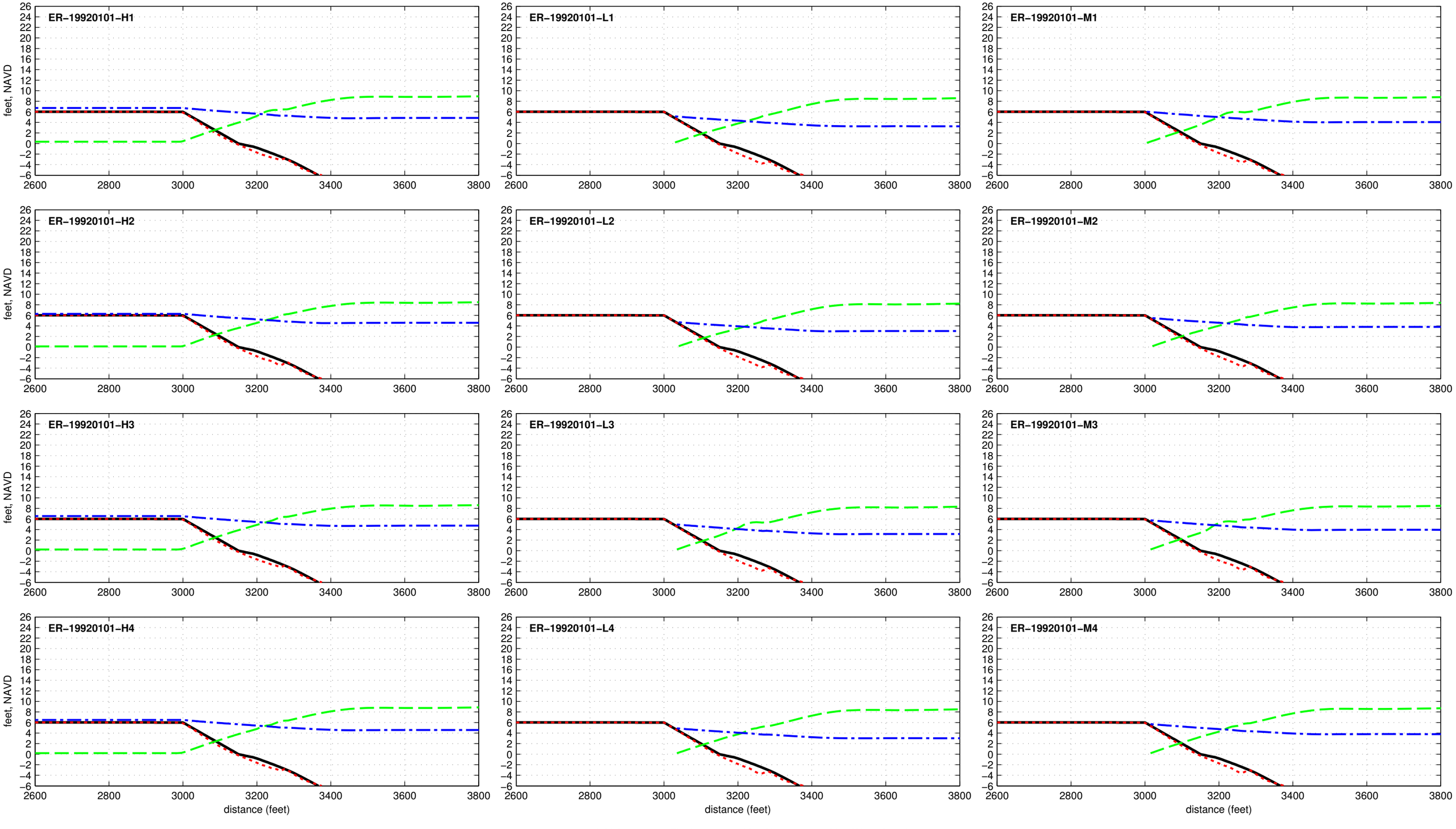
Dune R1T1-6.0-000-000 - ER-19910817



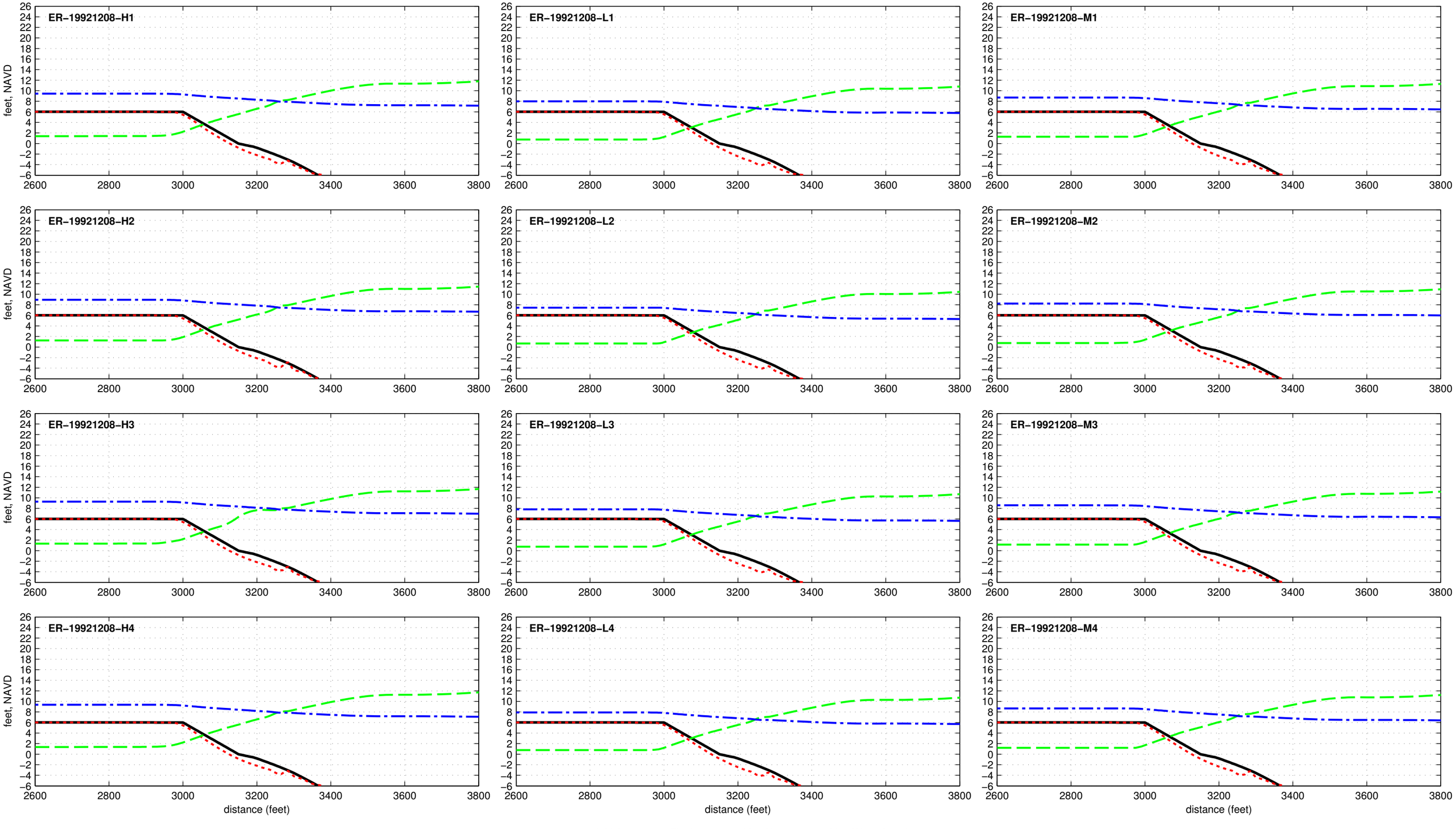
Dune R1T1-6.0-000-000 - ER-19911027



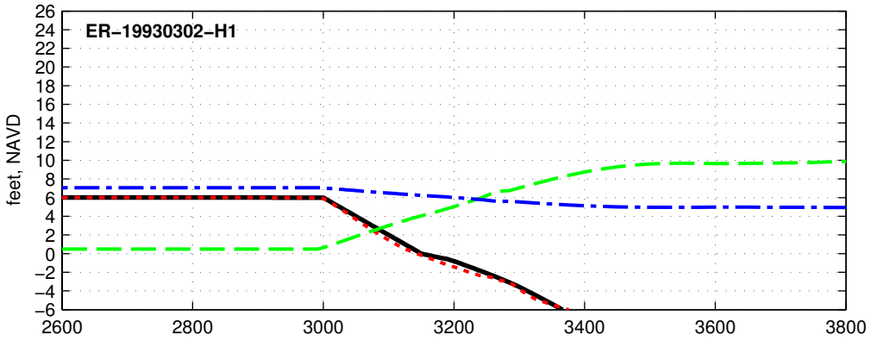
Dune R1T1-6.0-000-000 - ER-19920101

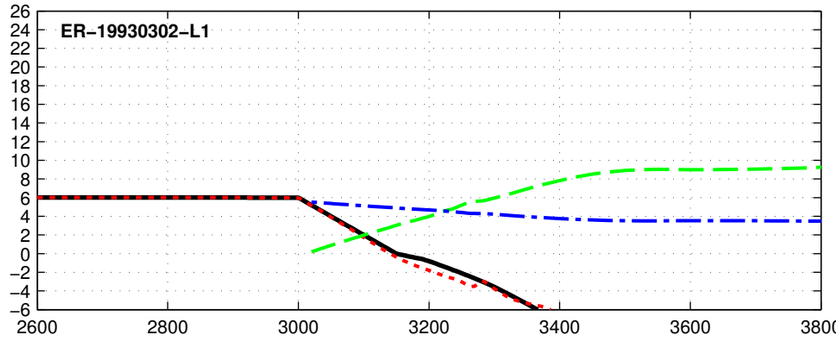


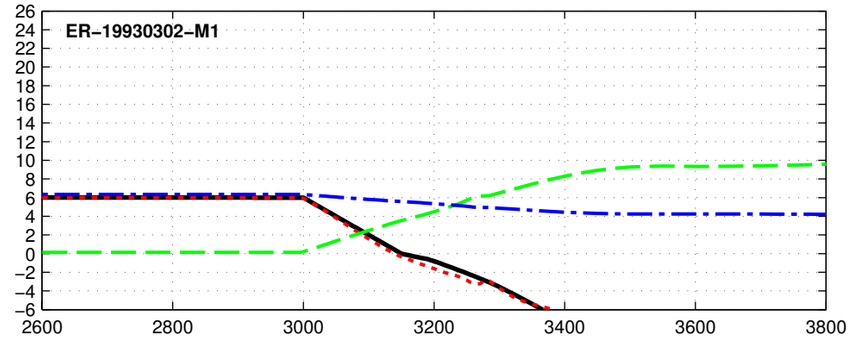
Dune R1T1-6.0-000-000 - ER-19921208

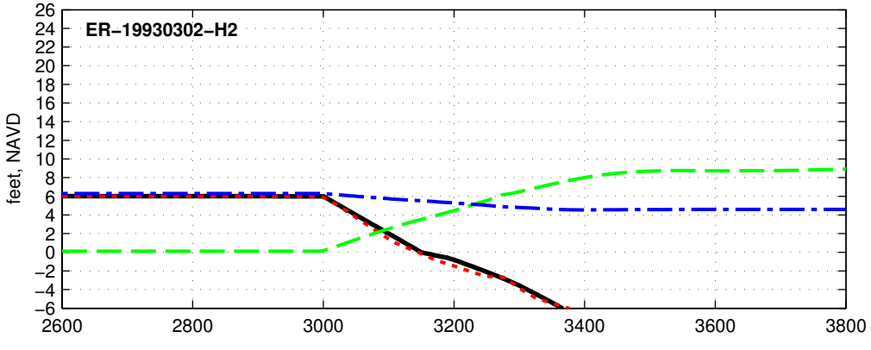


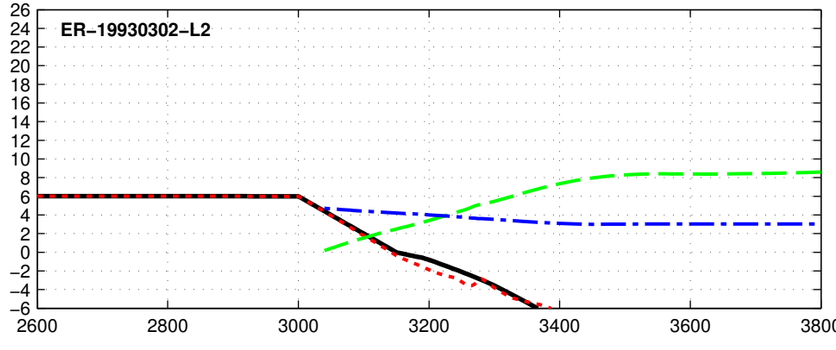
Dune R1T1-6.0-000-000 - ER-19930302

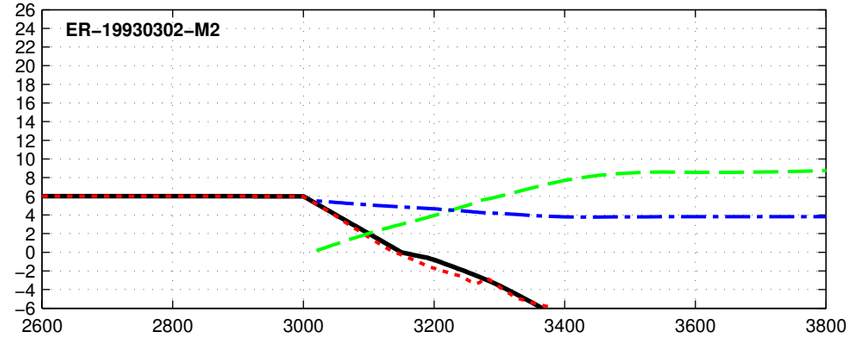


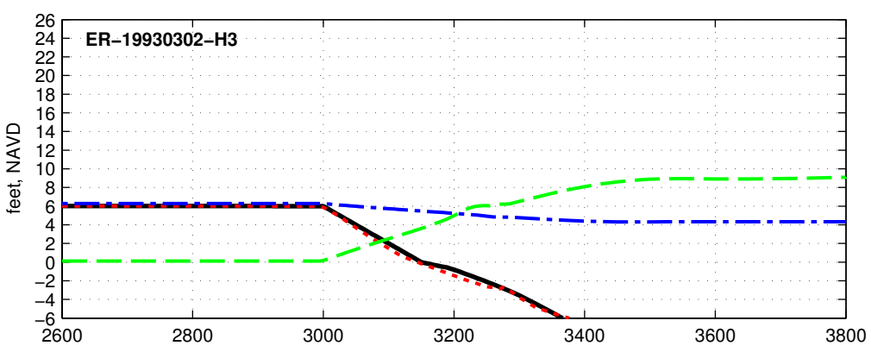


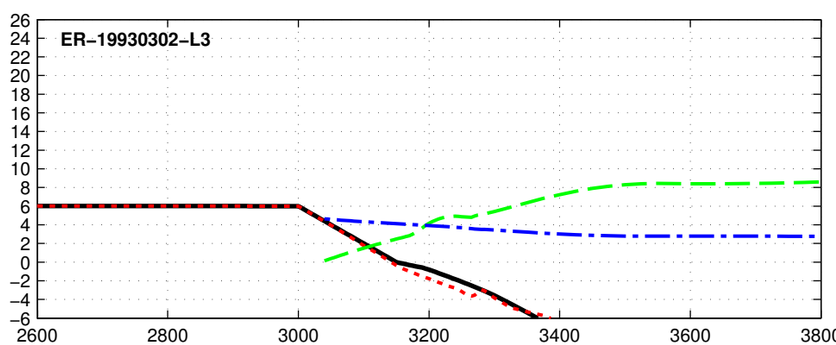


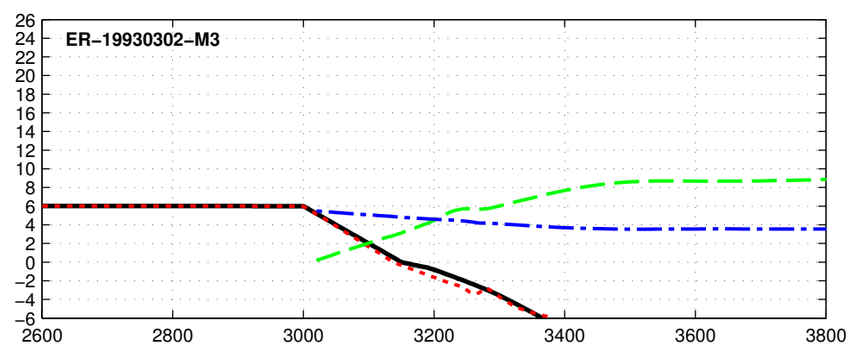


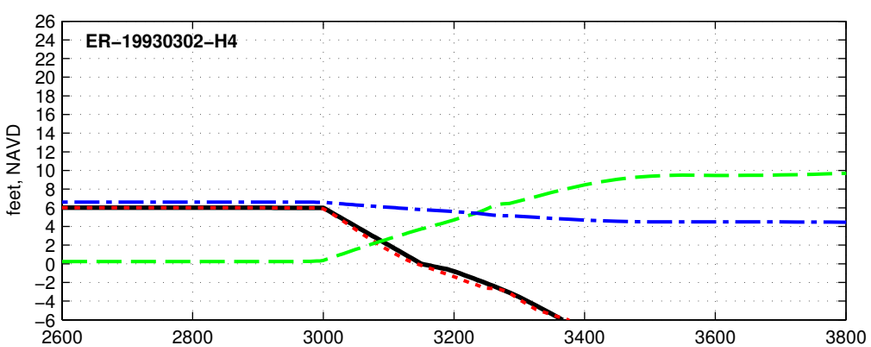


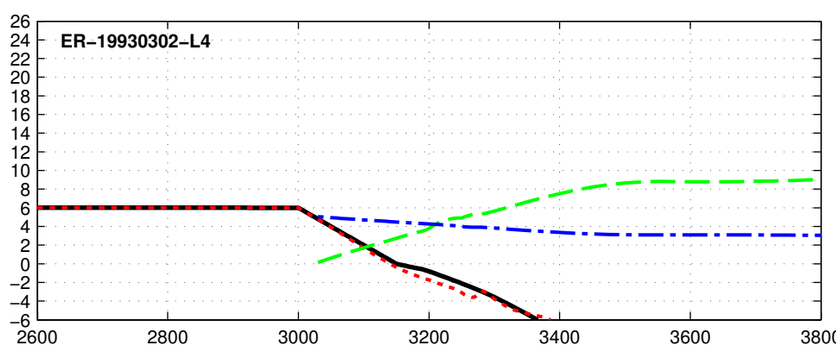


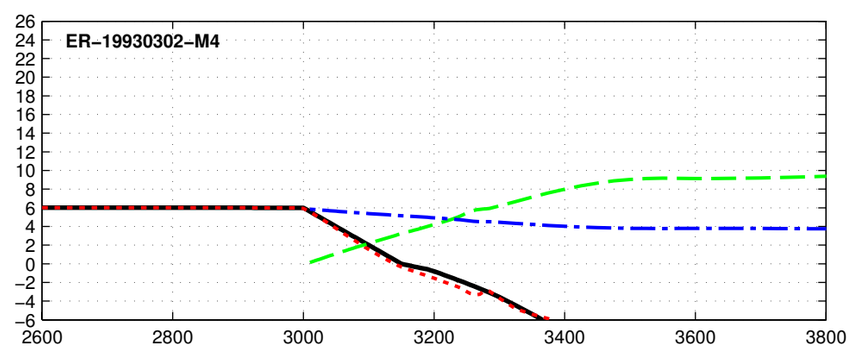










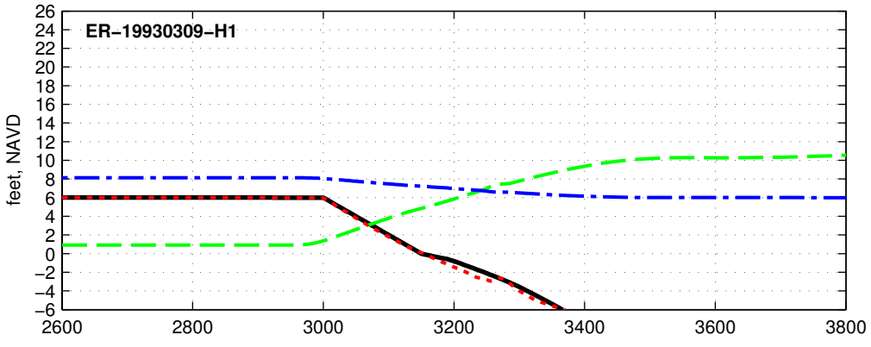


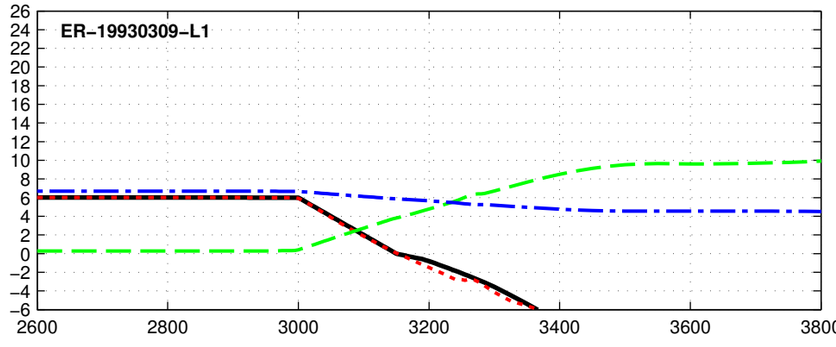
feet, NAVD

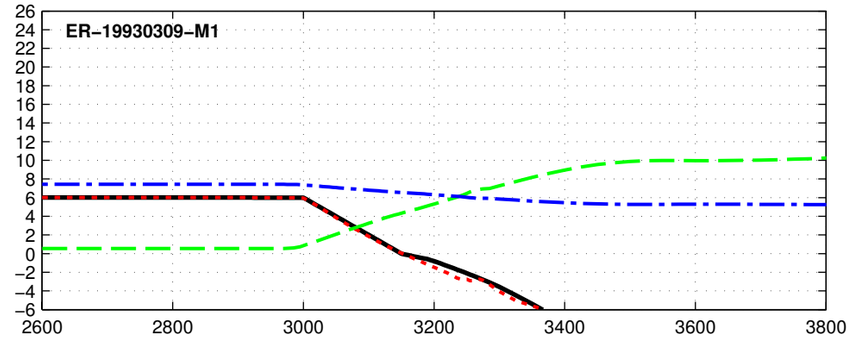
distance (feet)

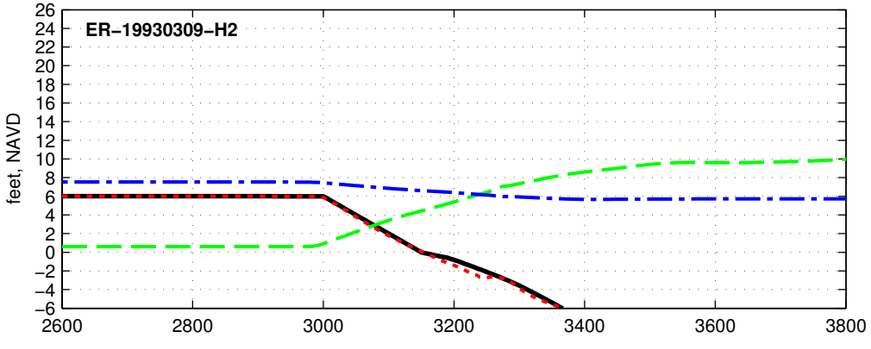
Initial Final Max Hs Max Water Level

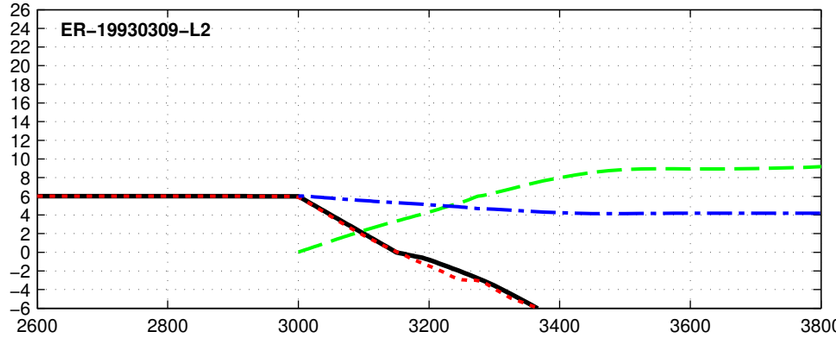
Dune R1T1-6.0-000-000 - ER-19930309

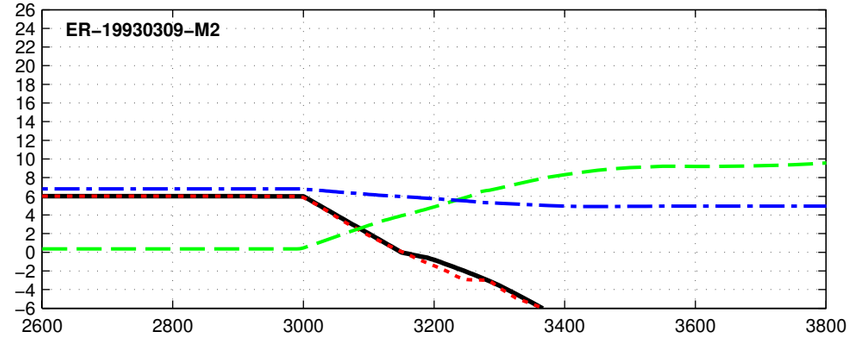


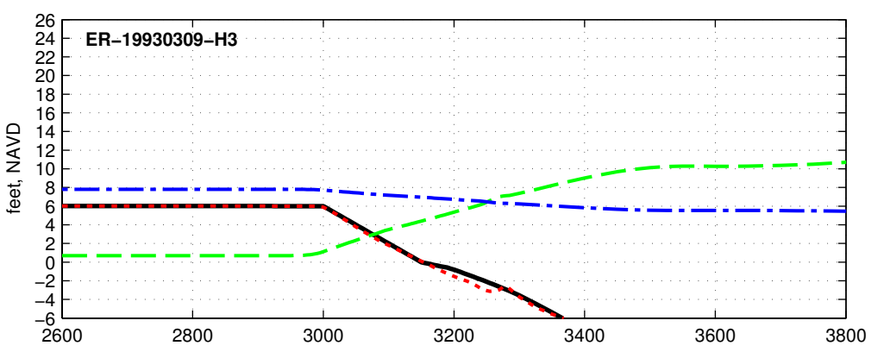


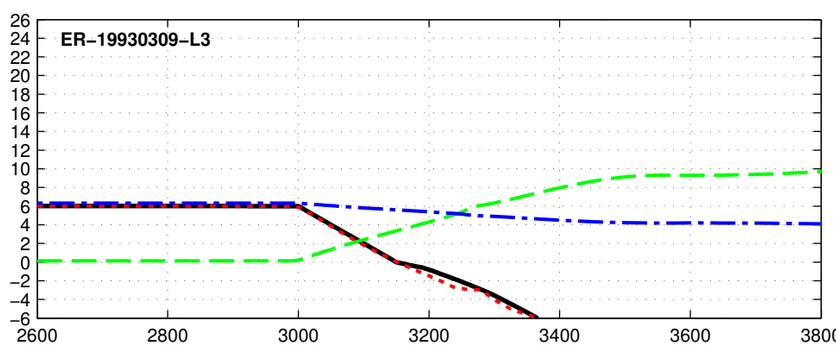


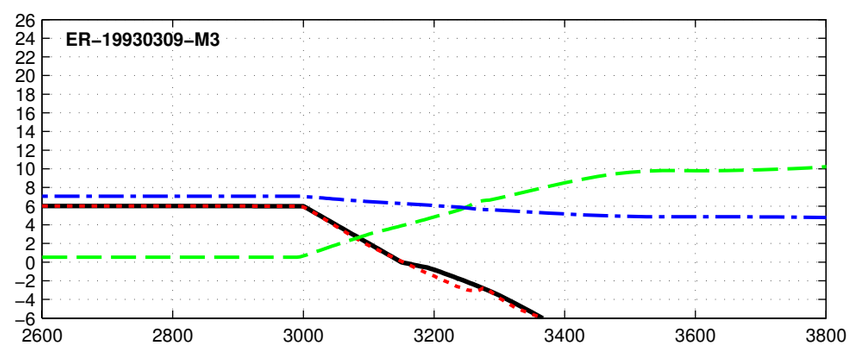


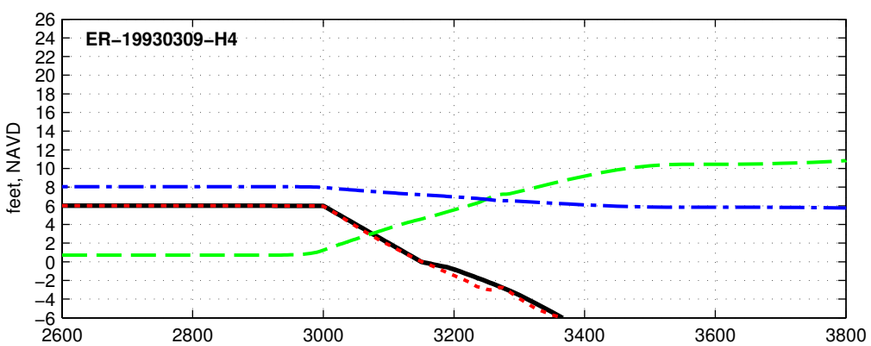


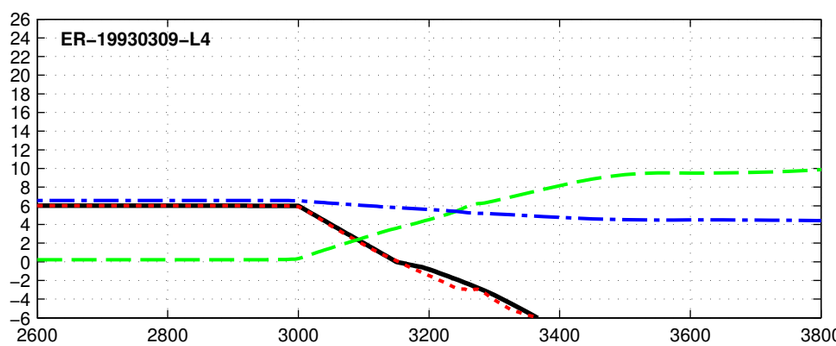


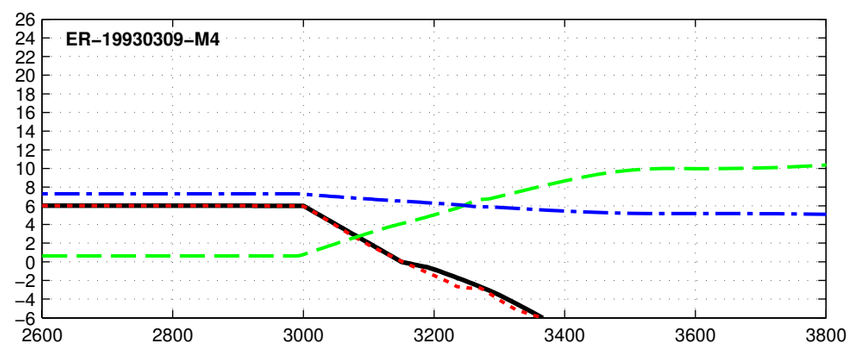






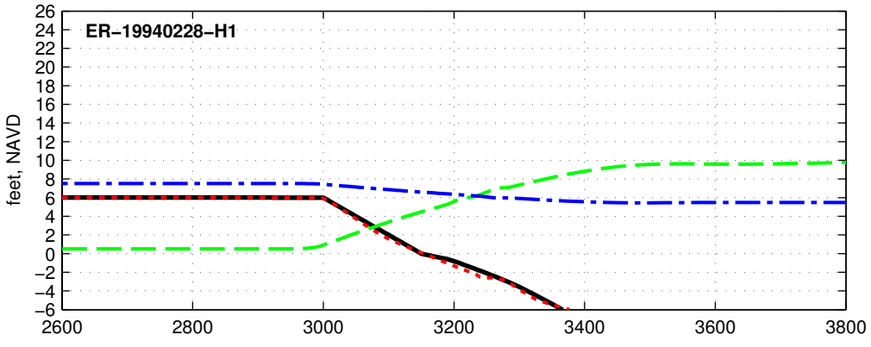


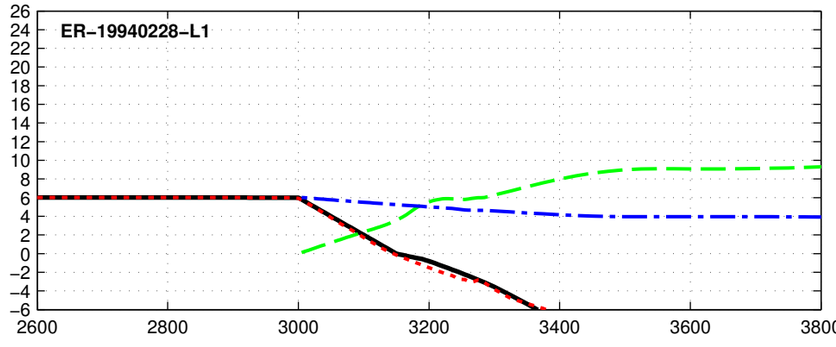


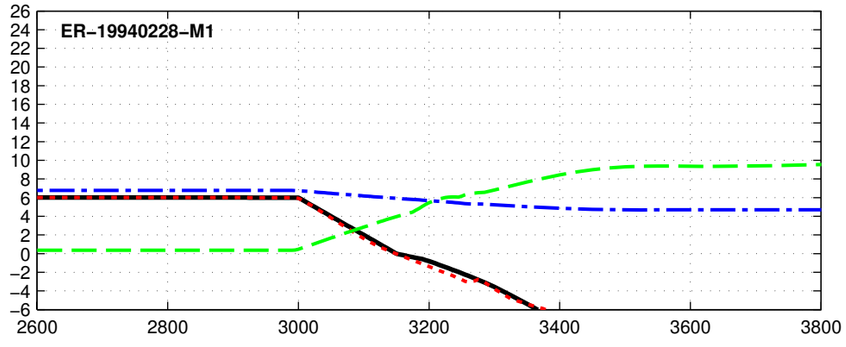


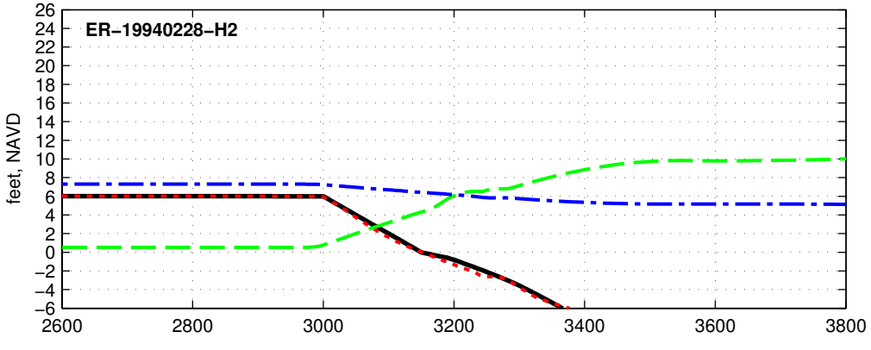
Initial Final Max Hs Max Water Level

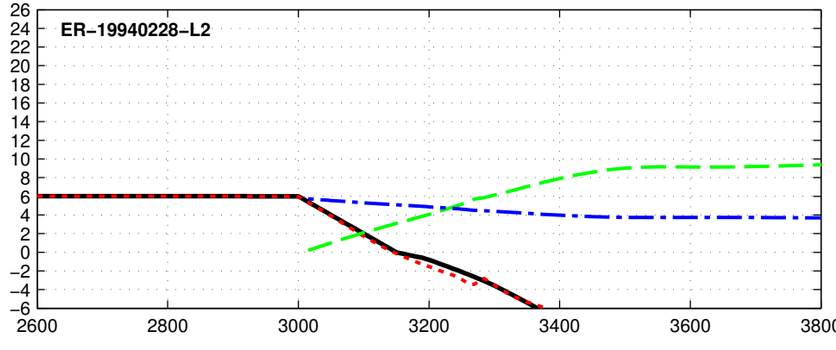
Dune R1T1-6.0-000-000 - ER-19940228

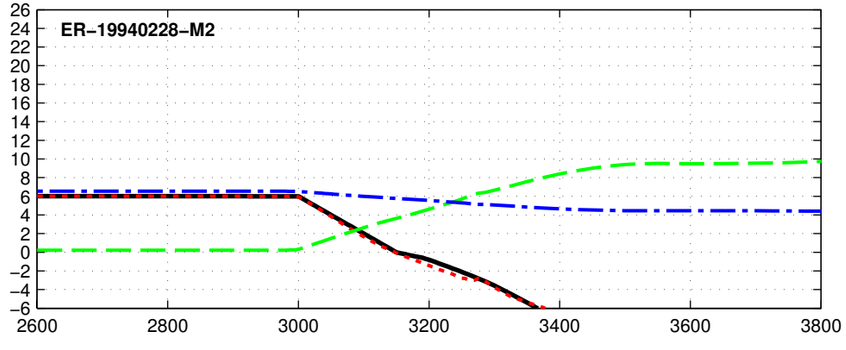


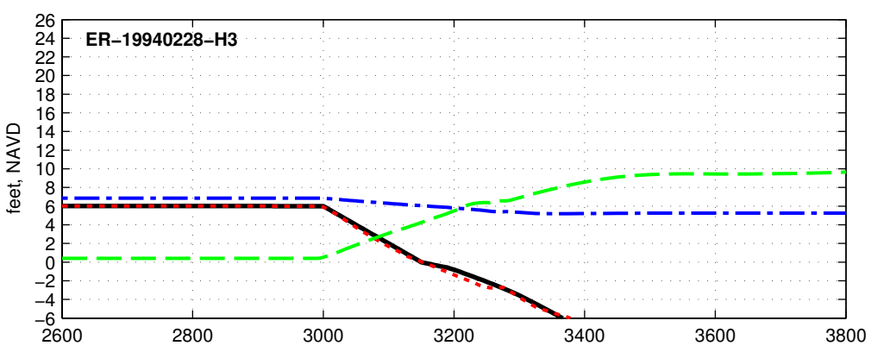


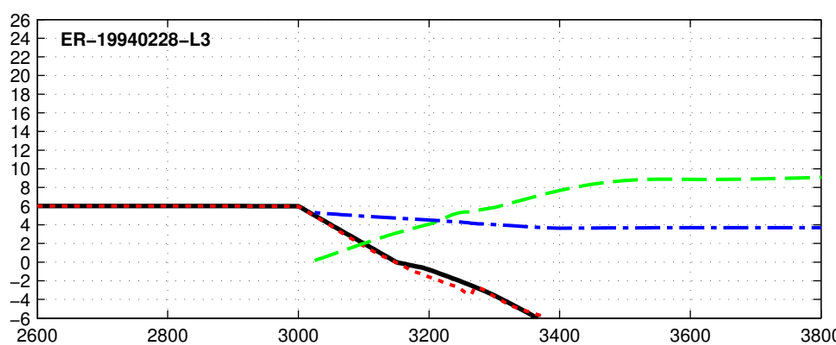


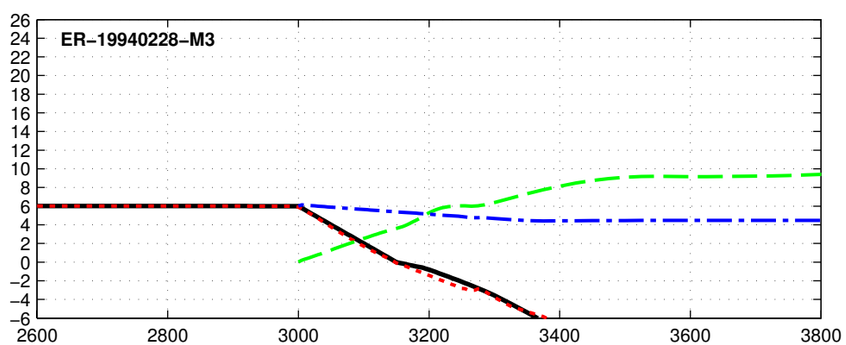


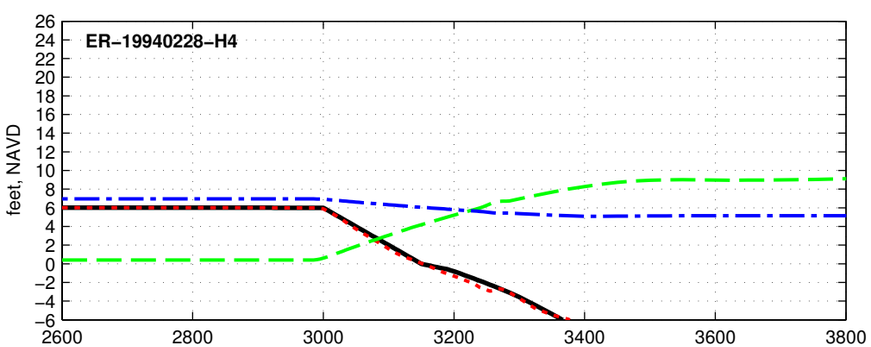


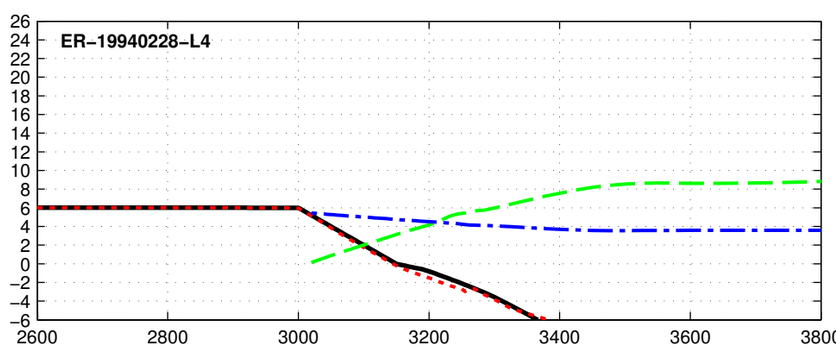


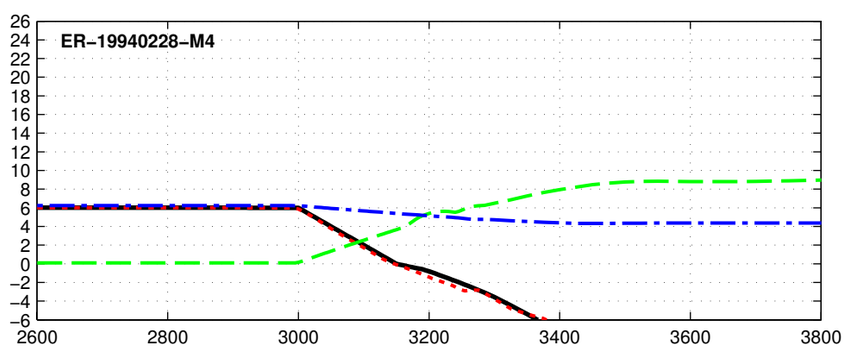










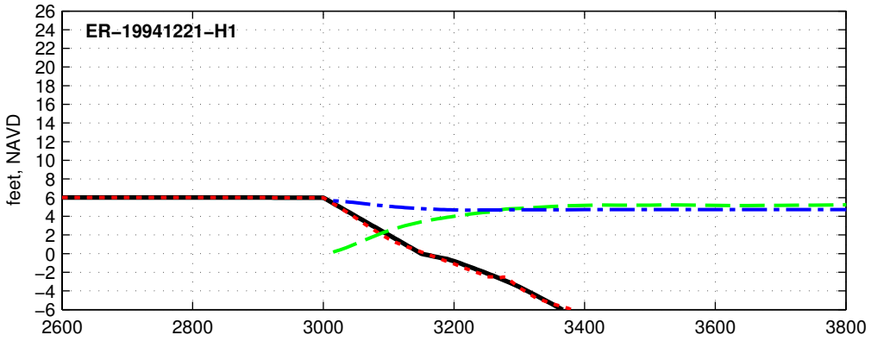


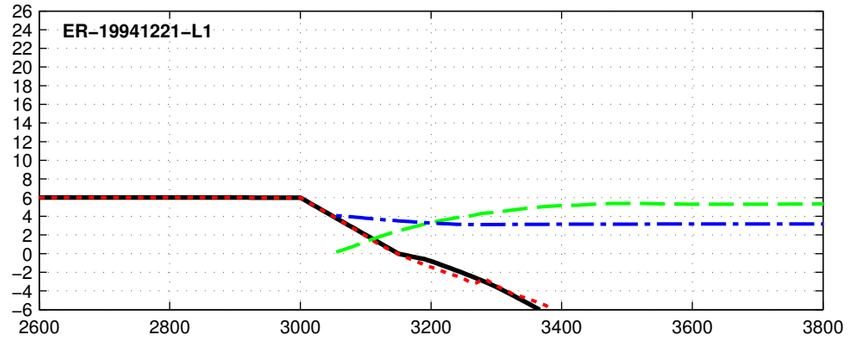
feet, NAVD

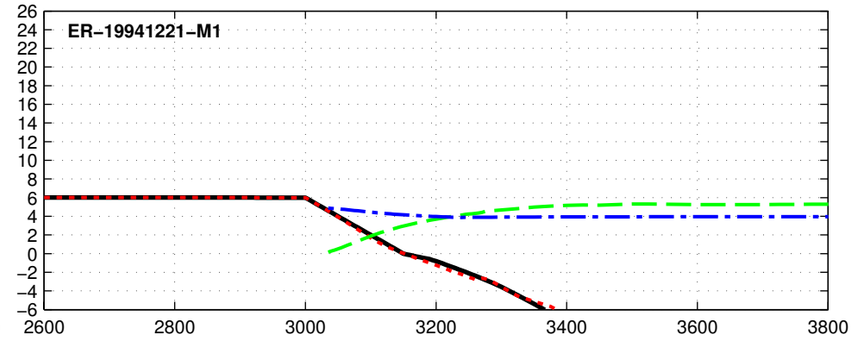
distance (feet)

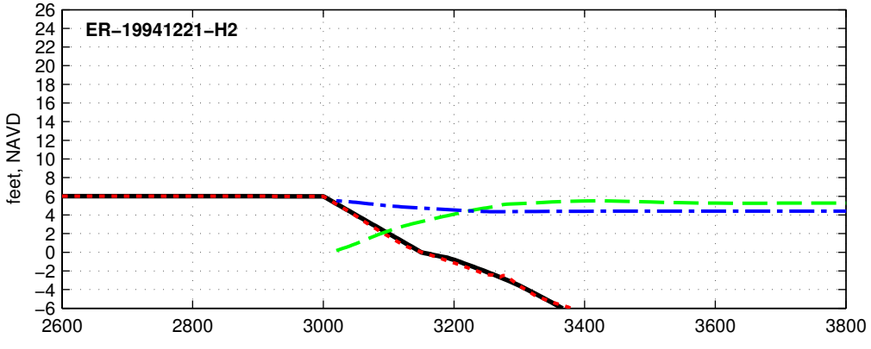
Initial Final Max Hs Max Water Level

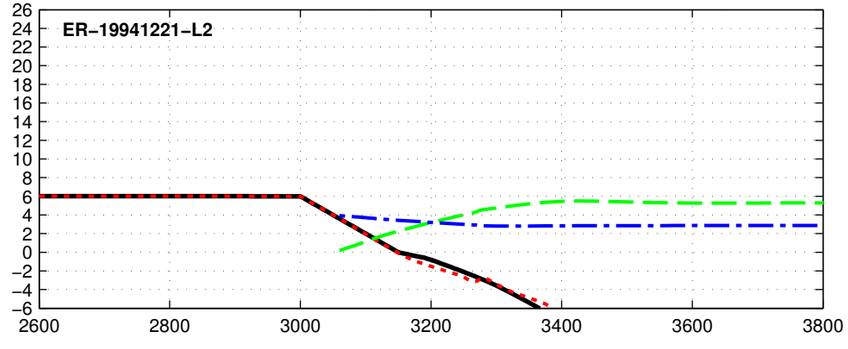
Dune R1T1-6.0-000-000 - ER-19941221

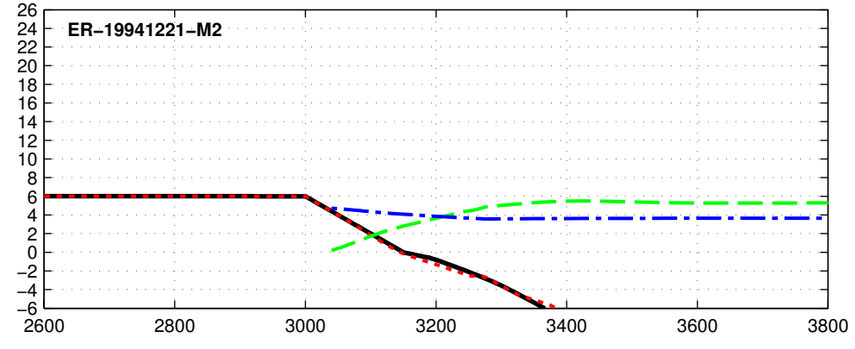


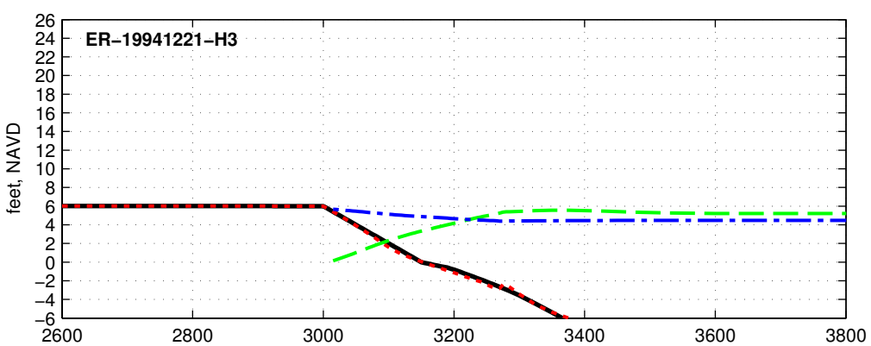


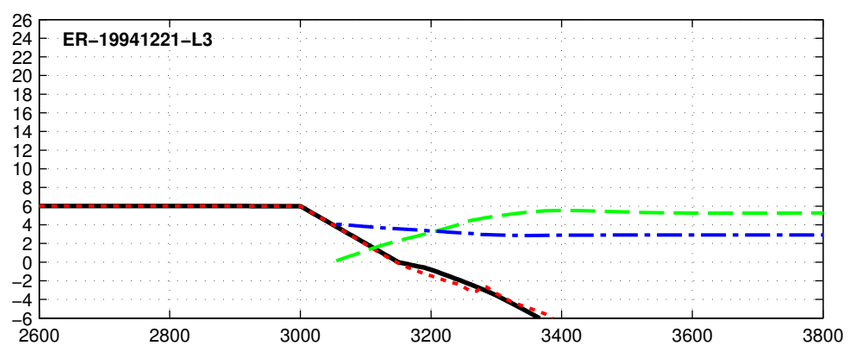


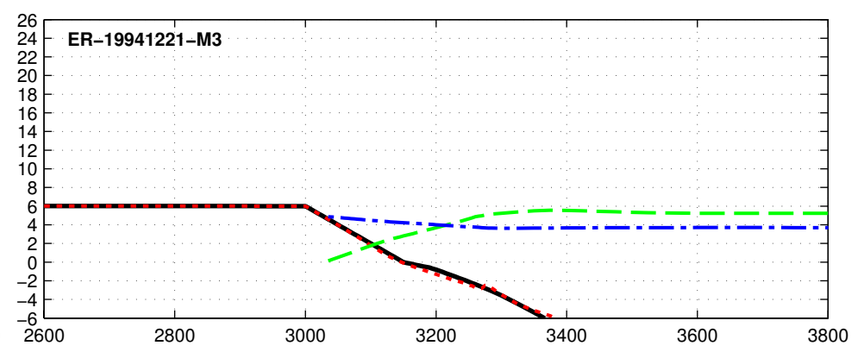


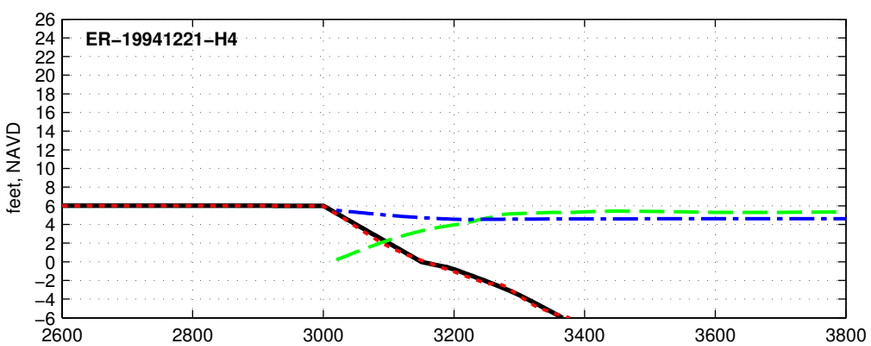


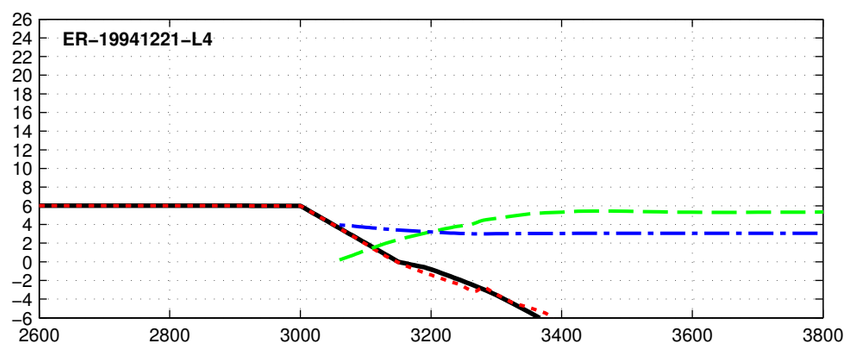


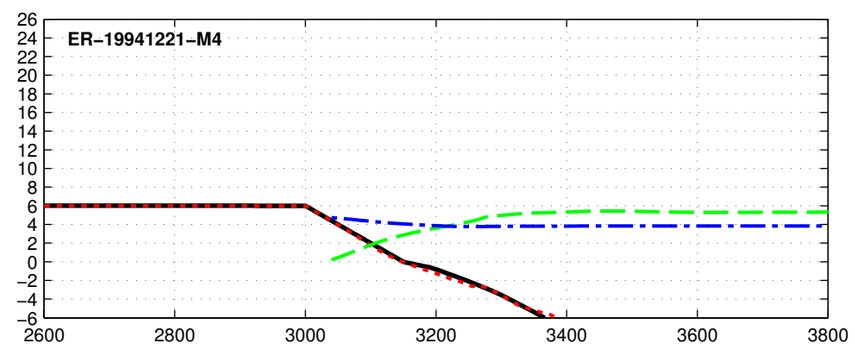






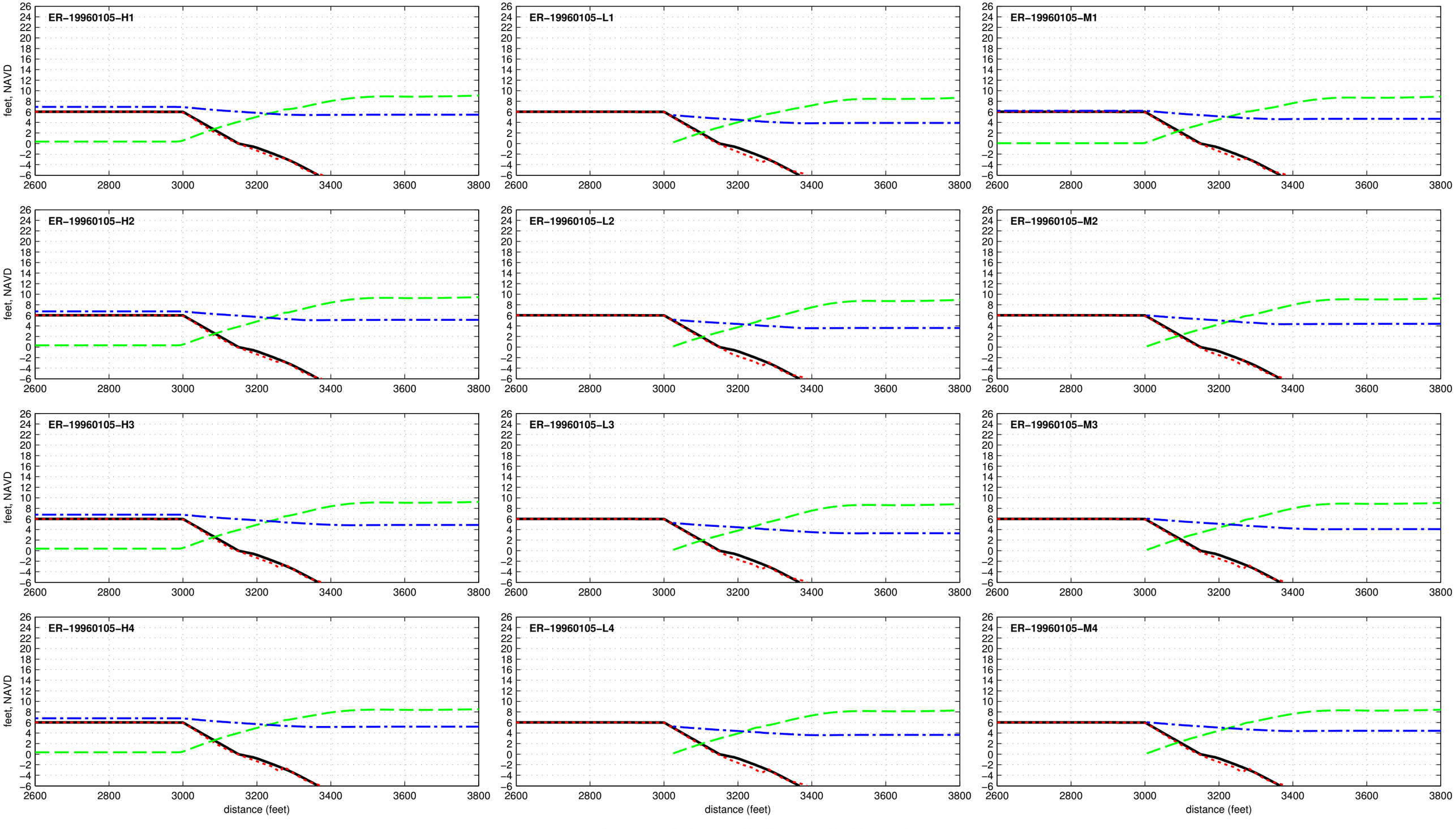




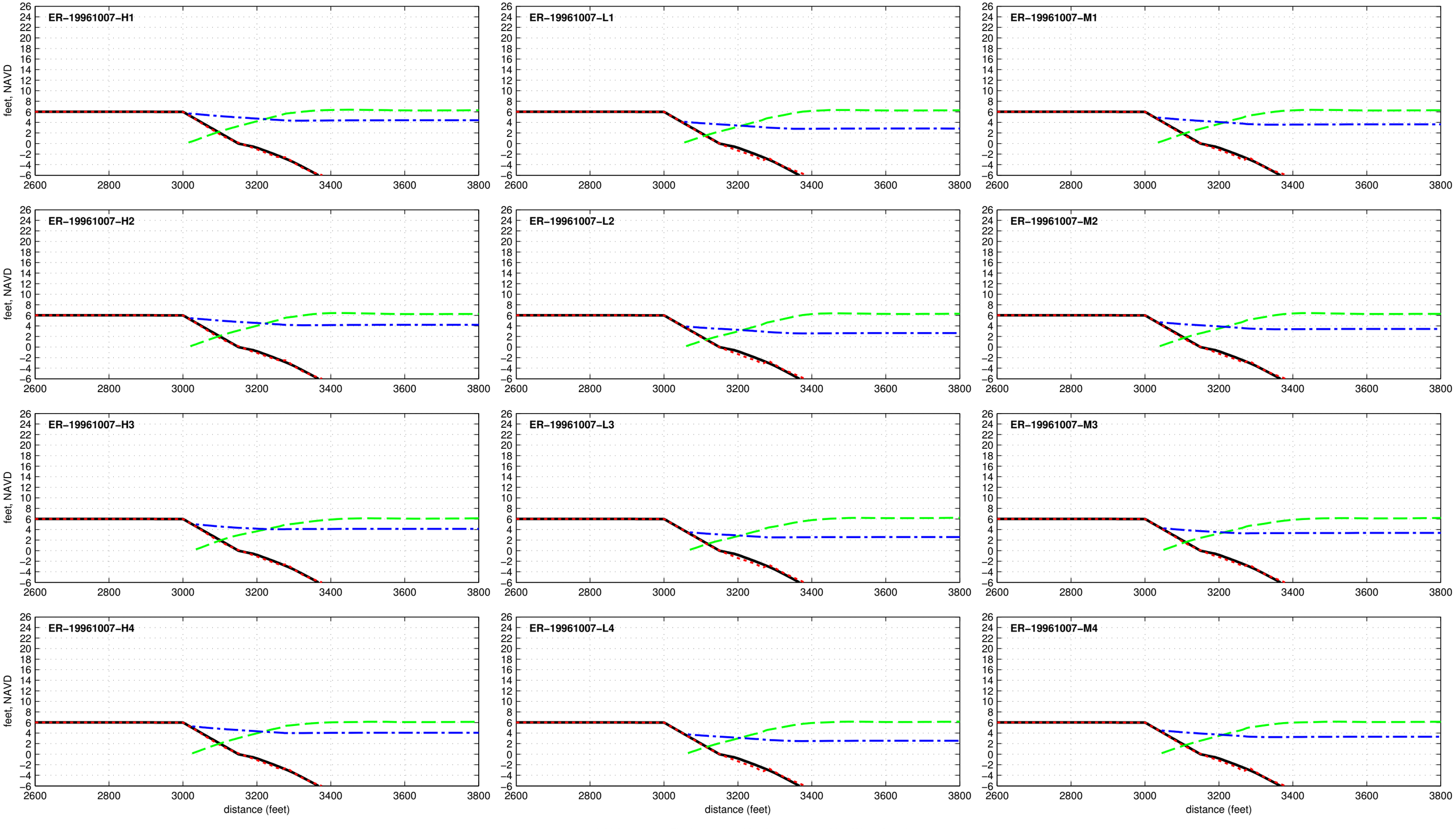


Initial Final Max Hs Max Water Level

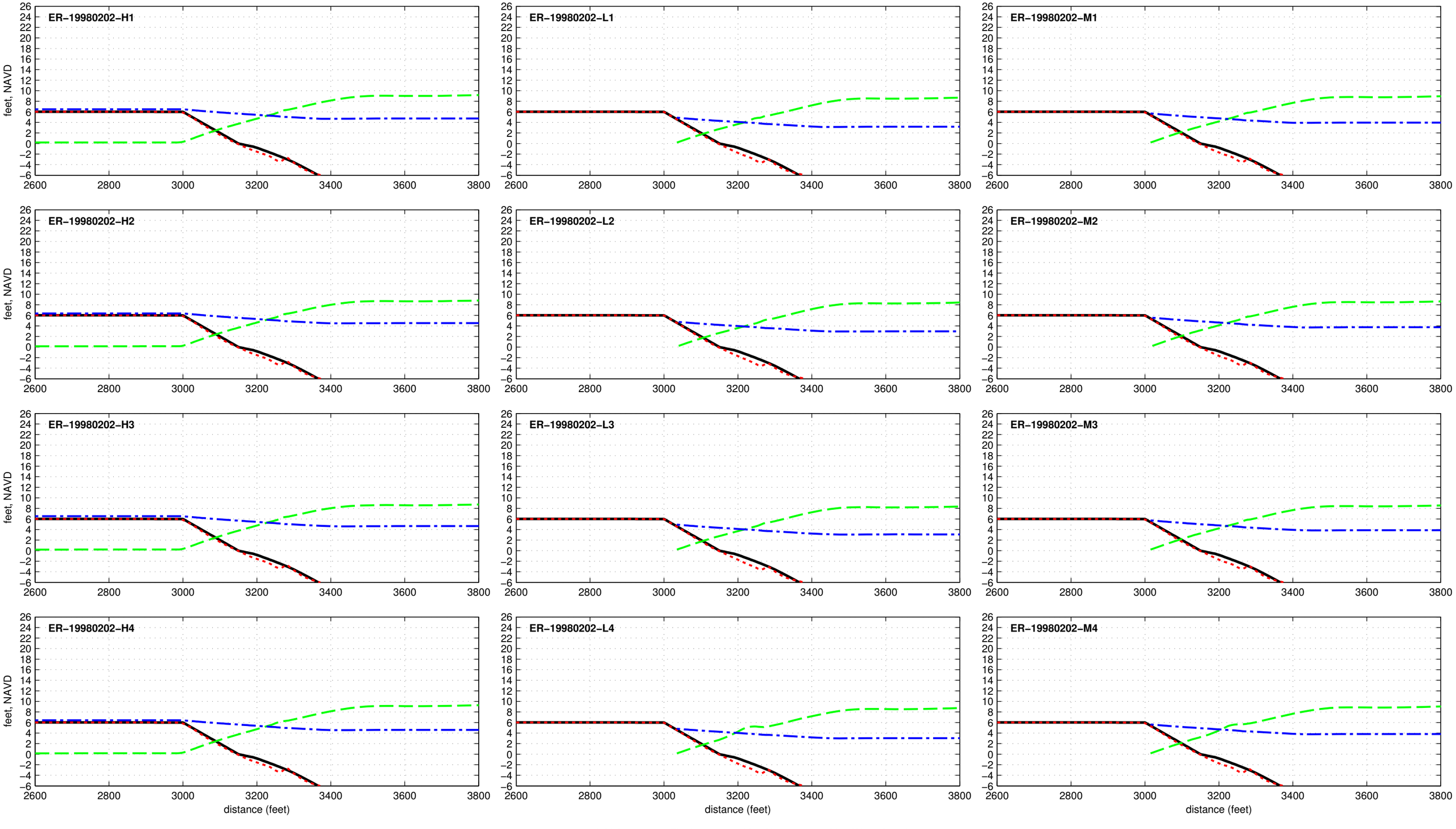
Dune R1T1-6.0-000-000 - ER-19960105



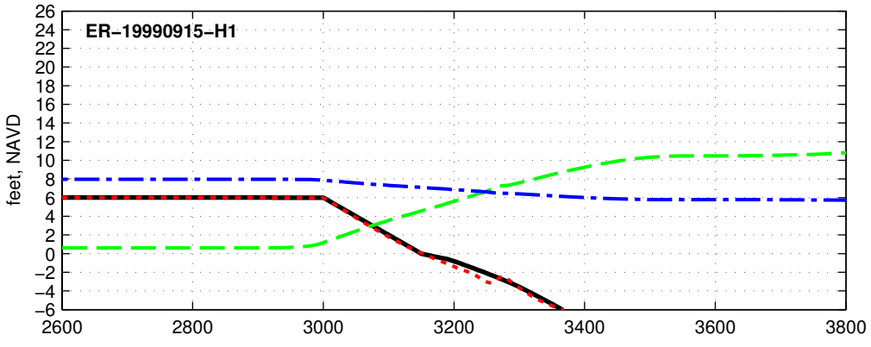
Dune R1T1-6.0-000-000 - ER-19961007

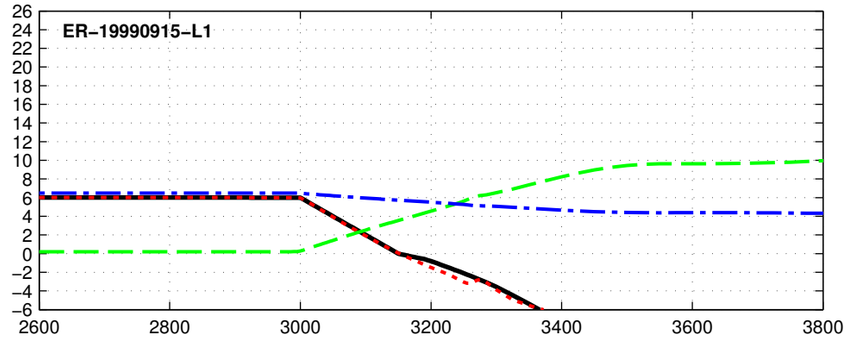


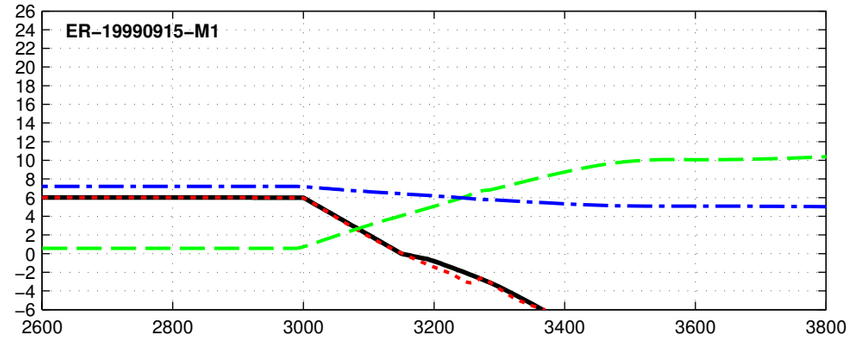
Dune R1T1-6.0-000-000 - ER-19980202

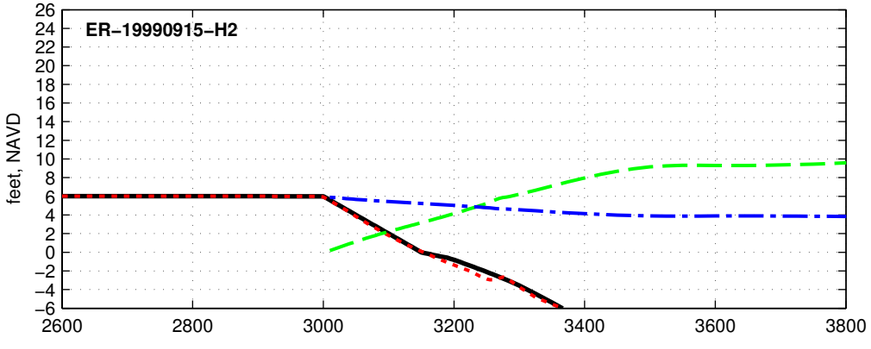


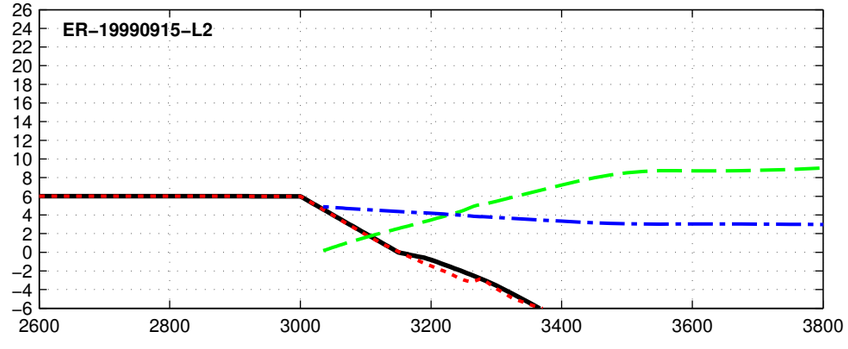
Dune R1T1-6.0-000-000 - ER-19990915

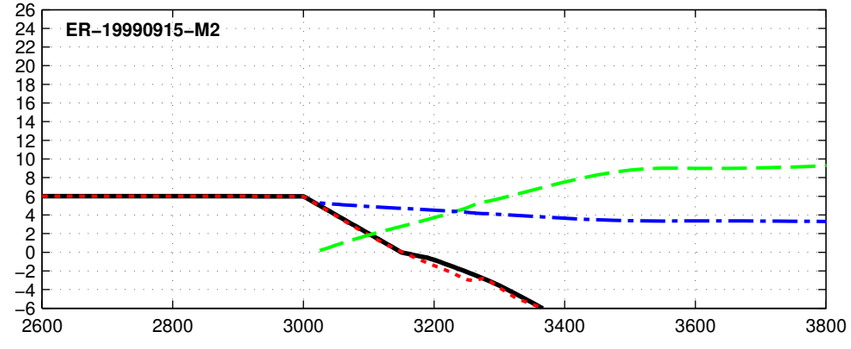


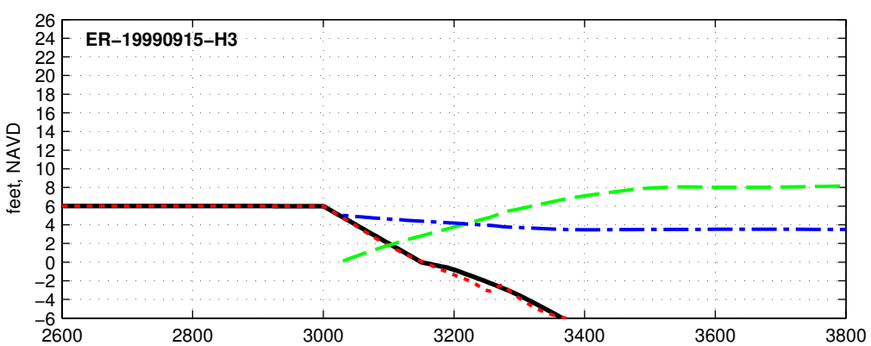


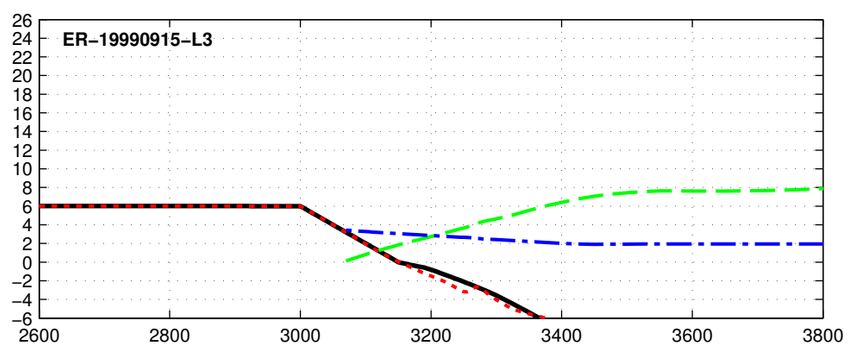


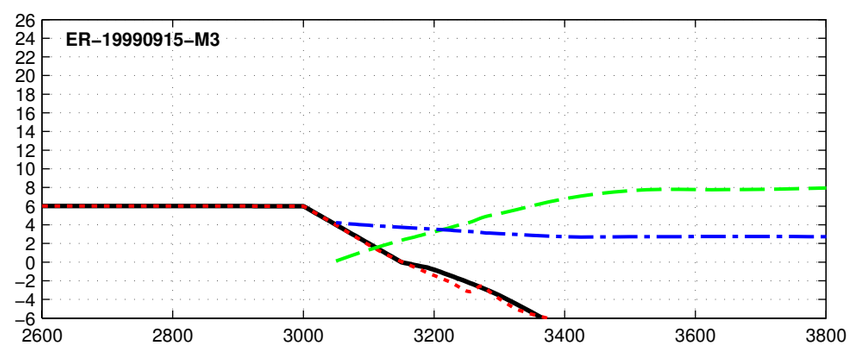


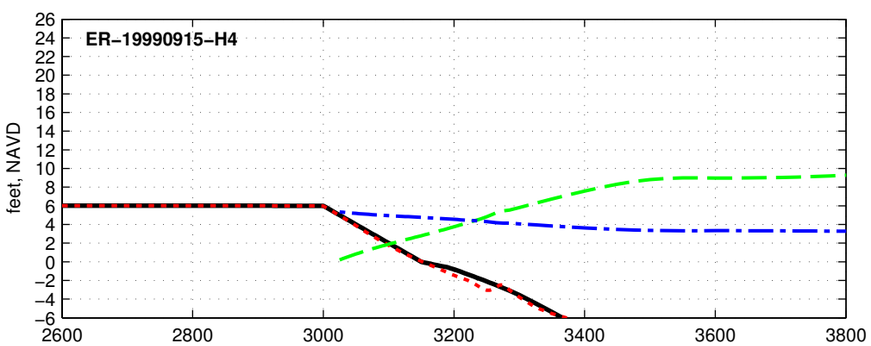


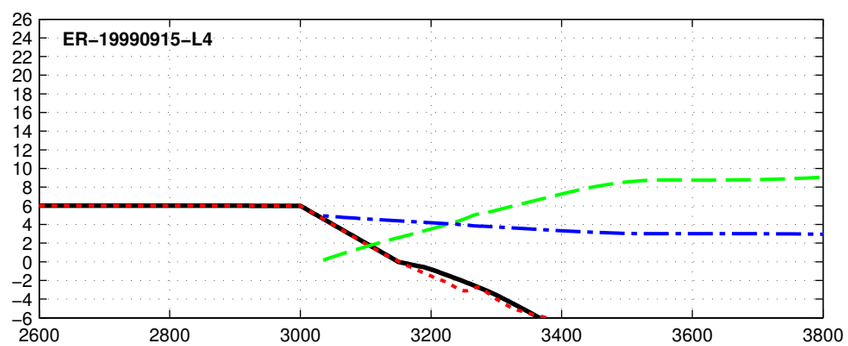


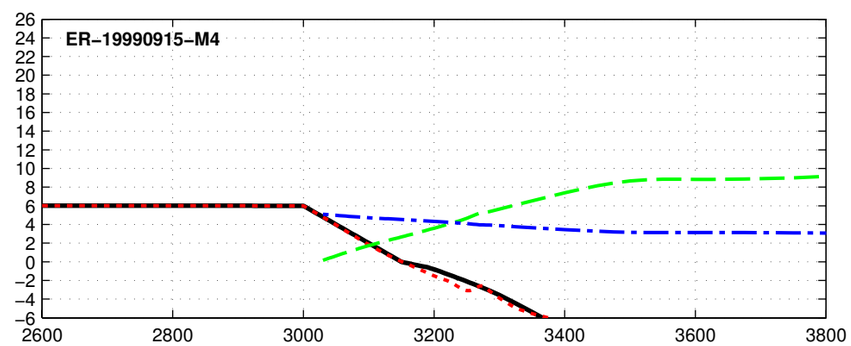






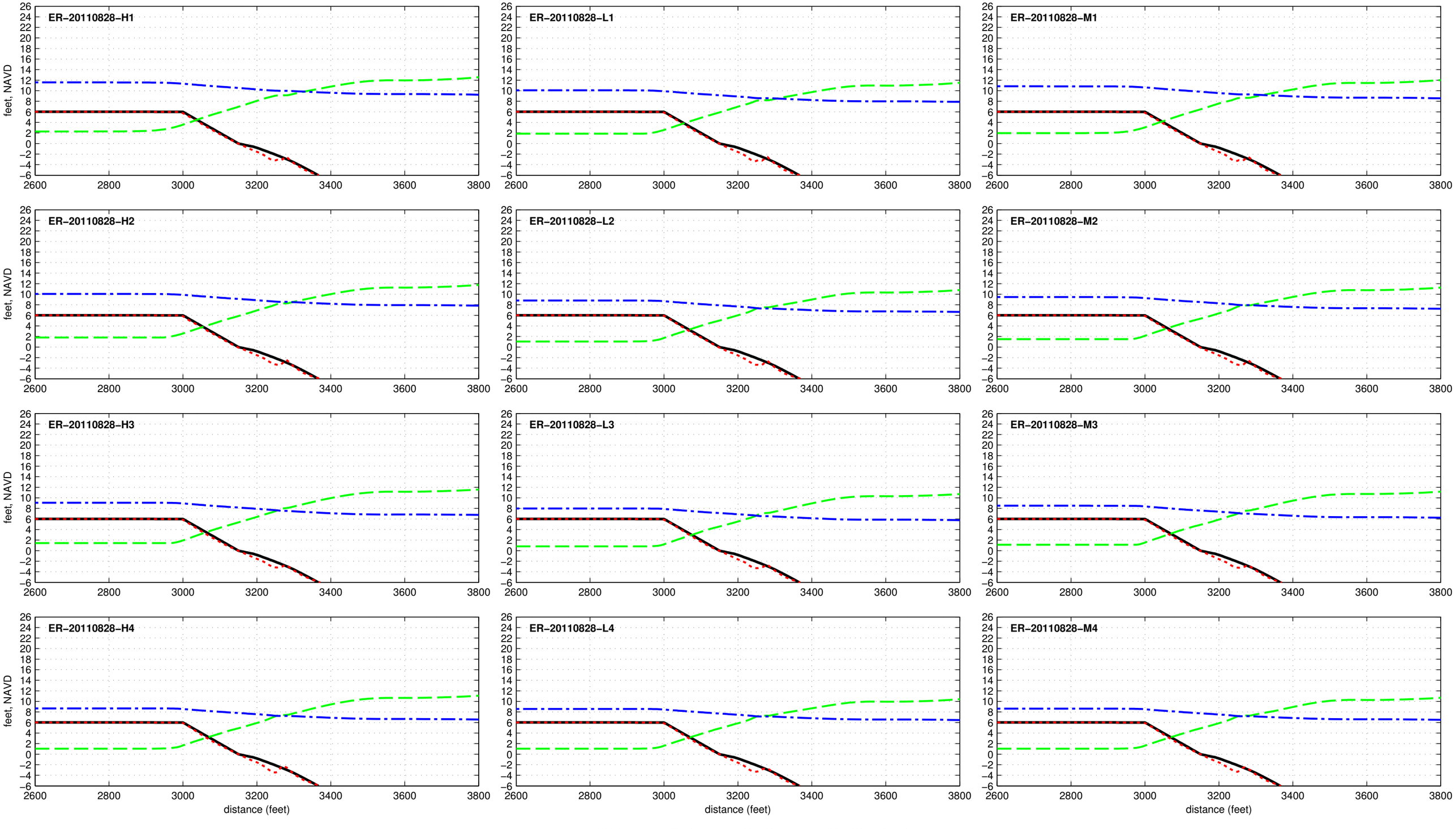




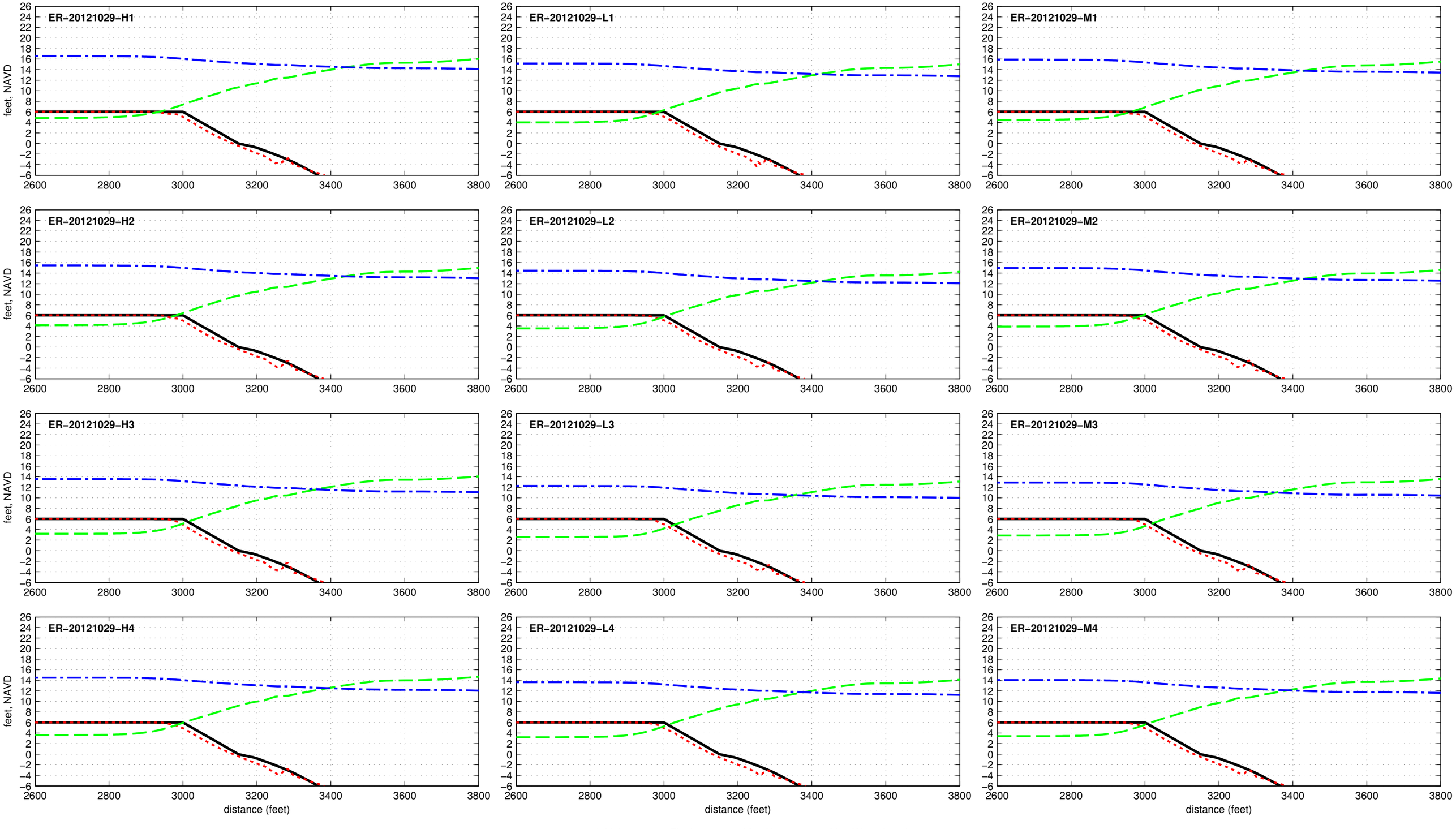


Initial Final Max Hs Max Water Level

Dune R1T1-6.0-000-000 - ER-20110828

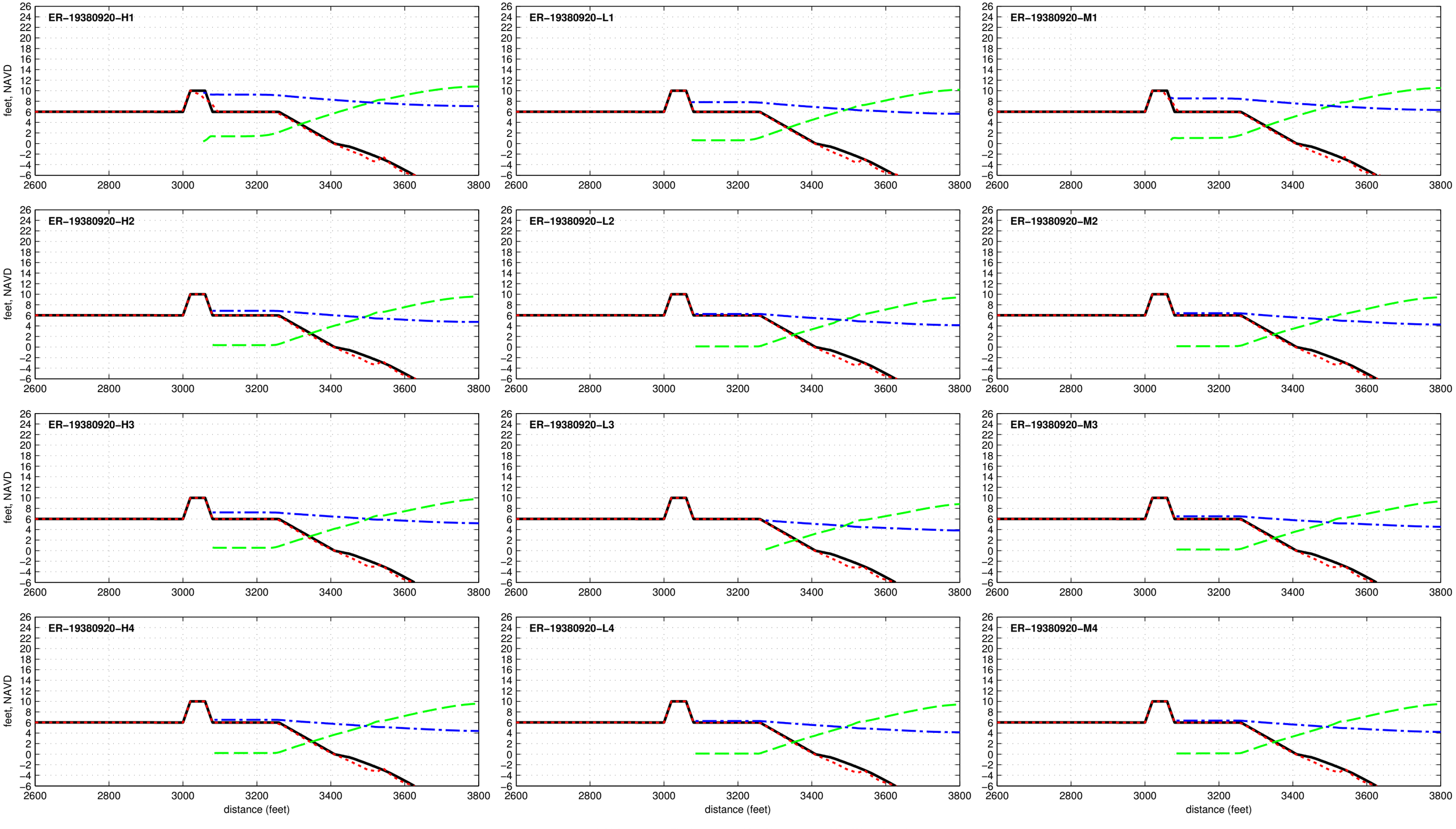


Dune R1T1-6.0-000-000 - ER-20121029

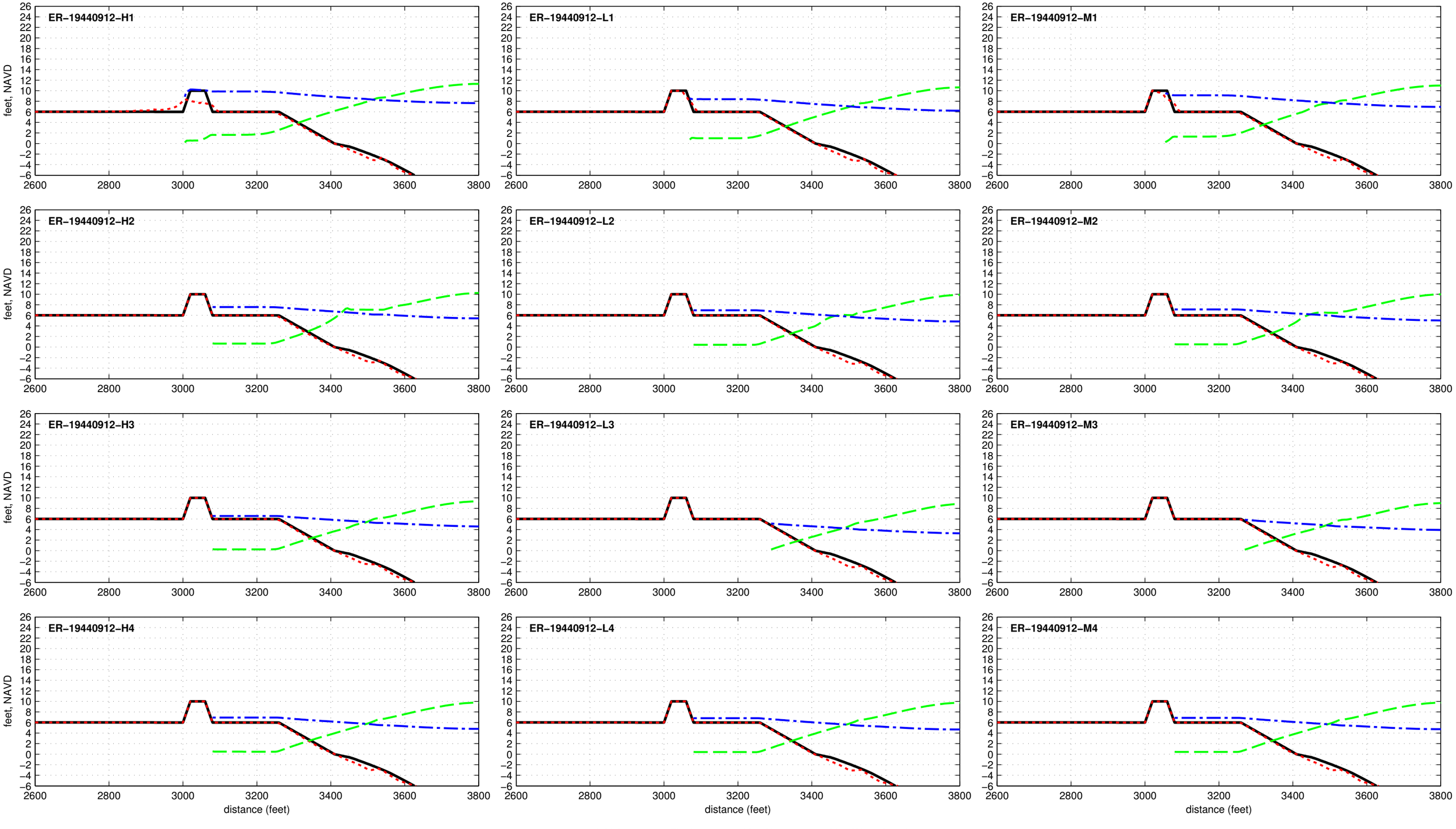


R1T1_10.0_040_180 - DUNE

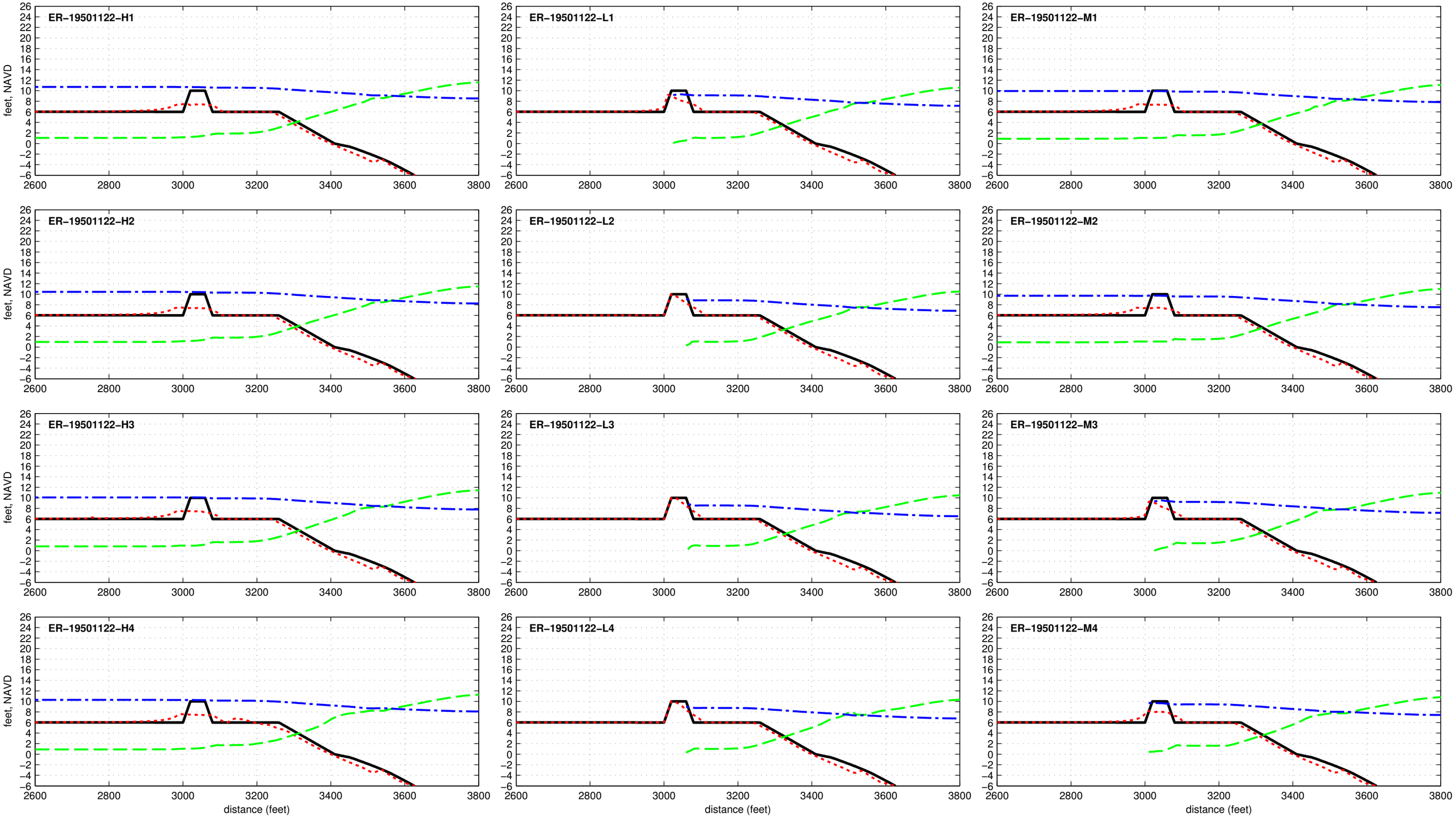
Dune R1T1–10.0–040–180 – ER–19380920



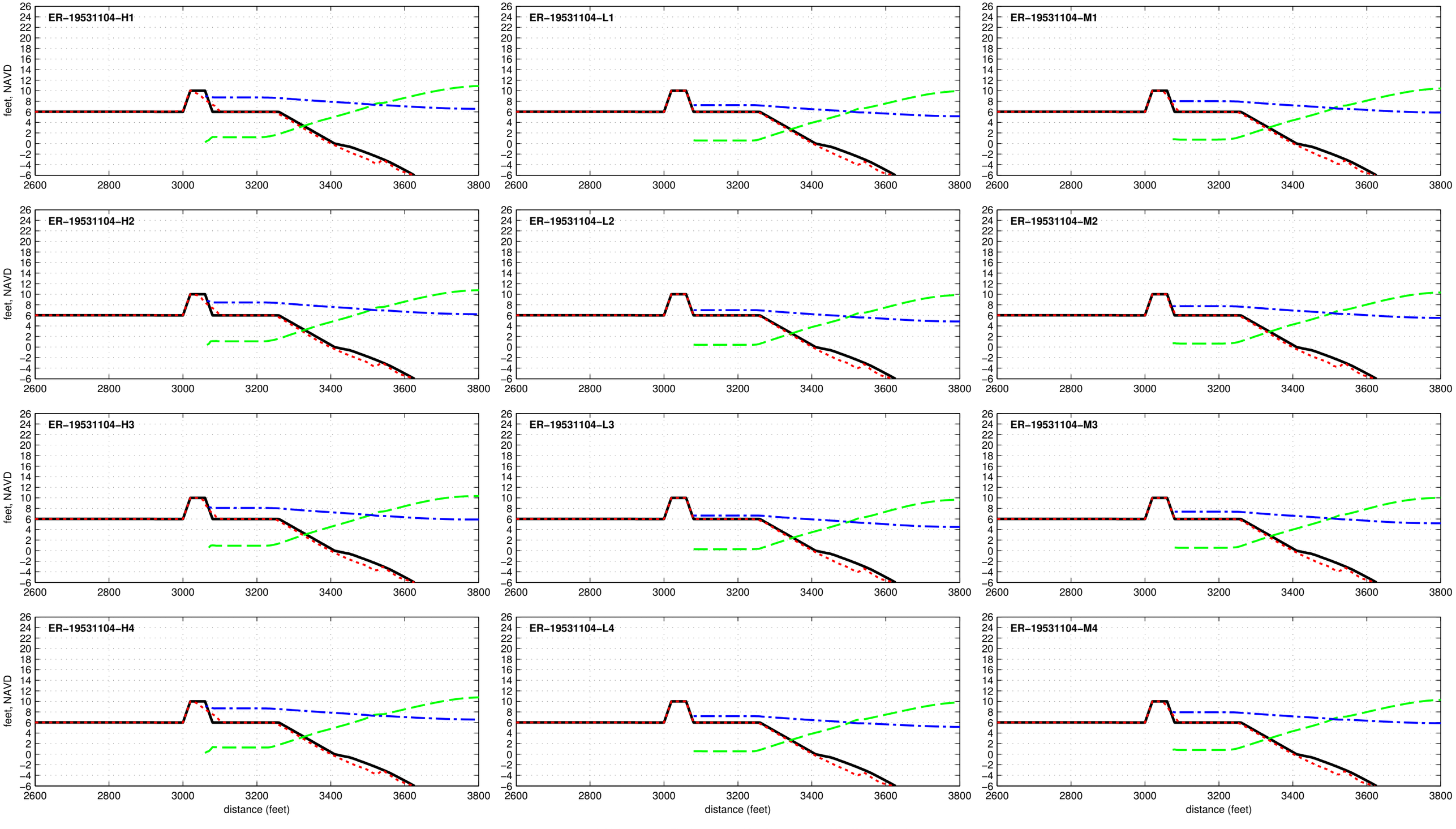
Dune R1T1–10.0–040–180 – ER–19440912



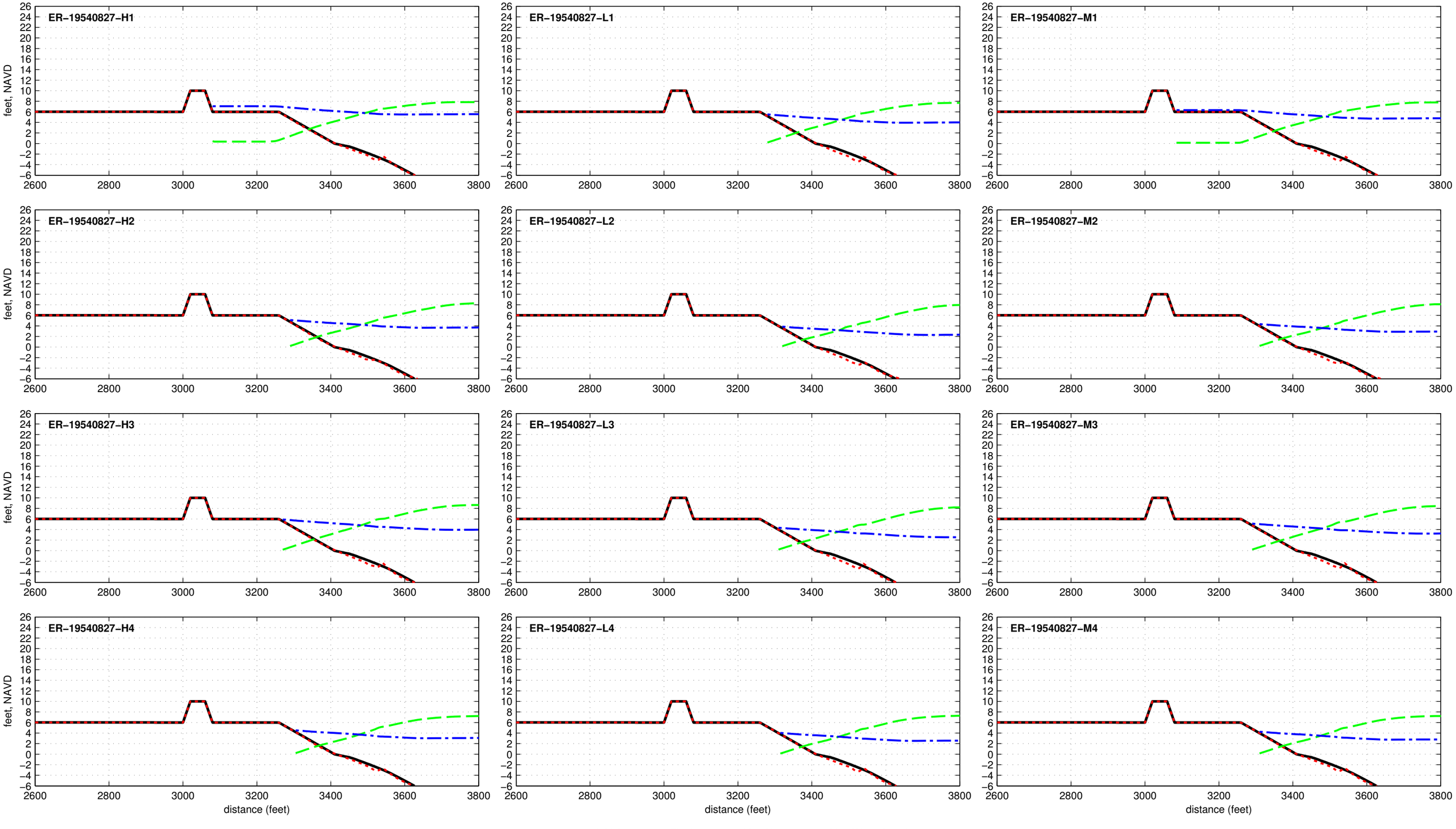
Dune R1T1–10.0–040–180 – ER–19501122



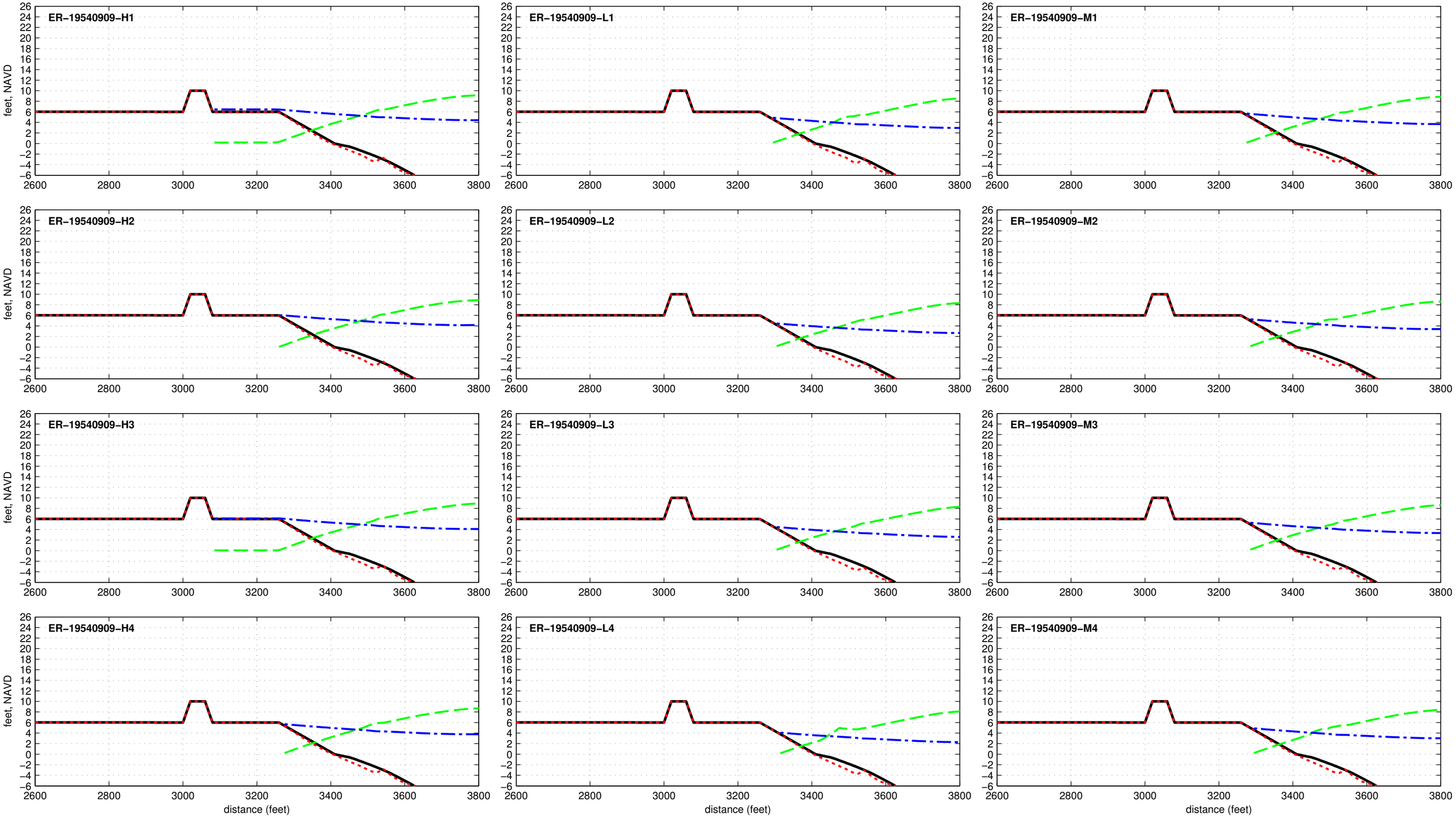
Dune R1T1–10.0–040–180 – ER–19531104



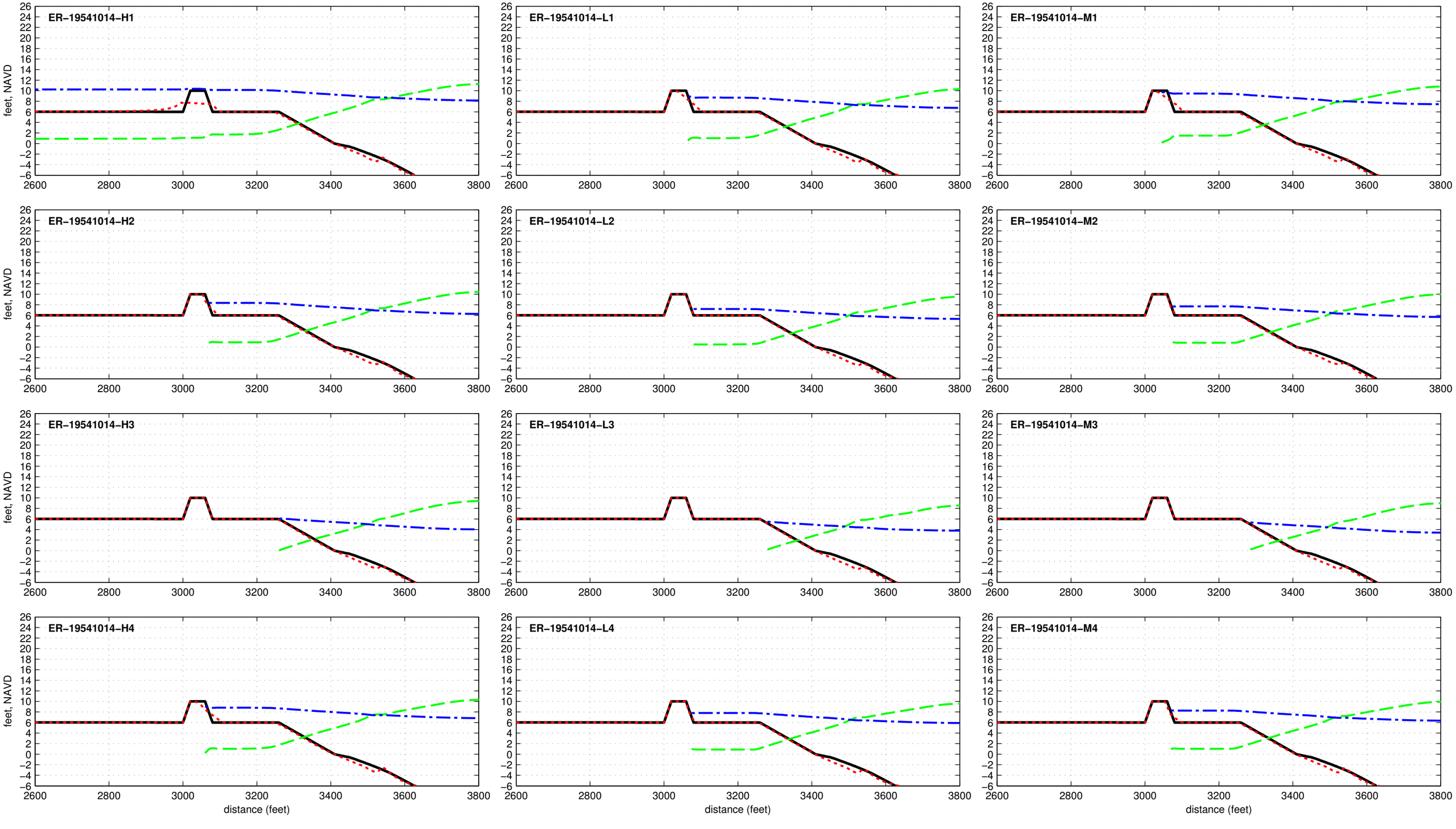
Dune R1T1–10.0–040–180 – ER–19540827



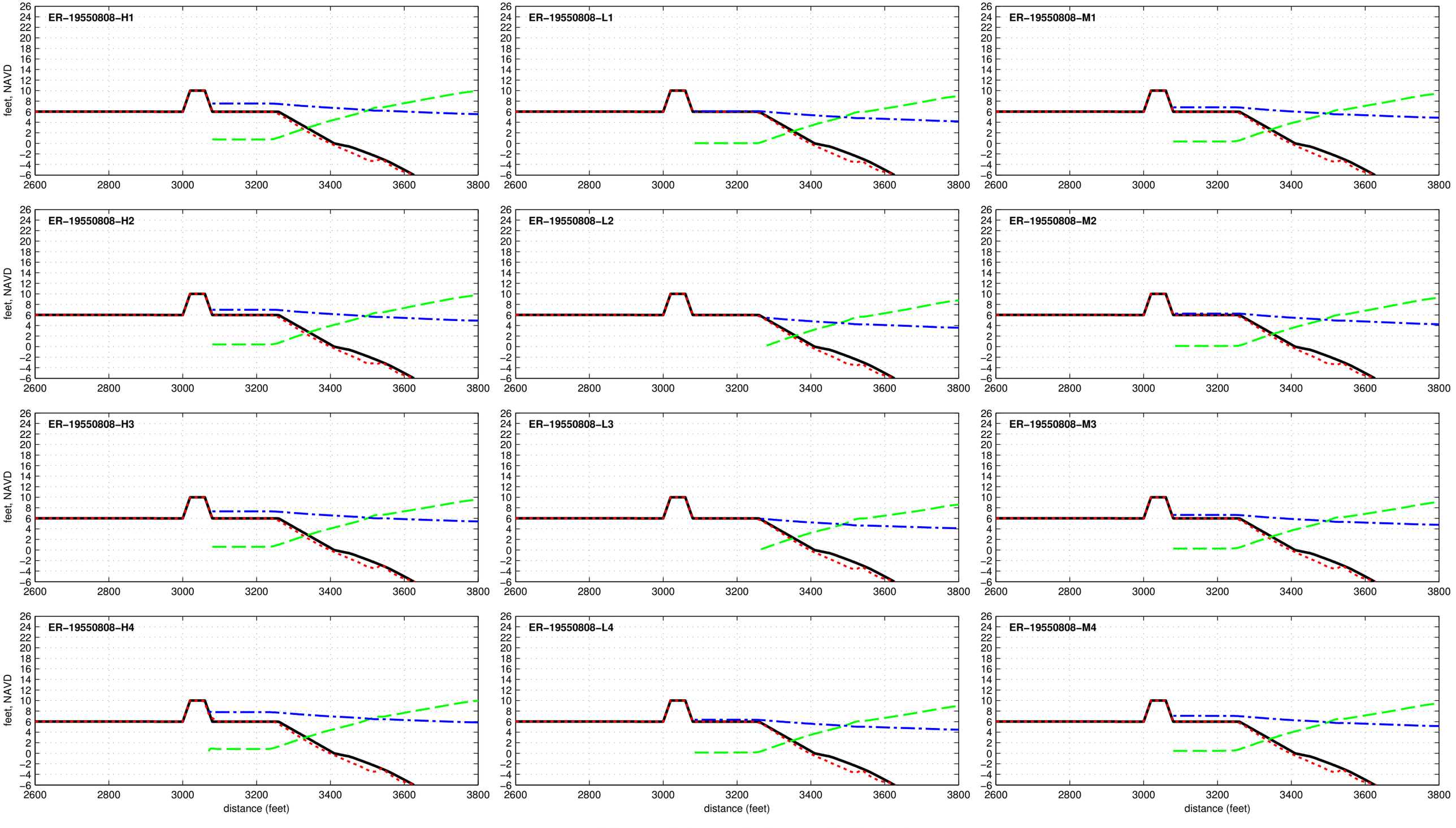
Dune R1T1–10.0–040–180 – ER–19540909



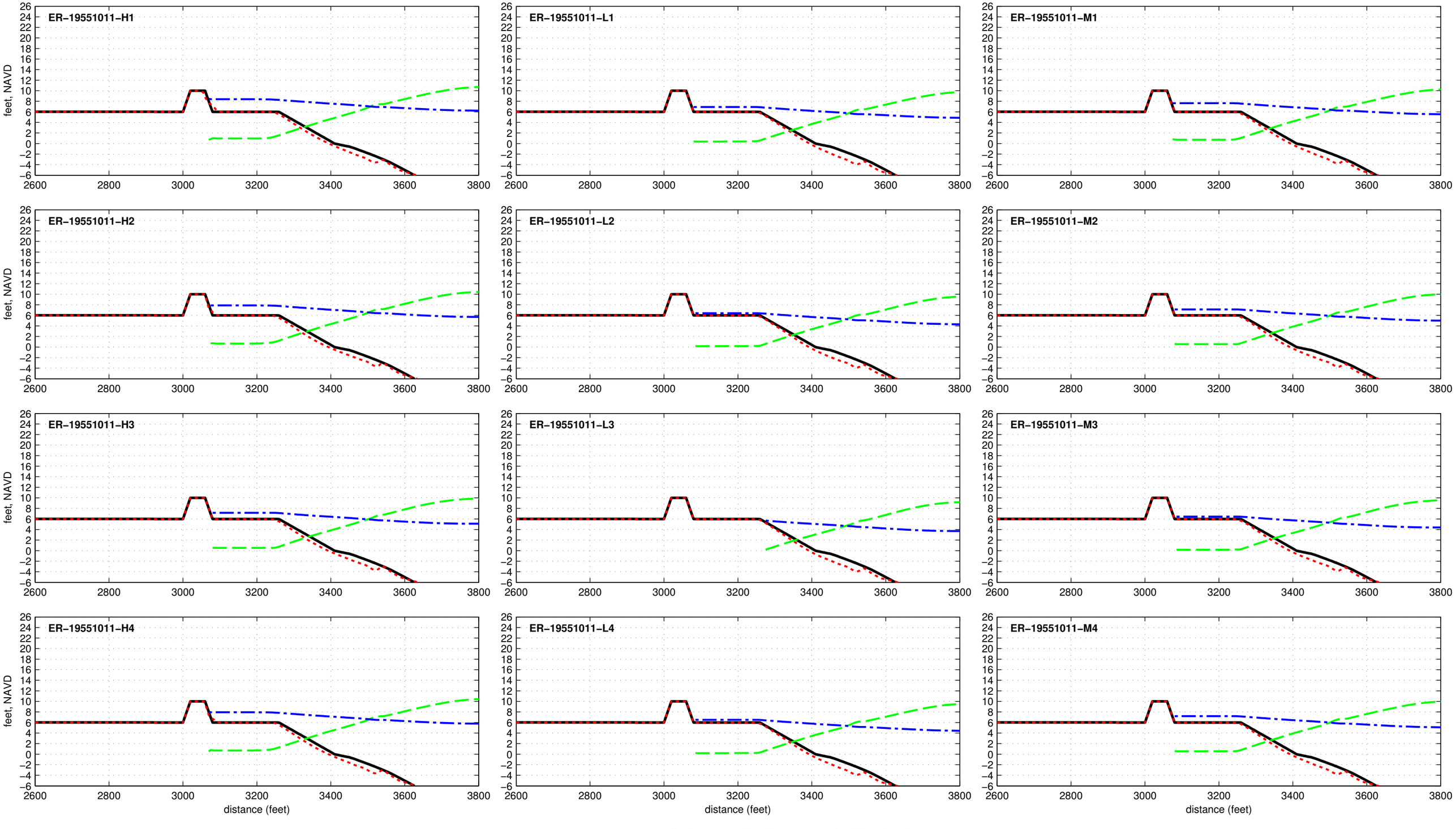
Dune R1T1–10.0–040–180 – ER–19541014



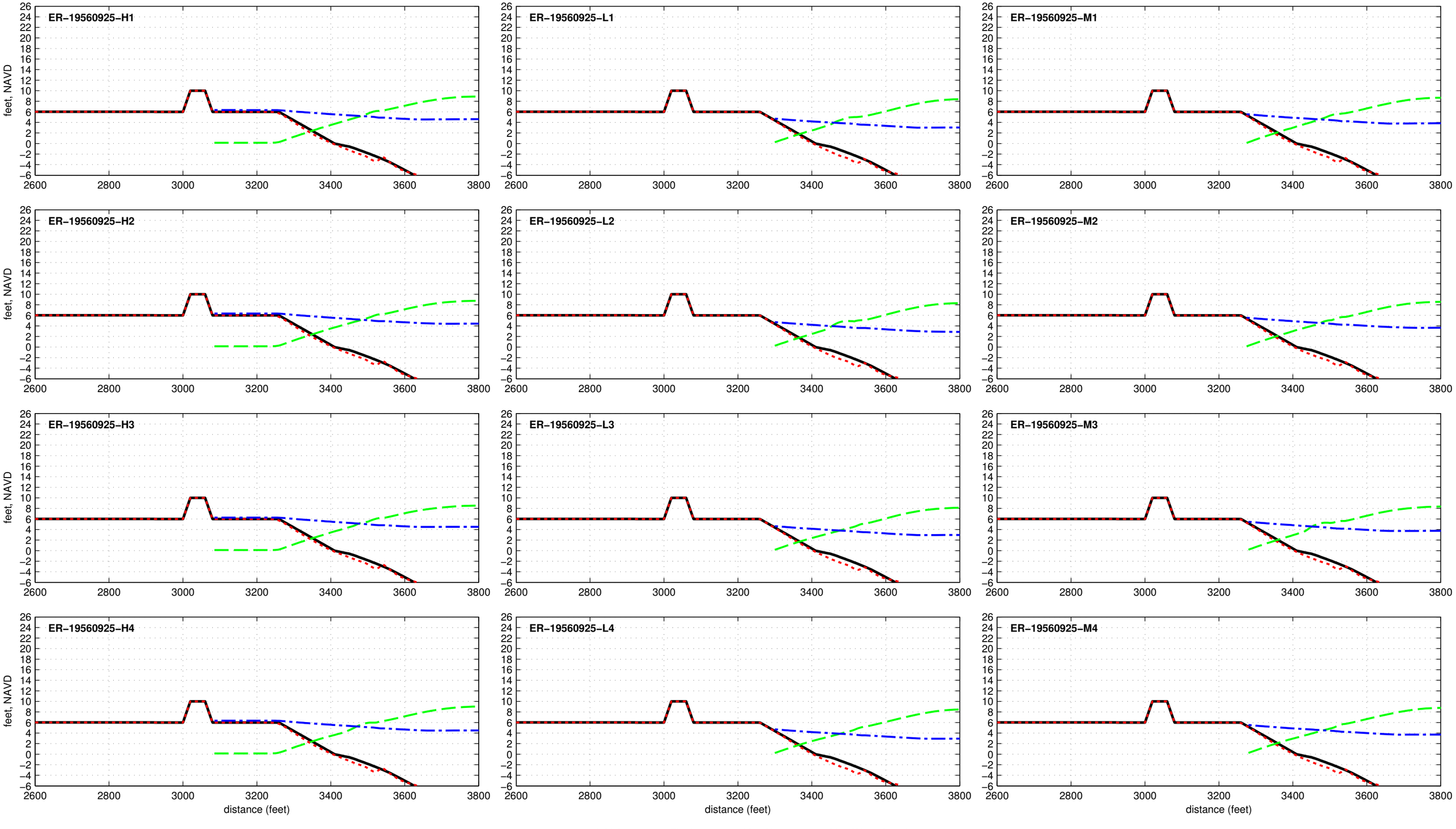
Dune R1T1–10.0–040–180 – ER–19550808



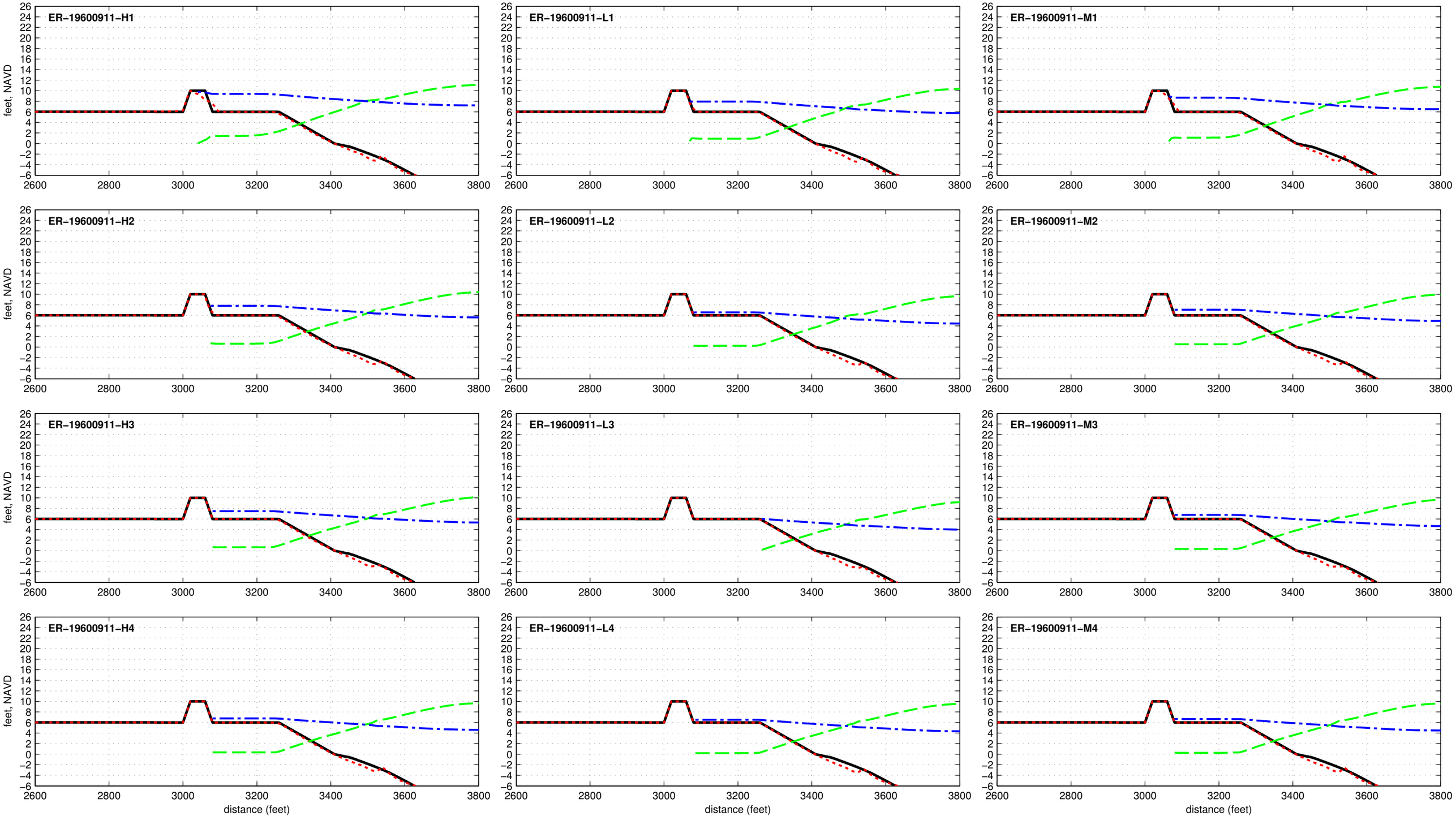
Dune R1T1-10.0-040-180 - ER-19551011



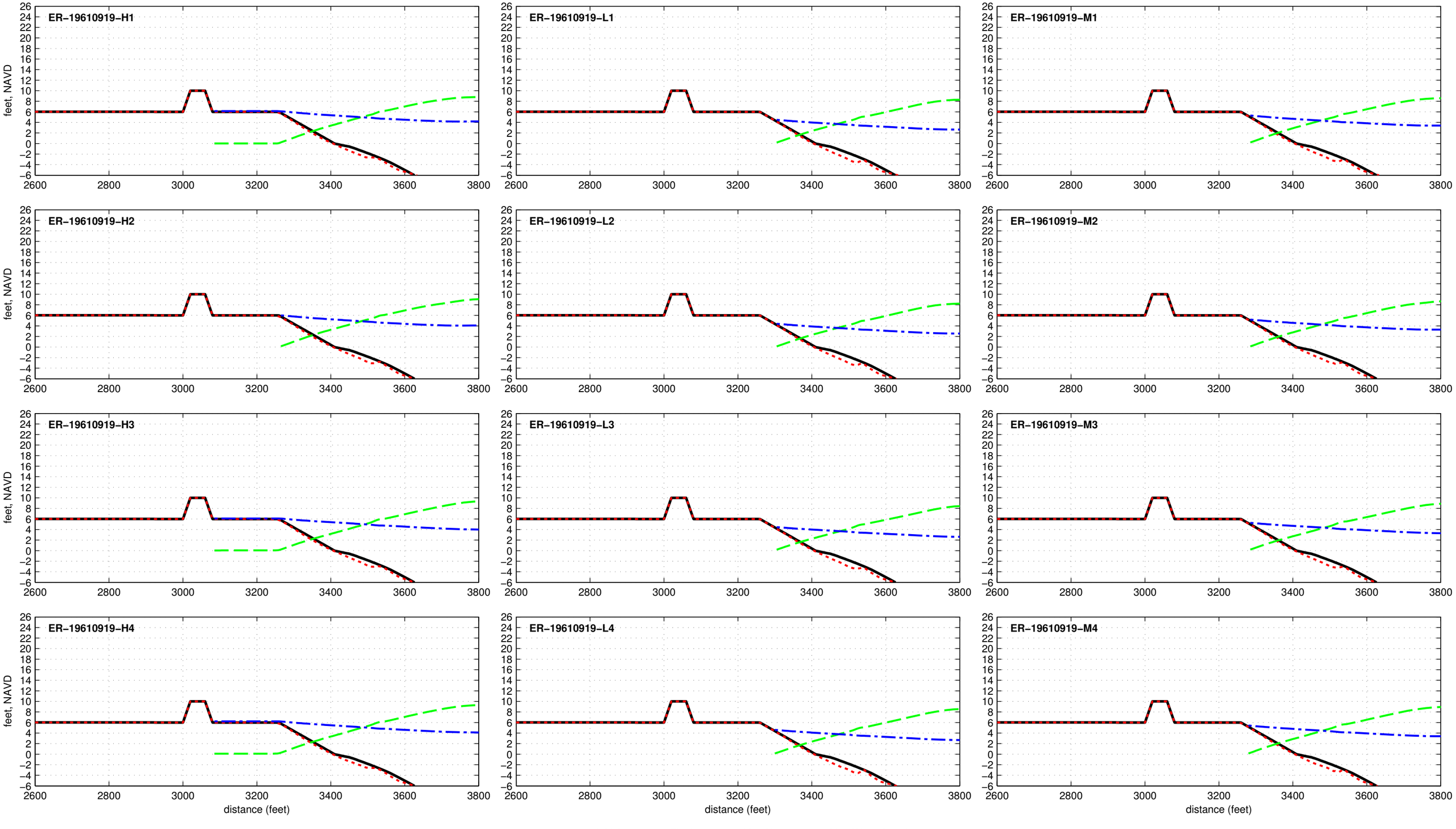
Dune R1T1–10.0–040–180 – ER–19560925



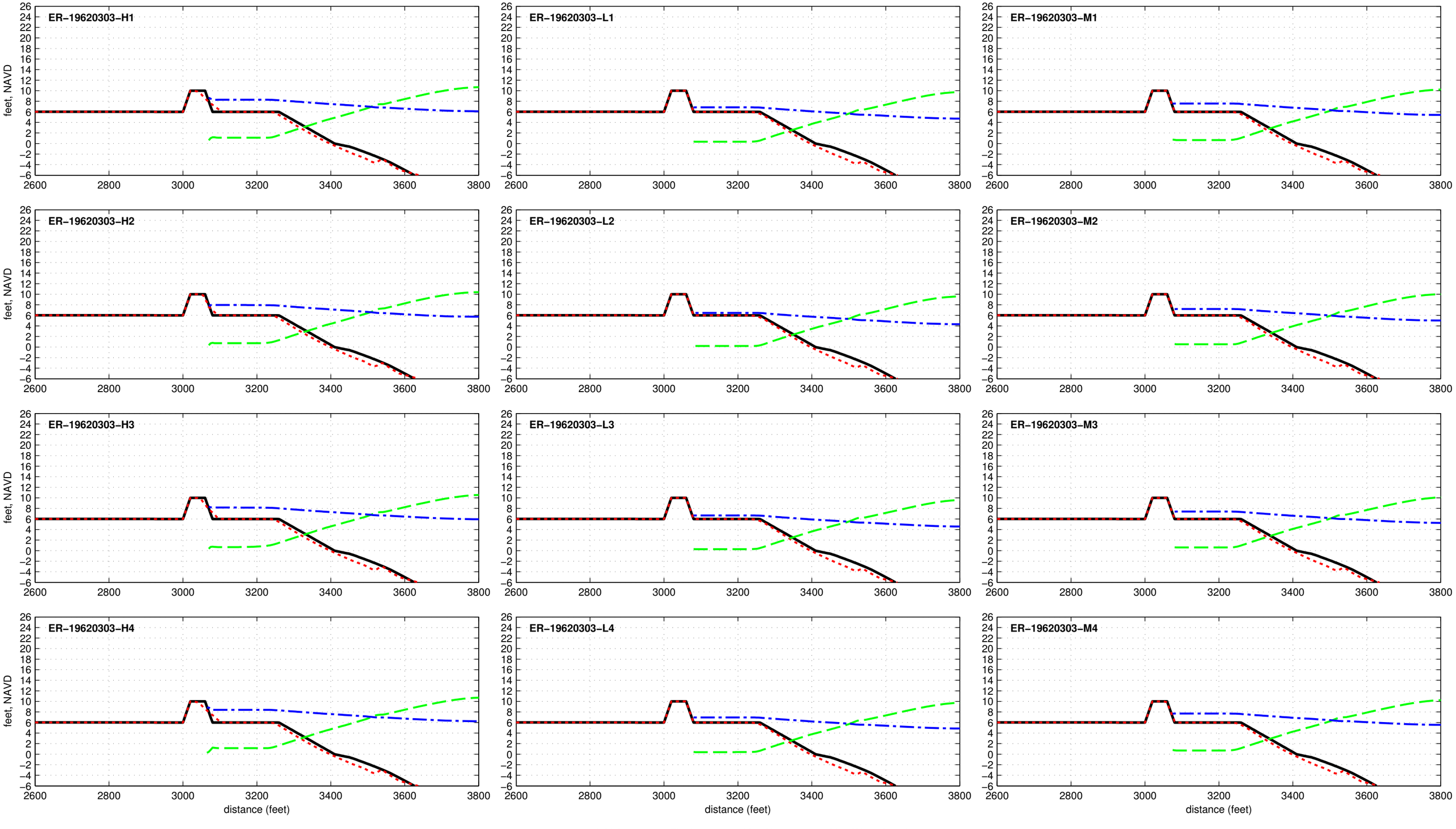
Dune R1T1–10.0–040–180 – ER–19600911



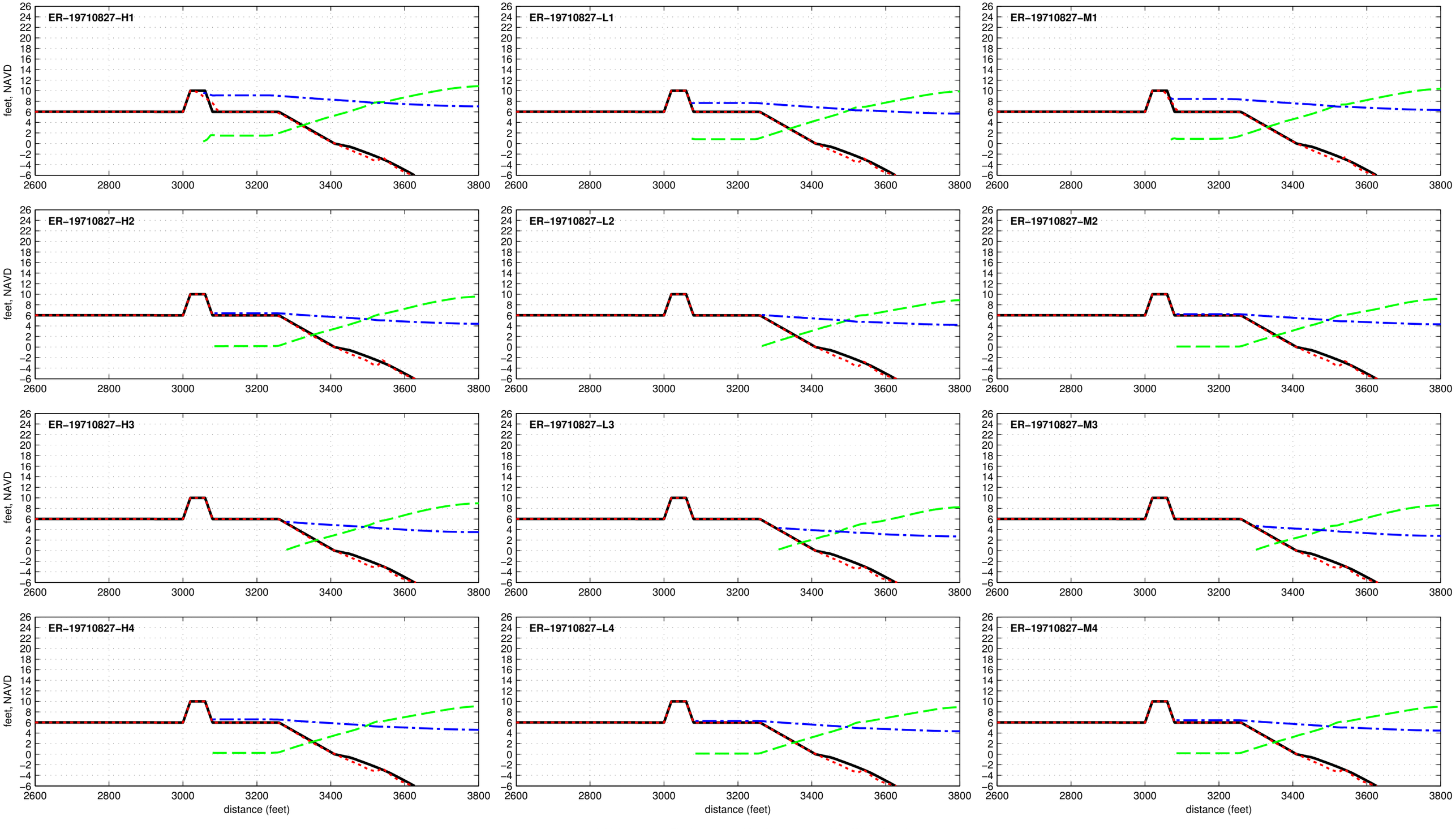
Dune R1T1–10.0–040–180 – ER–19610919



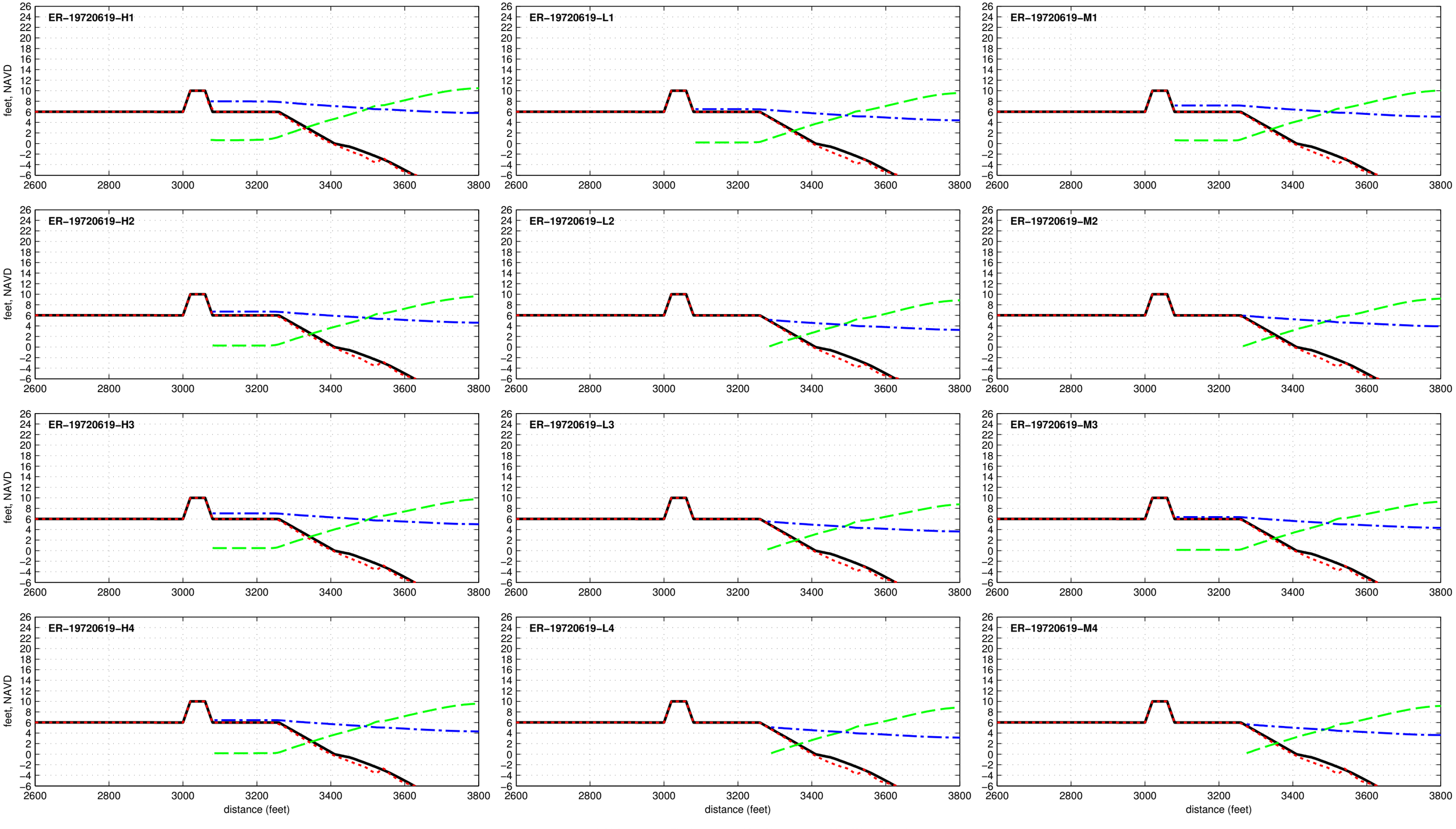
Dune R1T1–10.0–040–180 – ER–19620303



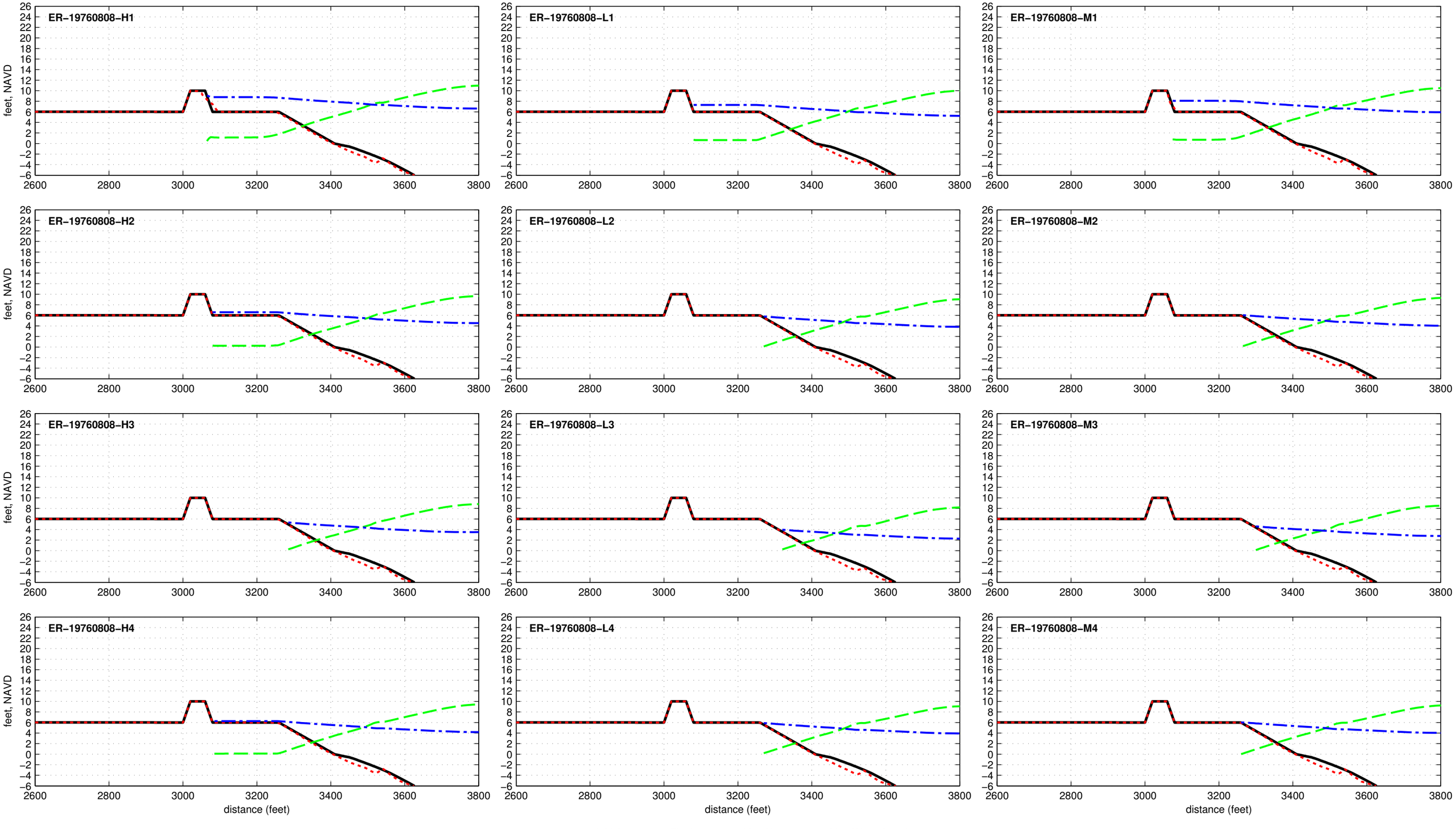
Dune R1T1–10.0–040–180 – ER–19710827



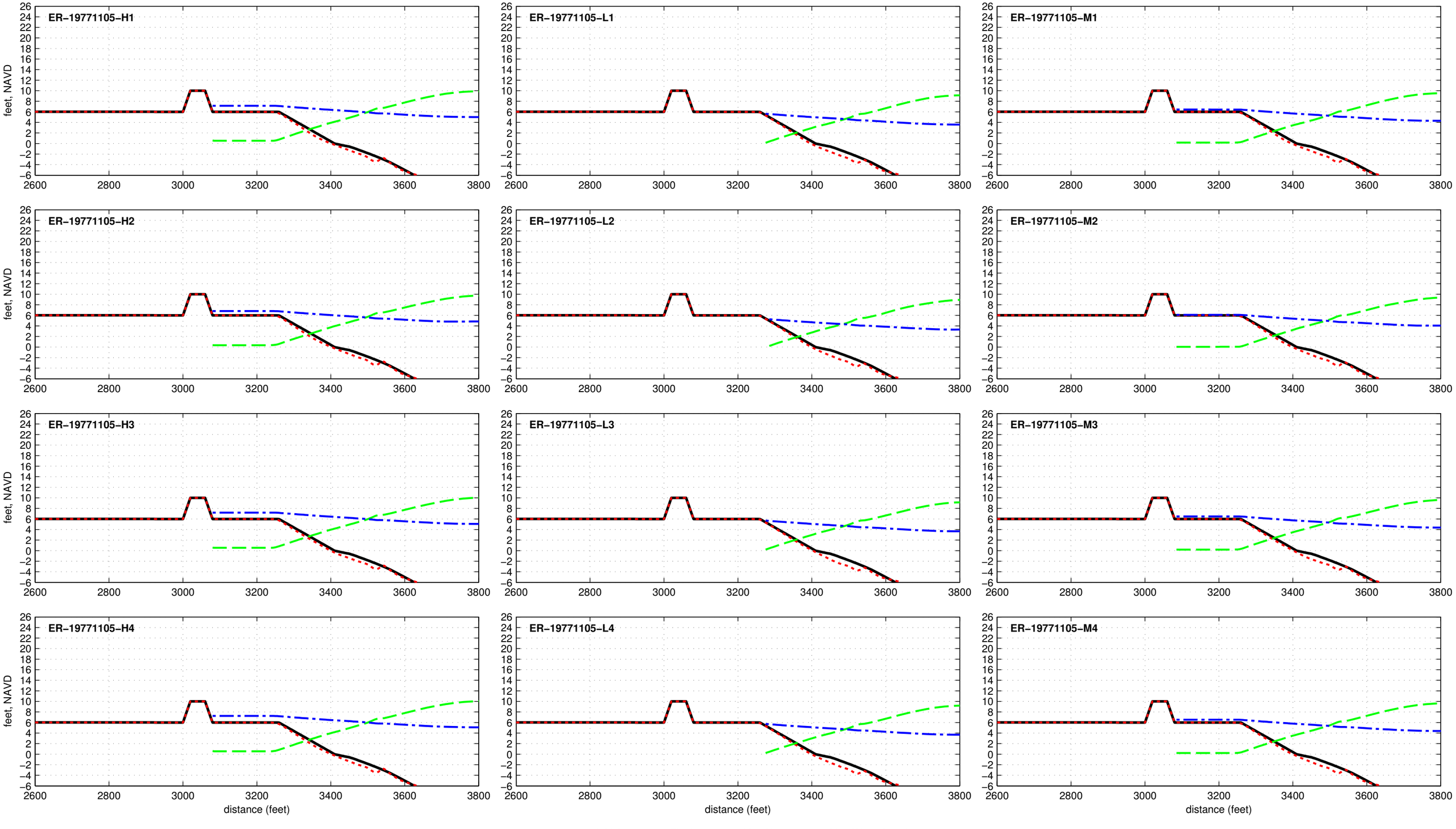
Dune R1T1–10.0–040–180 – ER–19720619



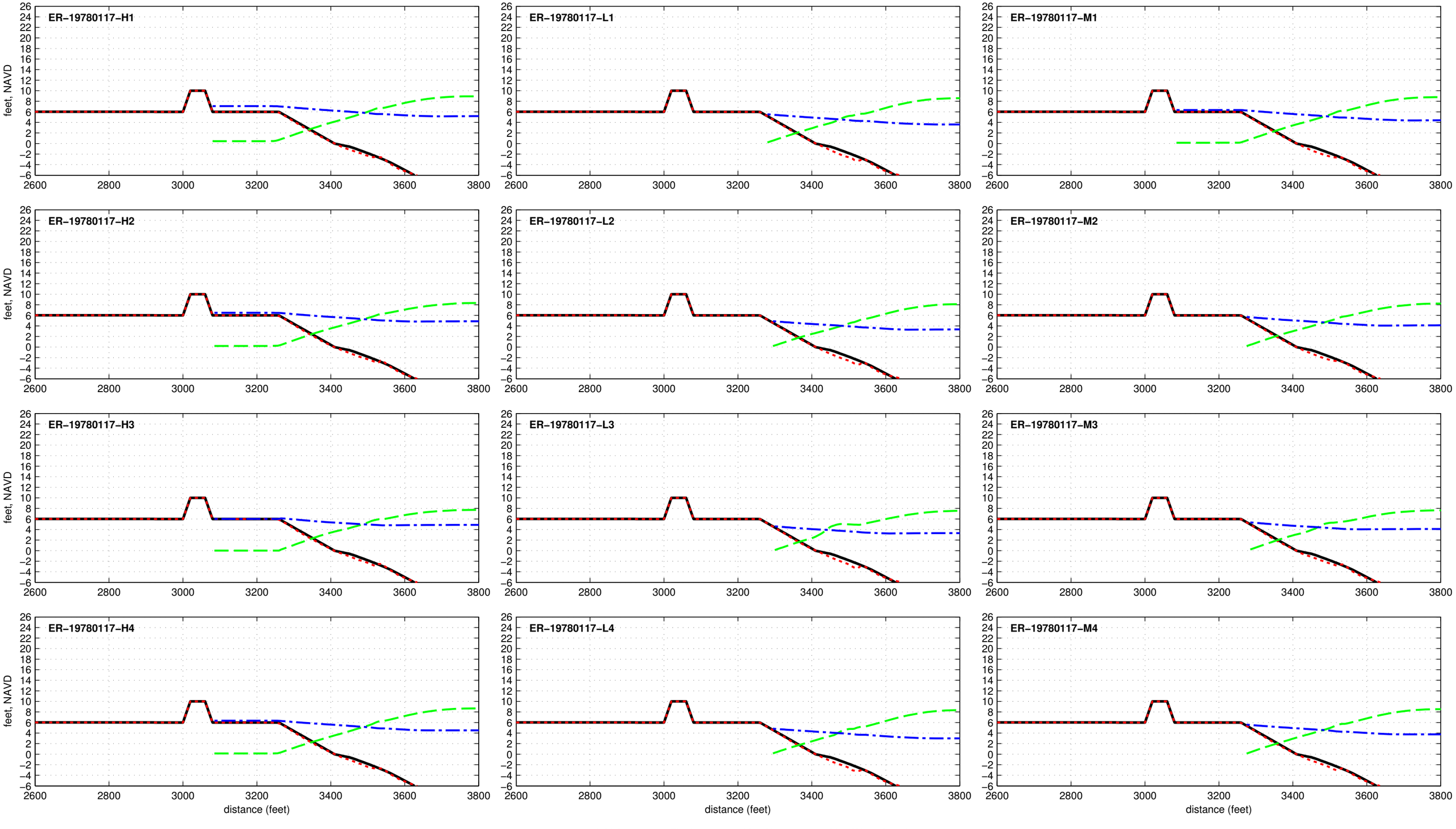
Dune R1T1–10.0–040–180 – ER–19760808



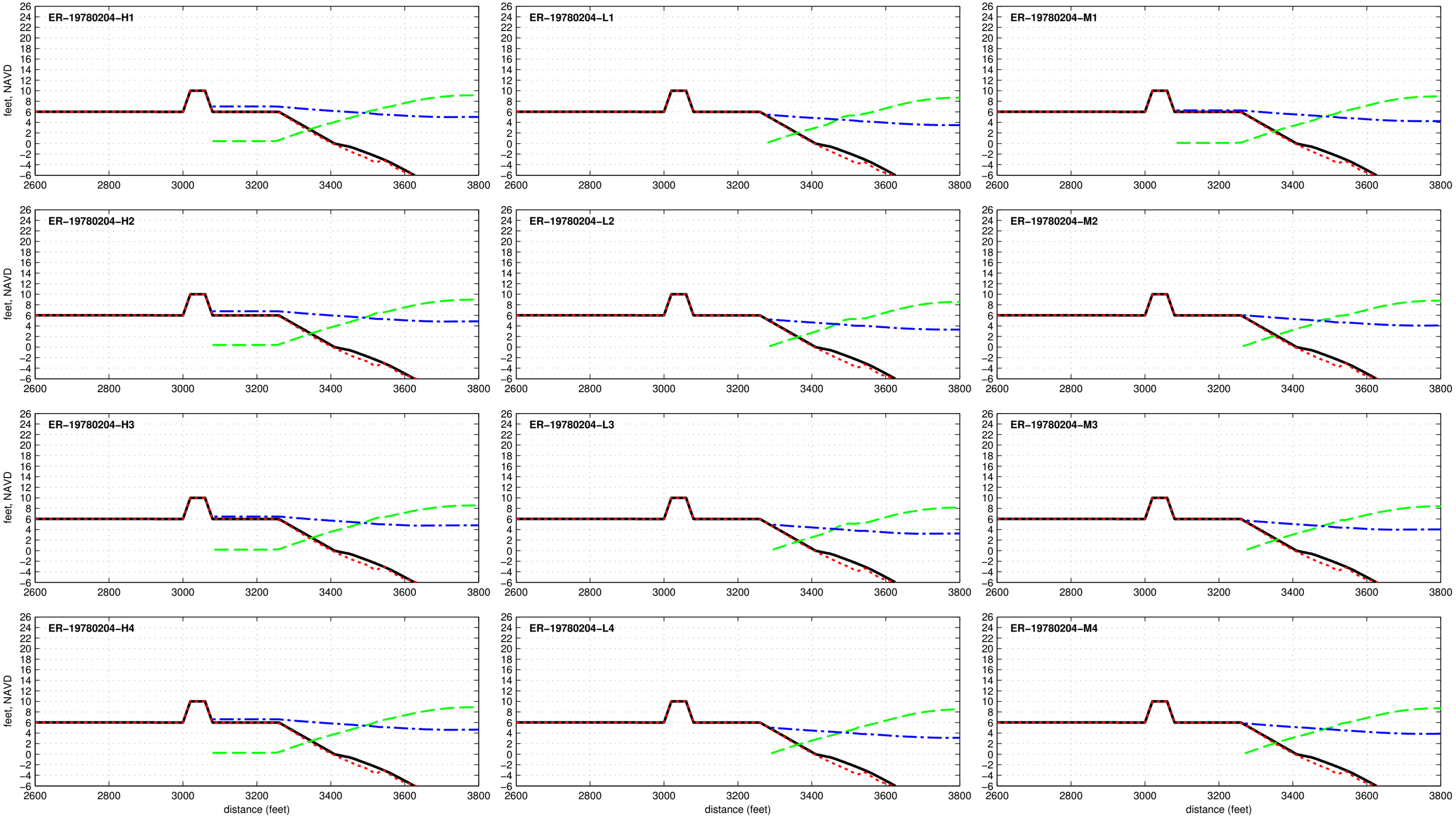
Dune R1T1–10.0–040–180 – ER–19771105



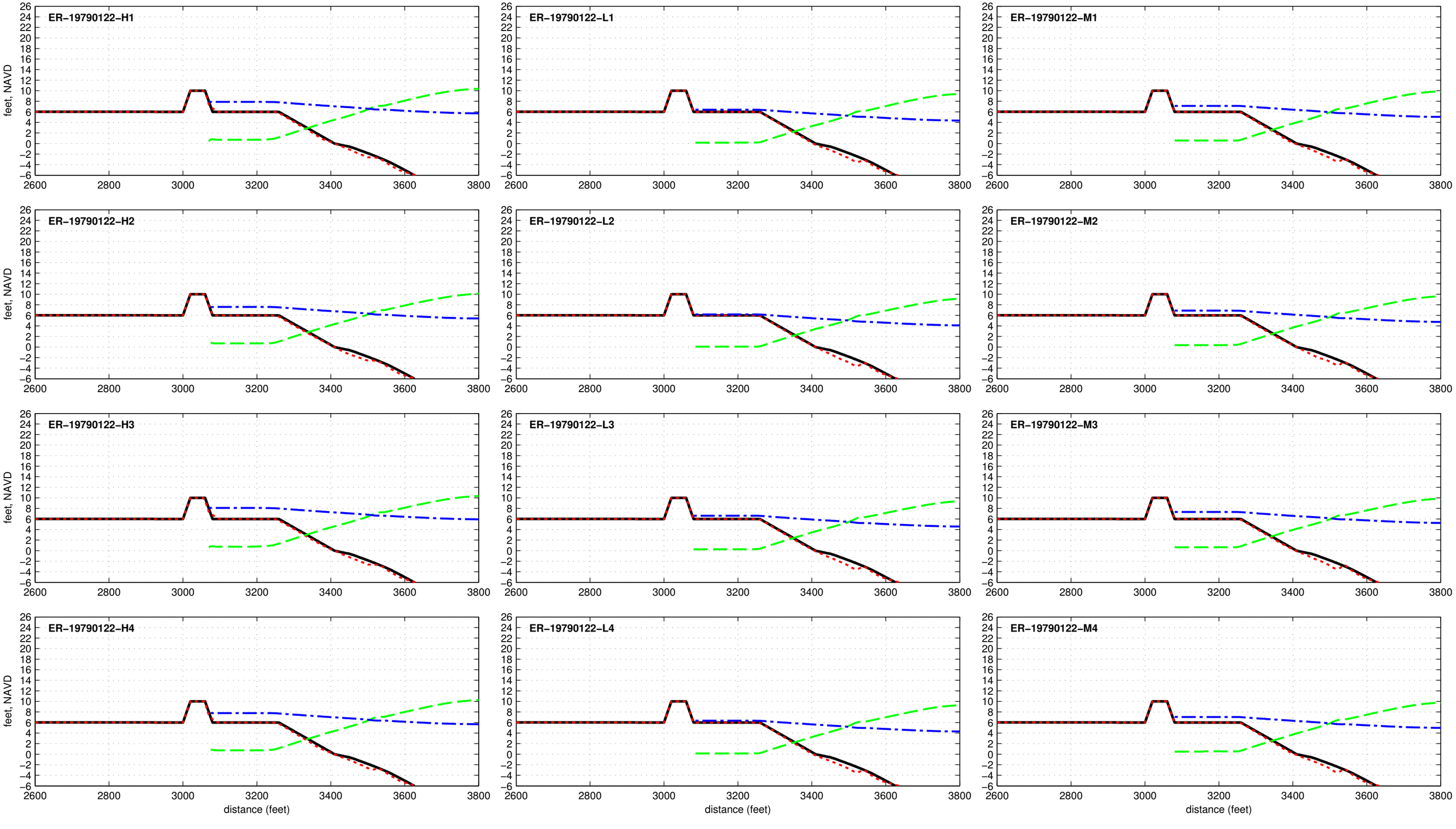
Dune R1T1–10.0–040–180 – ER–19780117



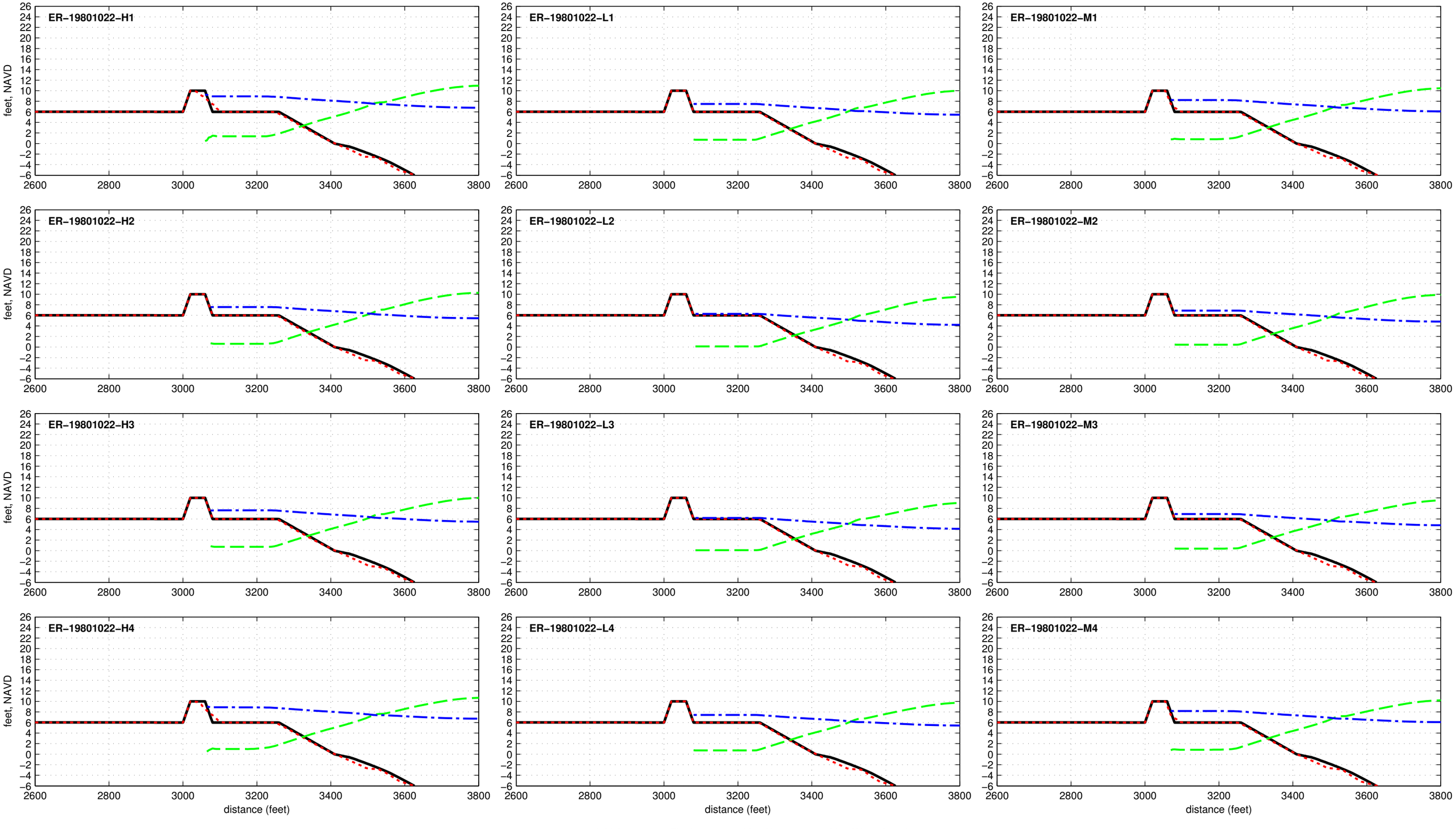
Dune R1T1–10.0–040–180 – ER–19780204



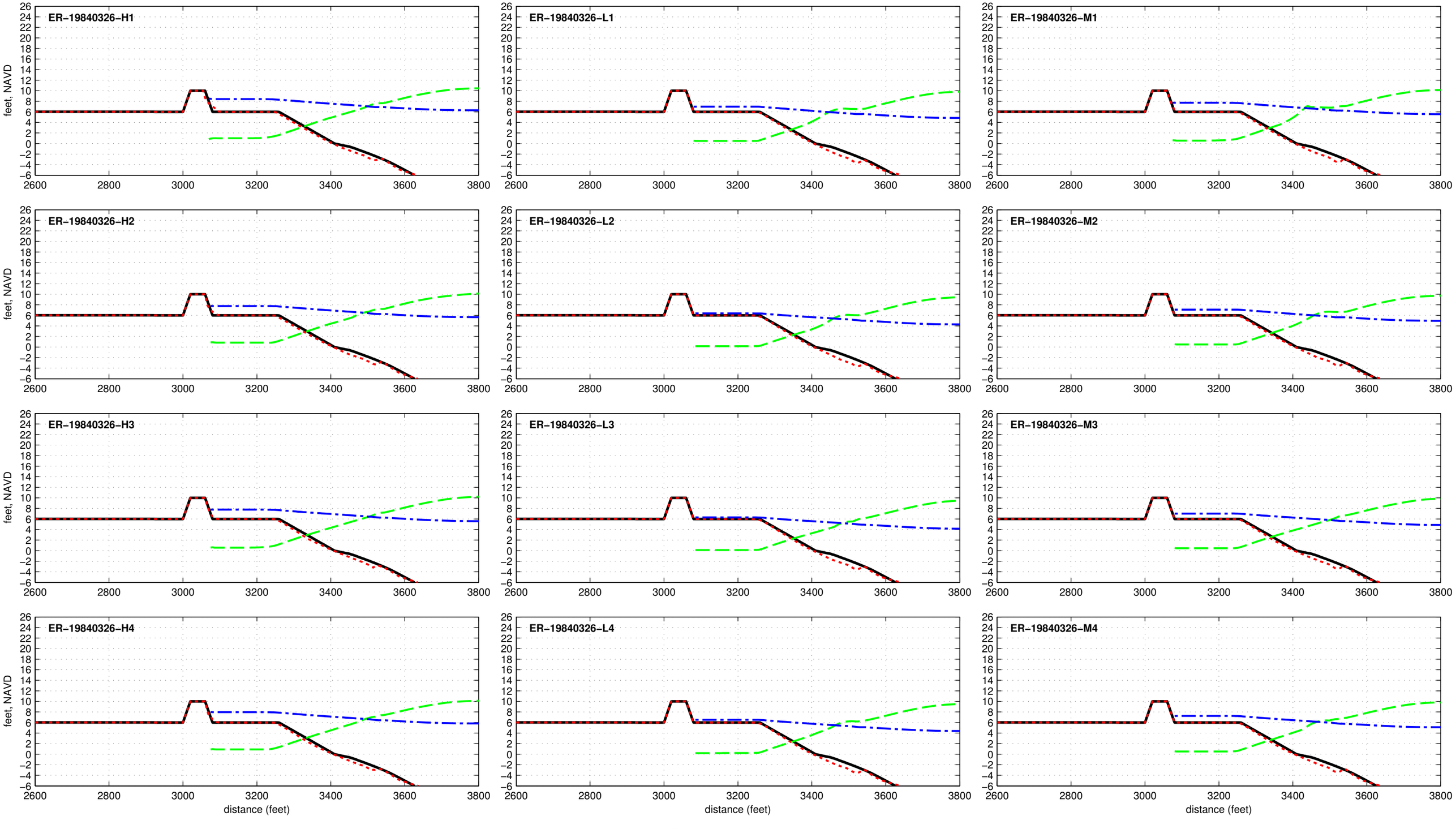
Dune R1T1–10.0–040–180 – ER–19790122



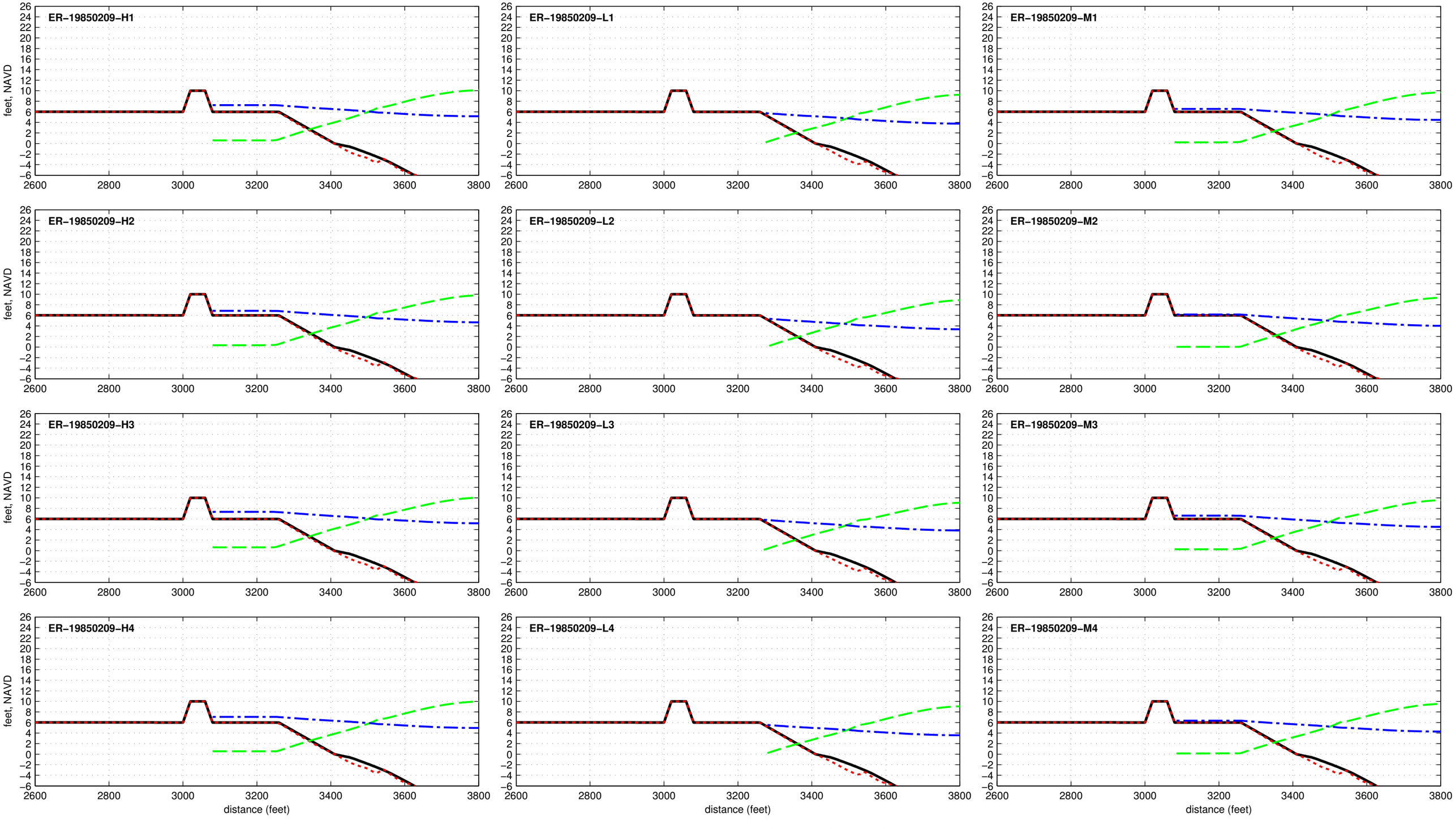
Dune R1T1–10.0–040–180 – ER–19801022



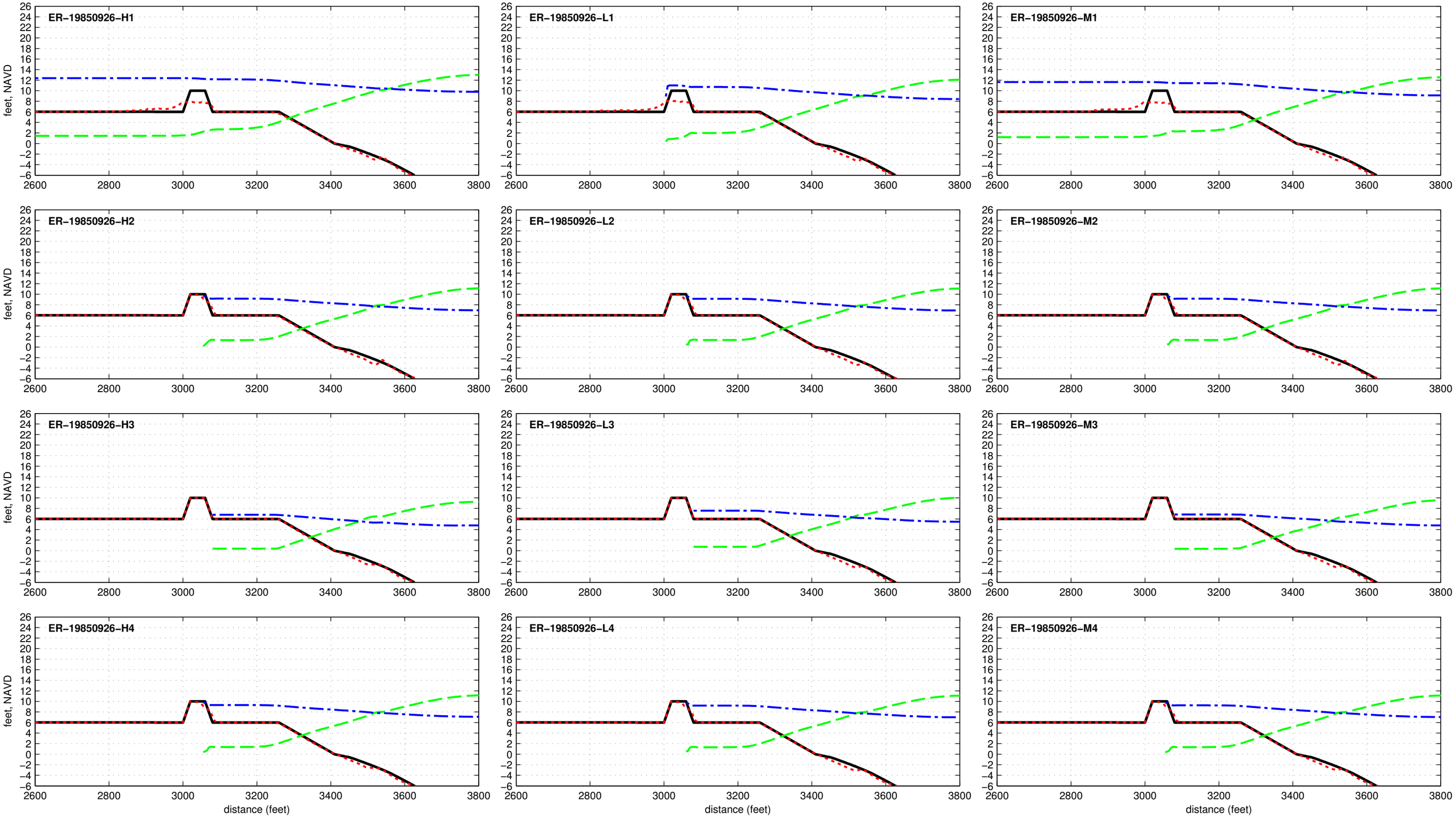
Dune R1T1–10.0–040–180 – ER–19840326



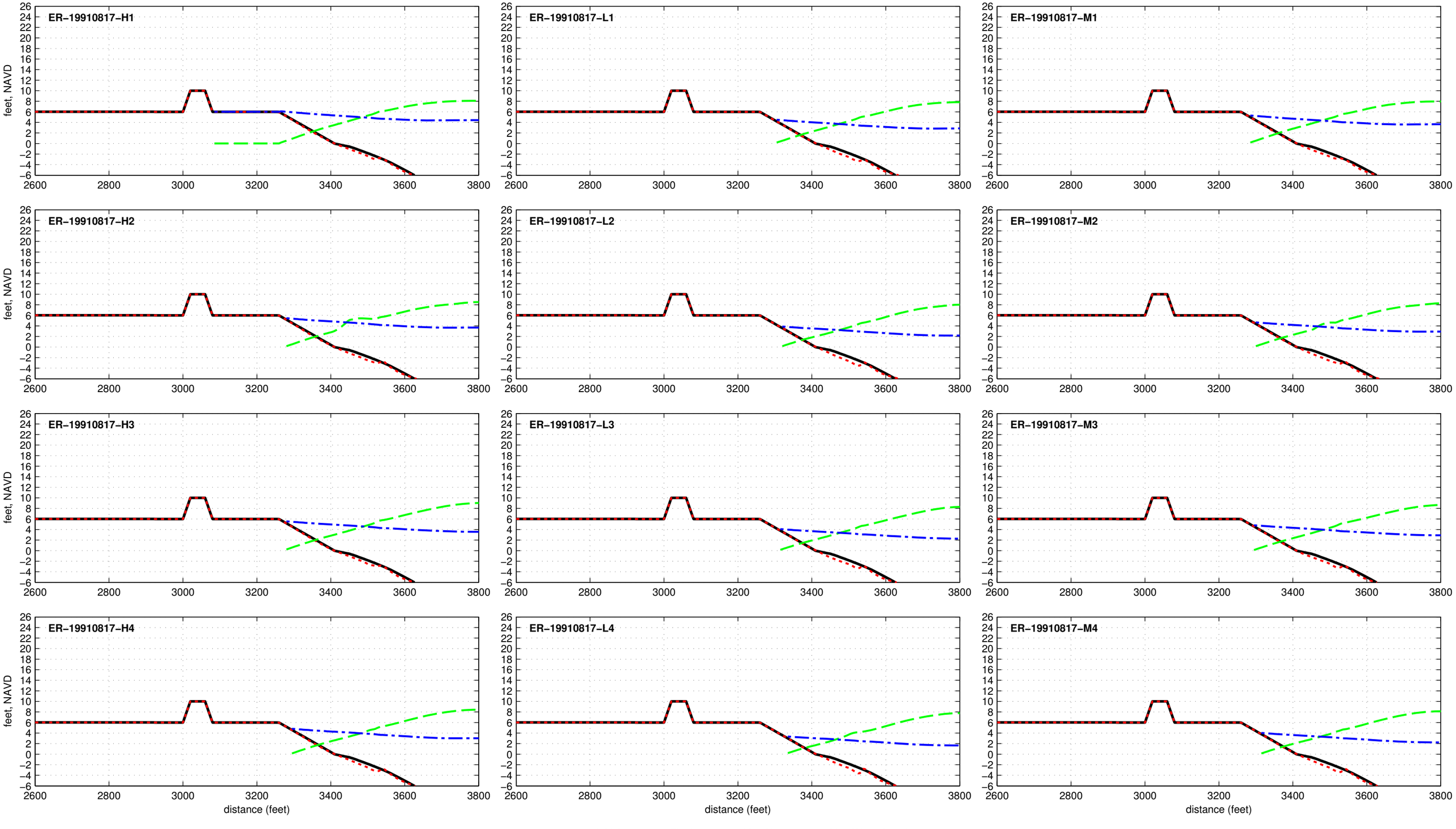
Dune R1T1–10.0–040–180 – ER–19850209



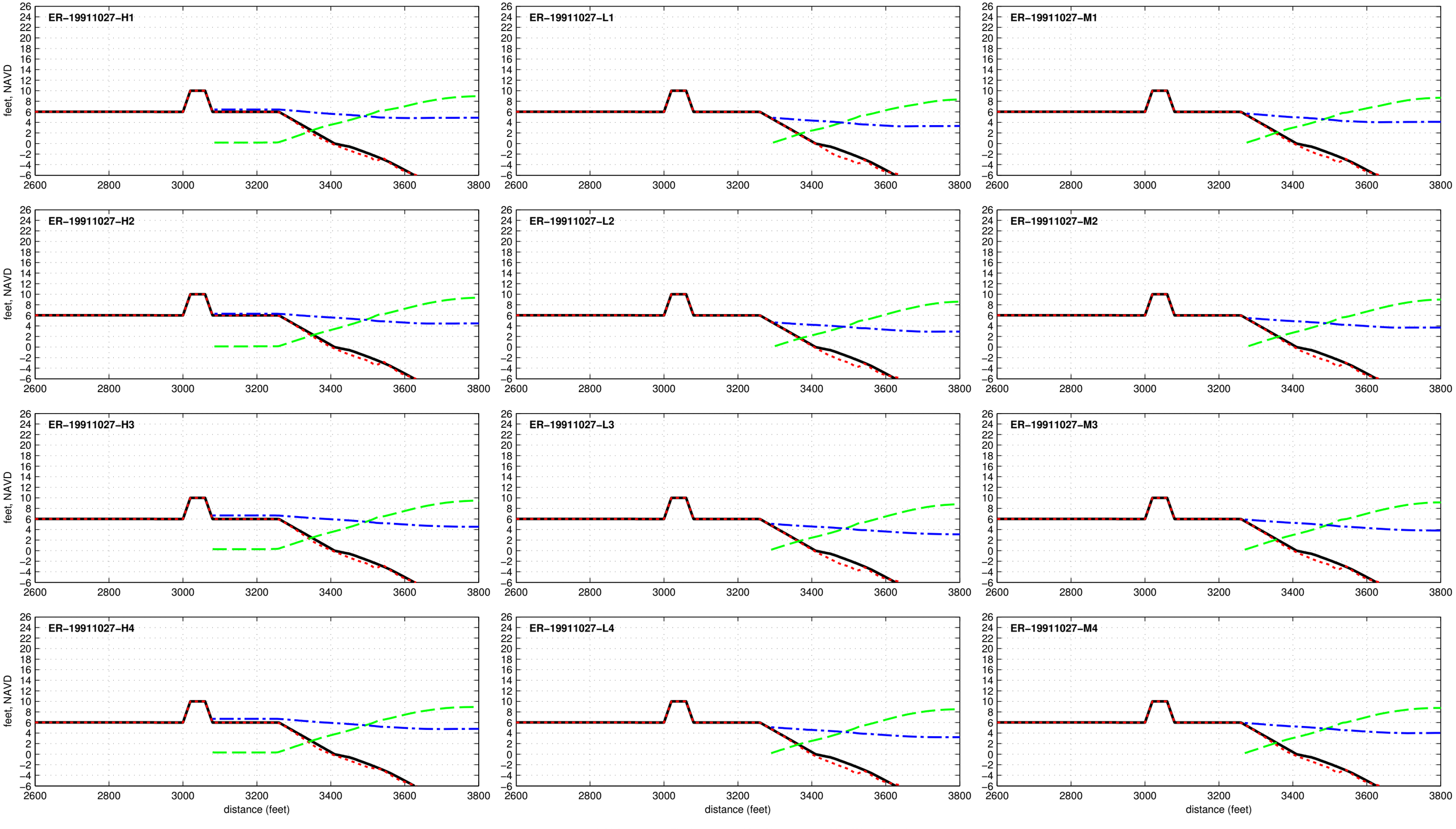
Dune R1T1–10.0–040–180 – ER–19850926



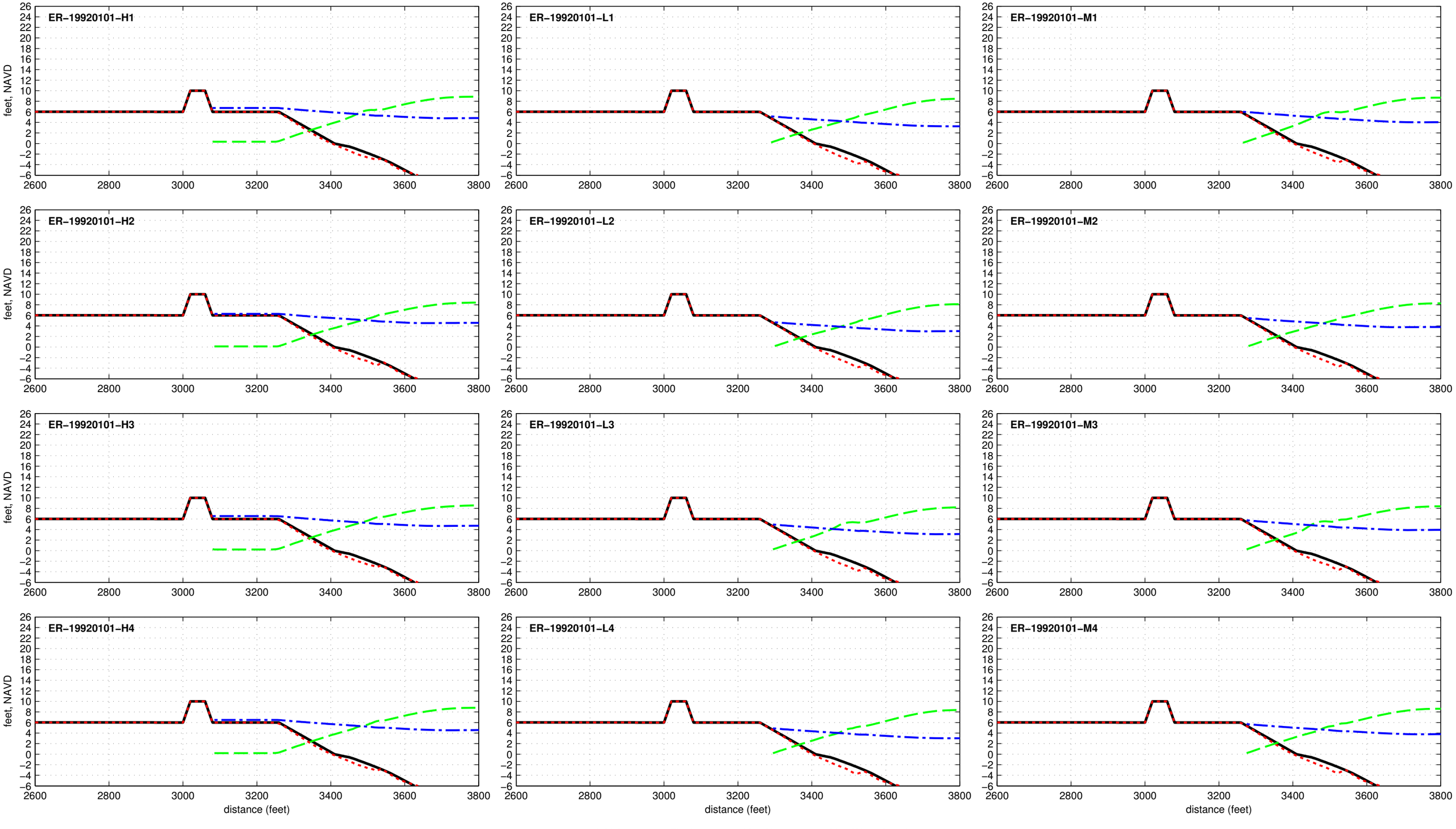
Dune R1T1–10.0–040–180 – ER–19910817



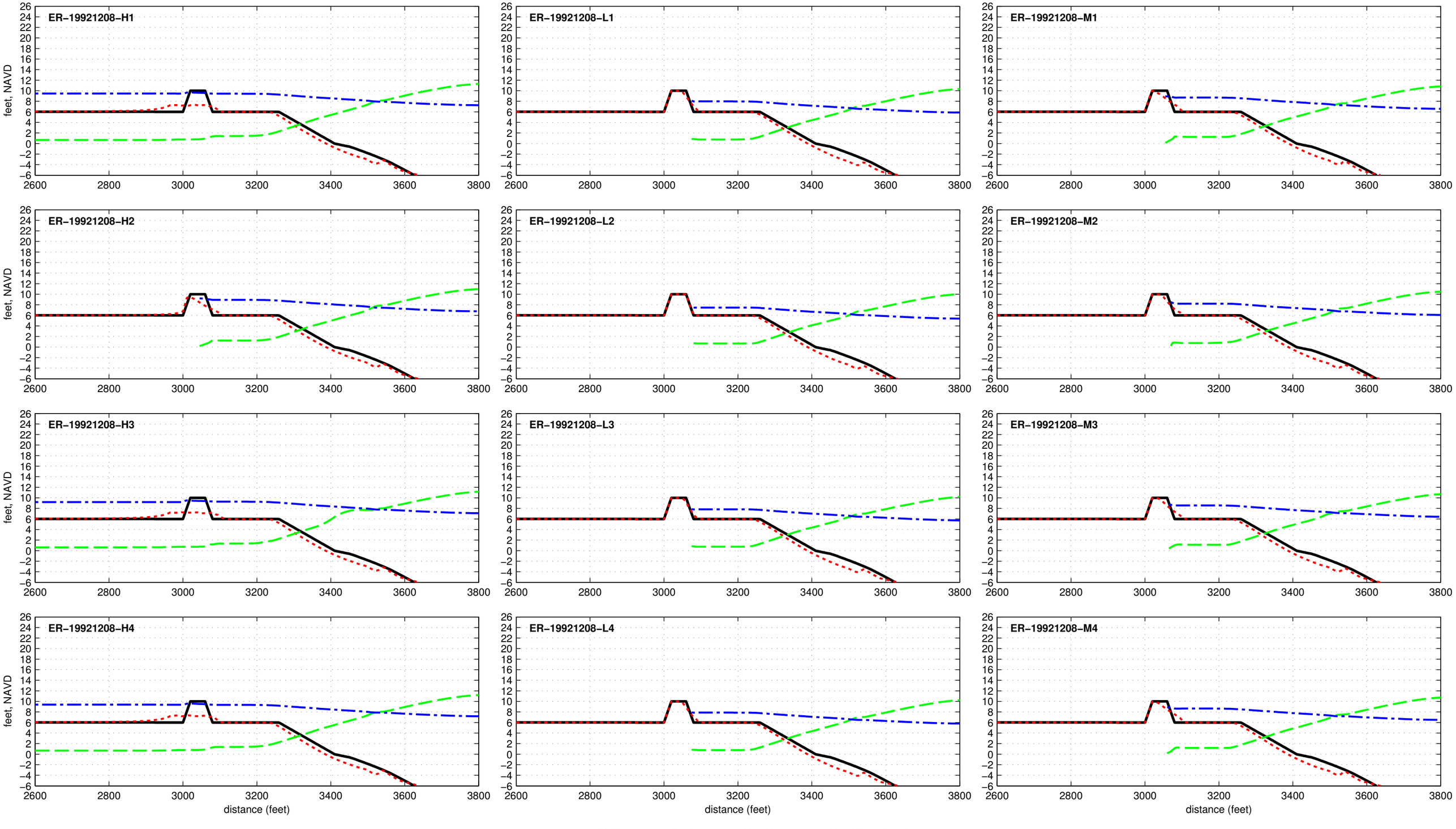
Dune R1T1–10.0–040–180 – ER–19911027



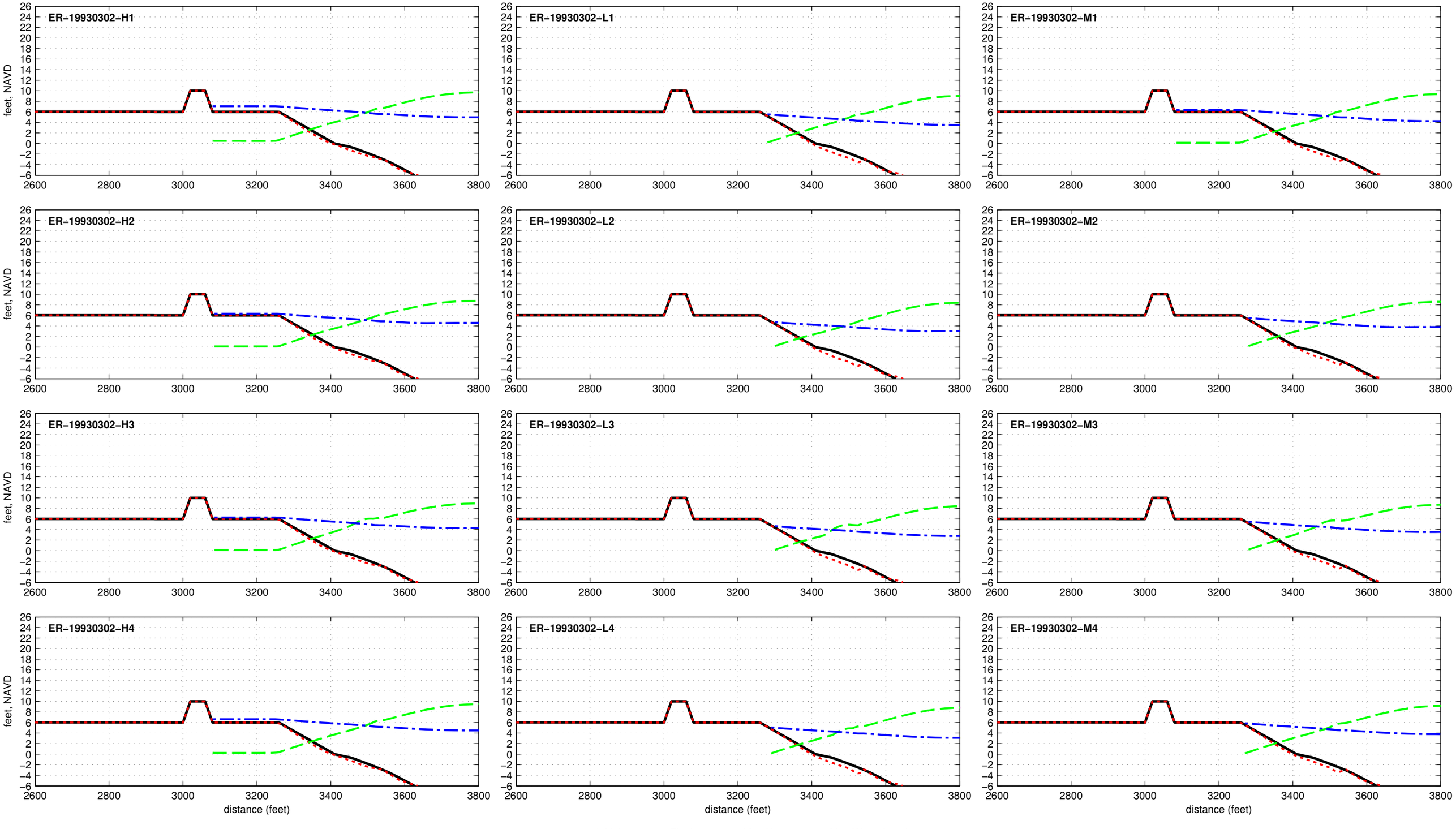
Dune R1T1–10.0–040–180 – ER–19920101



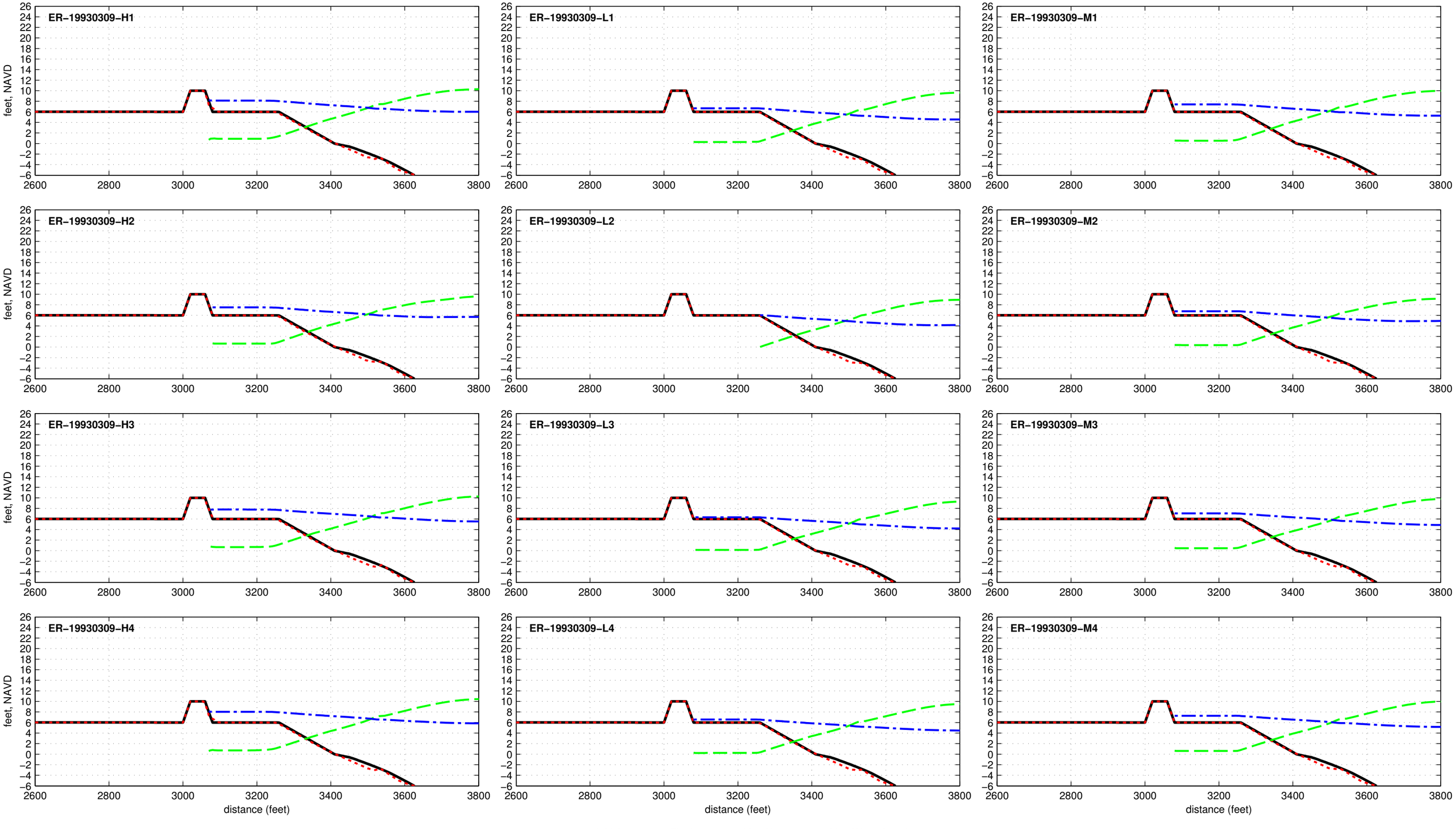
Dune R1T1–10.0–040–180 – ER–19921208



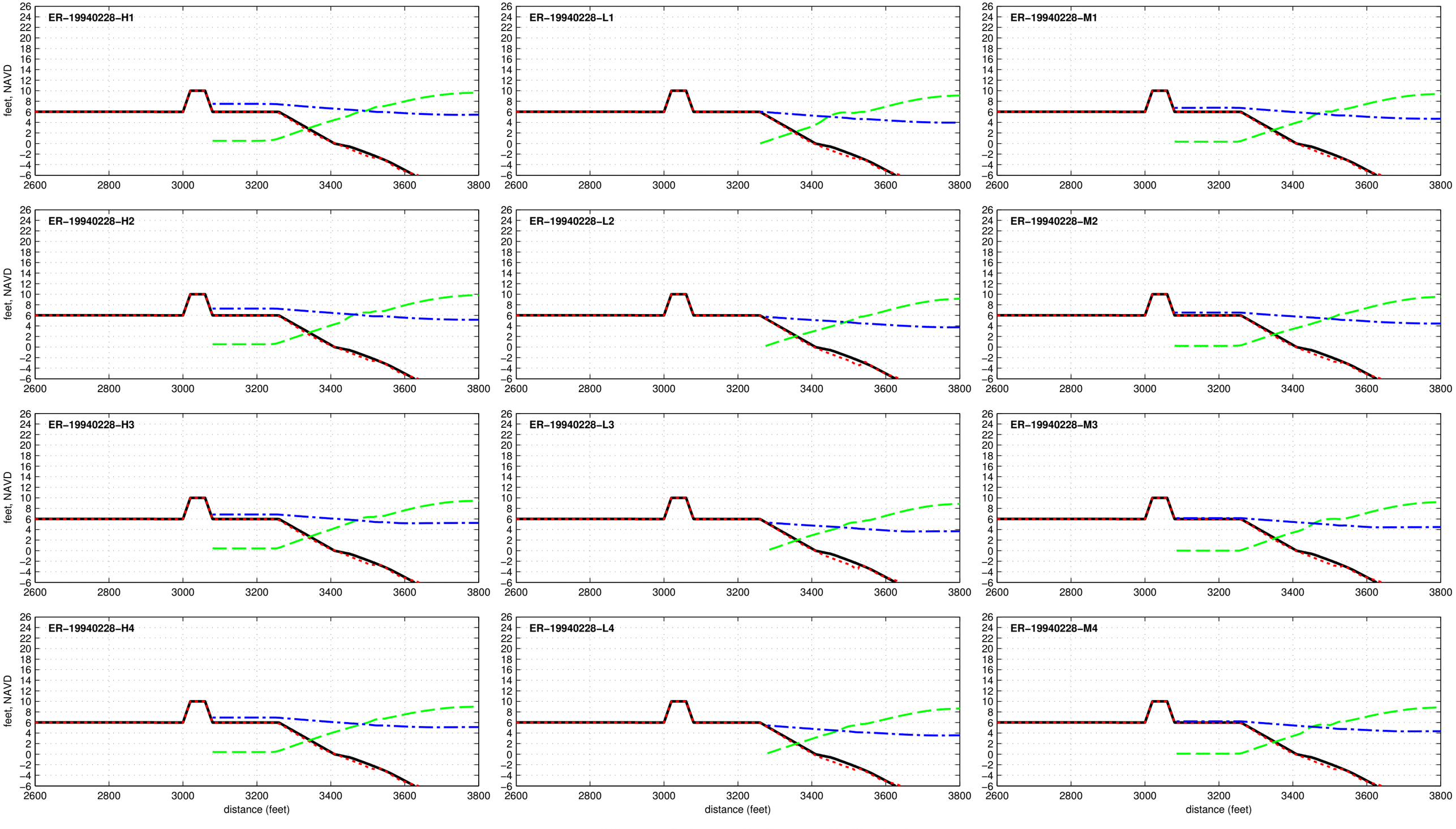
Dune R1T1–10.0–040–180 – ER–19930302



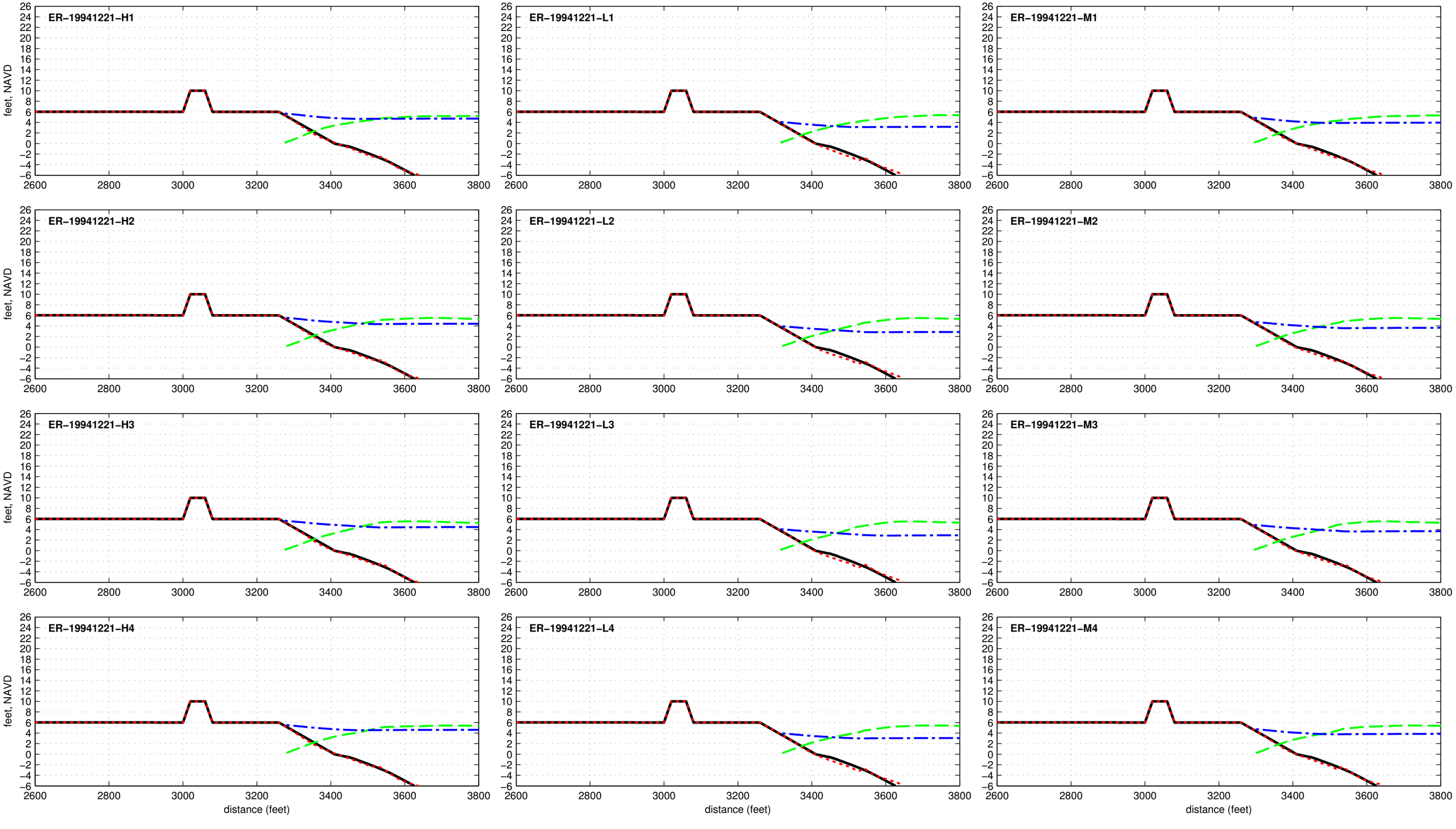
Dune R1T1–10.0–040–180 – ER–19930309



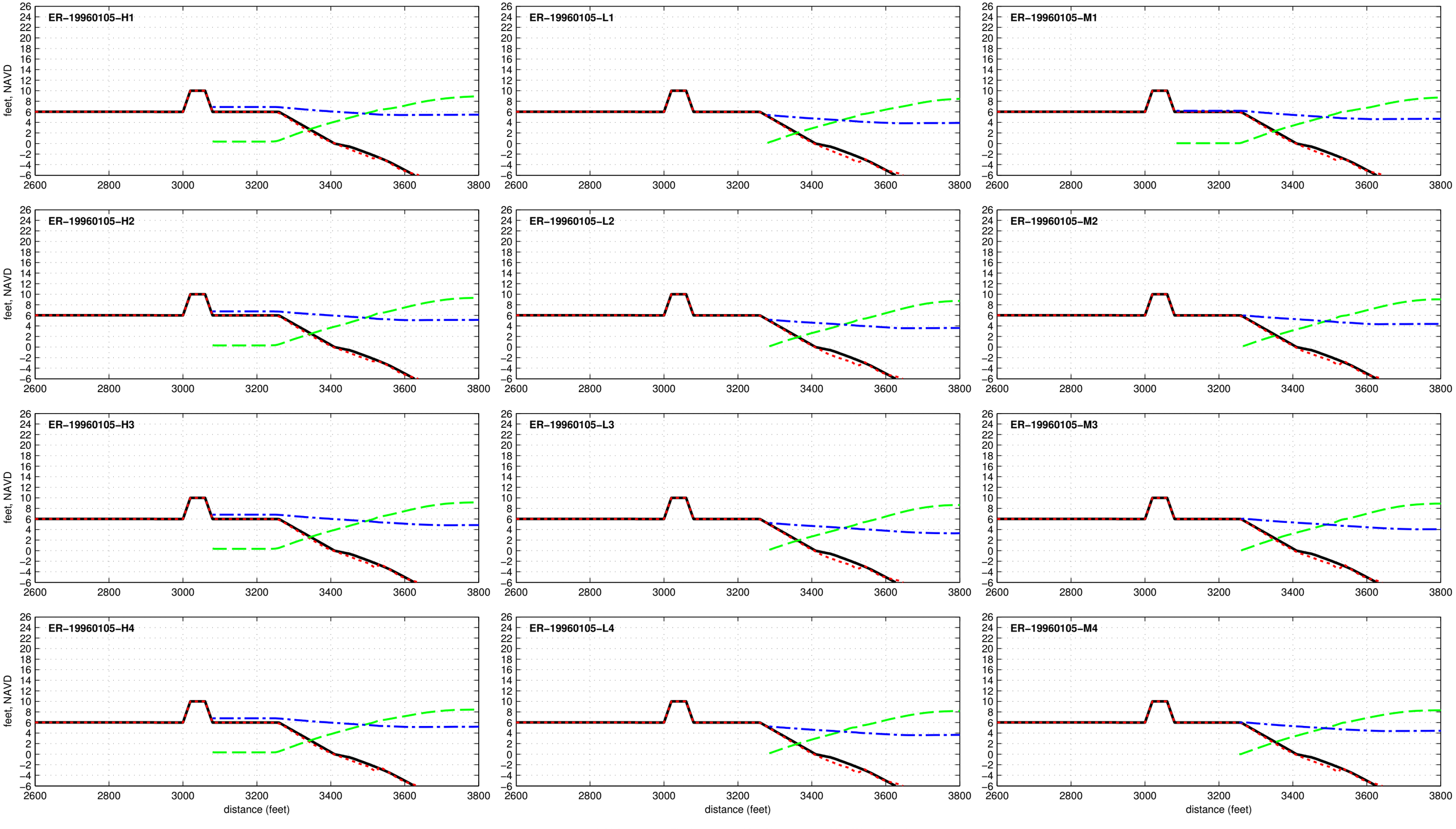
Dune R1T1–10.0–040–180 – ER–19940228



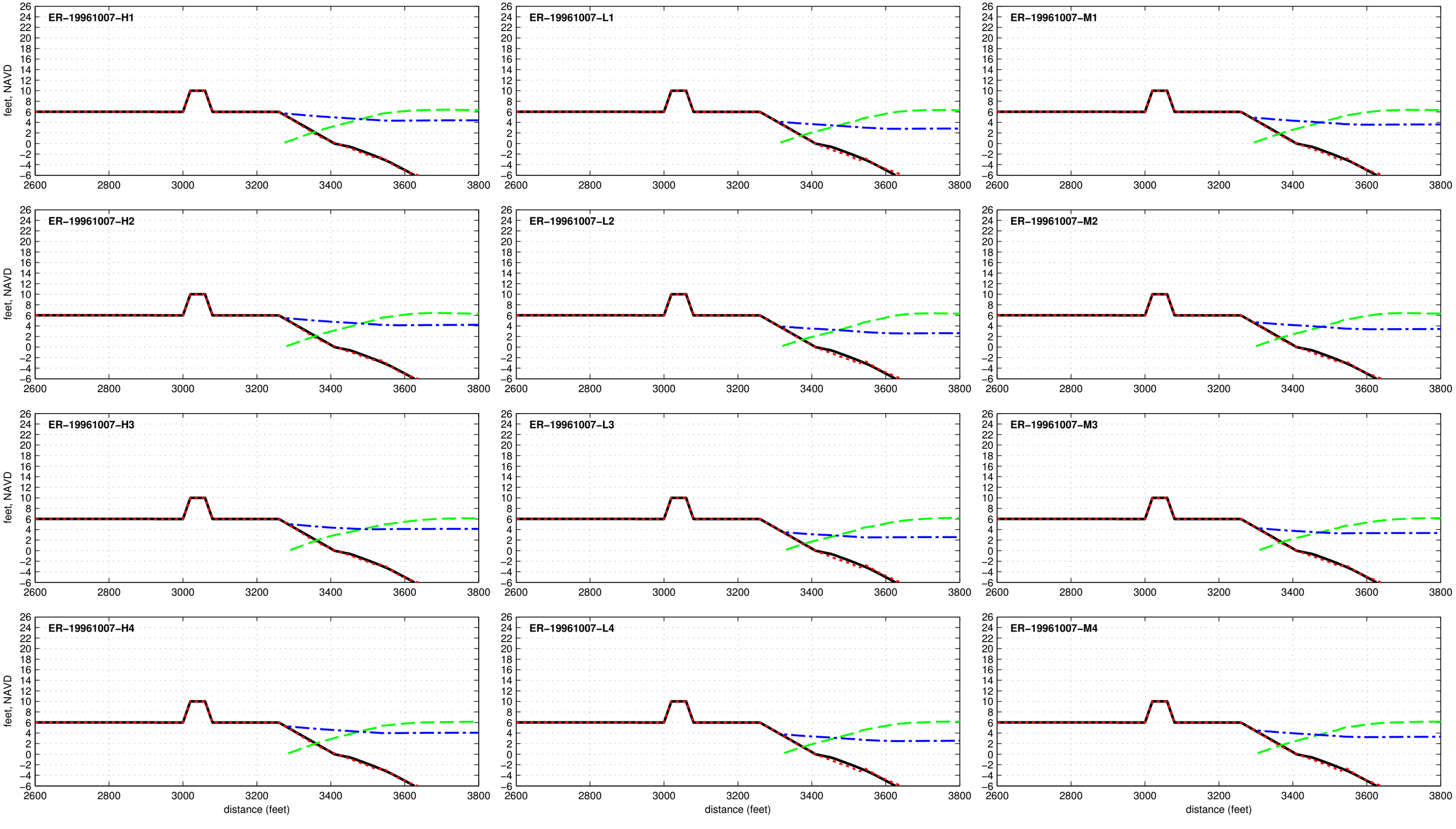
Dune R1T1–10.0–040–180 – ER–19941221



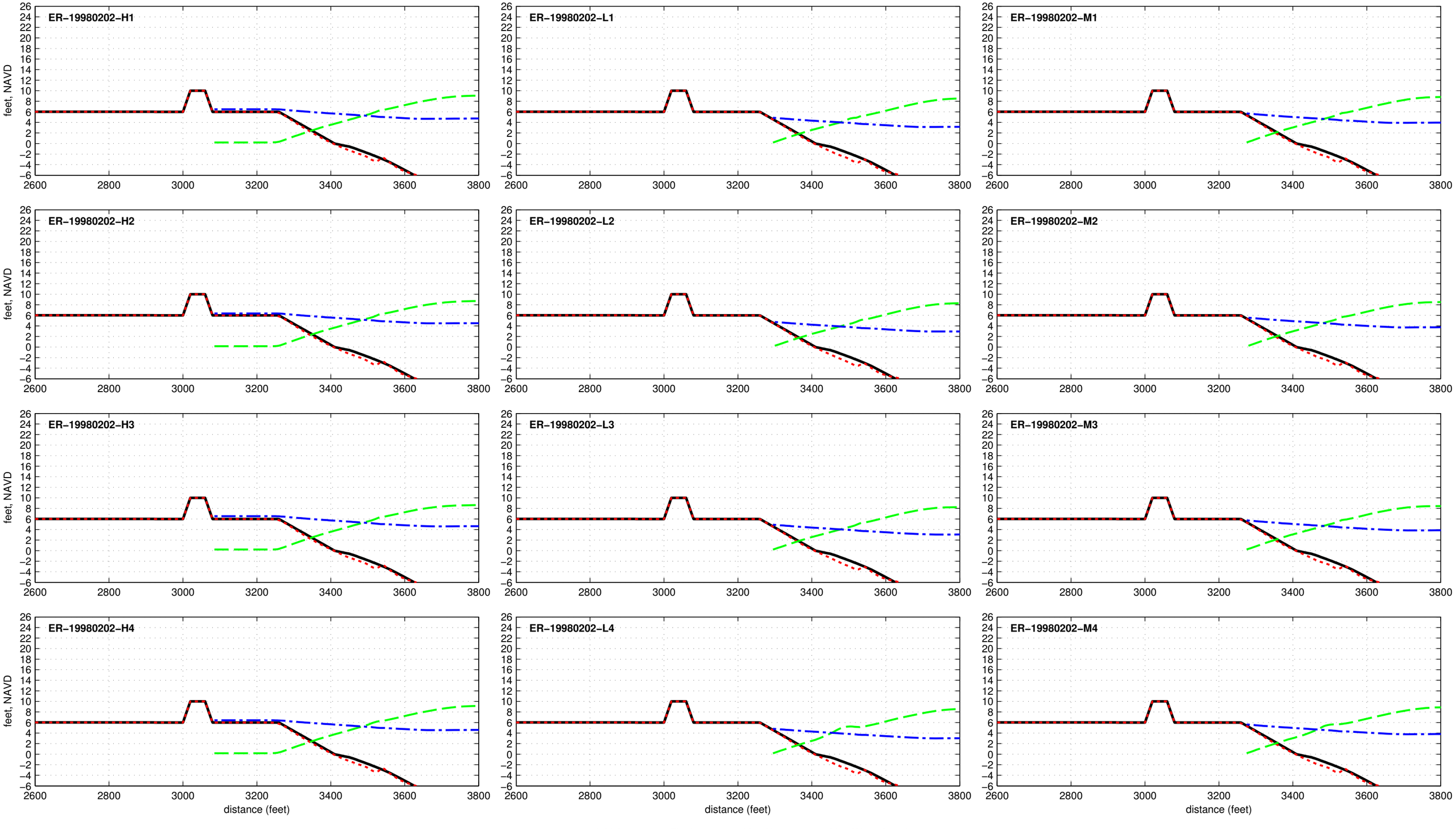
Dune R1T1–10.0–040–180 – ER–19960105



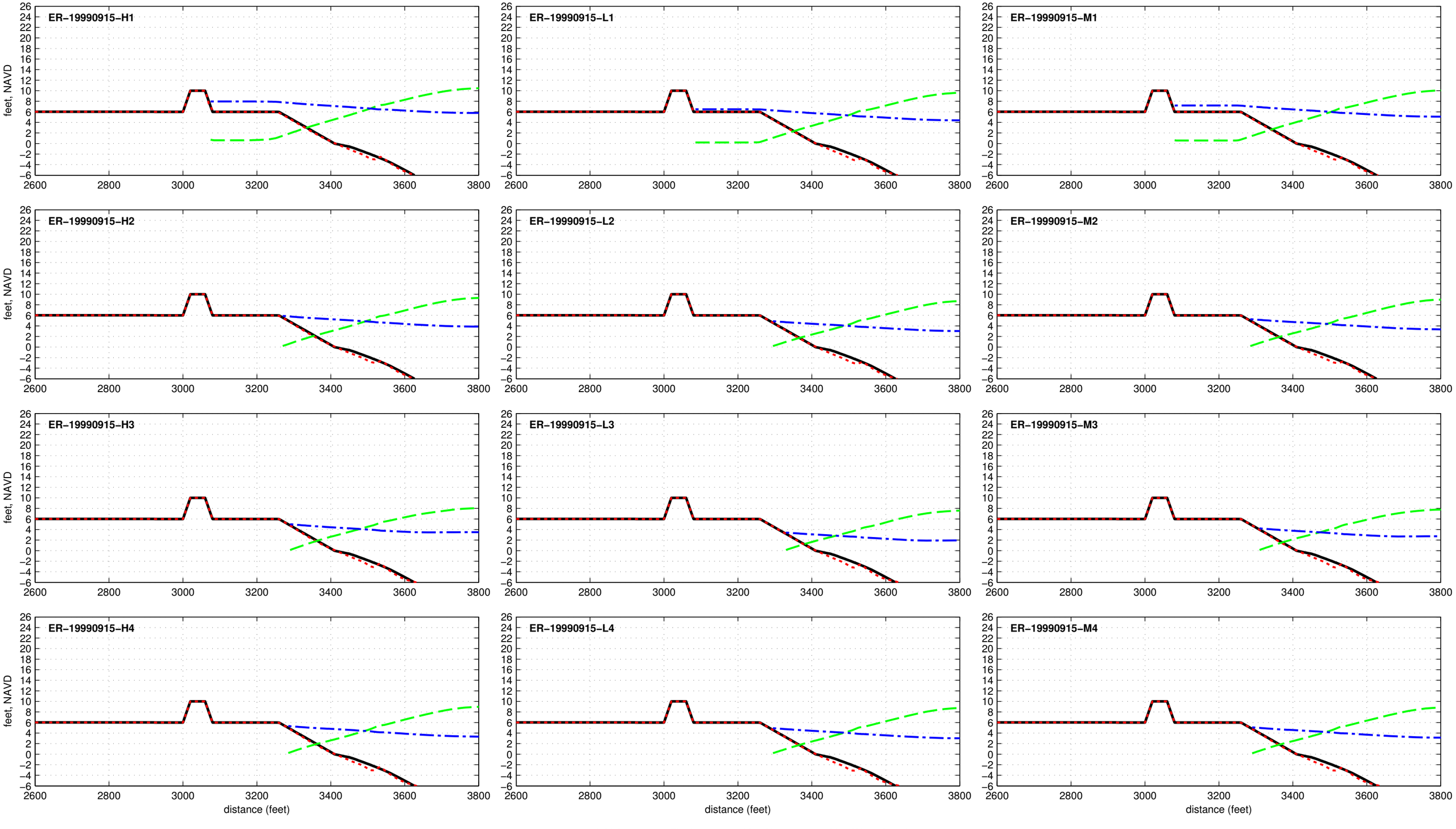
Dune R1T1–10.0–040–180 – ER–19961007



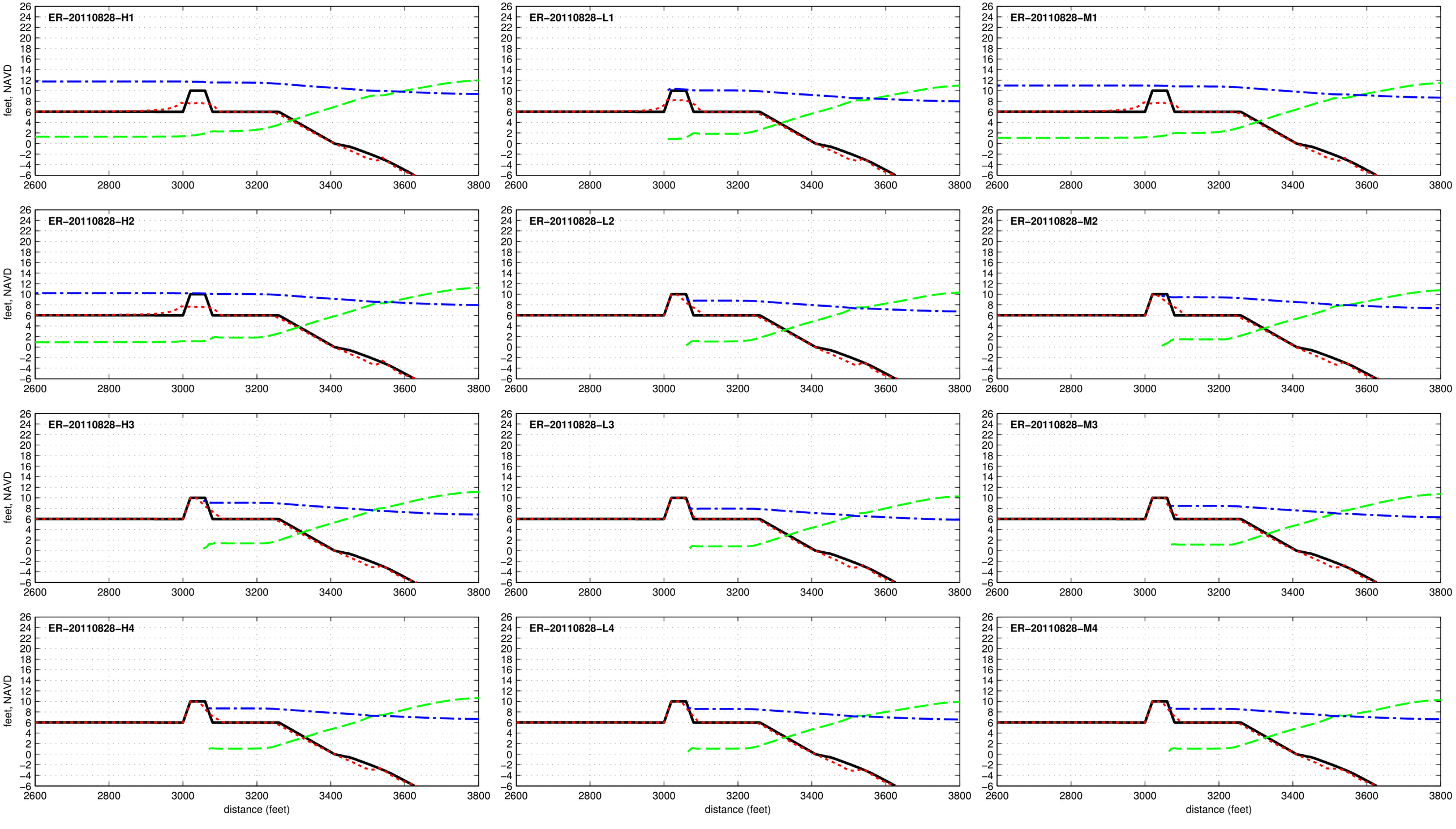
Dune R1T1–10.0–040–180 – ER–19980202



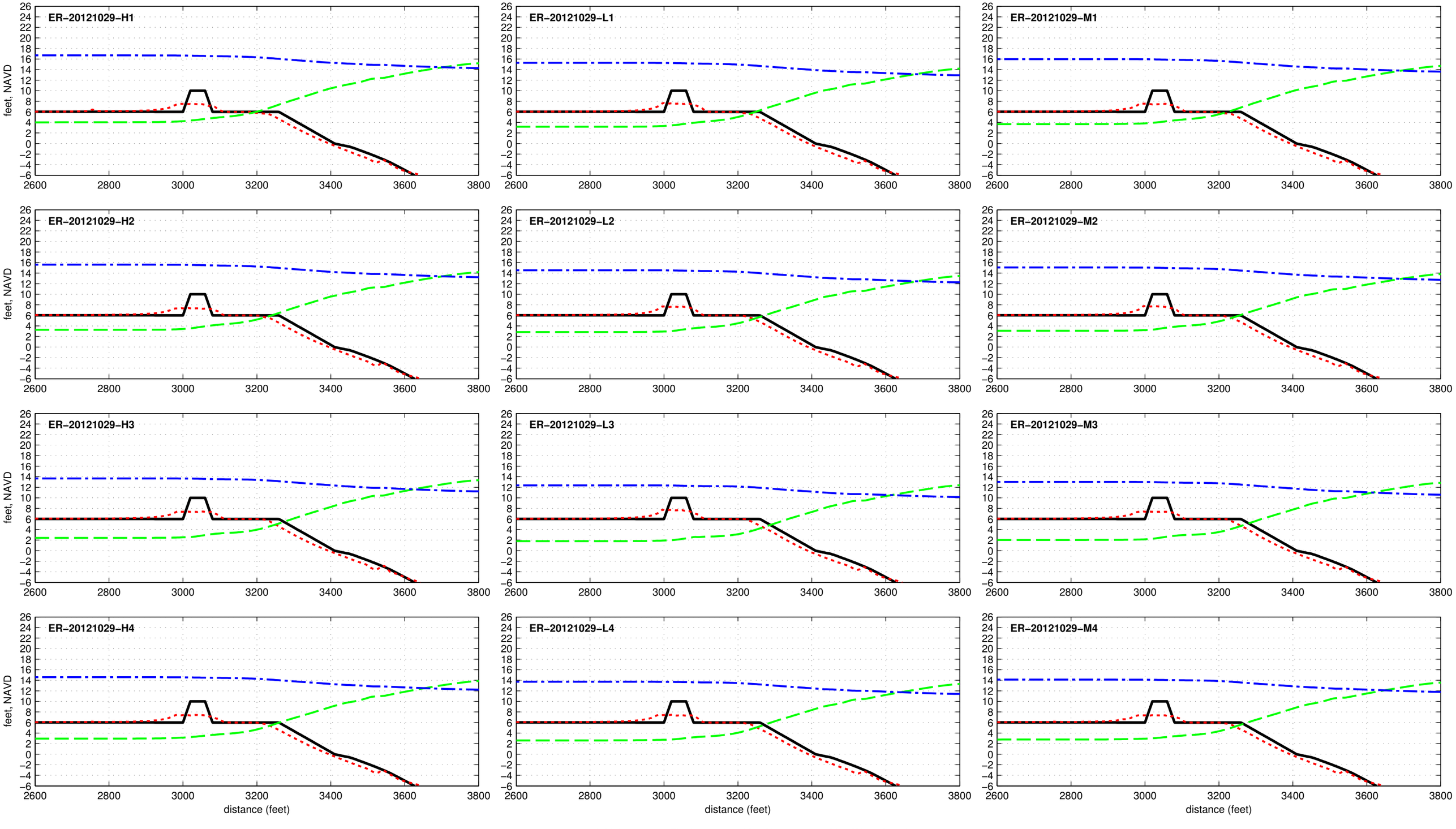
Dune R1T1–10.0–040–180 – ER–19990915



Dune R1T1–10.0–040–180 – ER–20110828

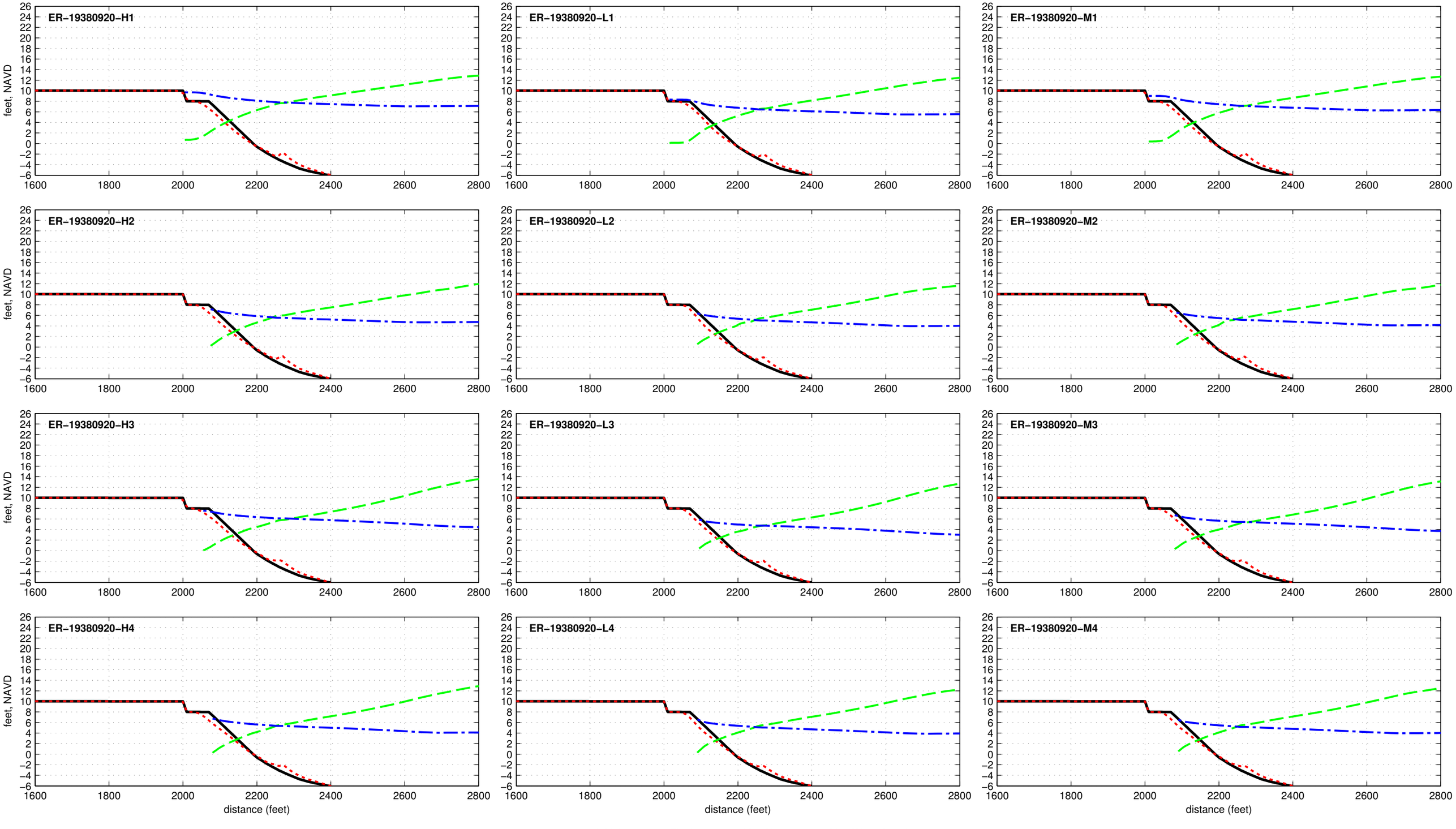


Dune R1T1–10.0–040–180 – ER–20121029

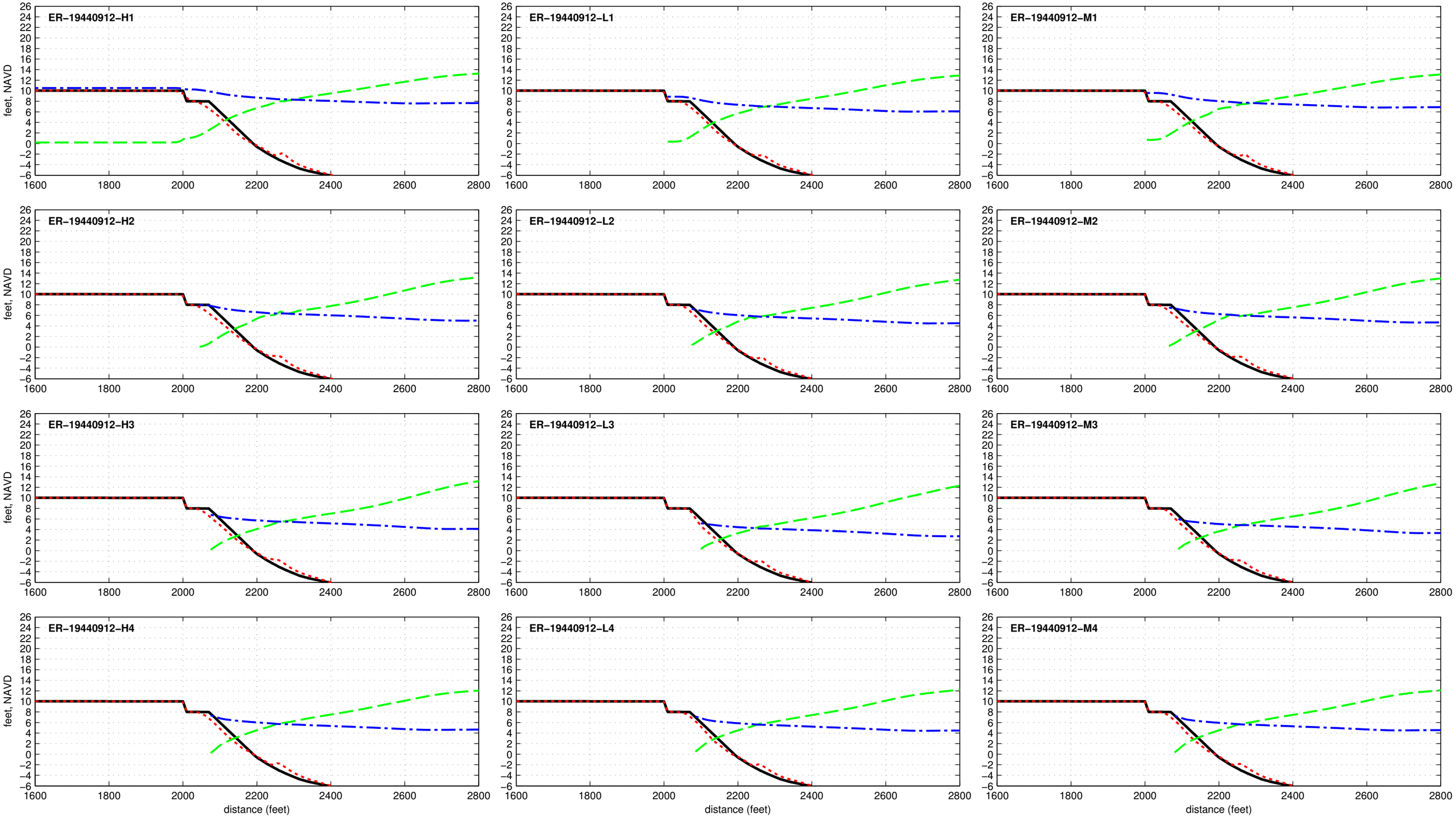


R2T1_10.0_000_060 - DUNE

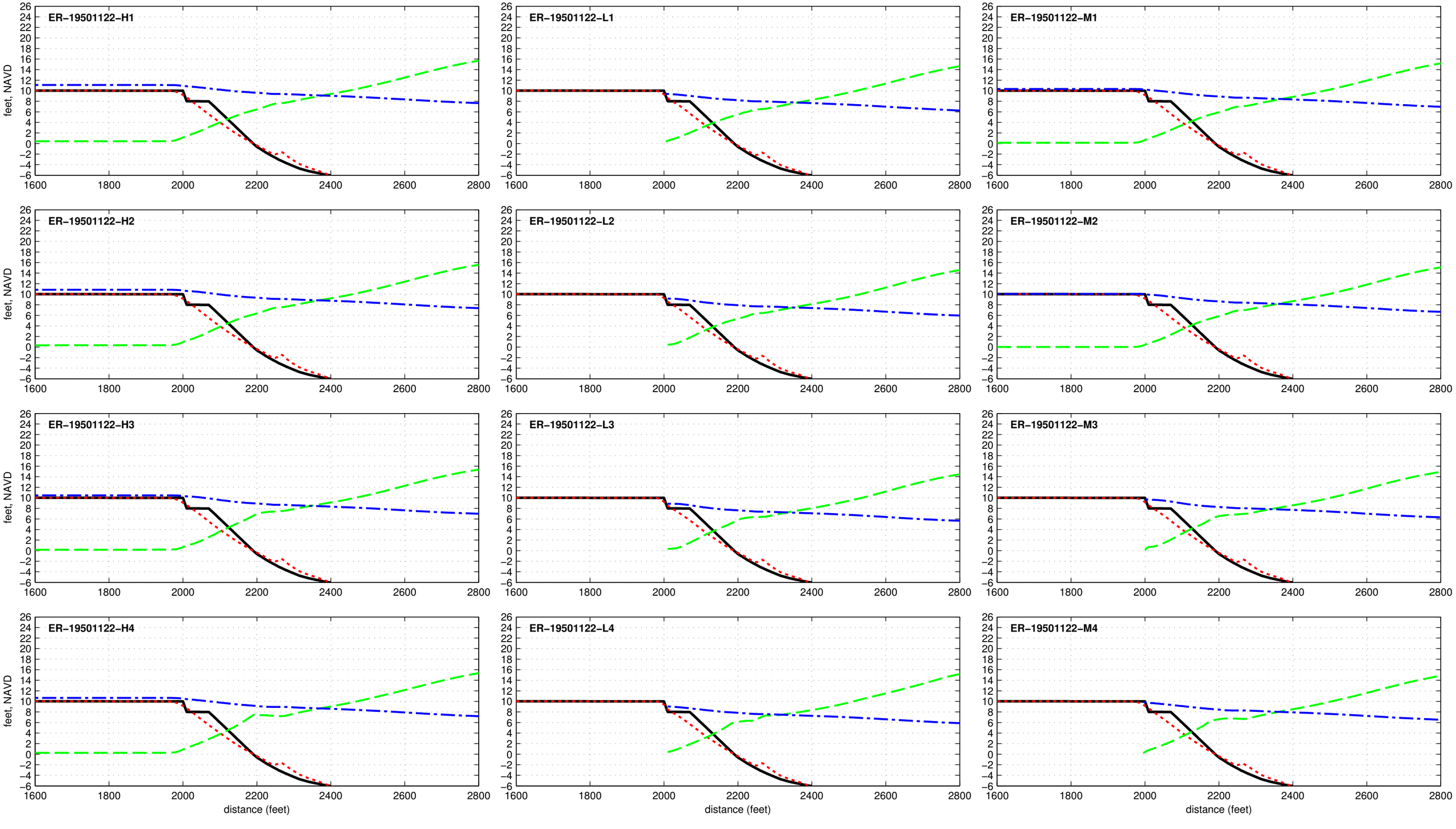
Dune R2T1-10.0-000-060 - ER-19380920



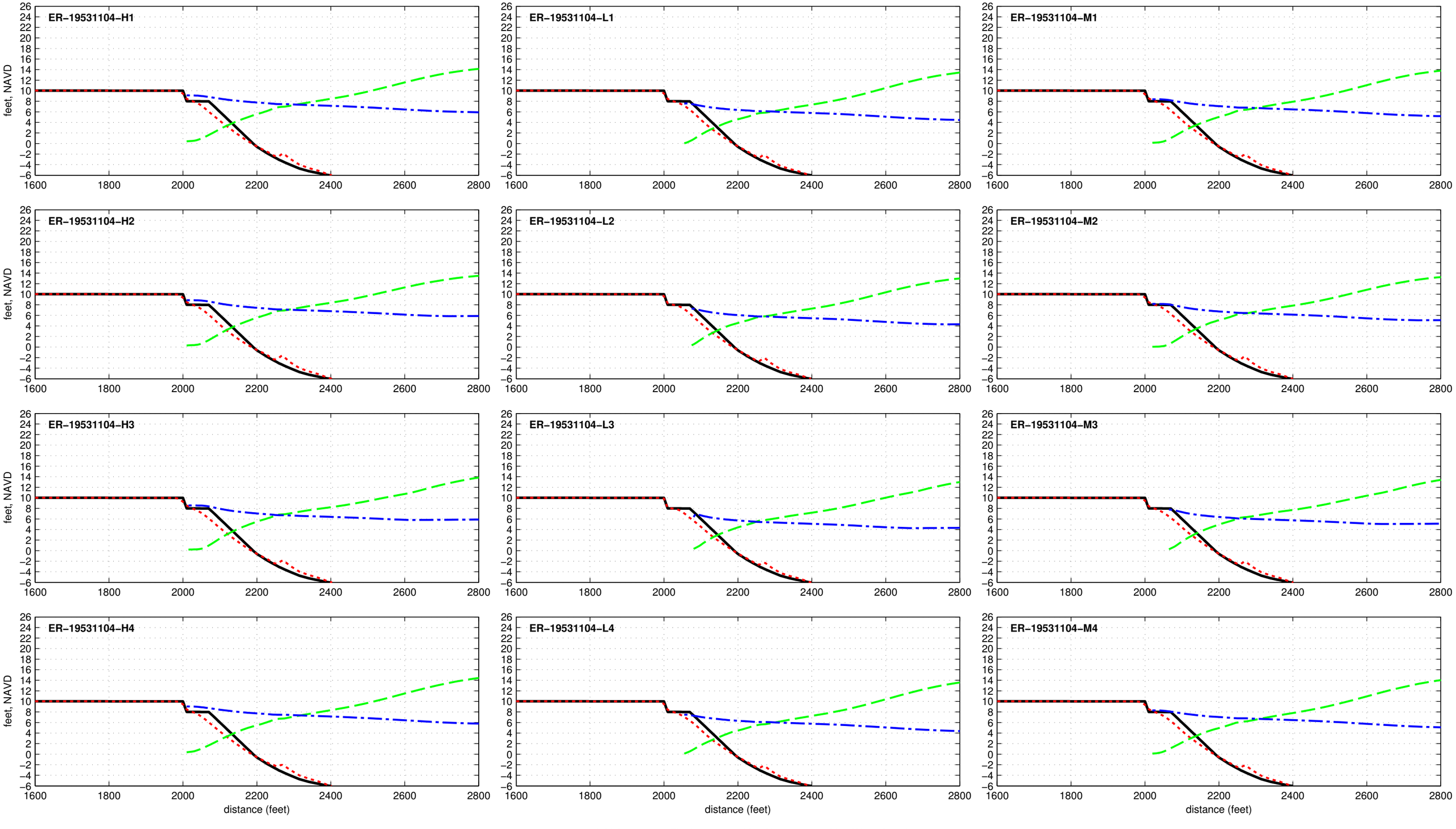
Dune R2T1-10.0-000-060 - ER-19440912



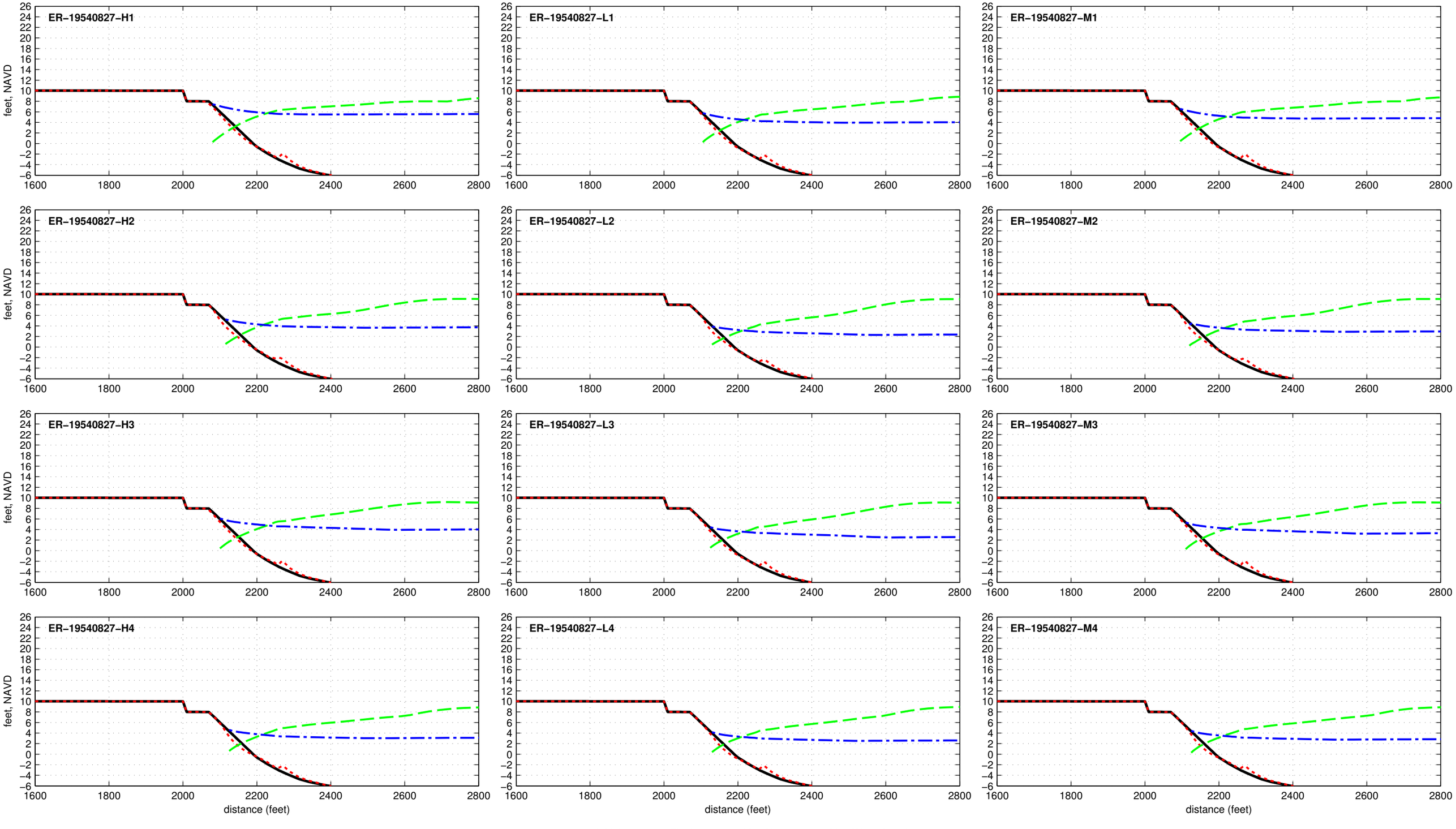
Dune R2T1-10.0-000-060 - ER-19501122



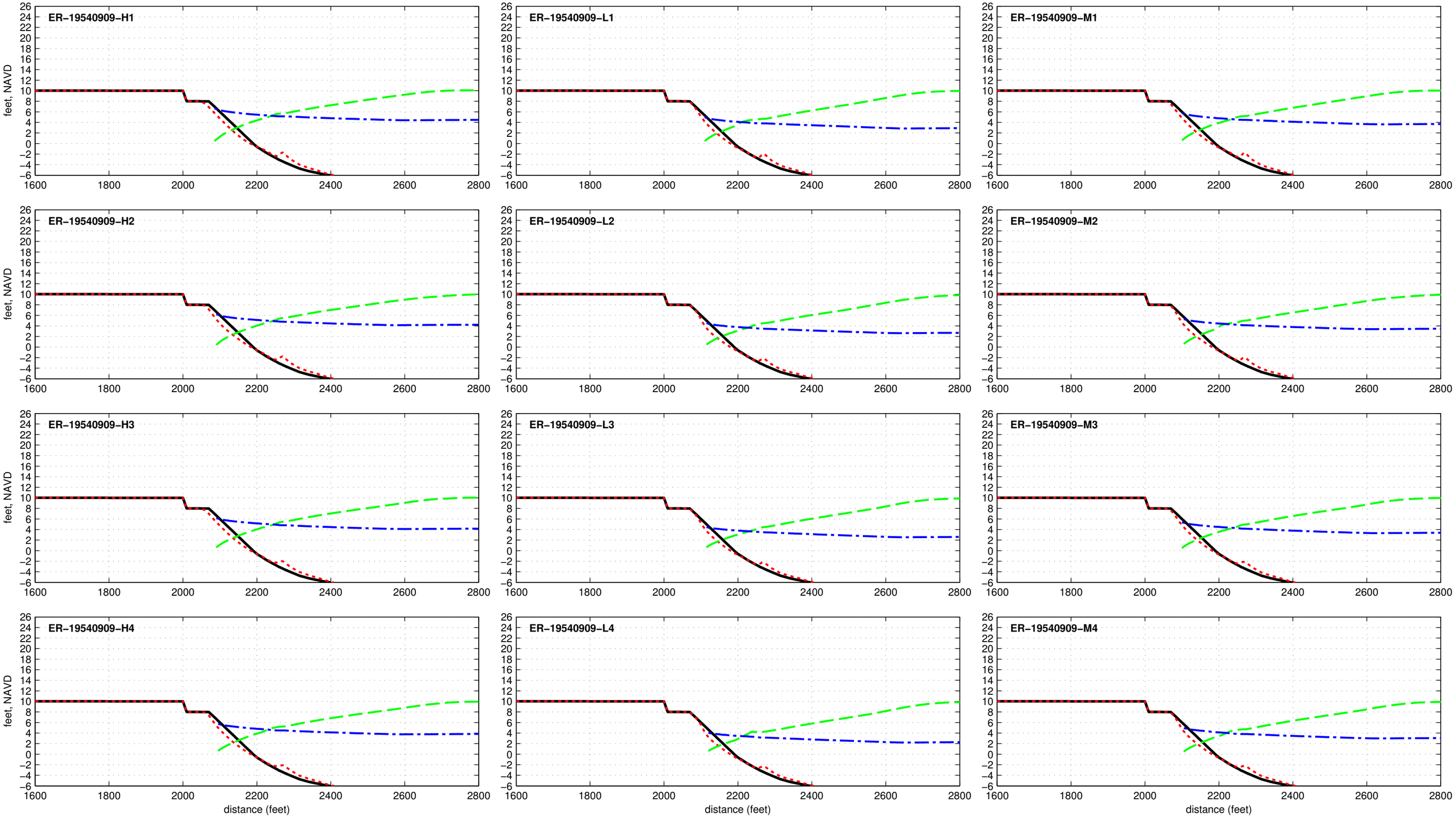
Dune R2T1-10.0-000-060 - ER-19531104



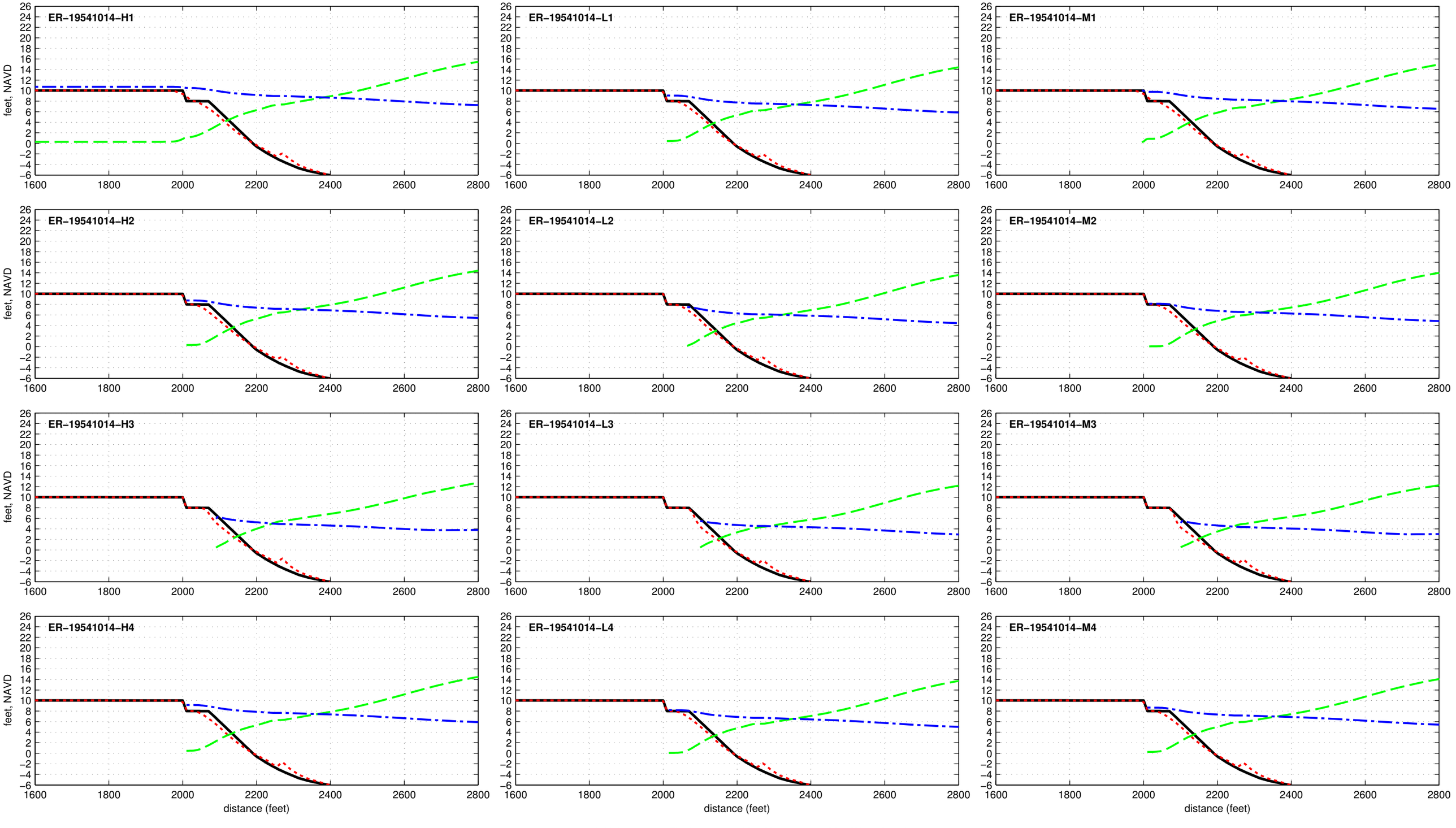
Dune R2T1–10.0–000–060 – ER–19540827



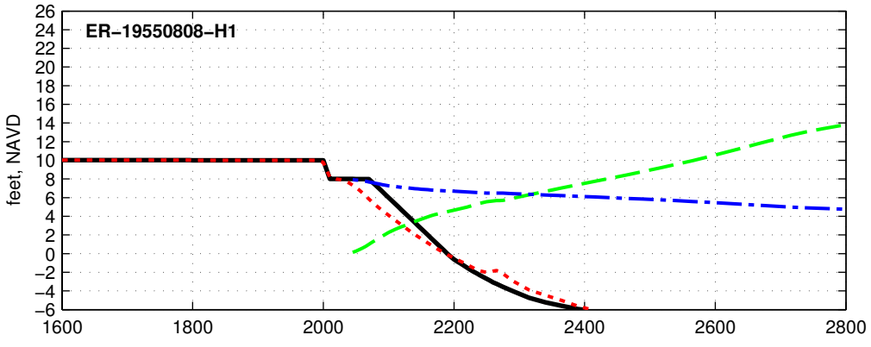
Dune R2T1-10.0-000-060 - ER-19540909

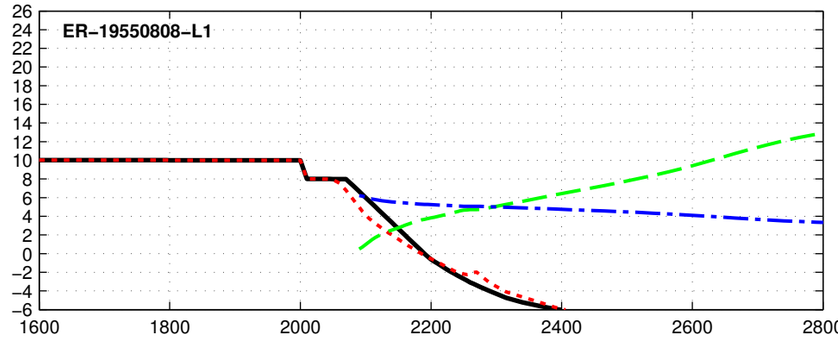


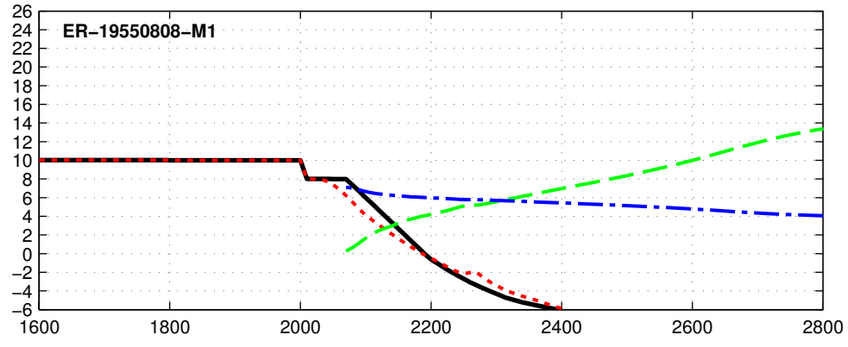
Dune R2T1-10.0-000-060 - ER-19541014

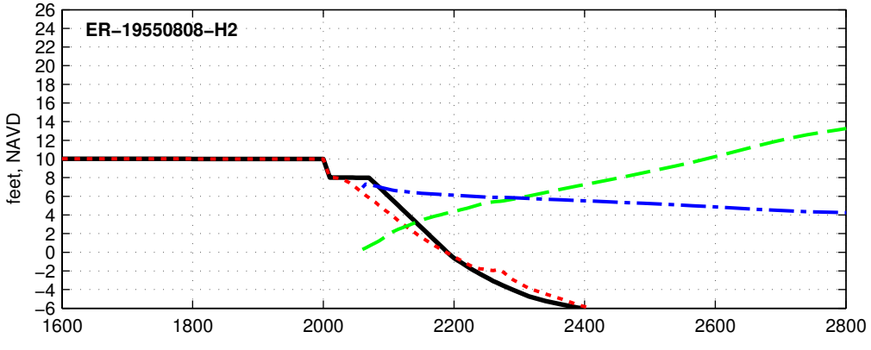


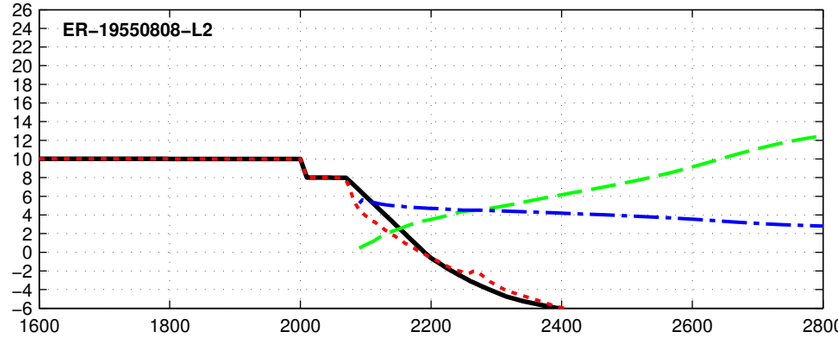
Dune R2T1-10.0-000-060 - ER-19550808

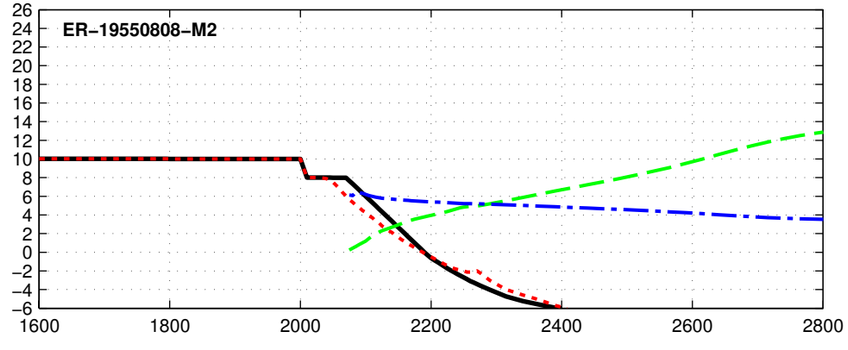


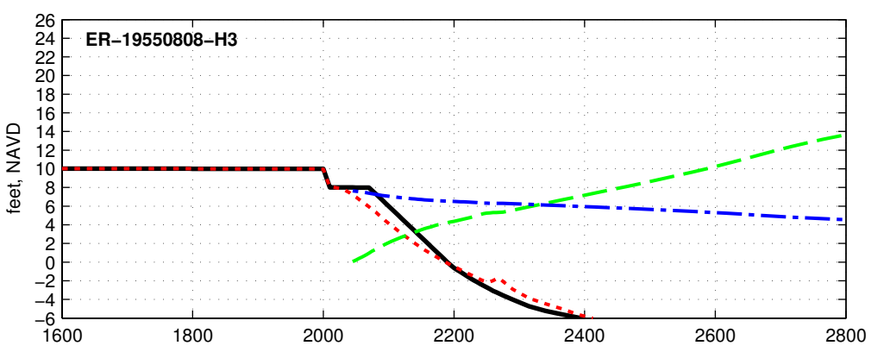


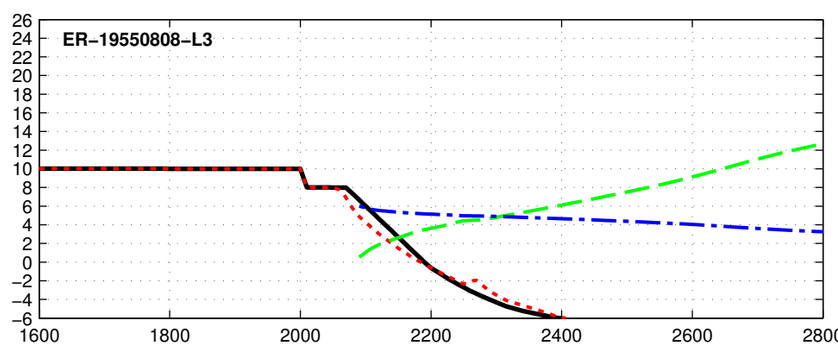


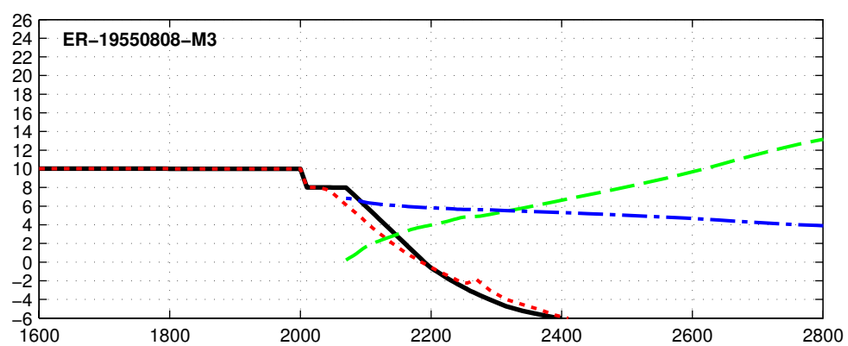


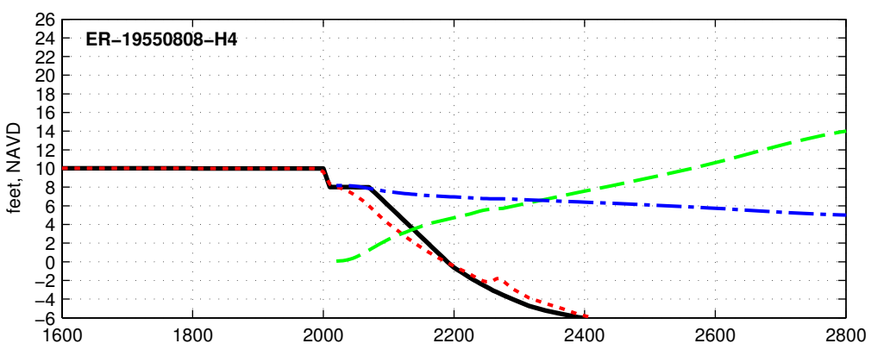


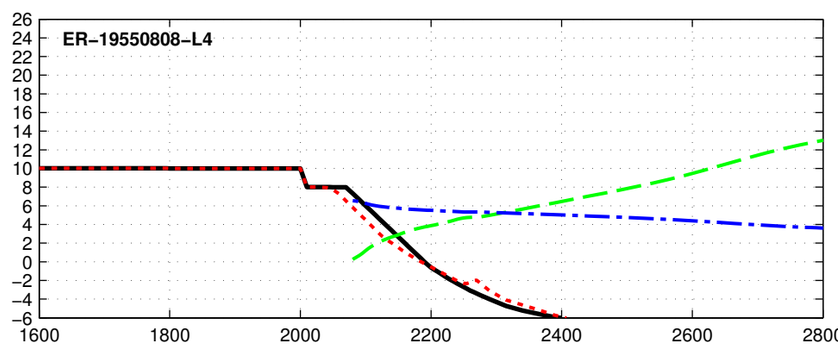


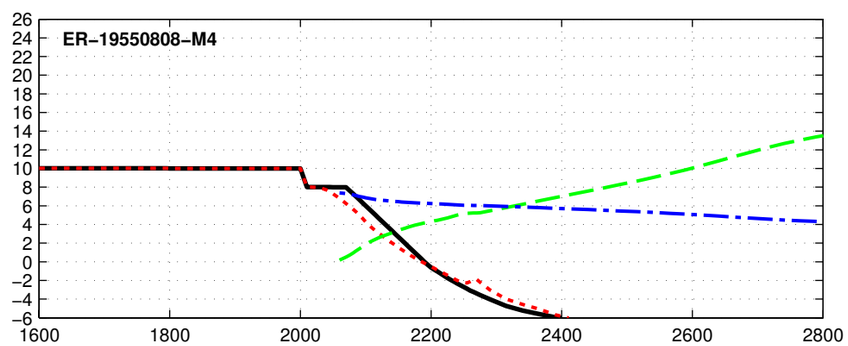










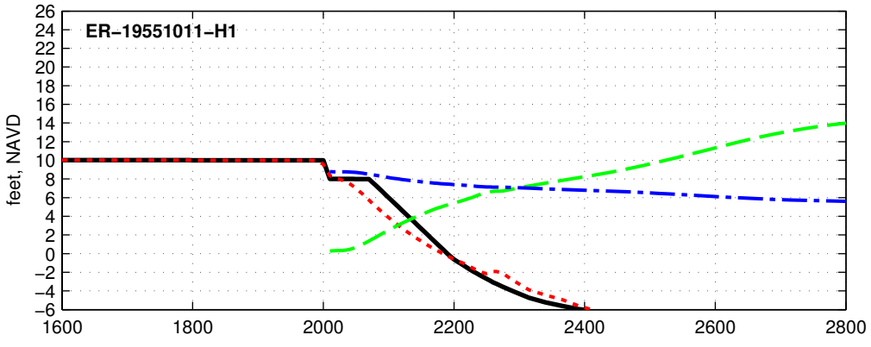


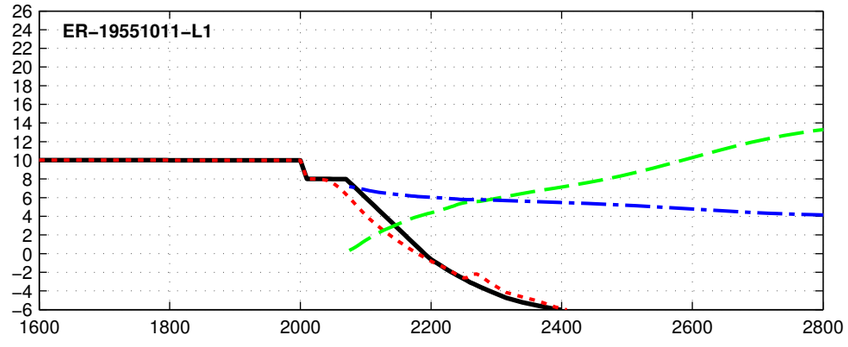
feet, NAVD

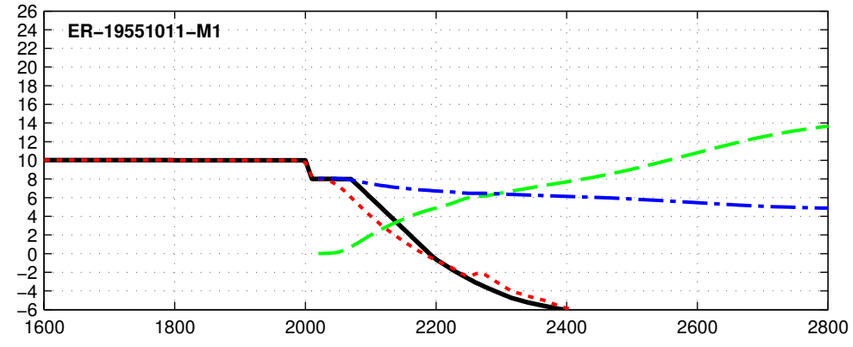
distance (feet)

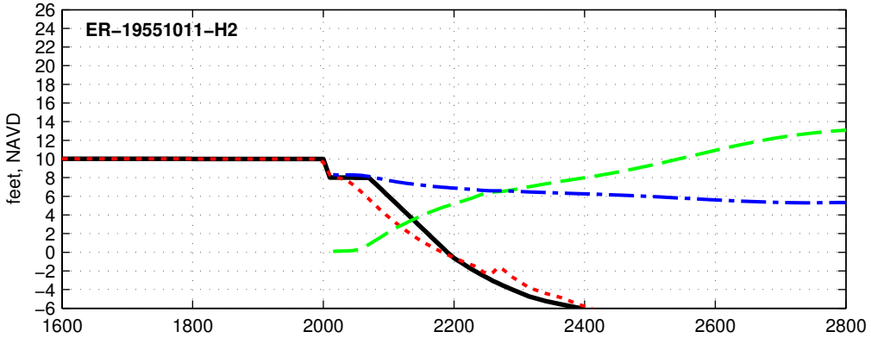
Initial Final Max Hs Max Water Level

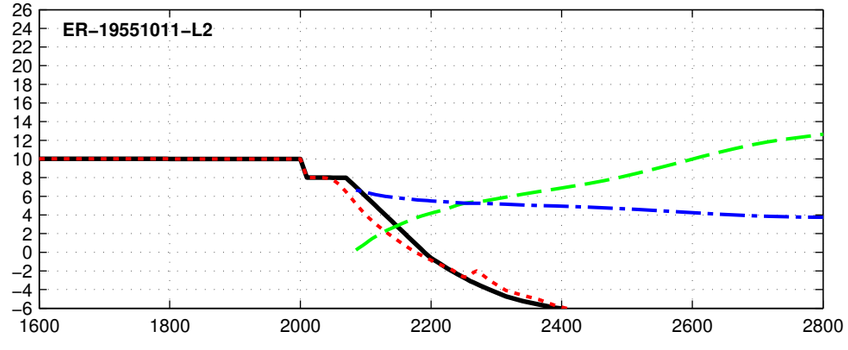
Dune R2T1-10.0-000-060 - ER-19551011

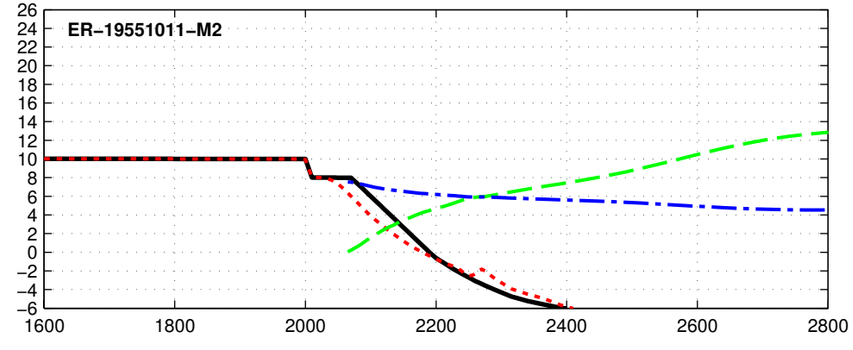


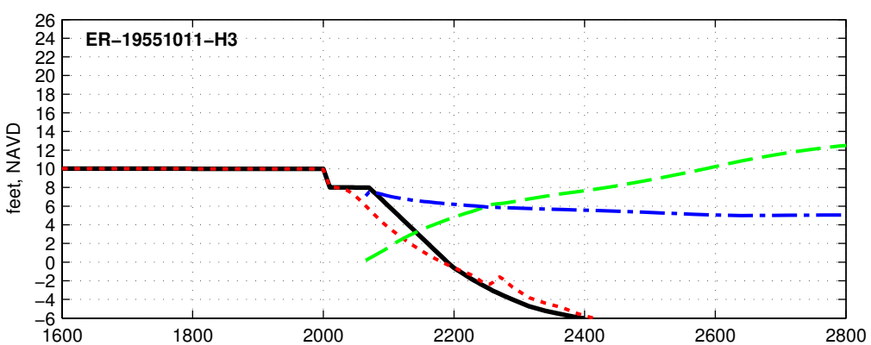


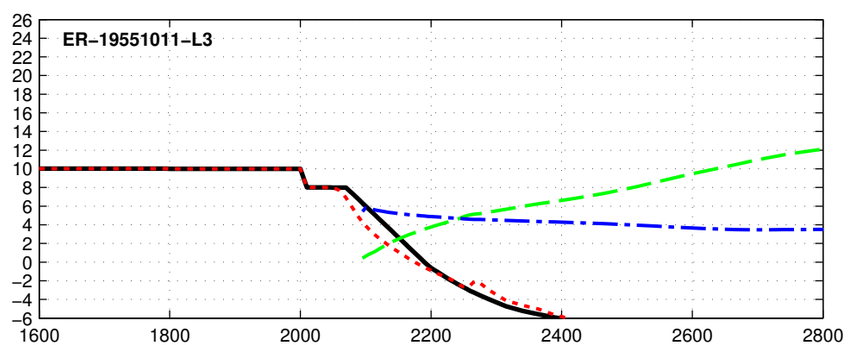


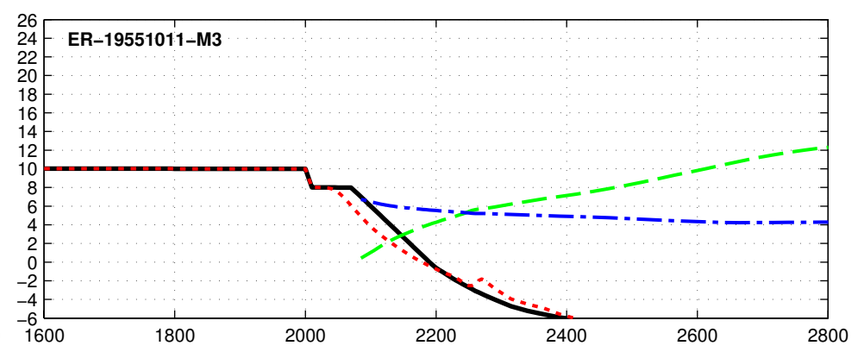


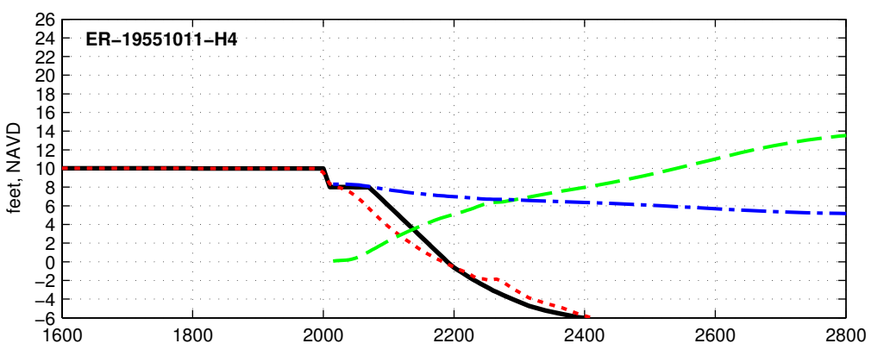


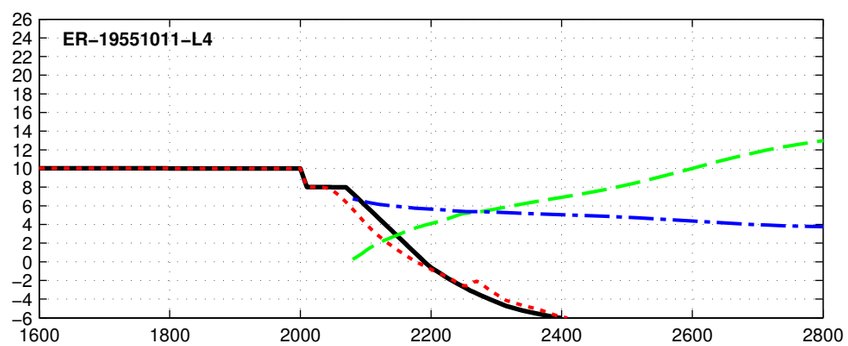


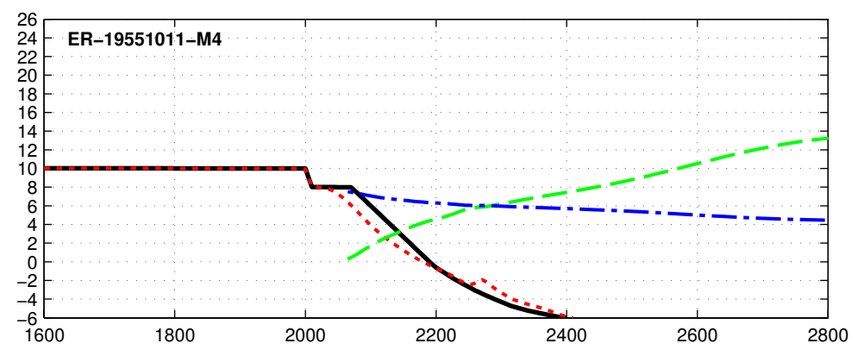






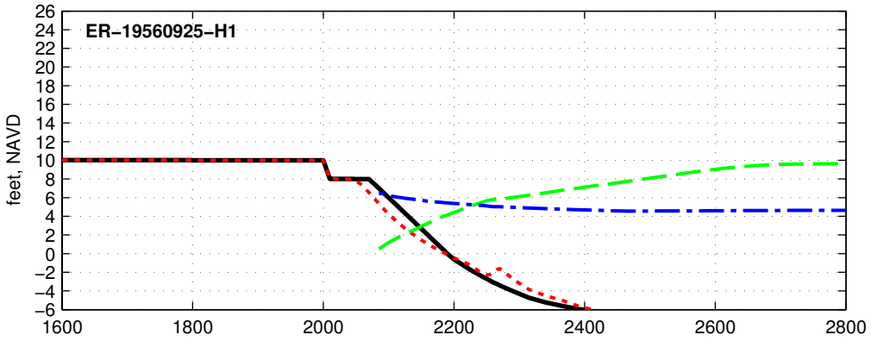


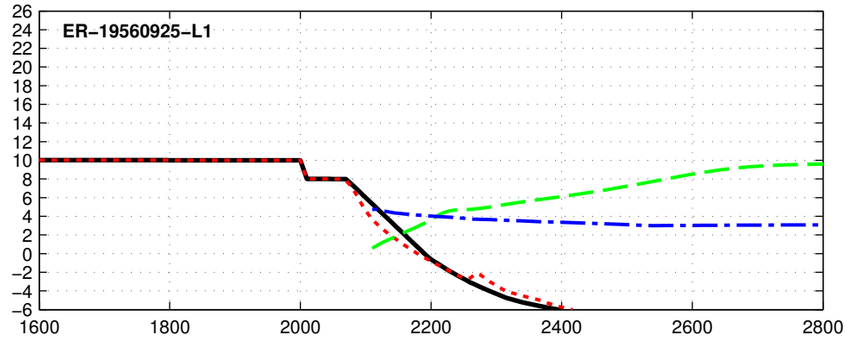


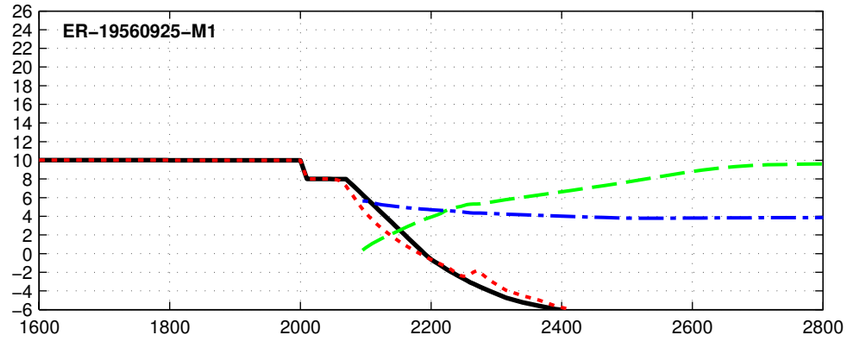


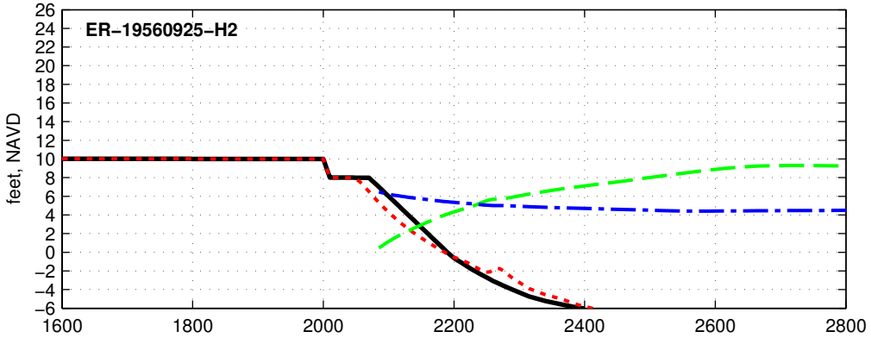
Initial Final Max Hs Max Water Level

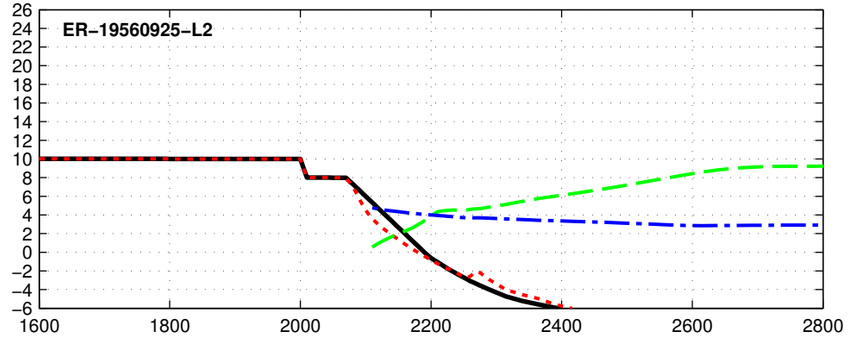
Dune R2T1-10.0-000-060 - ER-19560925

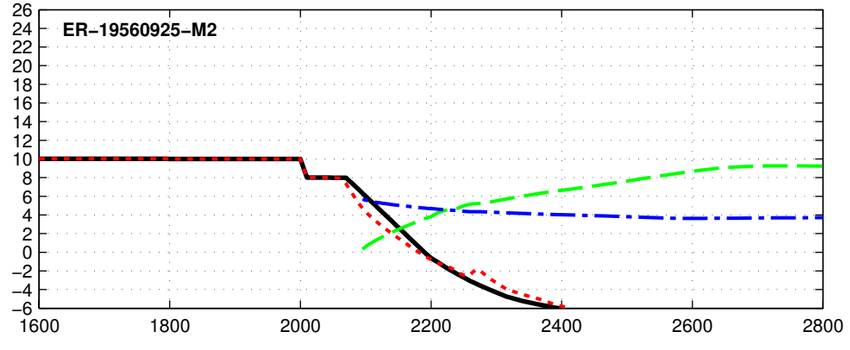


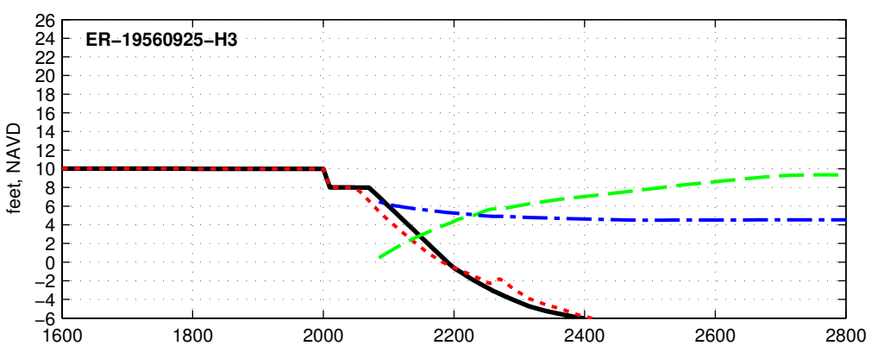


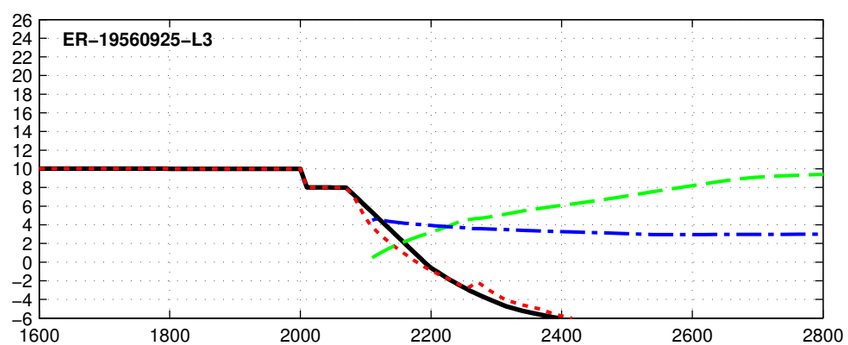


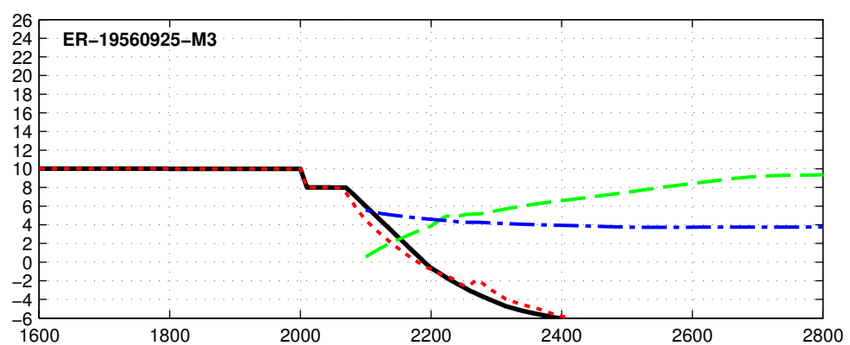


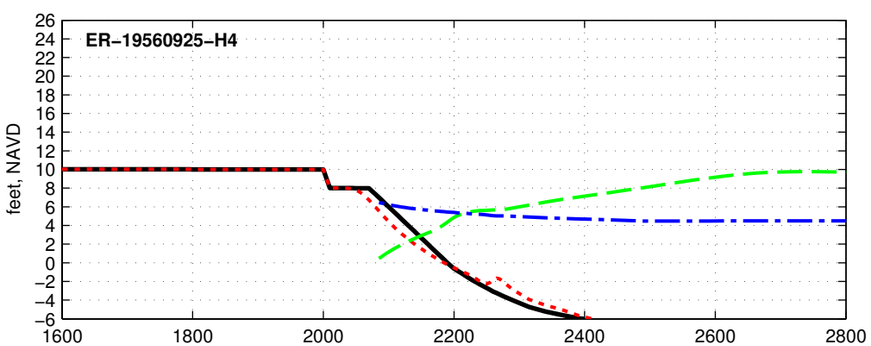


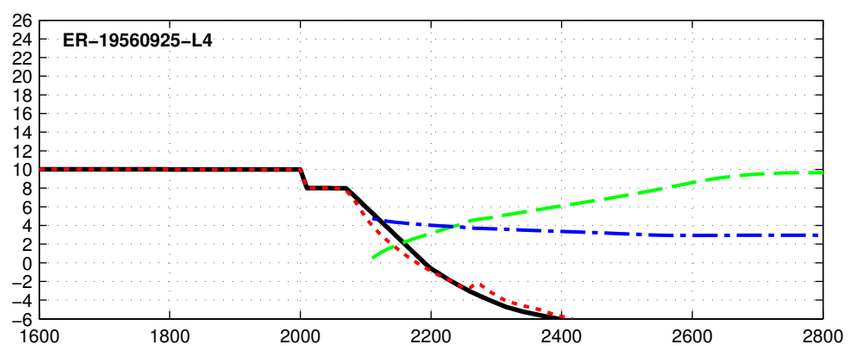


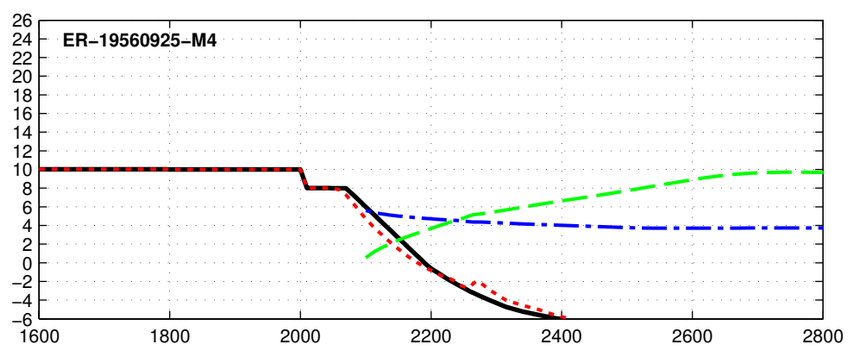






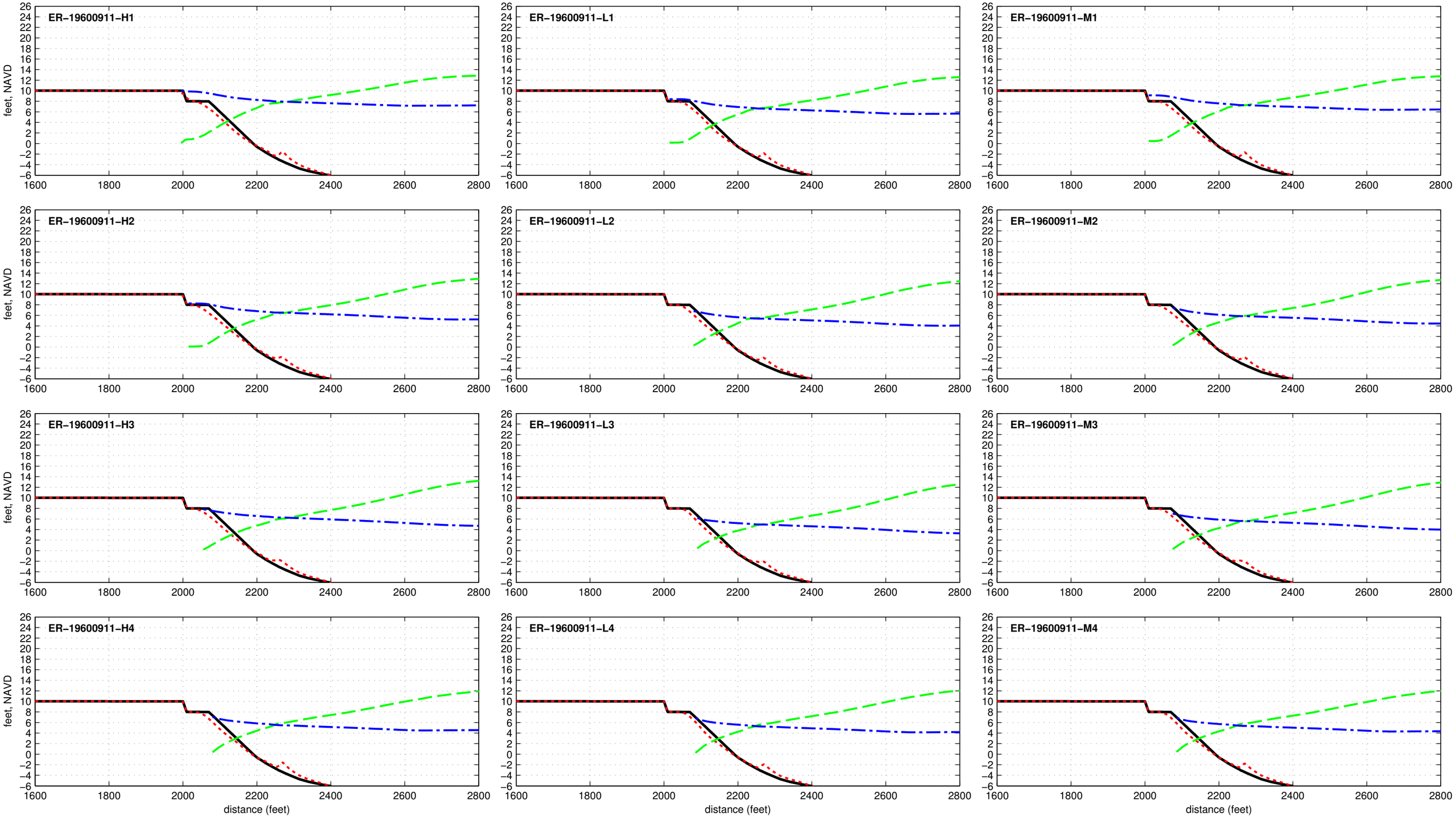




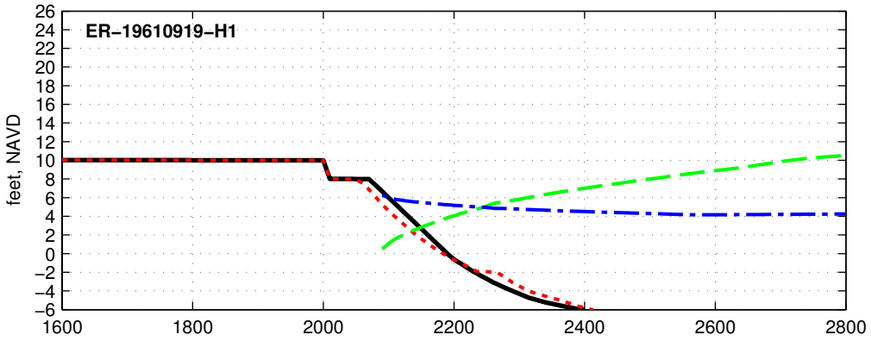


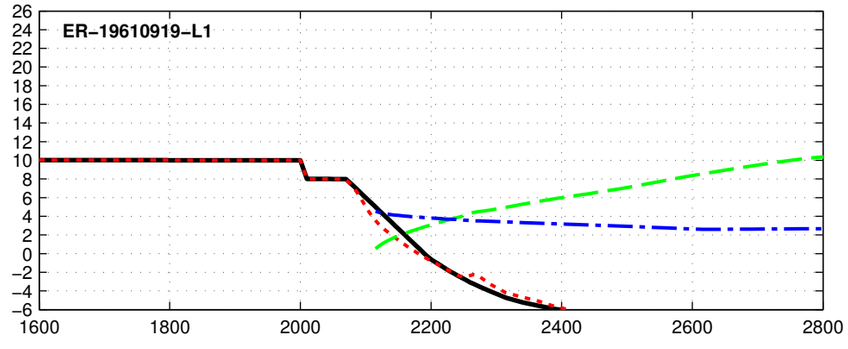
Initial Final Max Hs Max Water Level

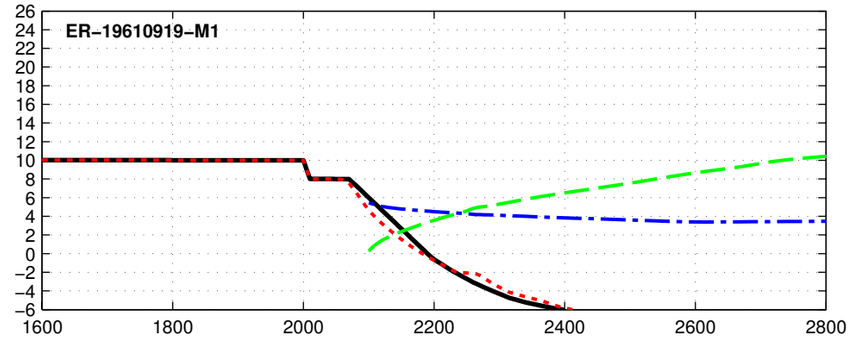
Dune R2T1-10.0-000-060 - ER-19600911

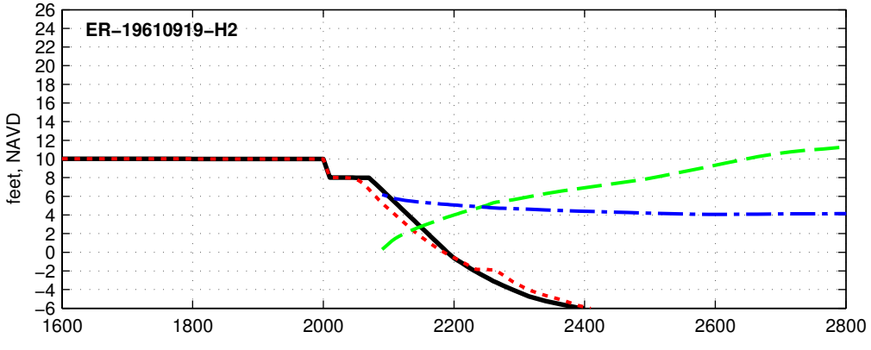


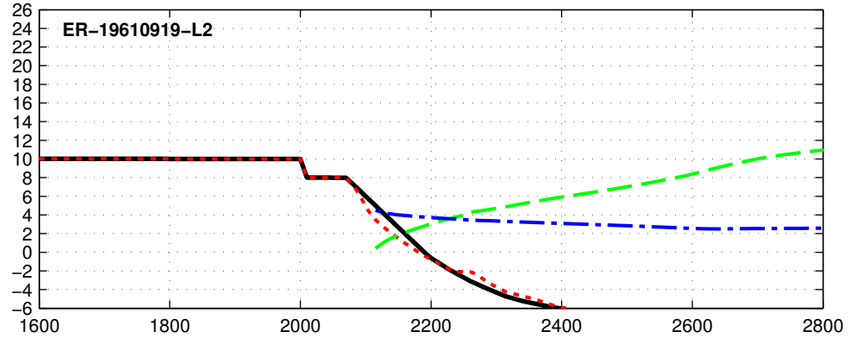
Dune R2T1-10.0-000-060 - ER-19610919

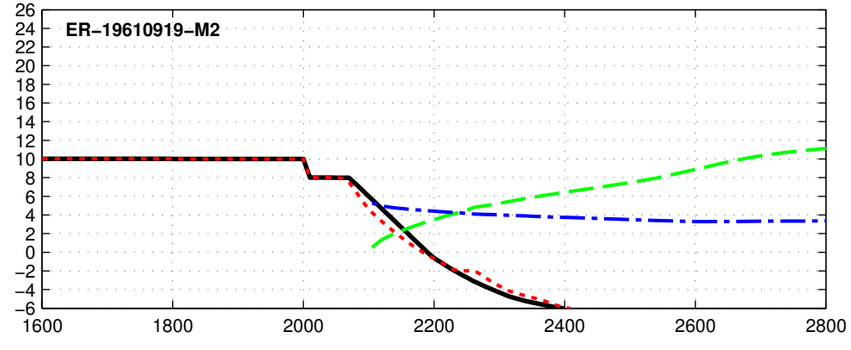


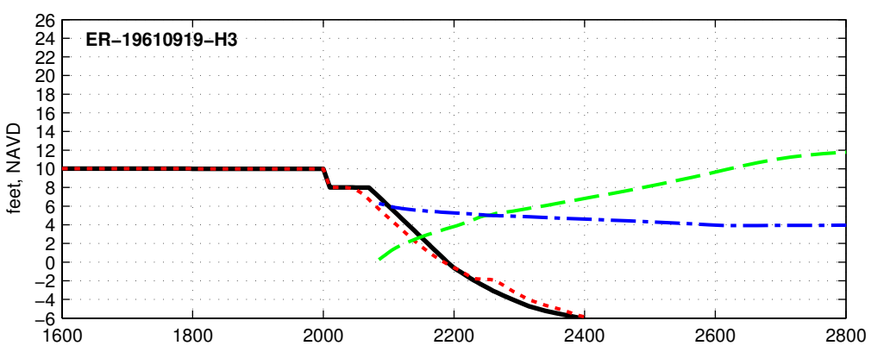


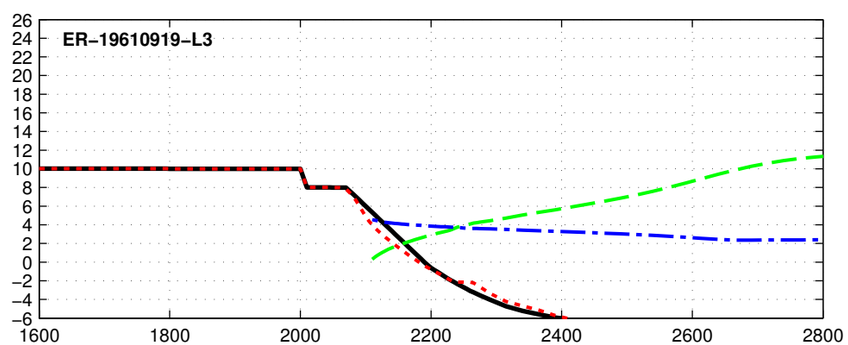


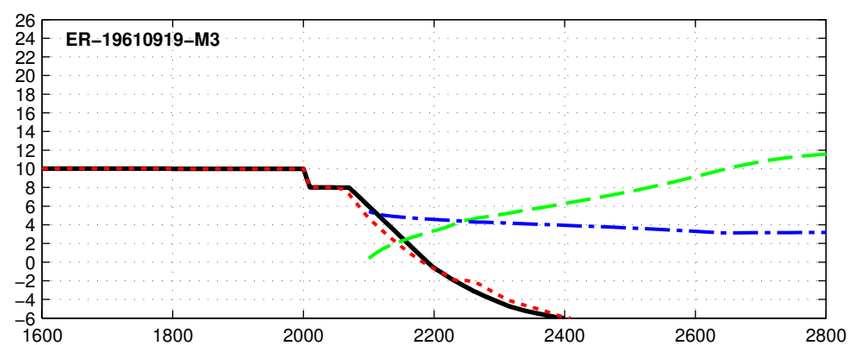


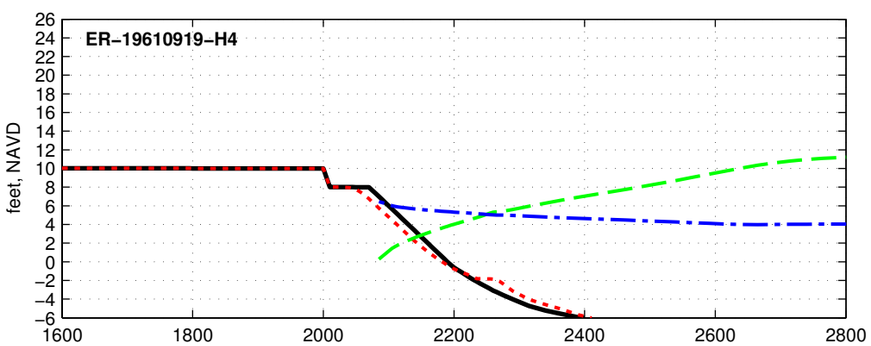


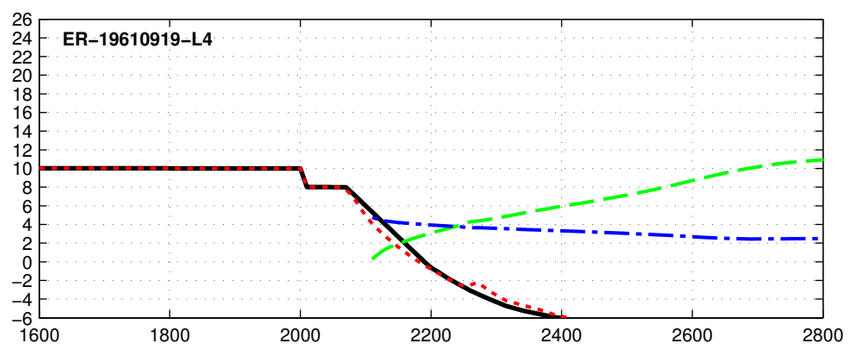


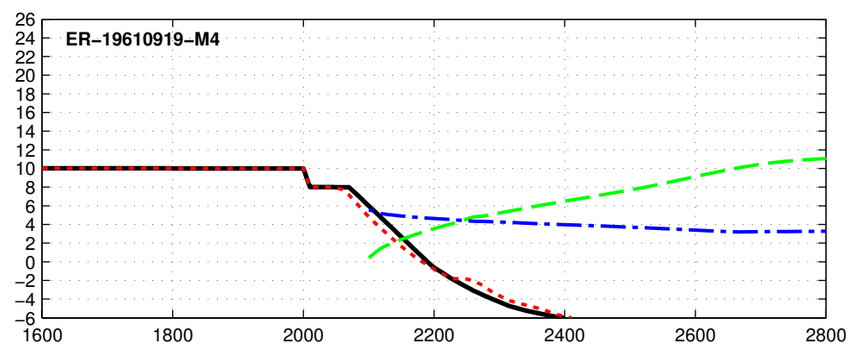






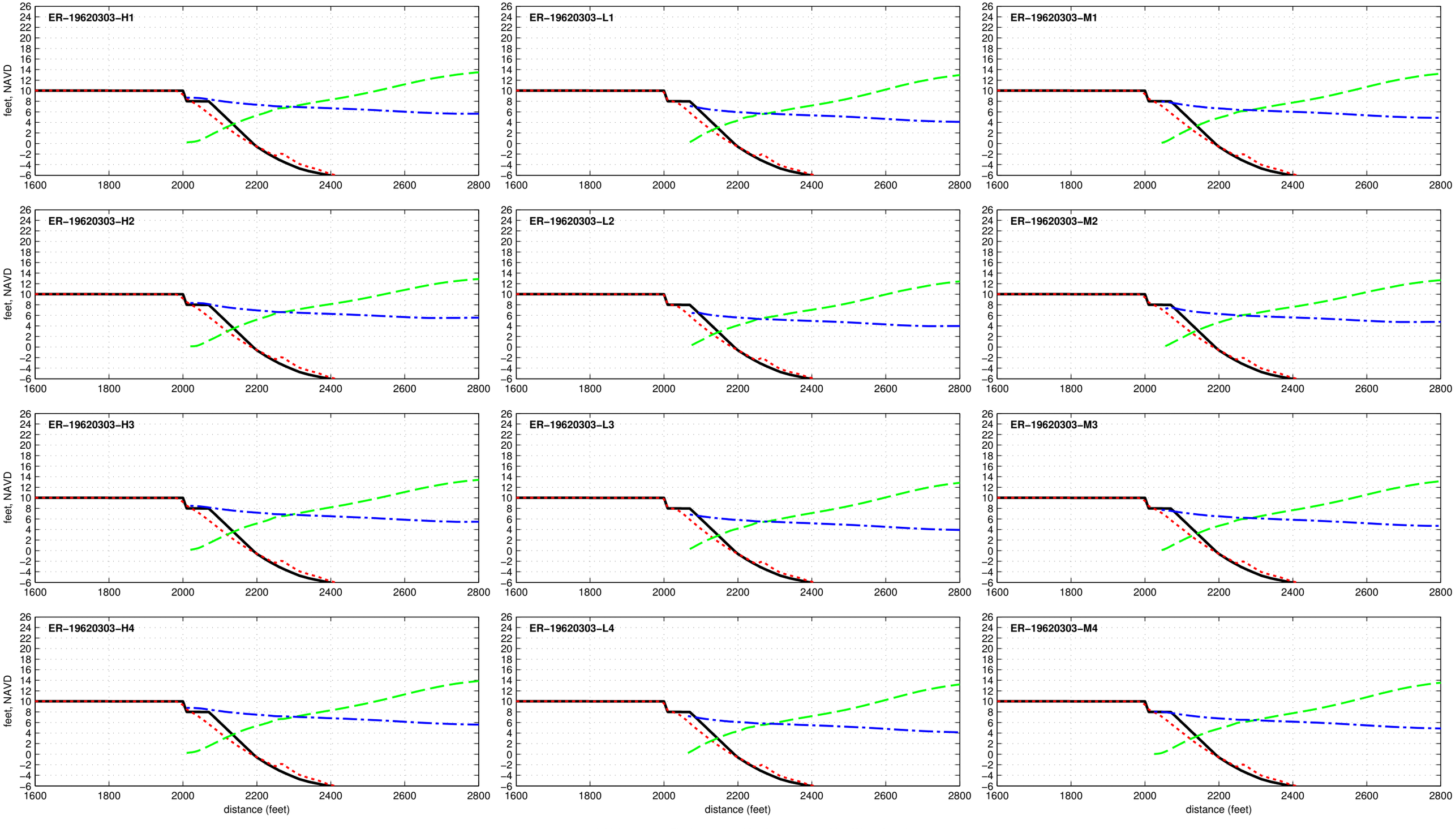




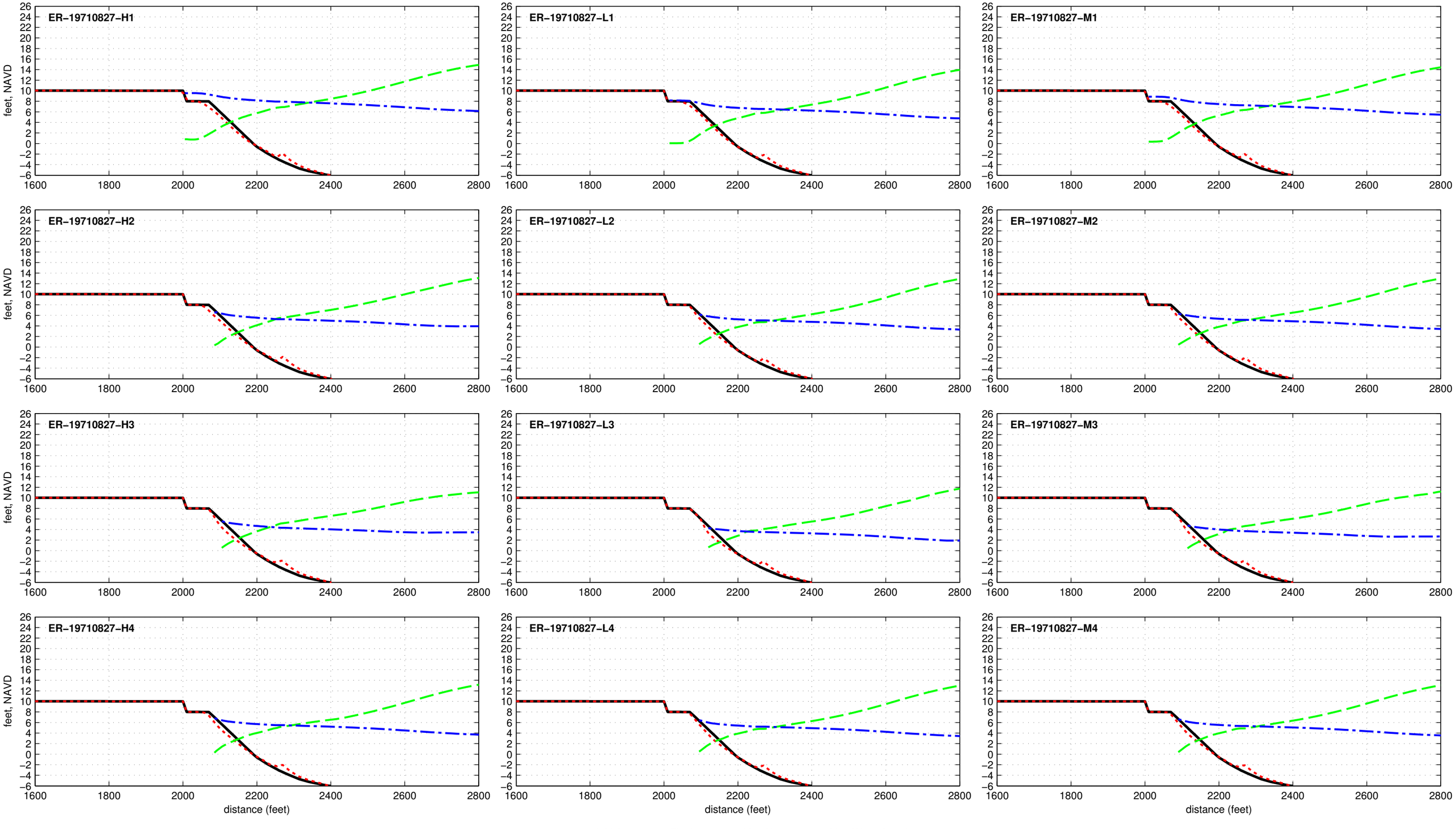


Initial Final Max Hs Max Water Level

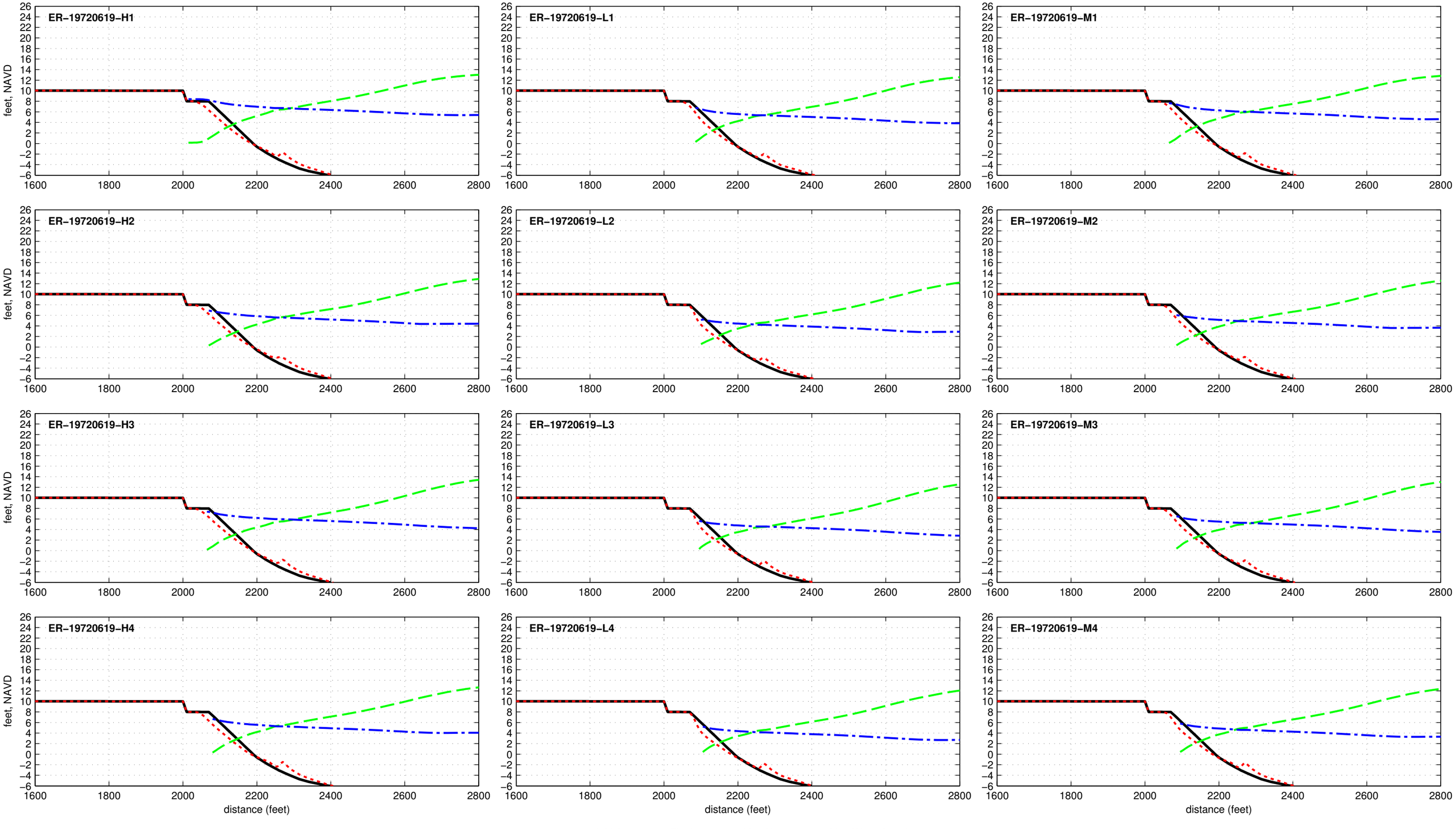
Dune R2T1-10.0-000-060 - ER-19620303



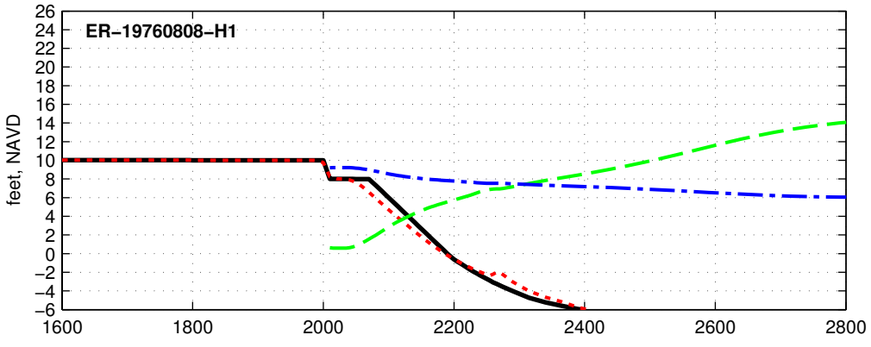
Dune R2T1-10.0-000-060 - ER-19710827

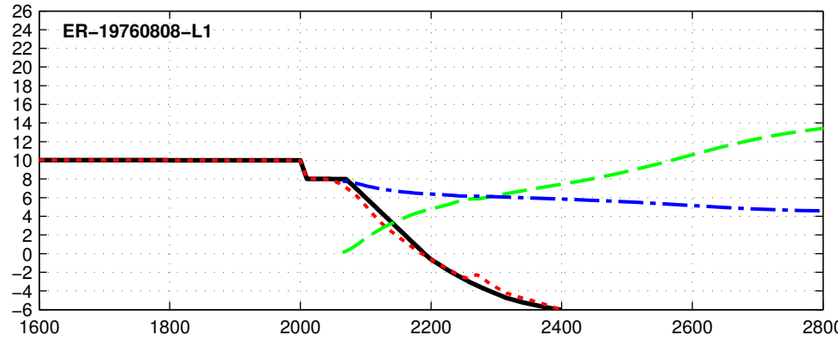


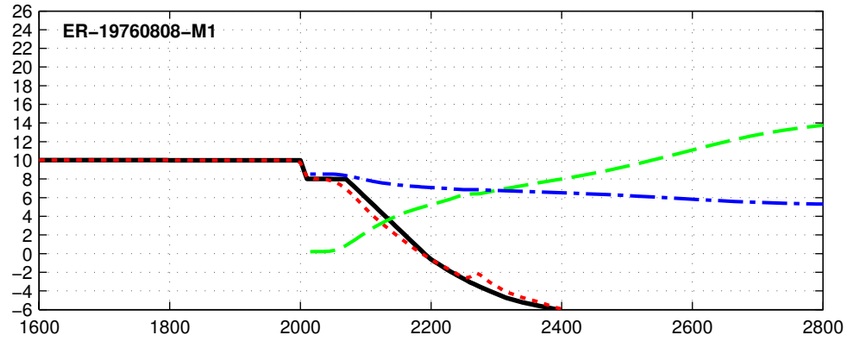
Dune R2T1-10.0-000-060 - ER-19720619

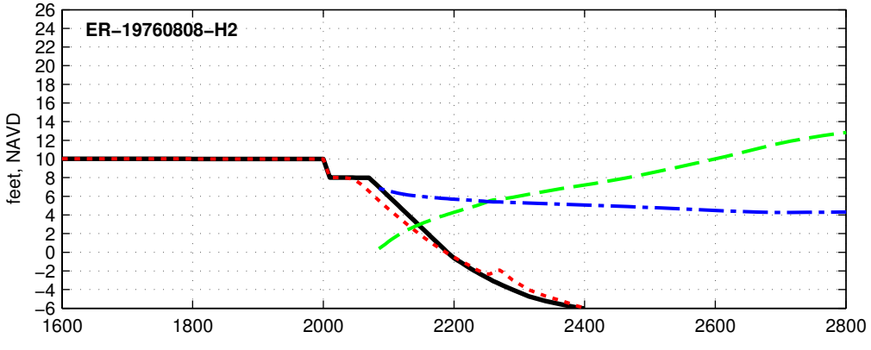


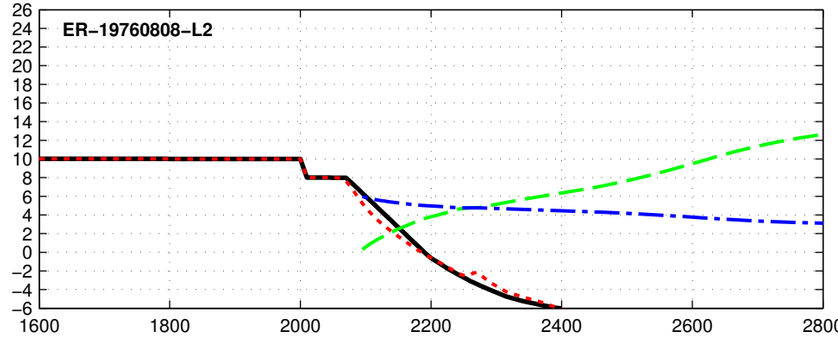
Dune R2T1-10.0-000-060 - ER-19760808

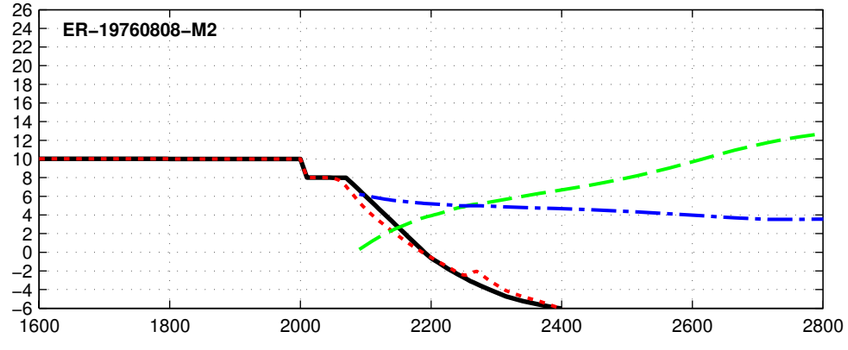


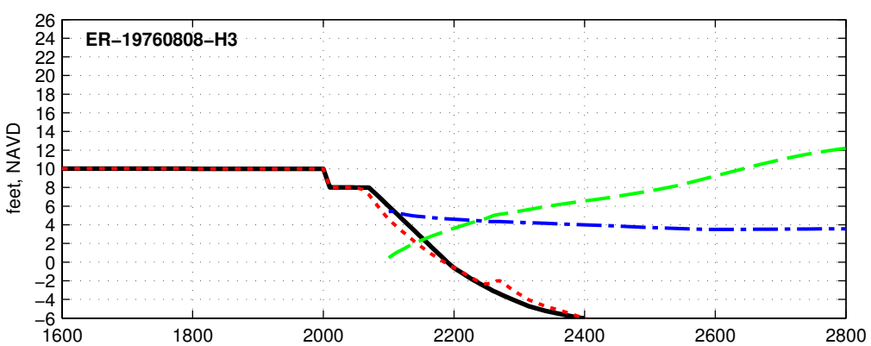


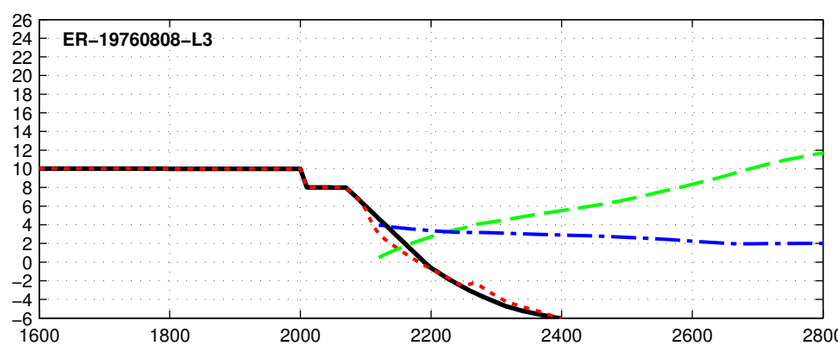


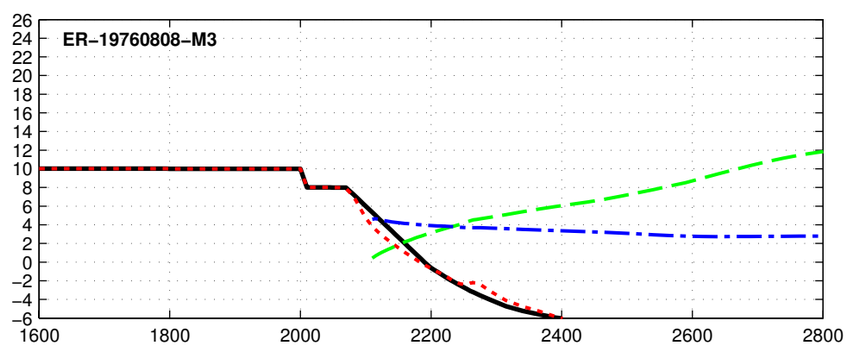


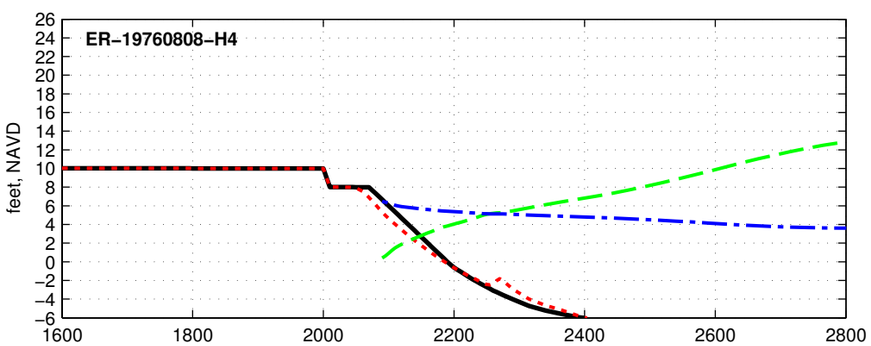


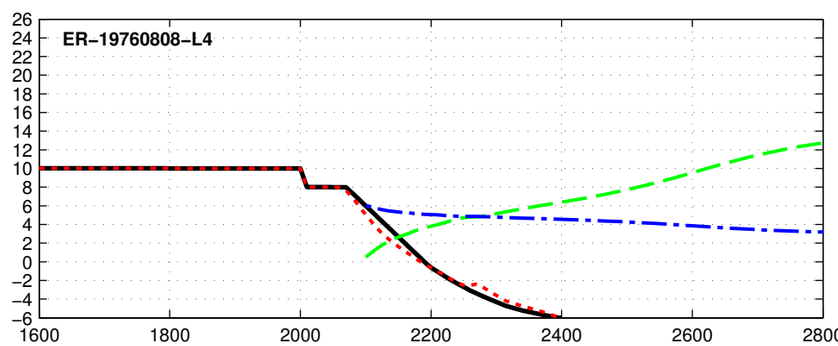


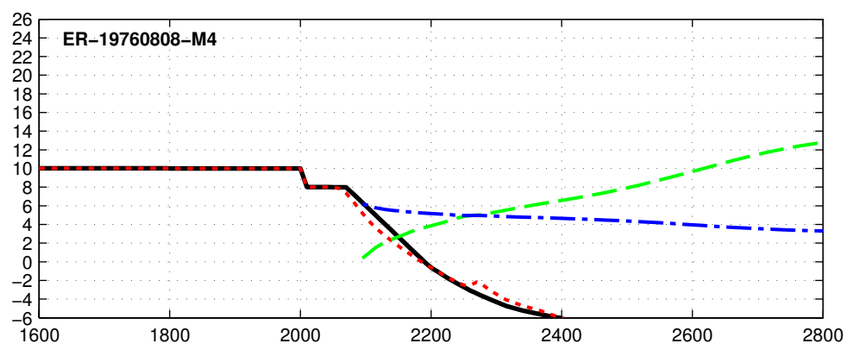






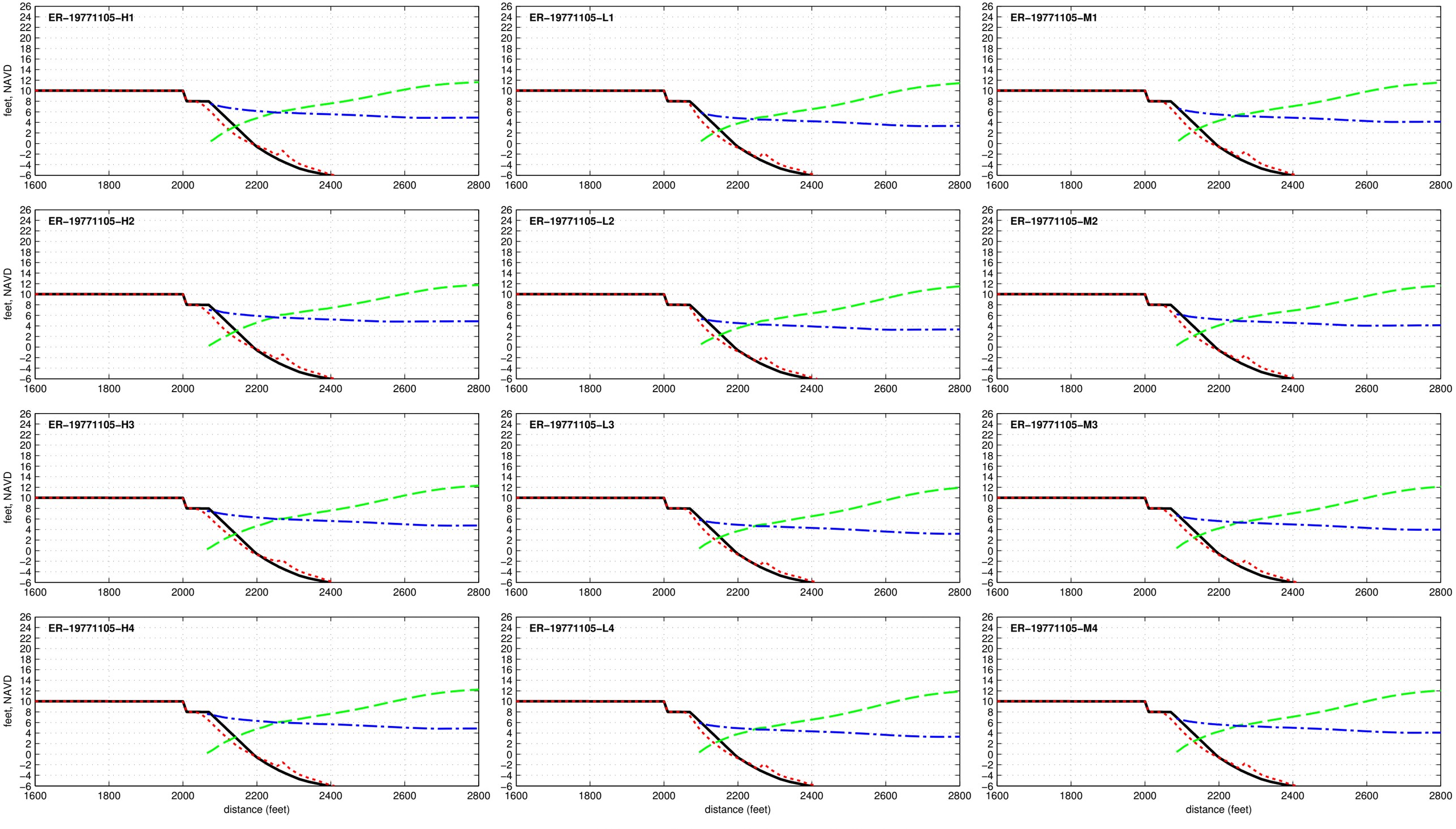




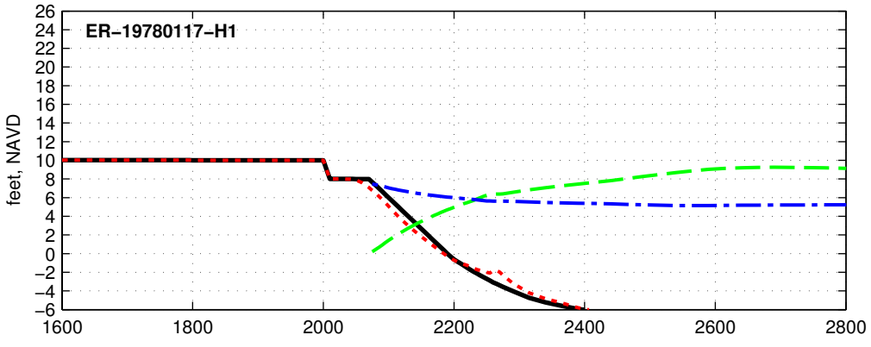


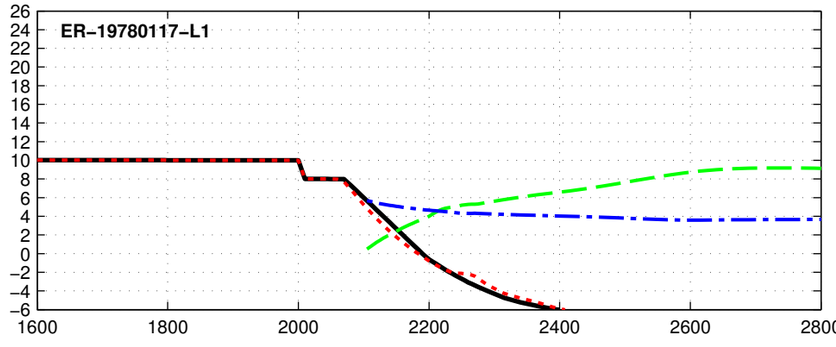
Initial Final Max Hs Max Water Level

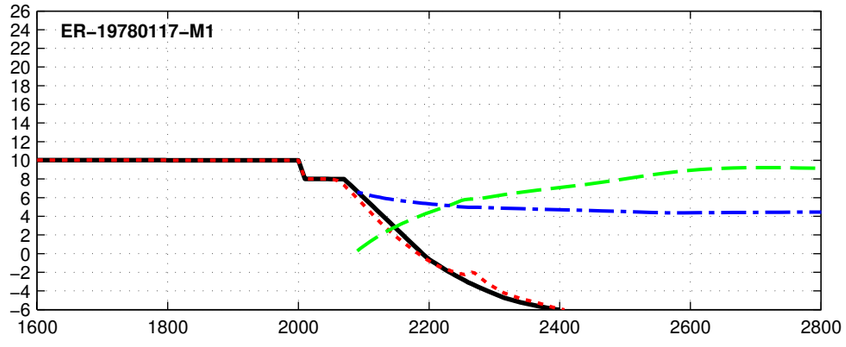
Dune R2T1-10.0-000-060 - ER-19771105

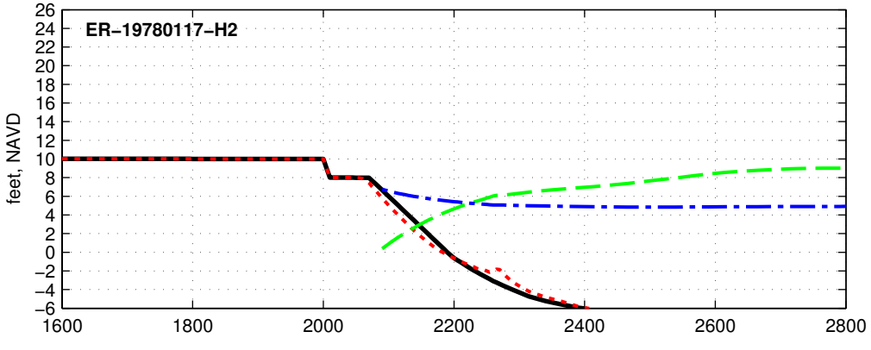


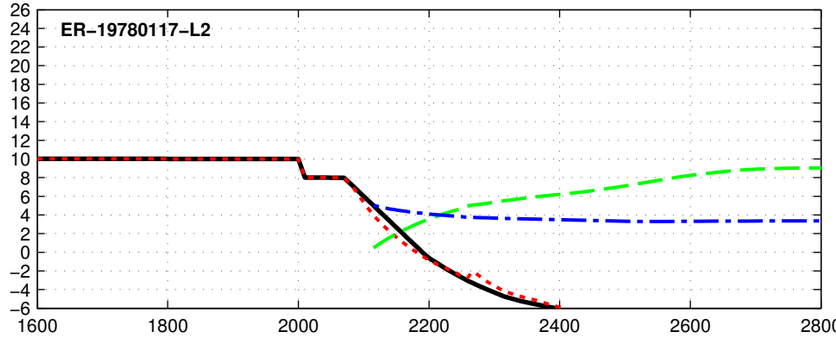
Dune R2T1–10.0–000–060 – ER–19780117

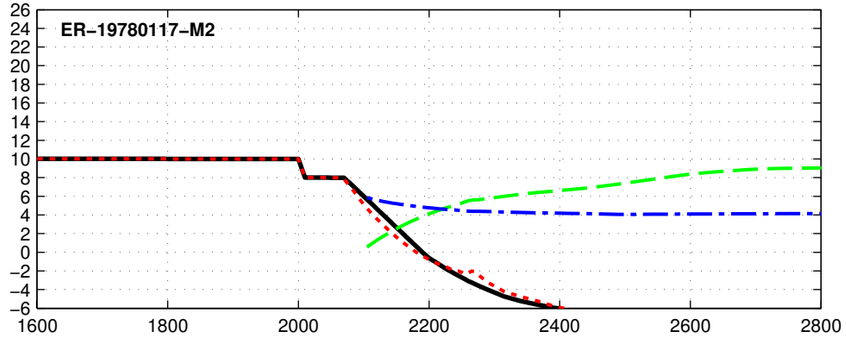


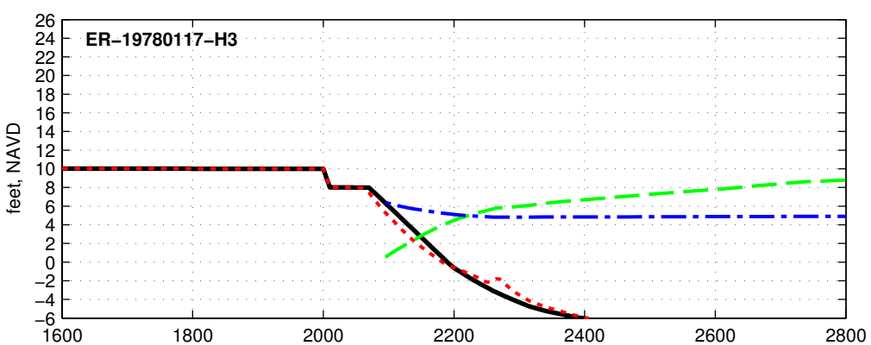


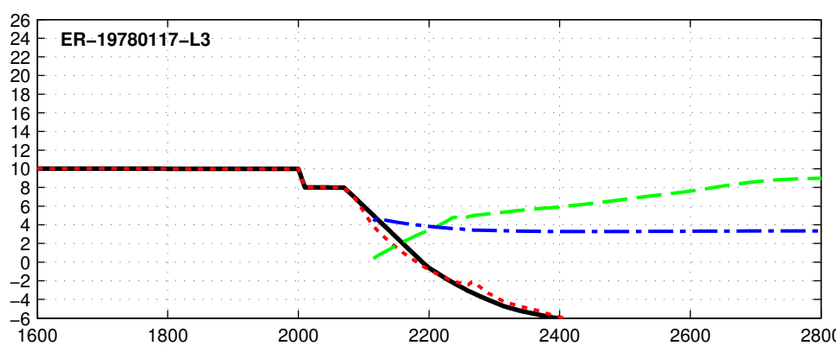


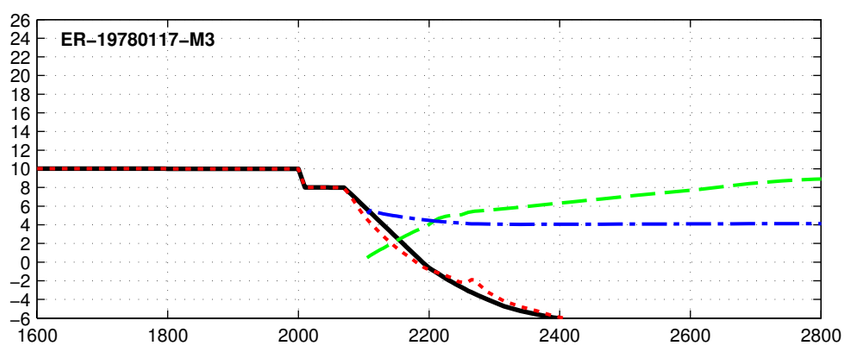


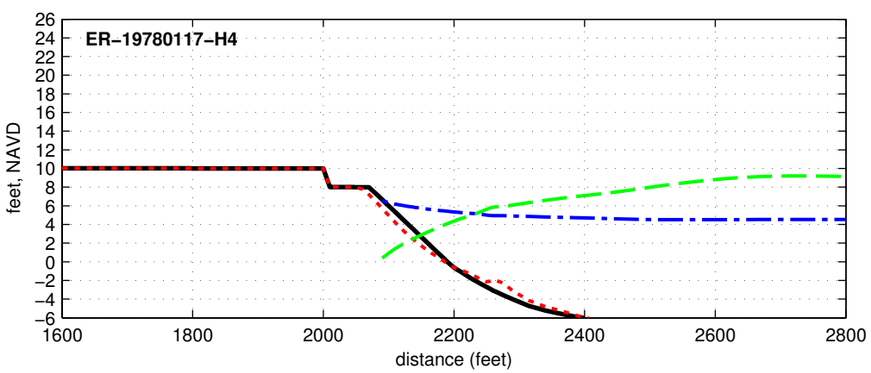


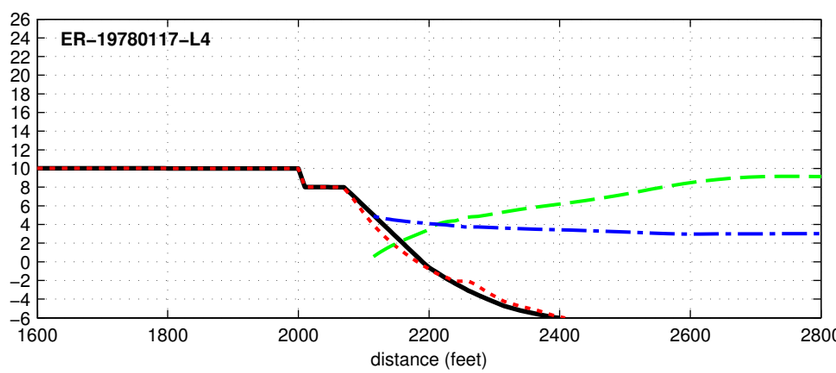


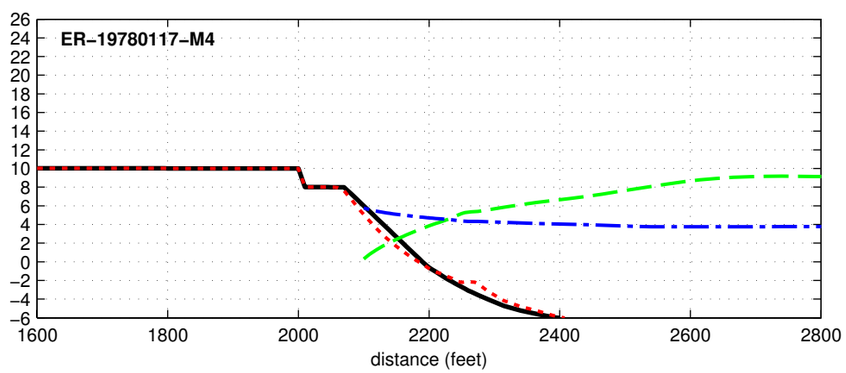






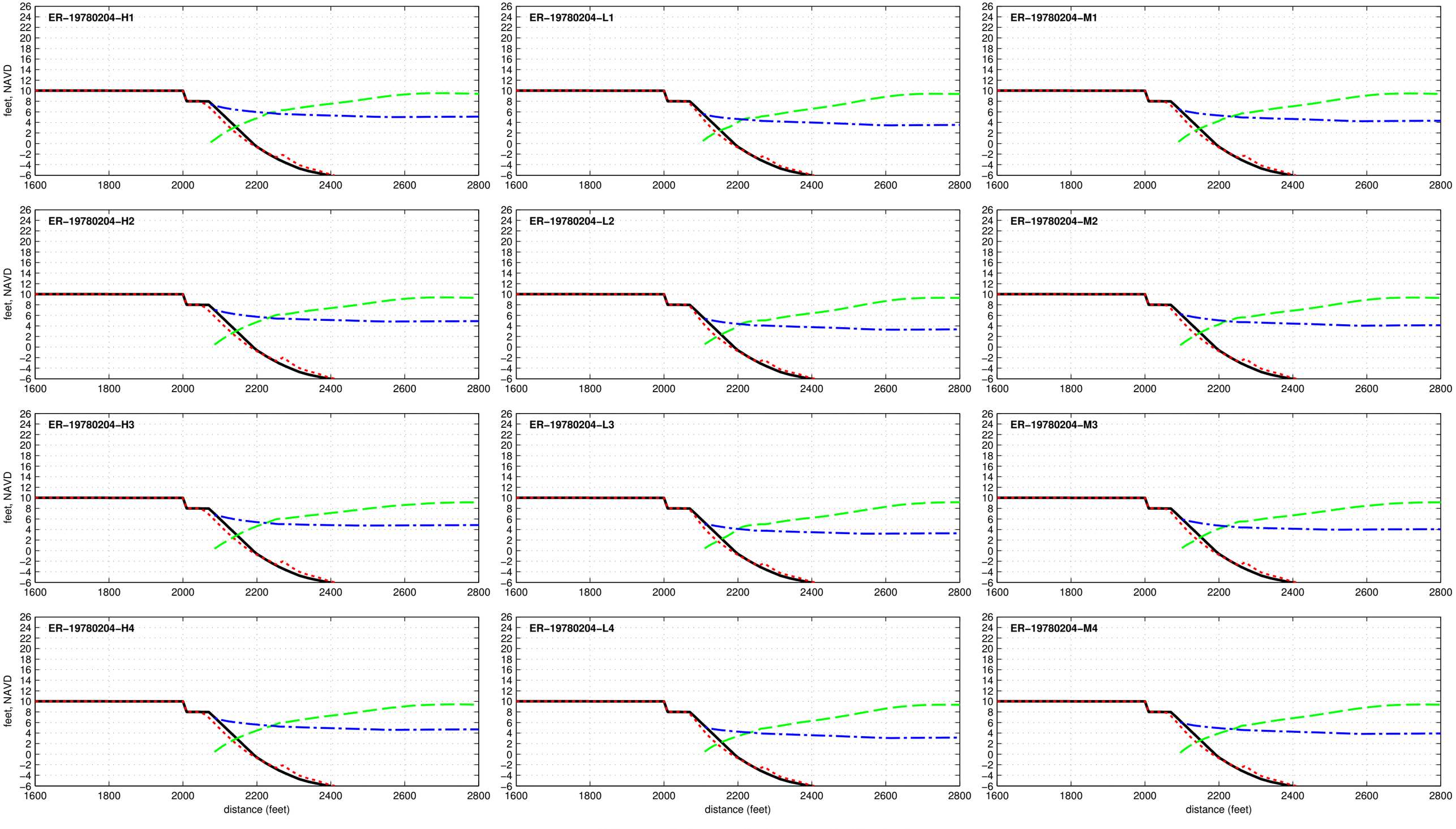




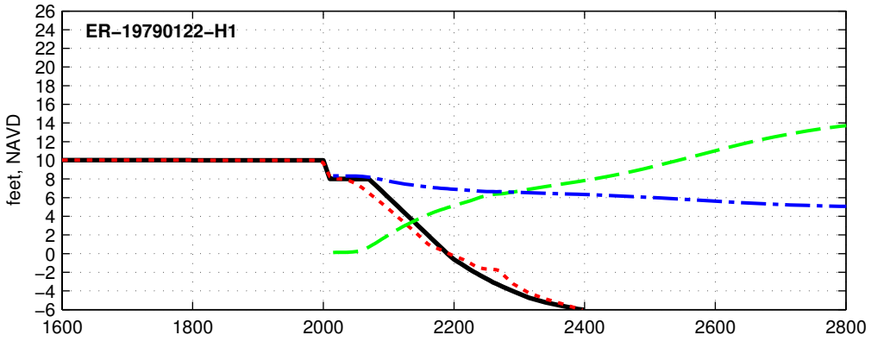


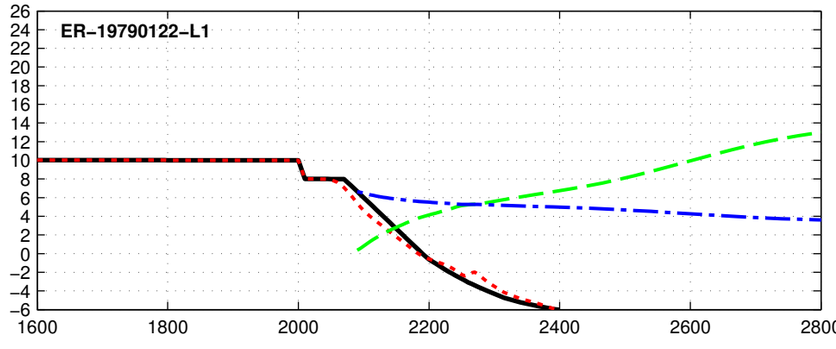
Initial Final Max Hs Max Water Level

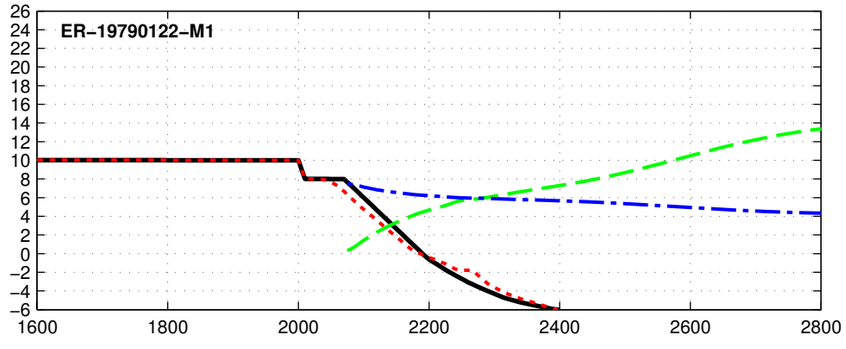
Dune R2T1-10.0-000-060 - ER-19780204

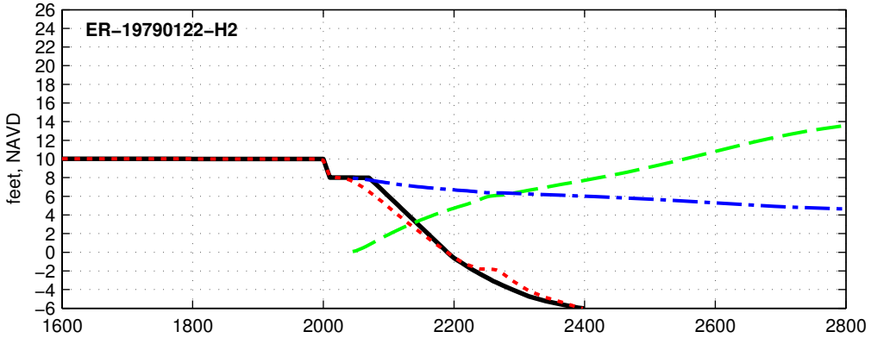


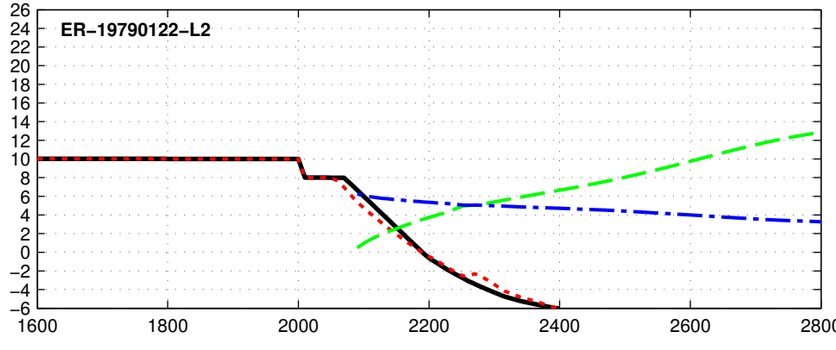
Dune R2T1-10.0-000-060 - ER-19790122

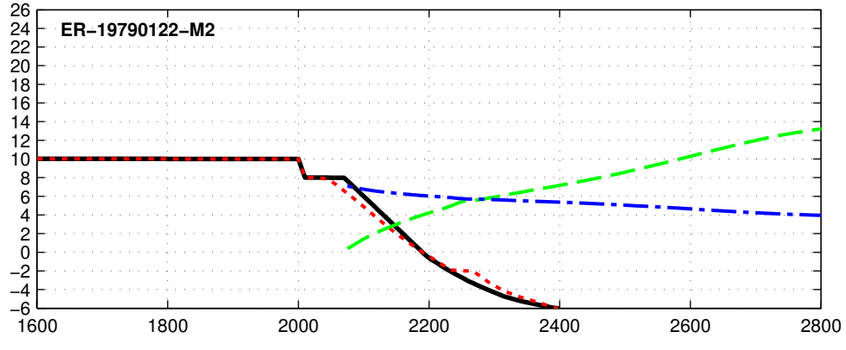


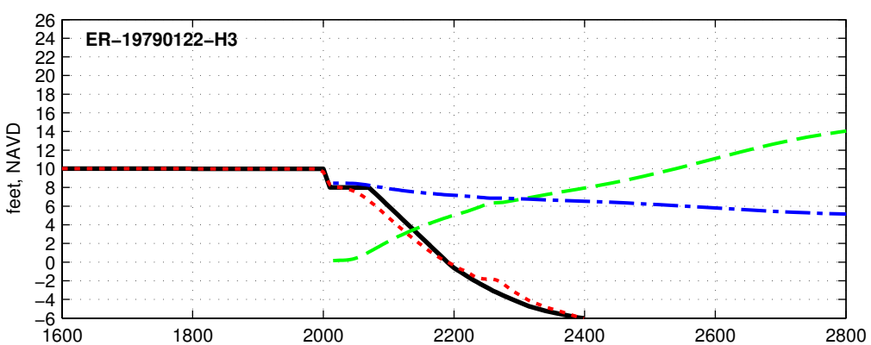


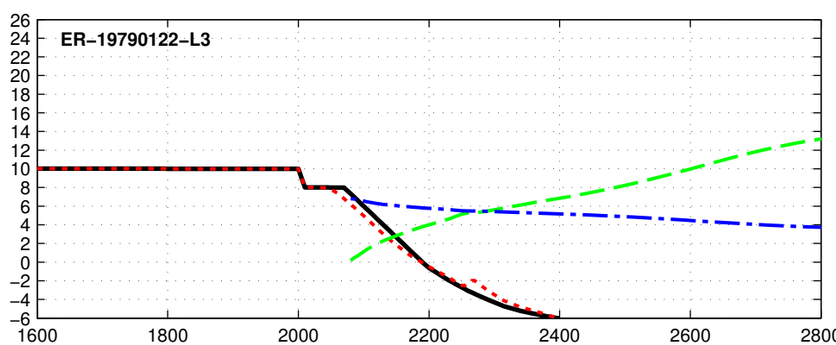


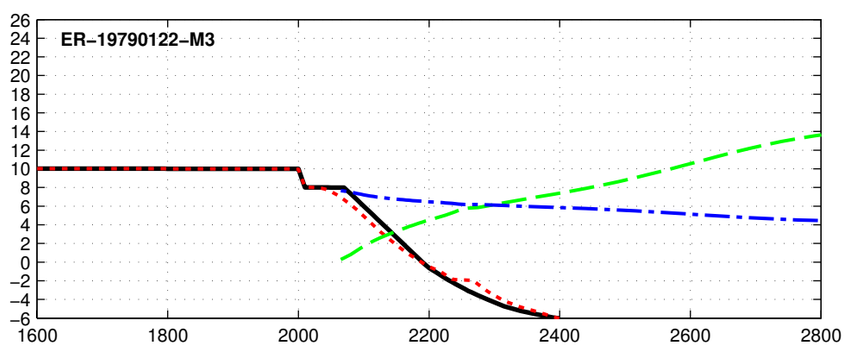


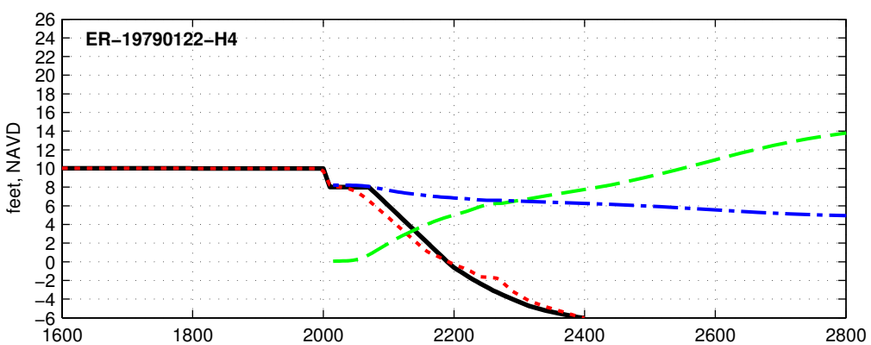


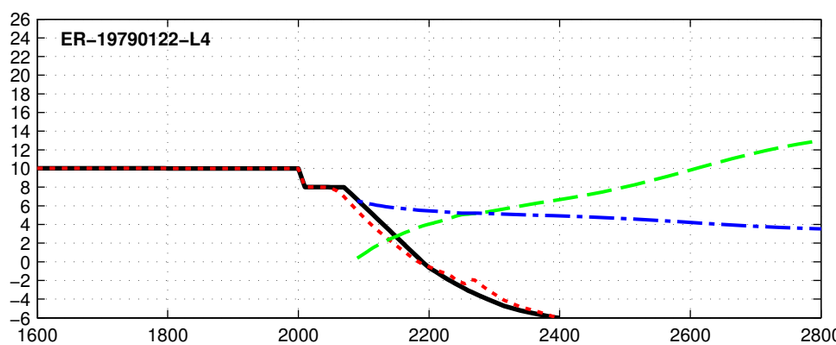


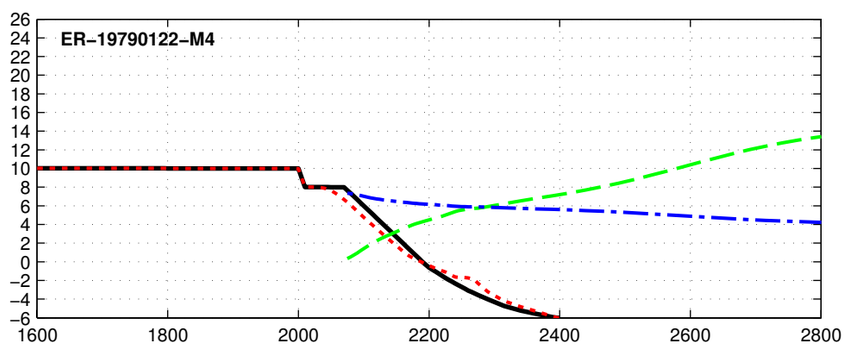










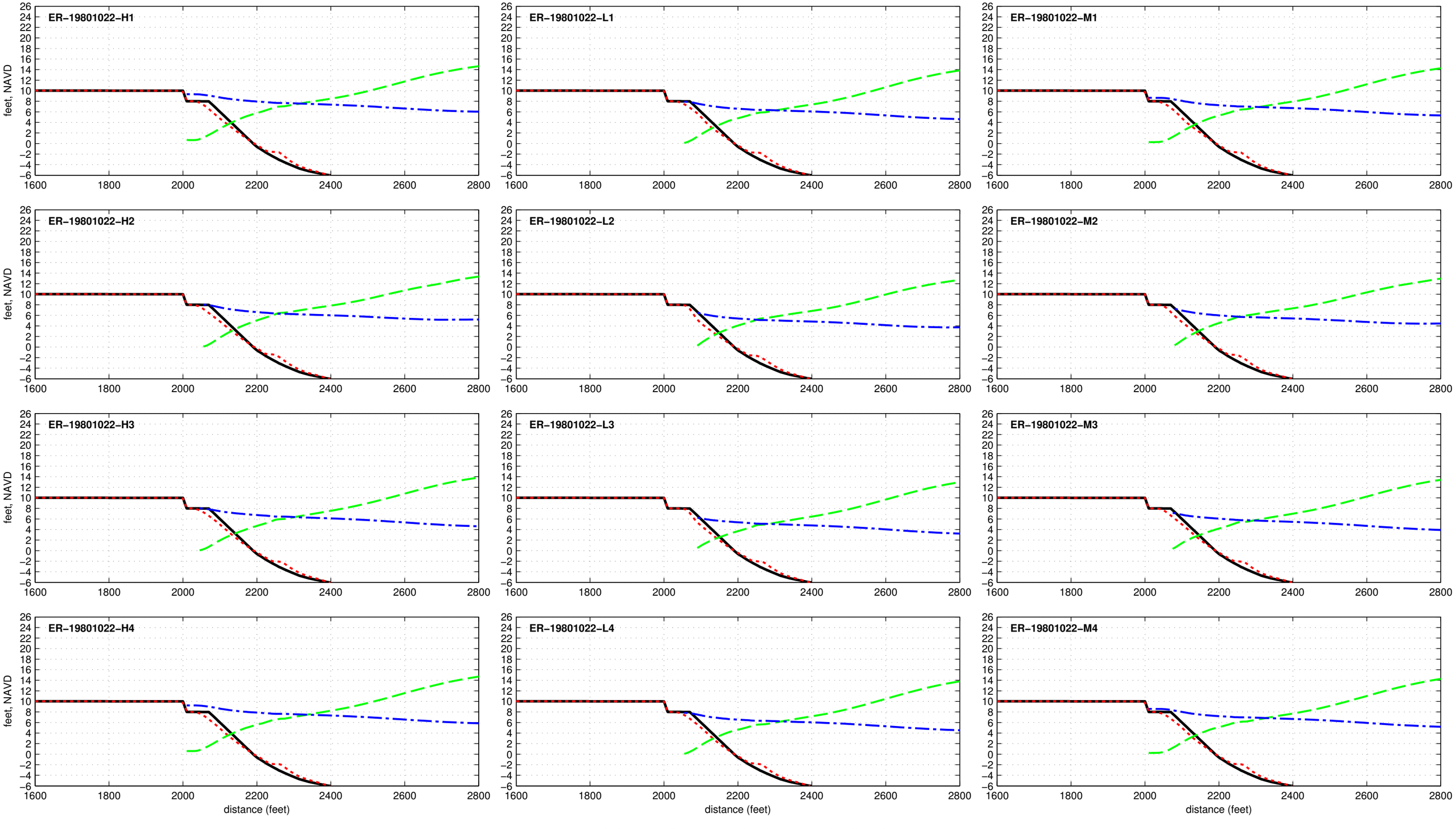


feet, NAVD

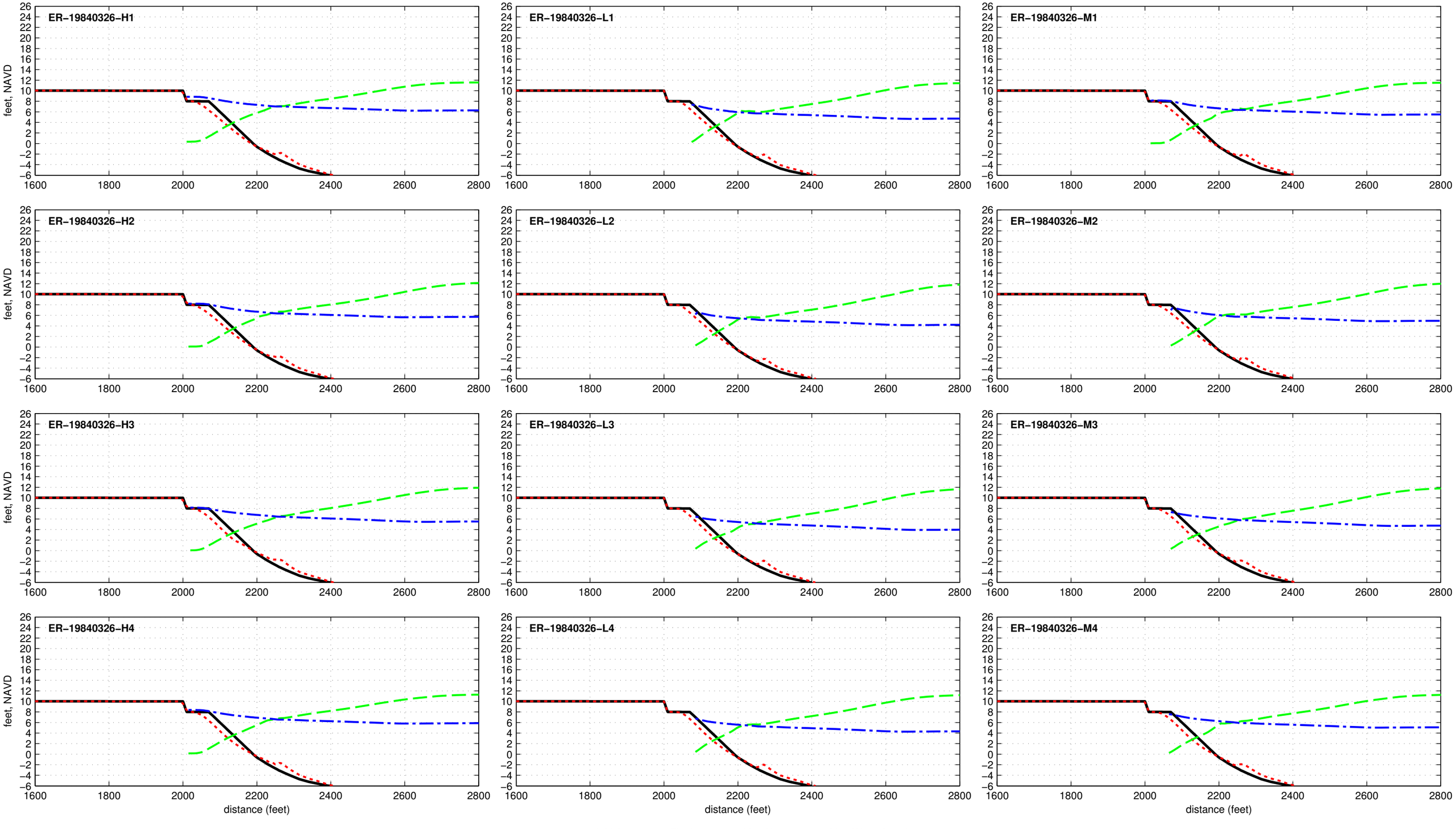
distance (feet)

Initial Final Max Hs Max Water Level

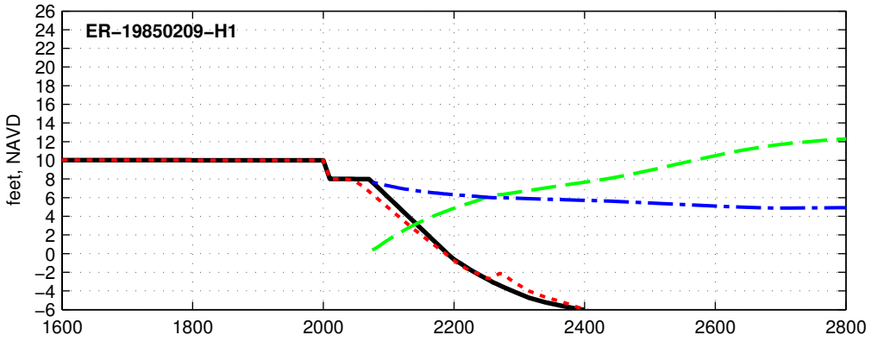
Dune R2T1-10.0-000-060 - ER-19801022

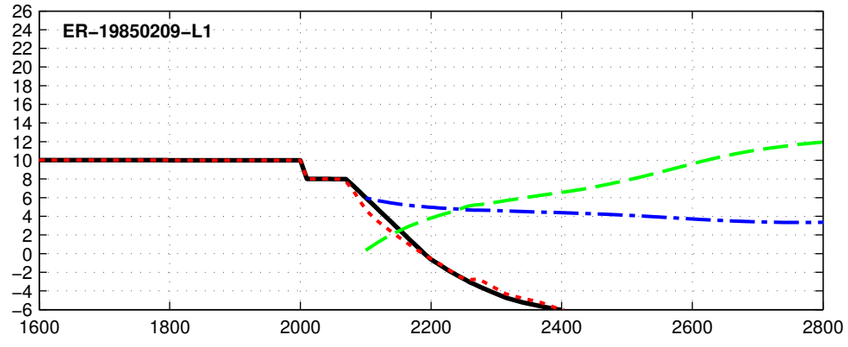


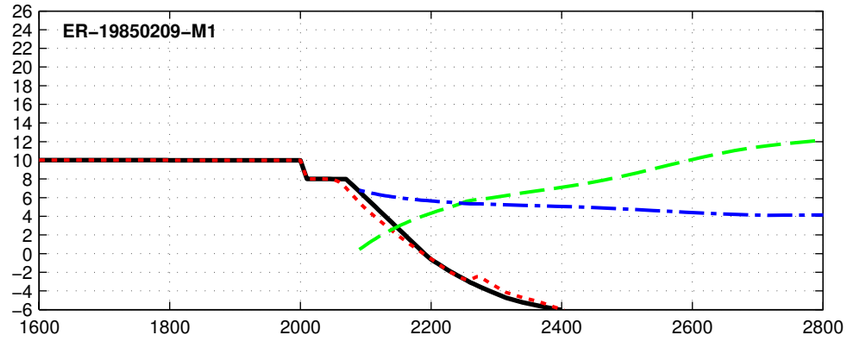
Dune R2T1-10.0-000-060 - ER-19840326

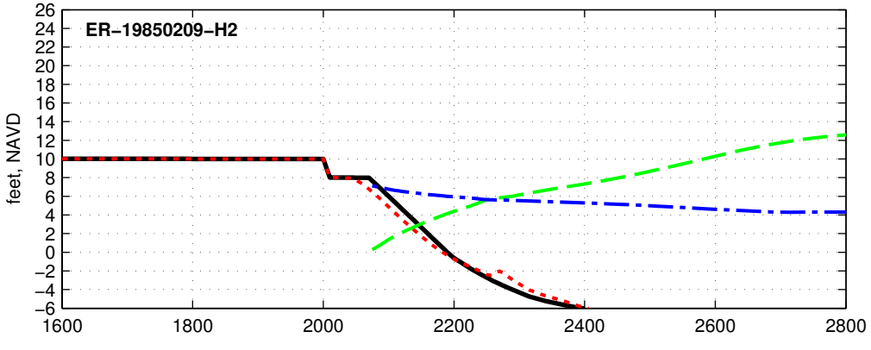


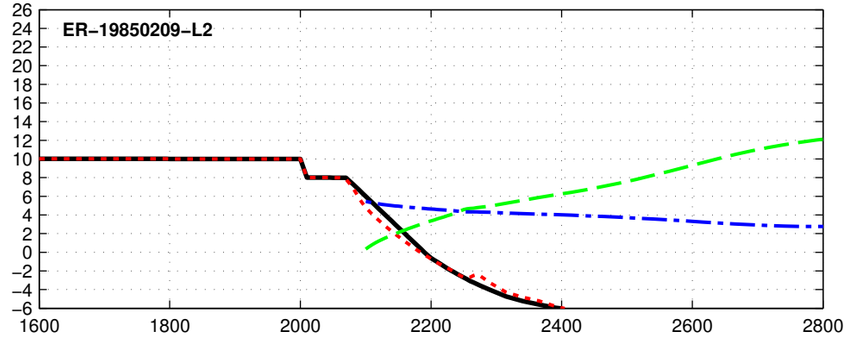
Dune R2T1-10.0-000-060 - ER-19850209

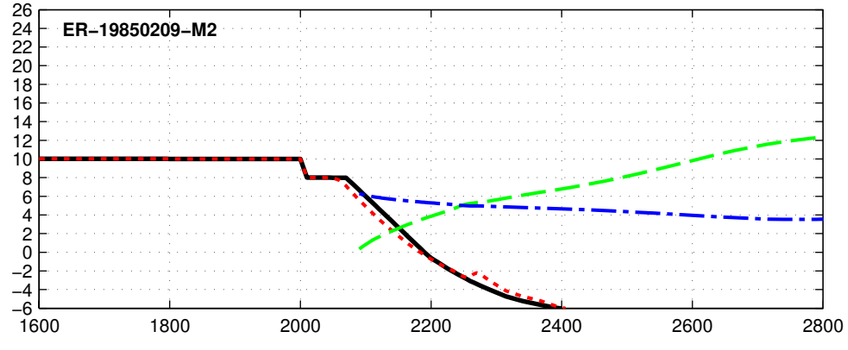


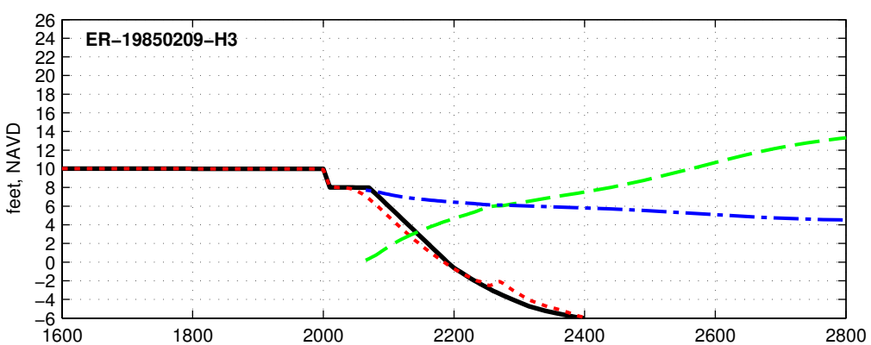


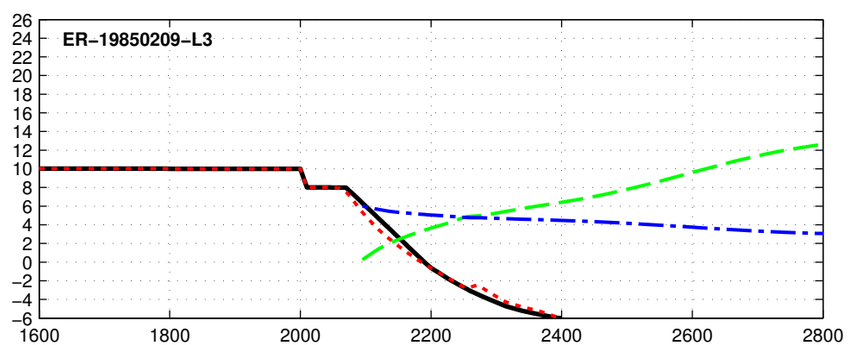


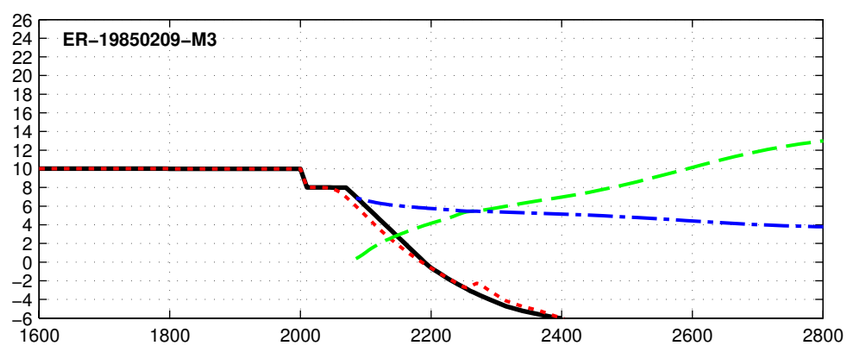


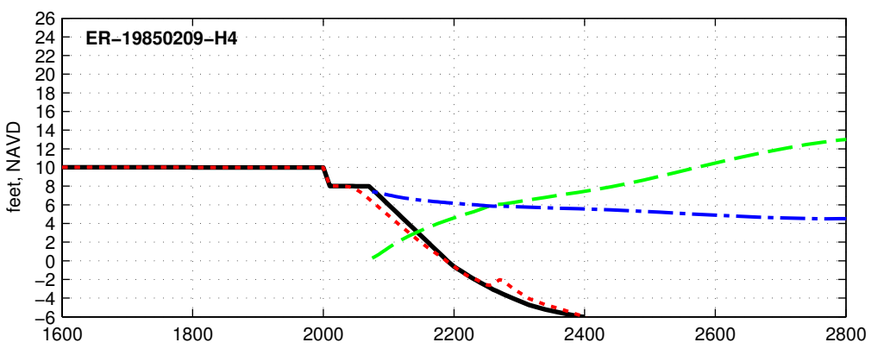


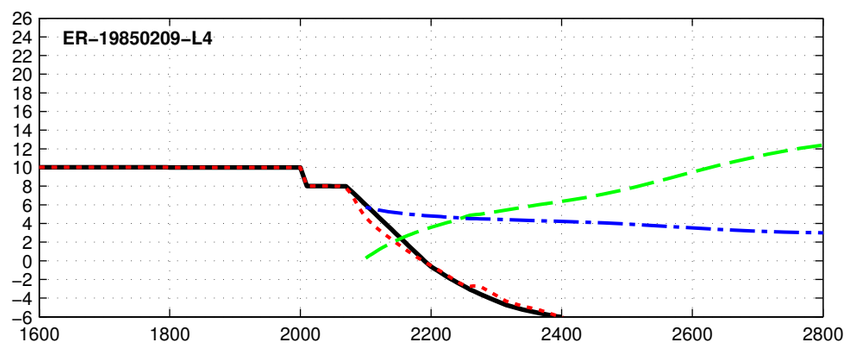


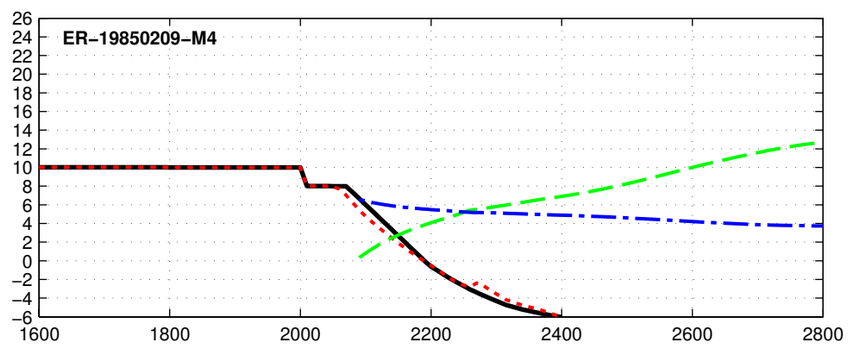






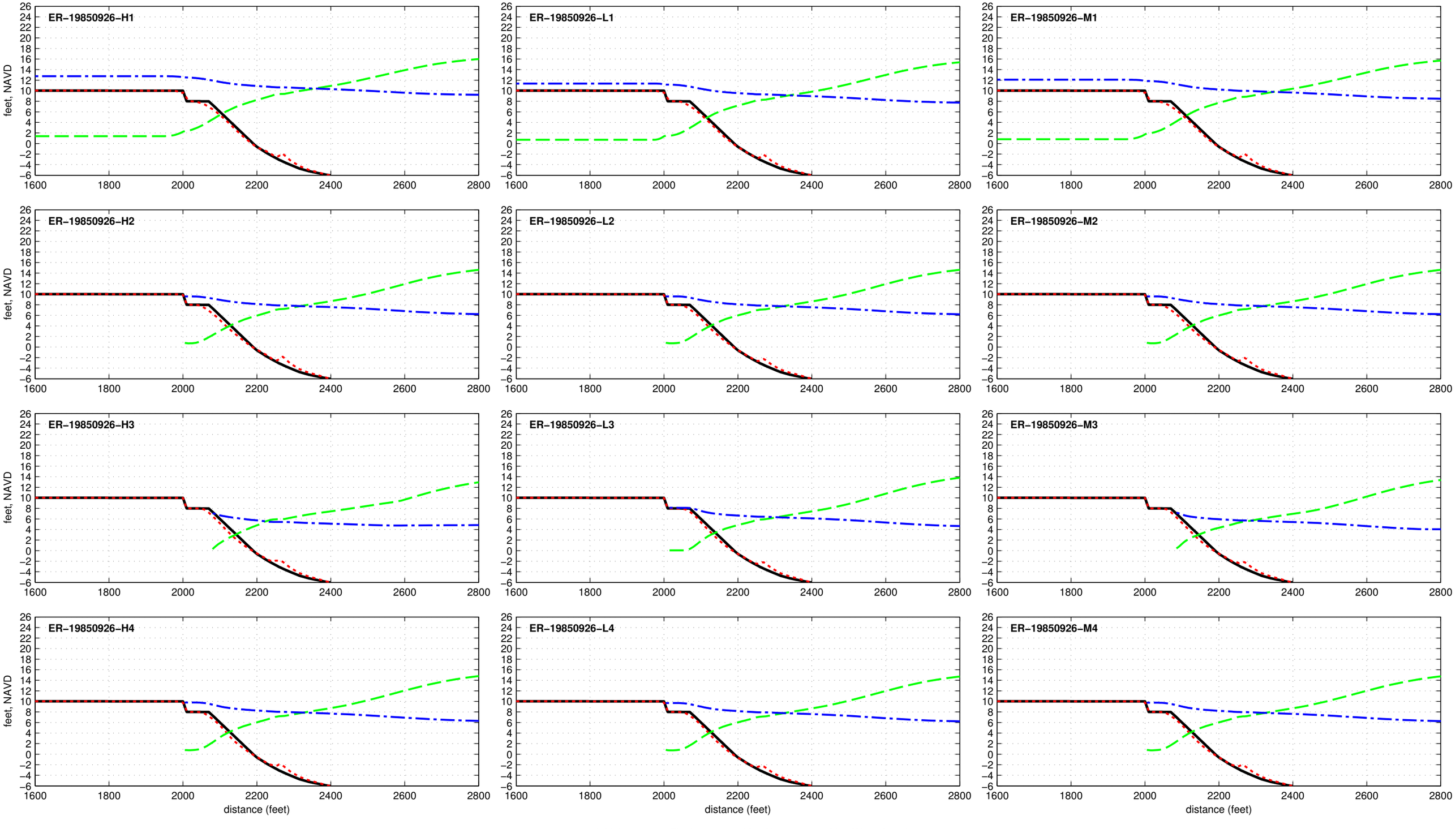




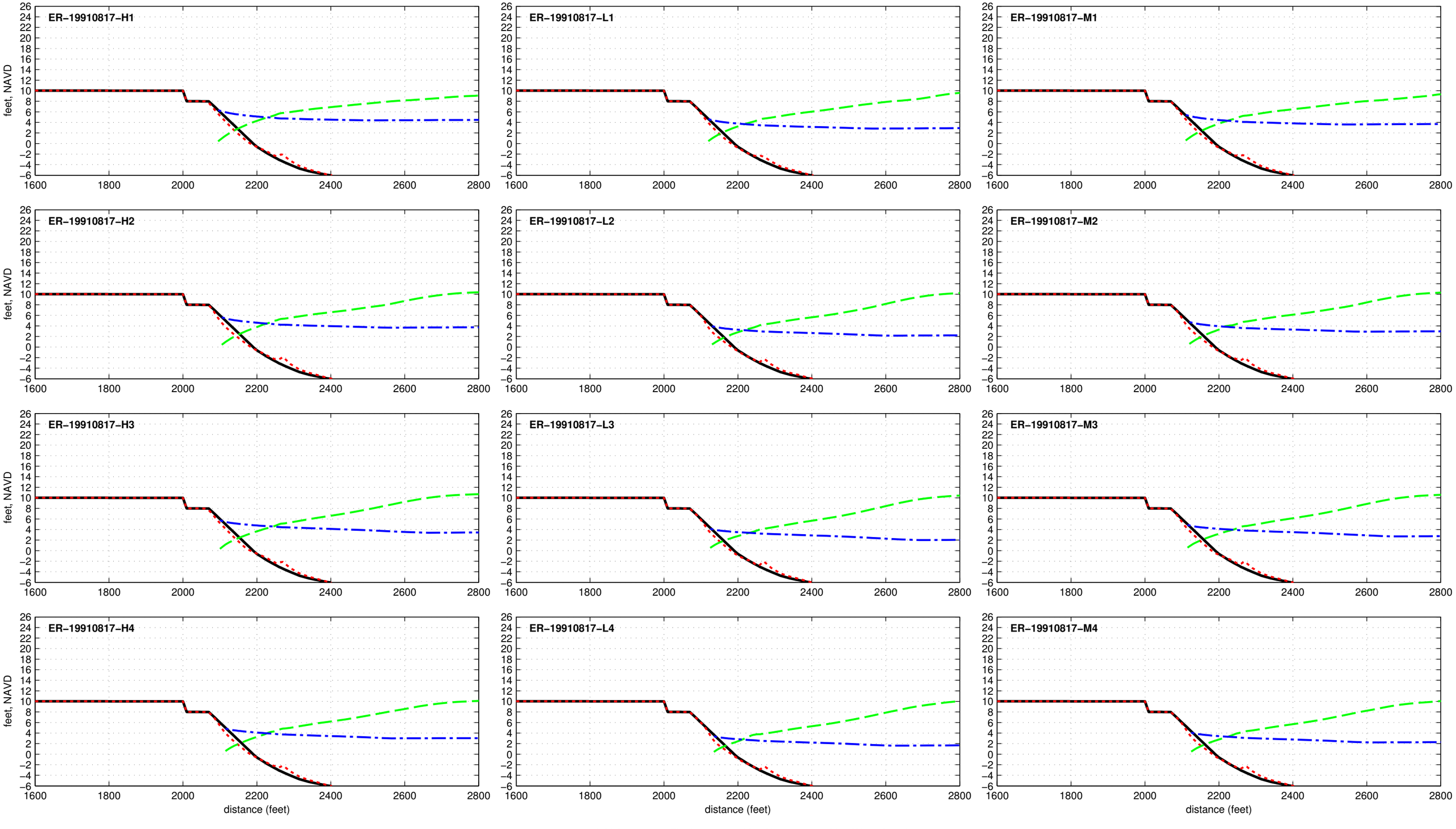


Initial Final Max Hs Max Water Level

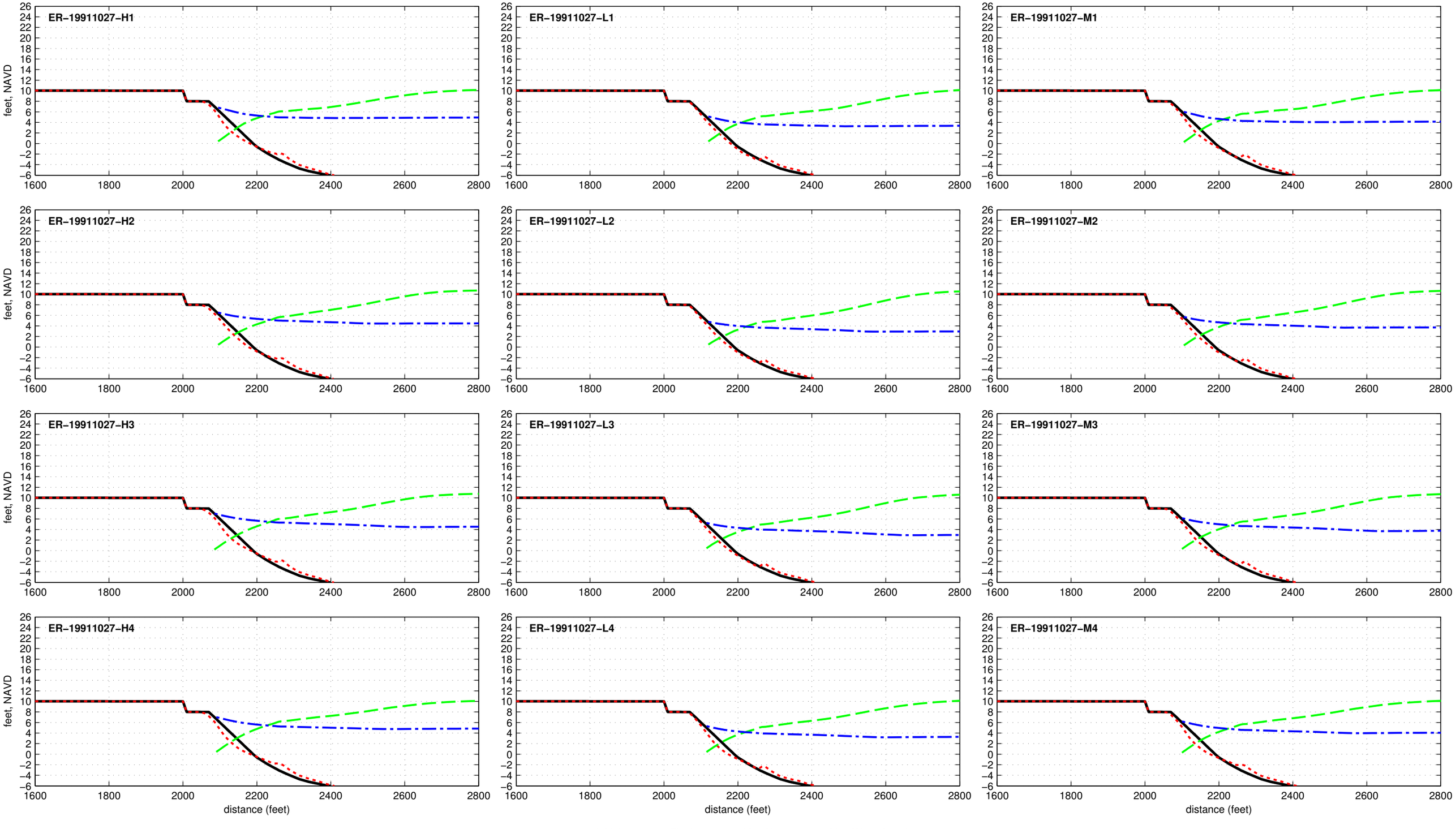
Dune R2T1-10.0-000-060 - ER-19850926



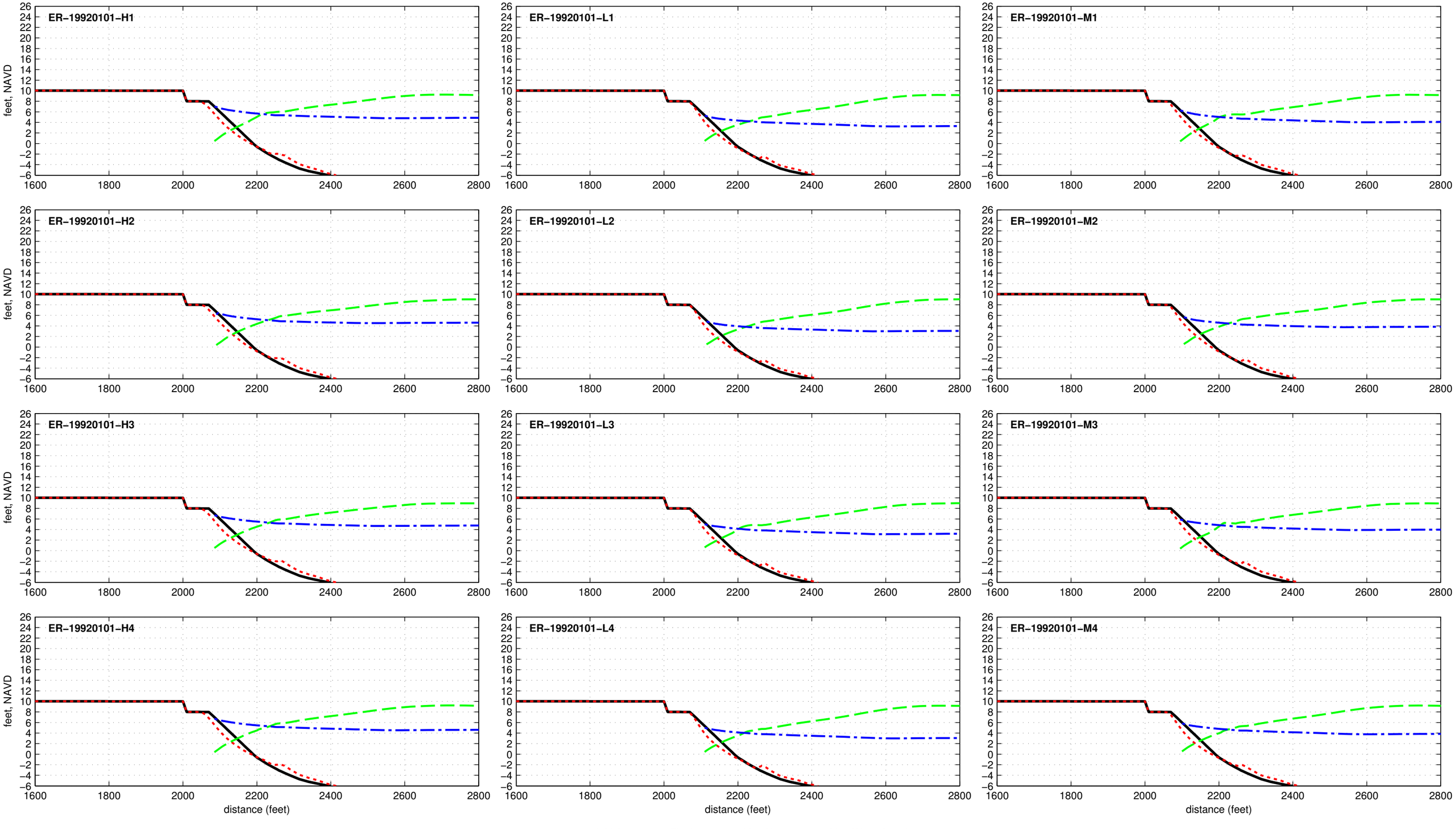
Dune R2T1-10.0-000-060 - ER-19910817



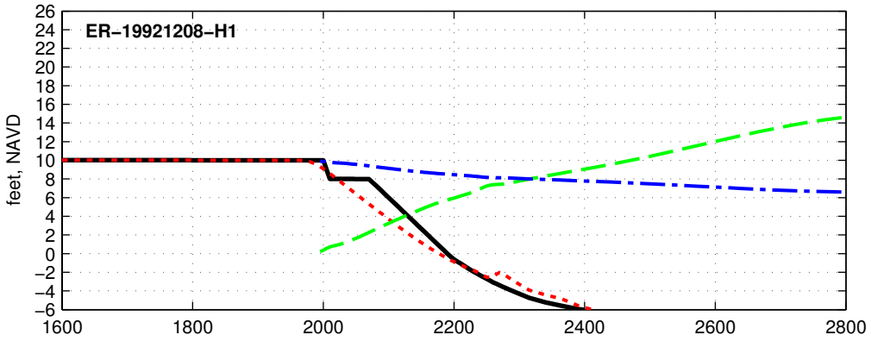
Dune R2T1-10.0-000-060 - ER-19911027

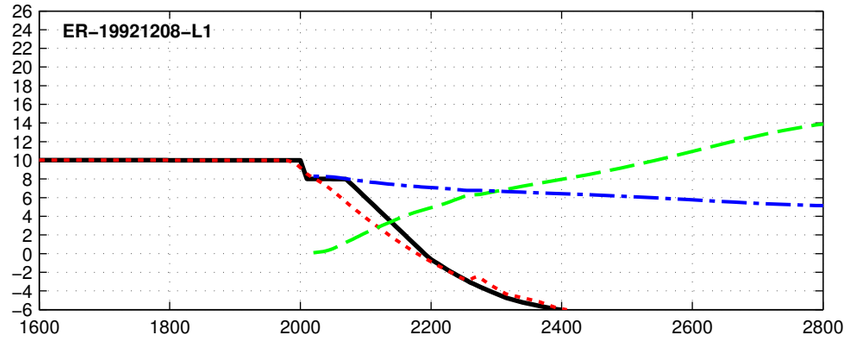


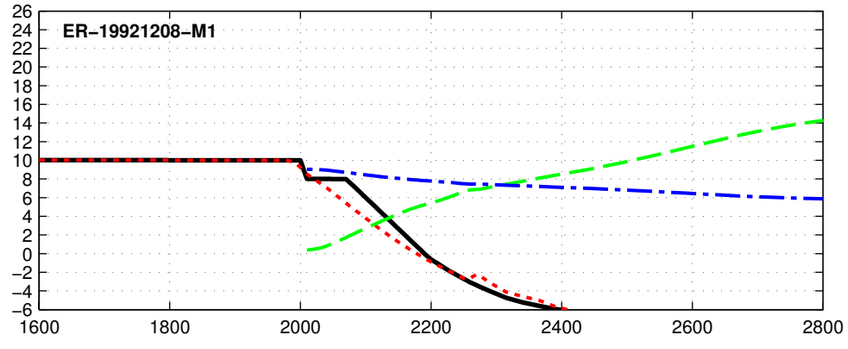
Dune R2T1-10.0-000-060 - ER-19920101

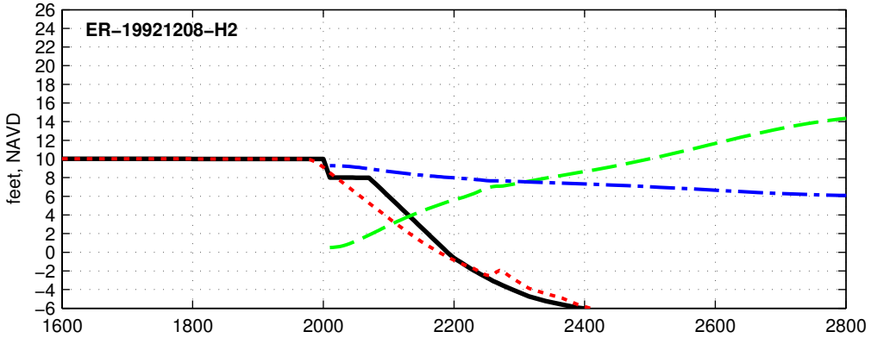


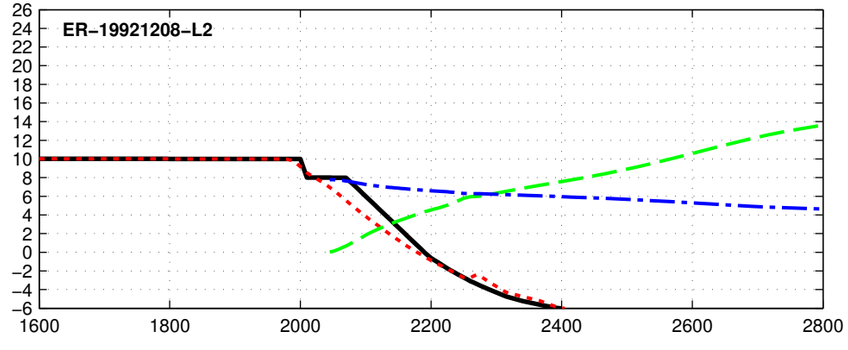
Dune R2T1-10.0-000-060 - ER-19921208

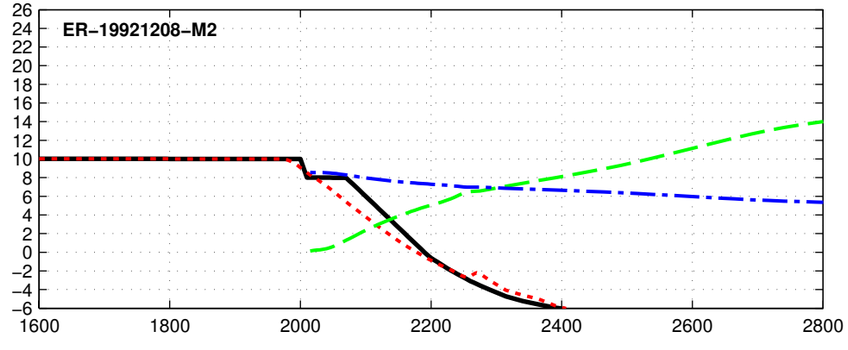


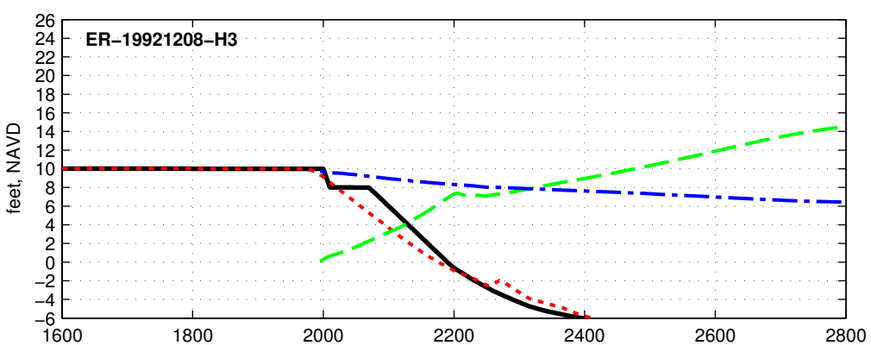


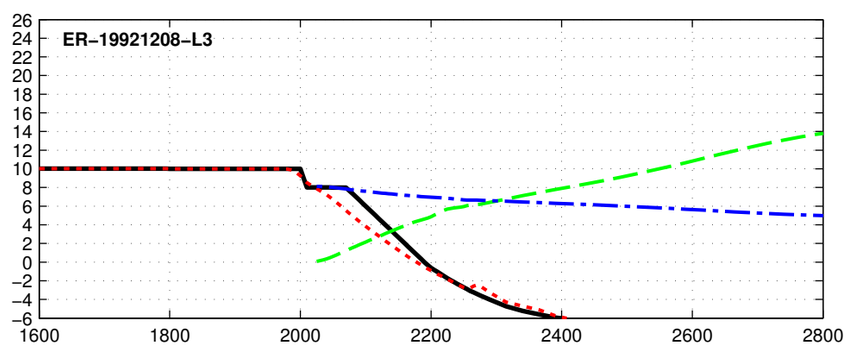


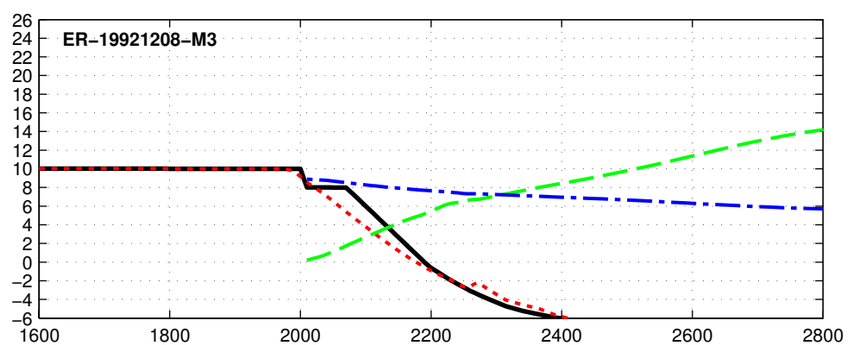


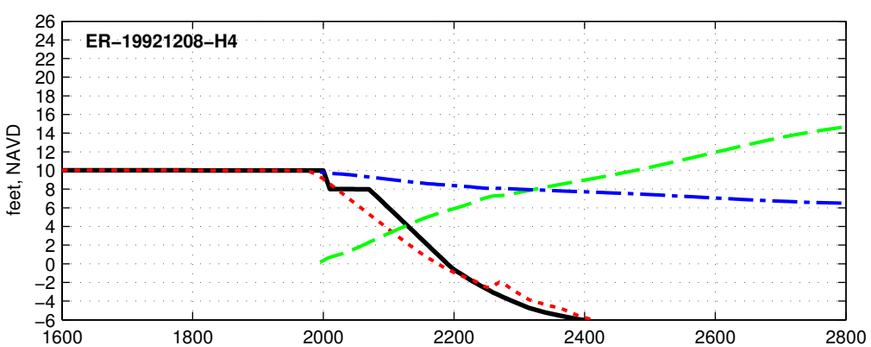


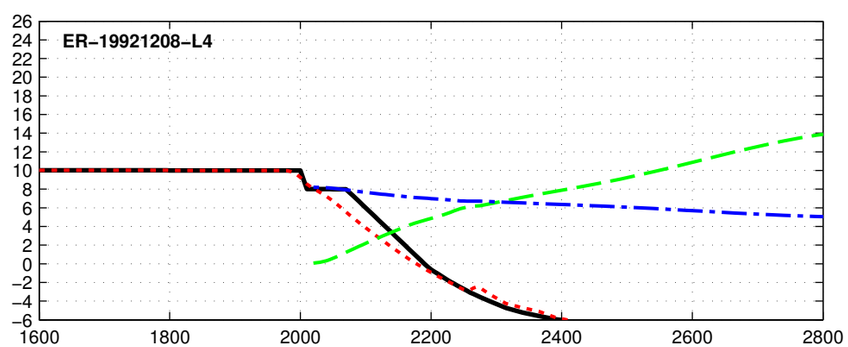


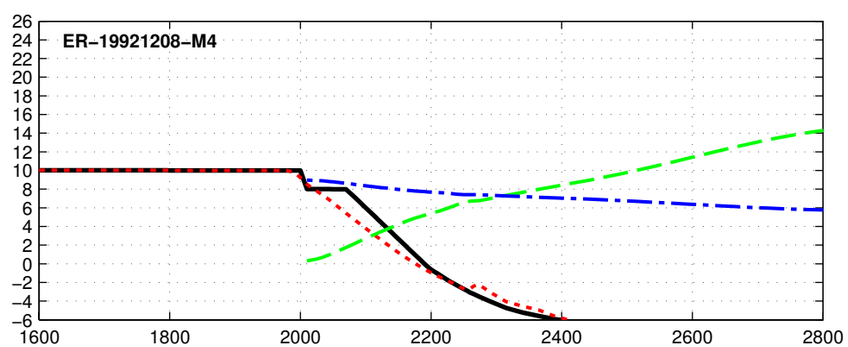






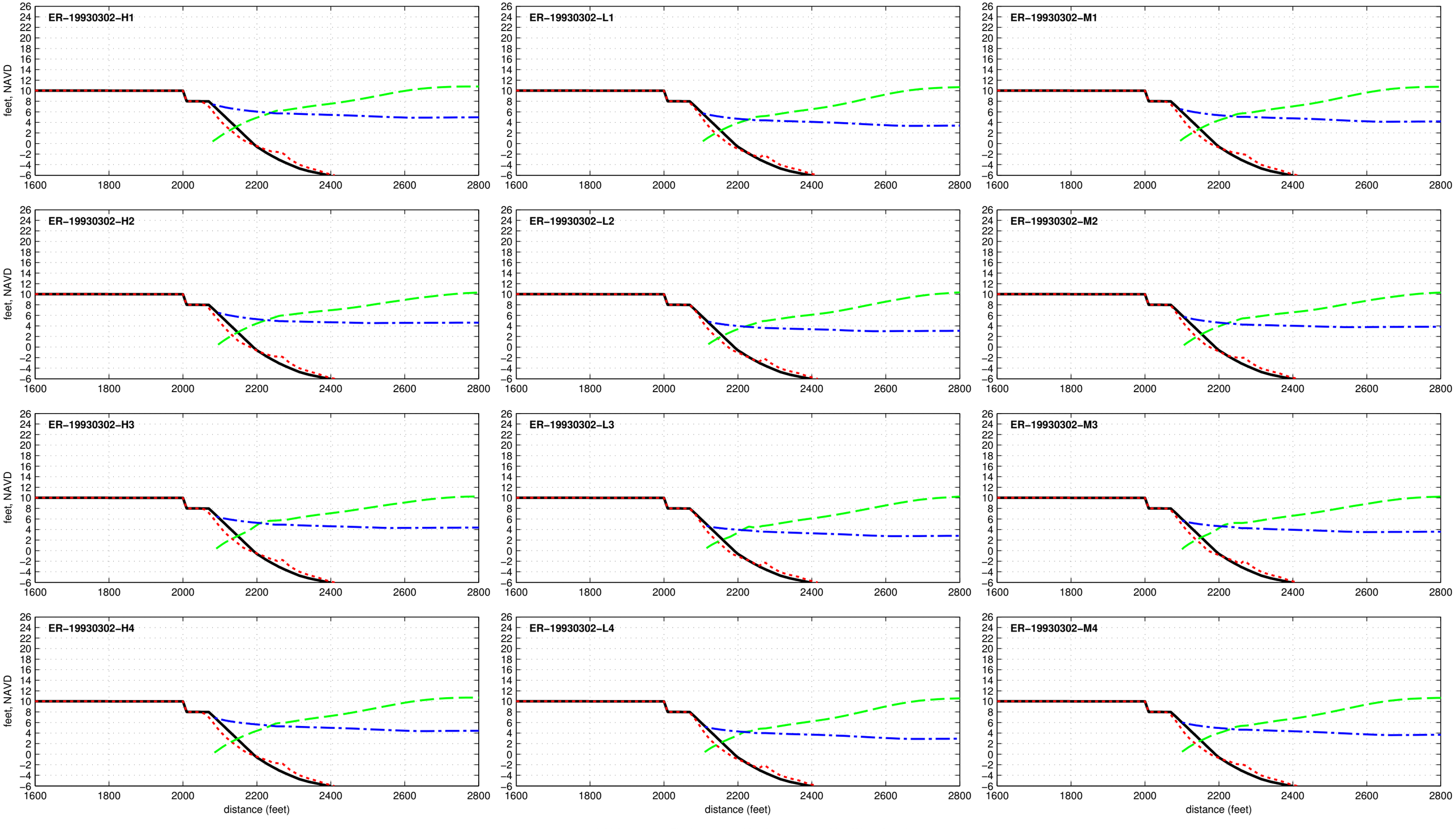




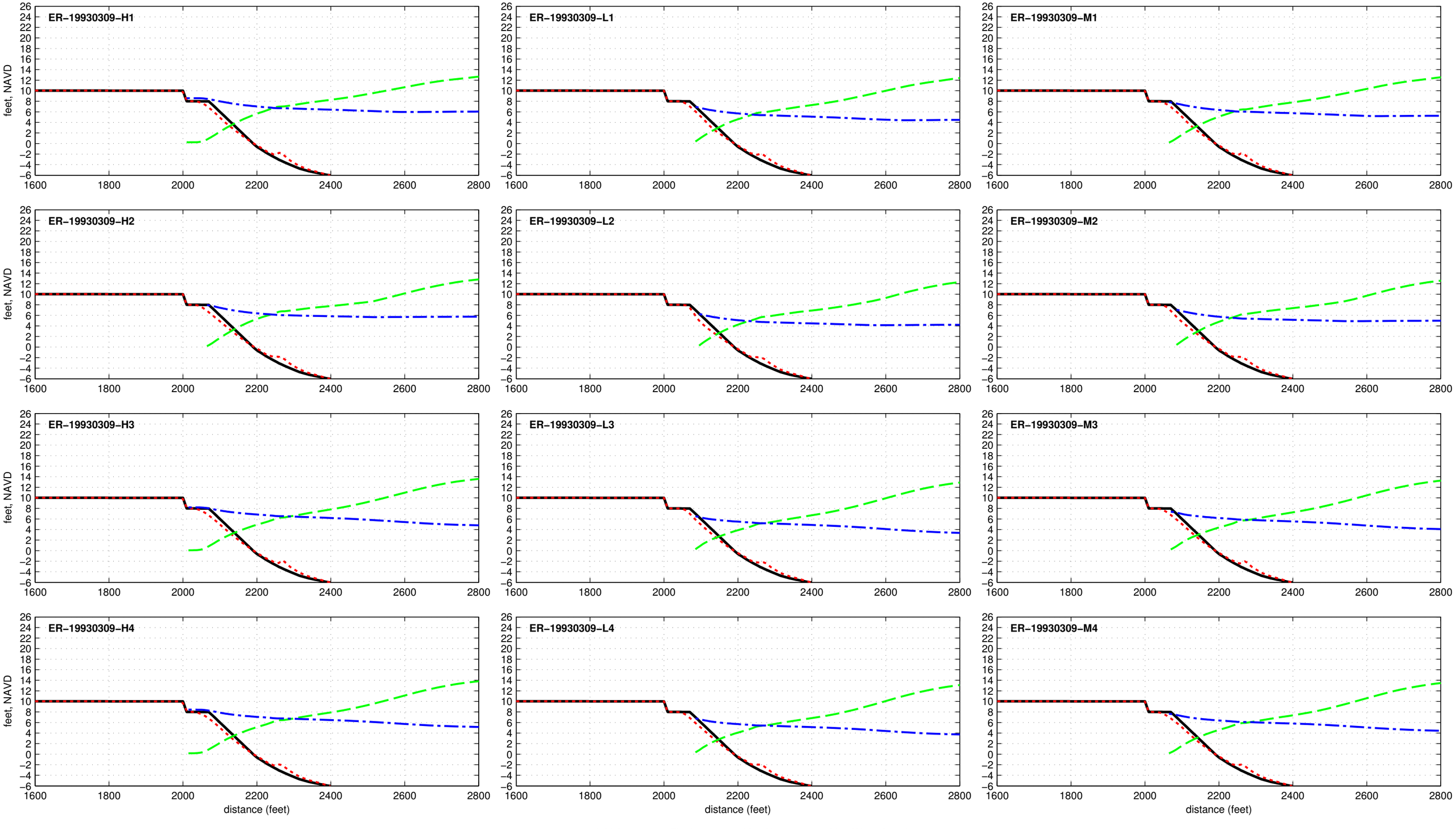


Initial Final Max Hs Max Water Level

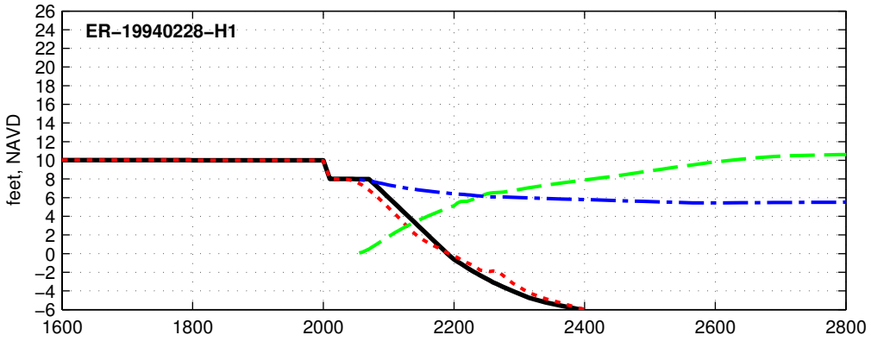
Dune R2T1–10.0–000–060 – ER–19930302

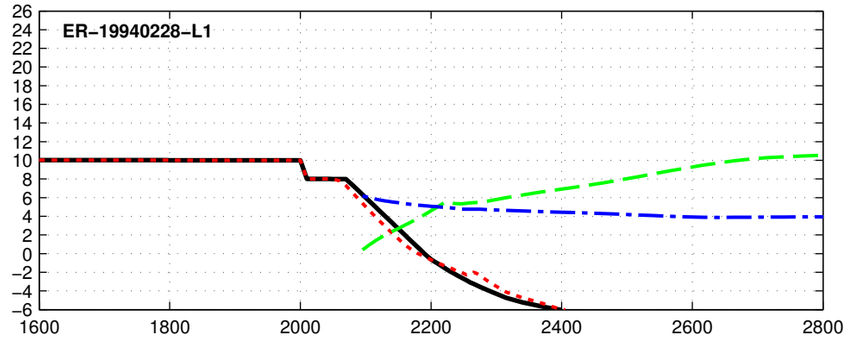


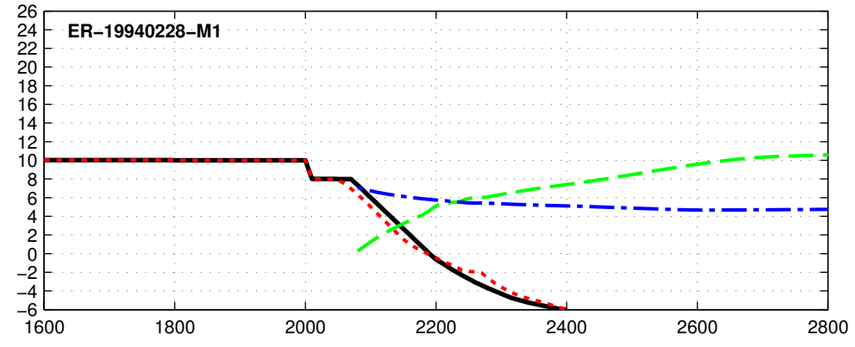
Dune R2T1-10.0-000-060 - ER-19930309

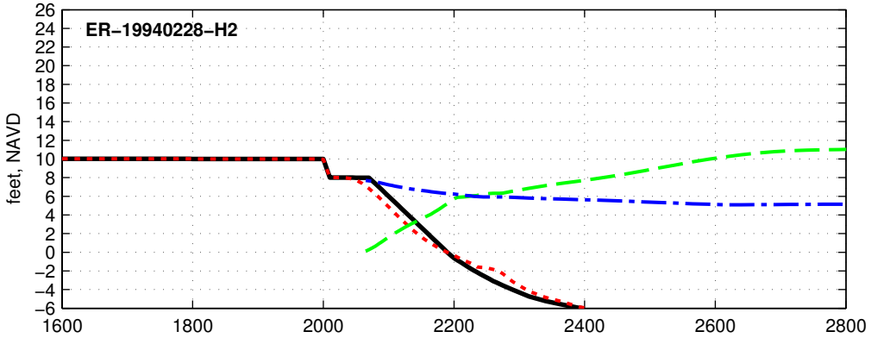


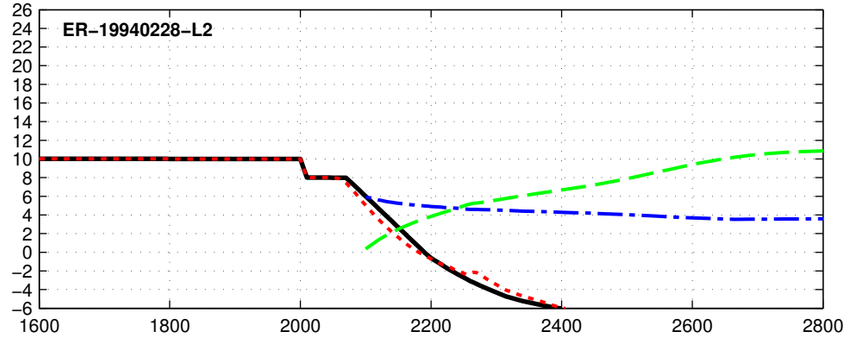
Dune R2T1-10.0-000-060 - ER-19940228

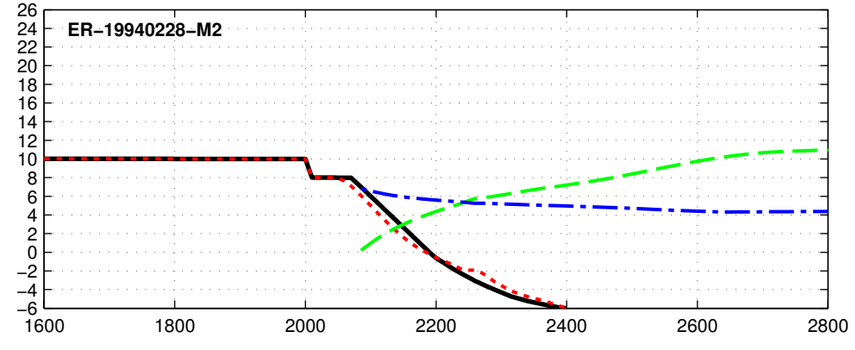


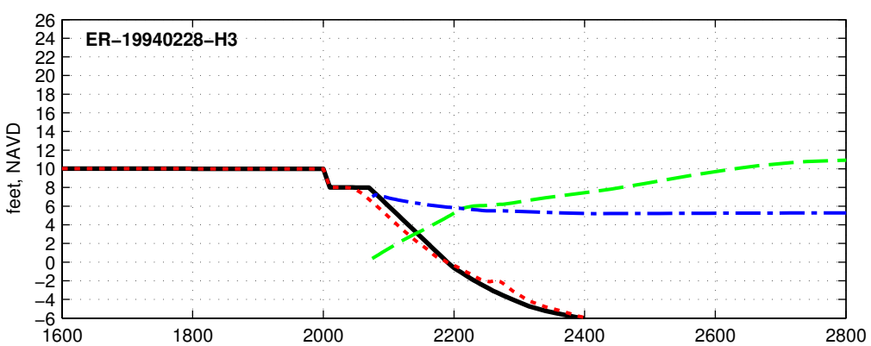


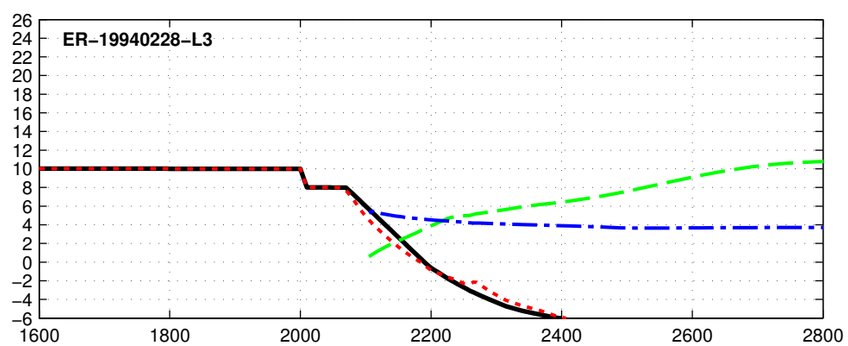


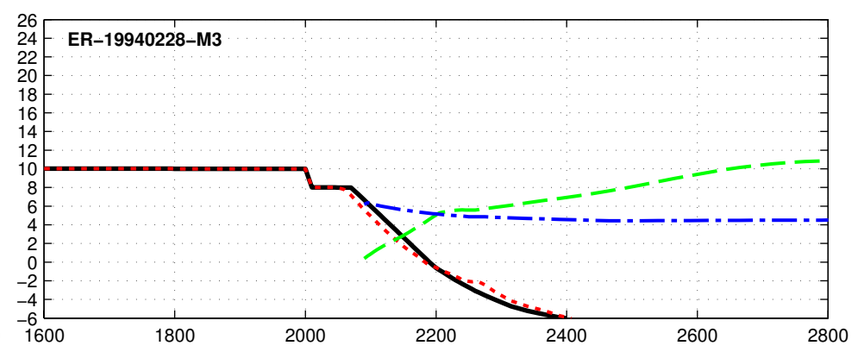


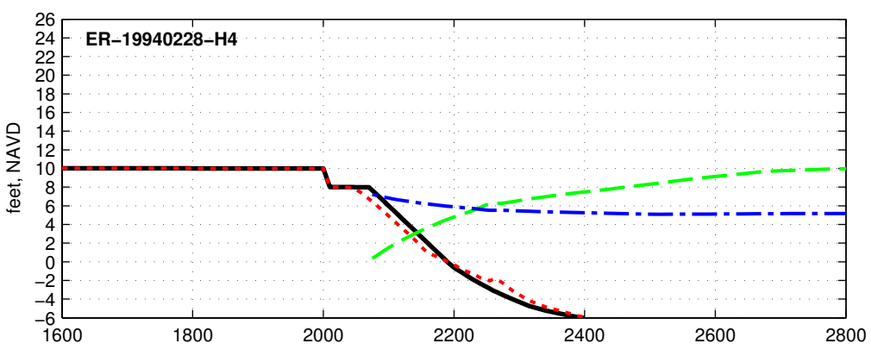


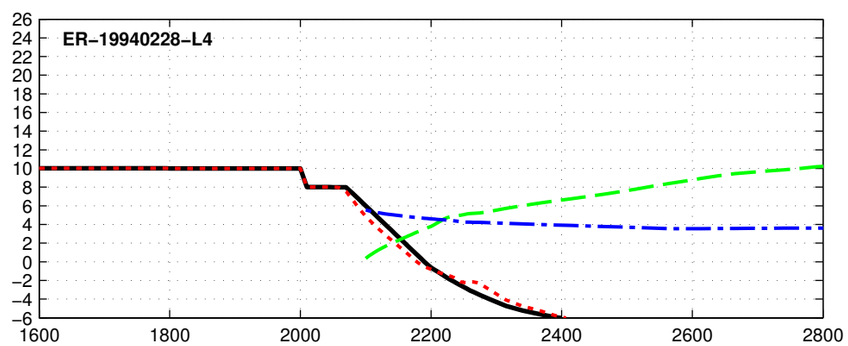


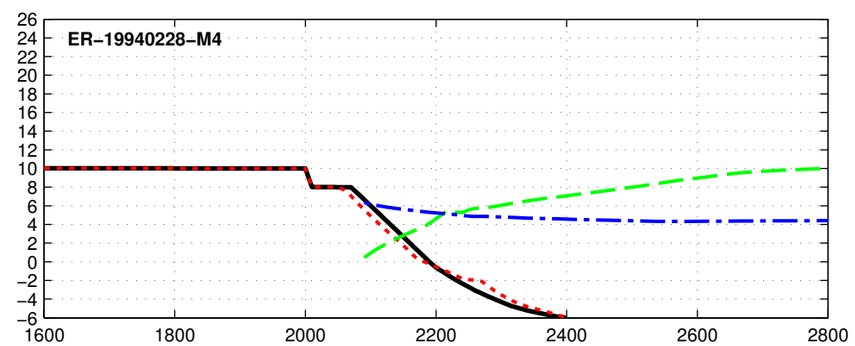






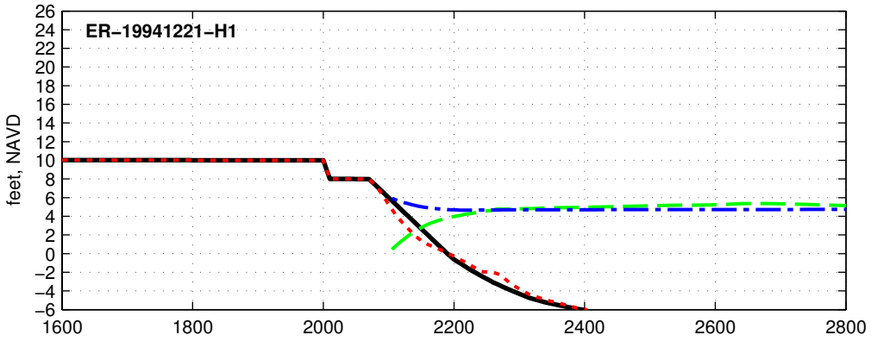


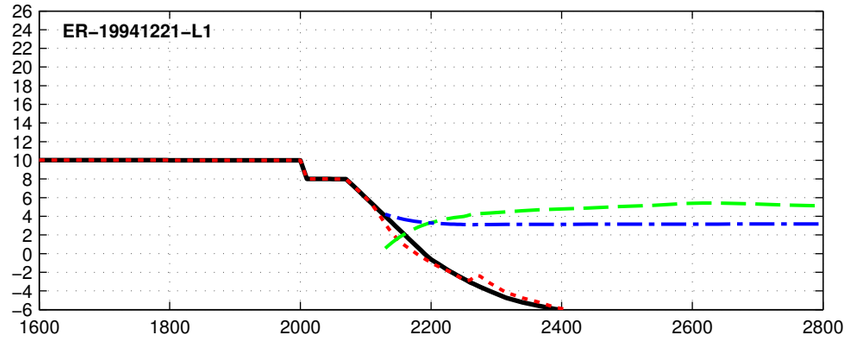


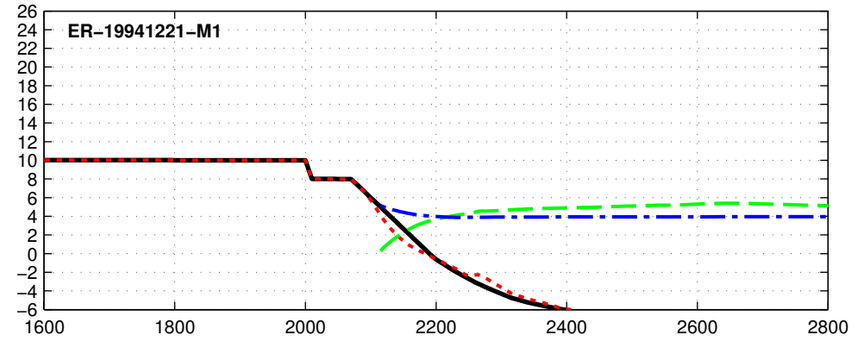


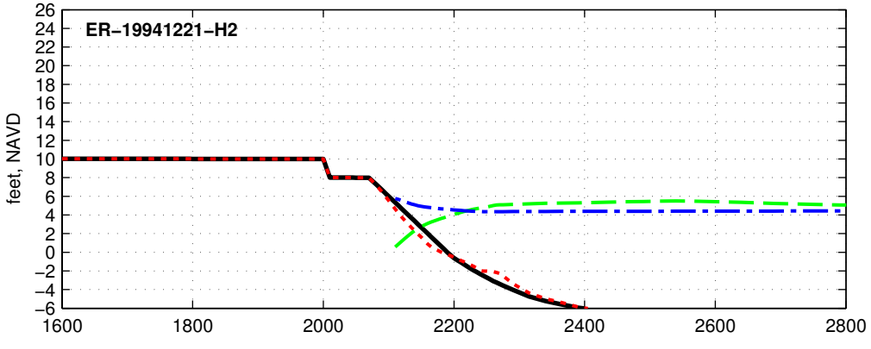
Initial Final Max Hs Max Water Level

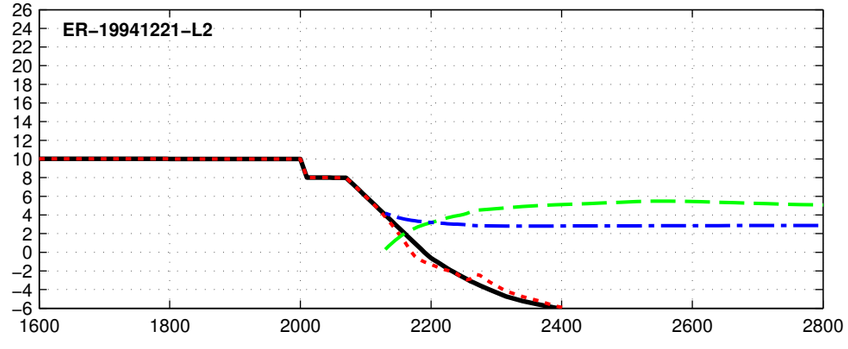
Dune R2T1-10.0-000-060 - ER-19941221

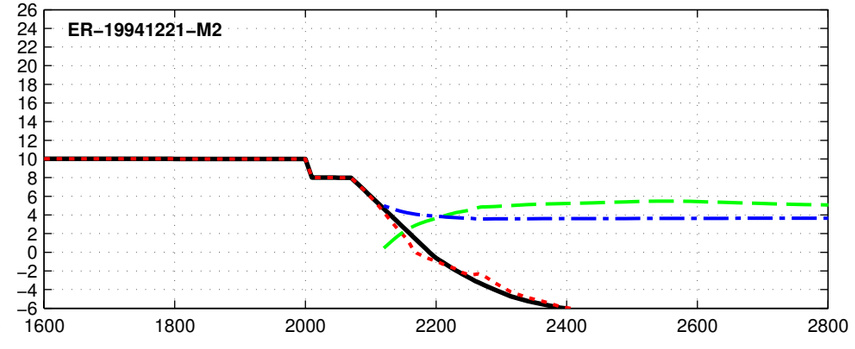


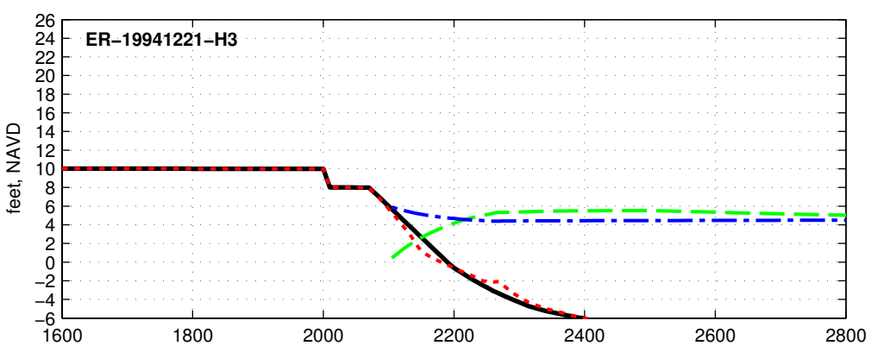


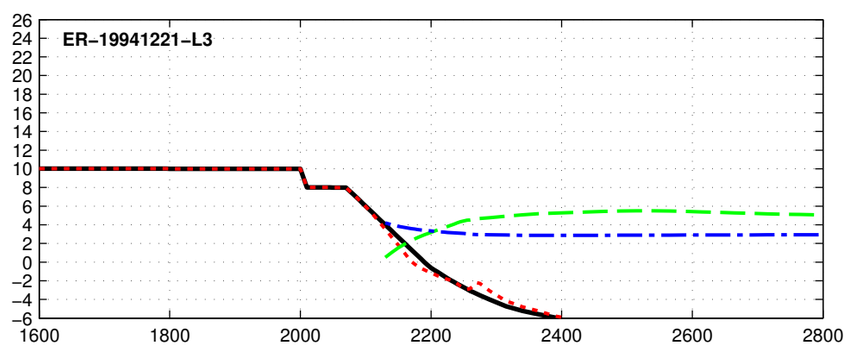


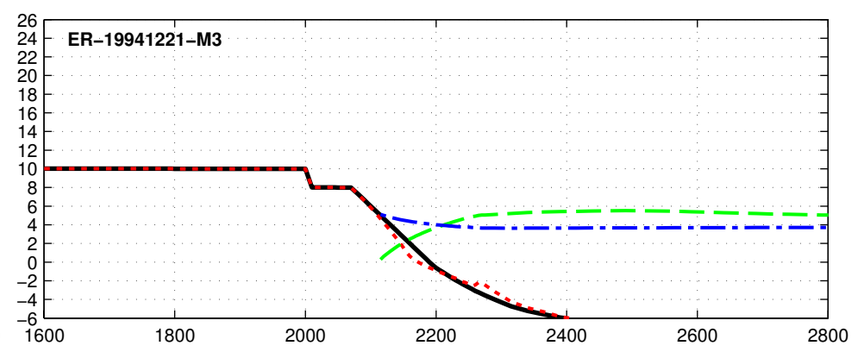


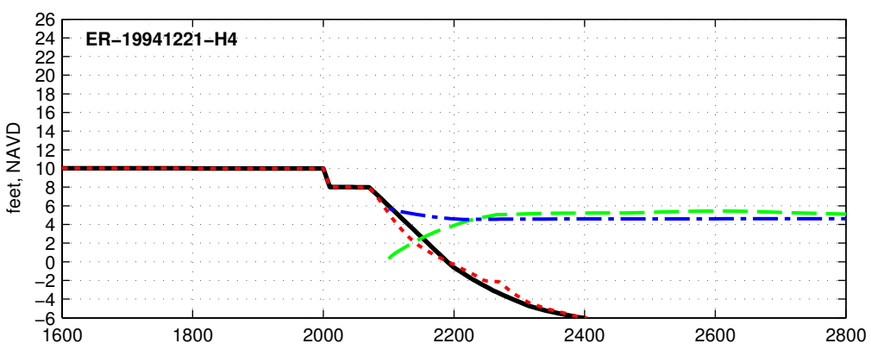


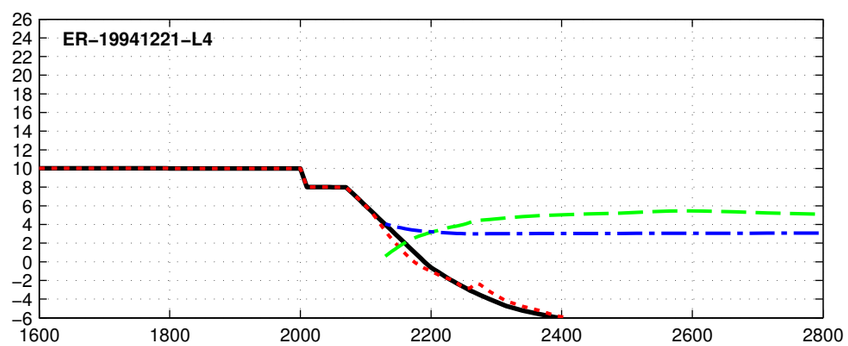


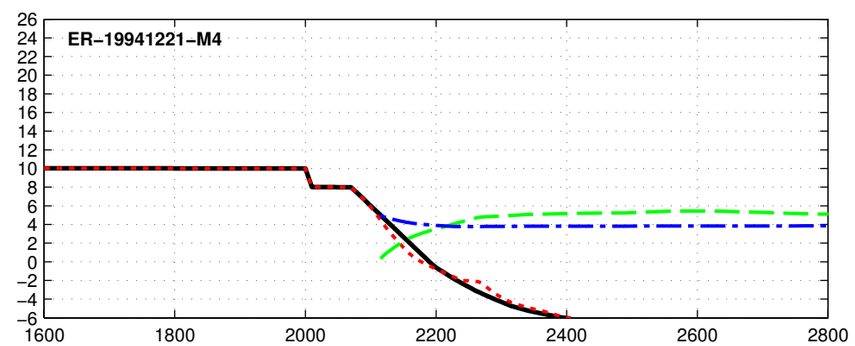






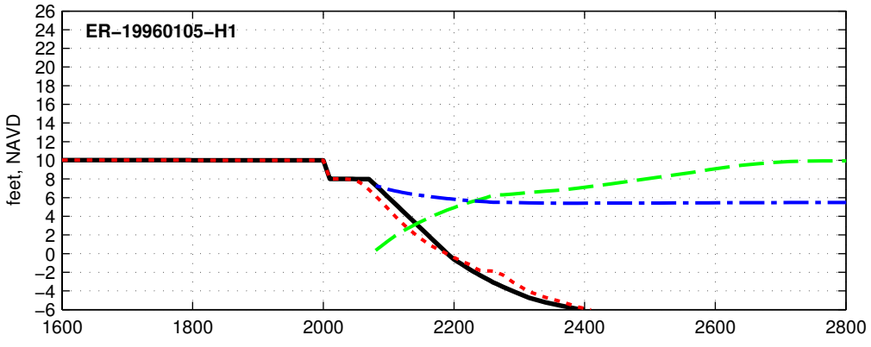


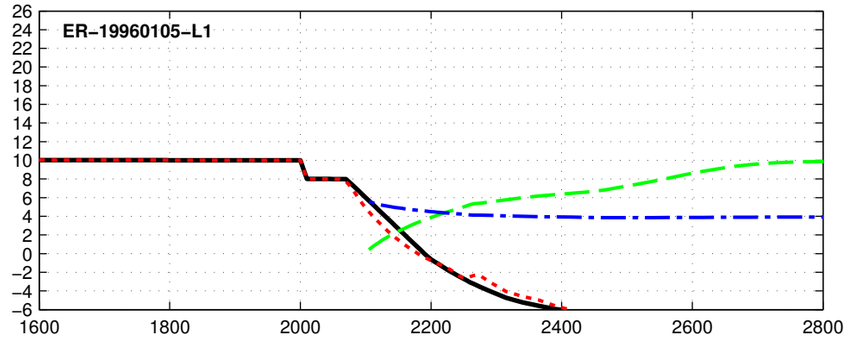


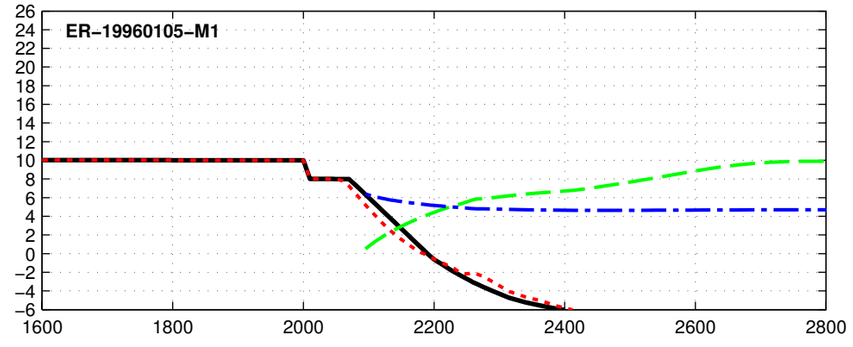


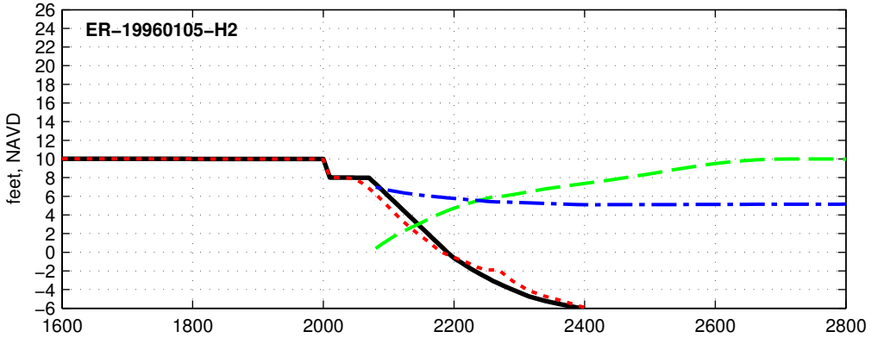
Initial Final Max Hs Max Water Level

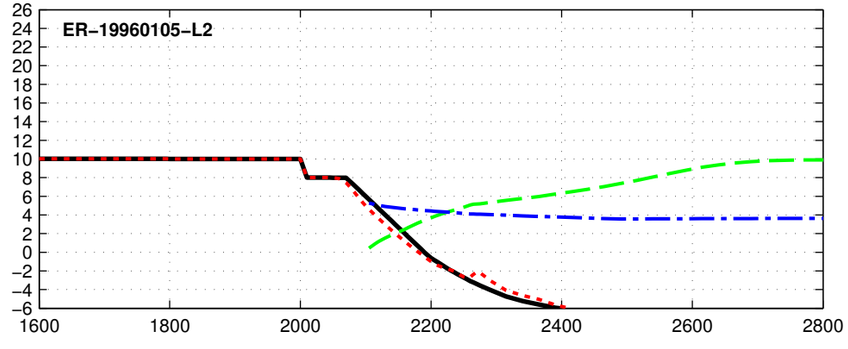
Dune R2T1-10.0-000-060 - ER-19960105

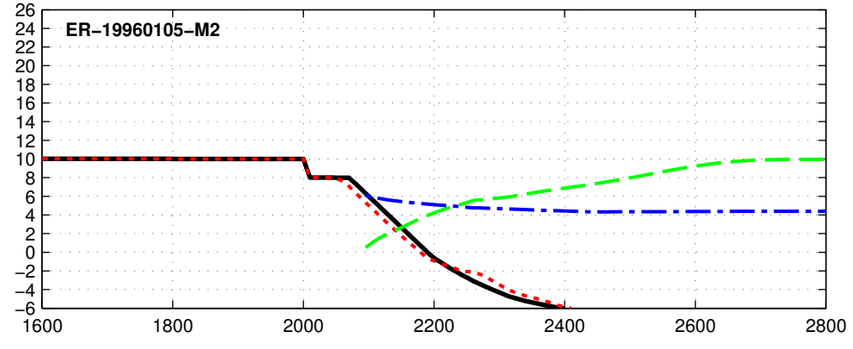


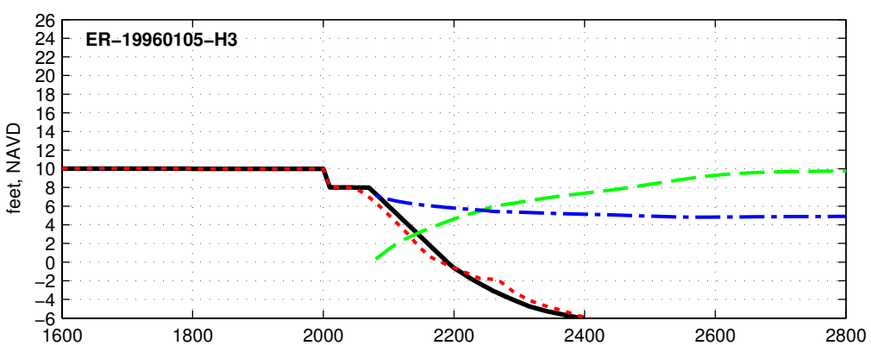


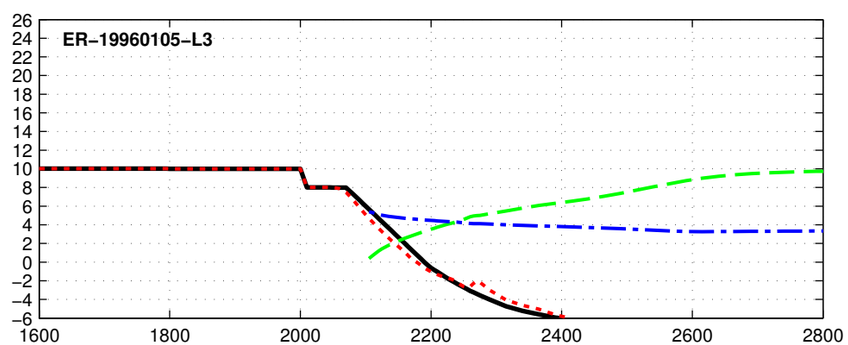


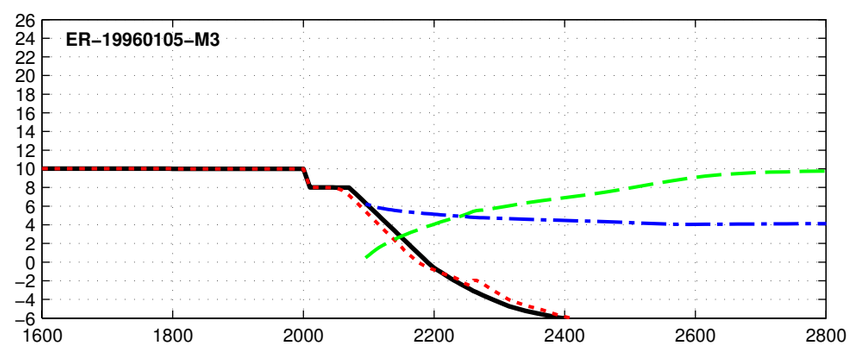


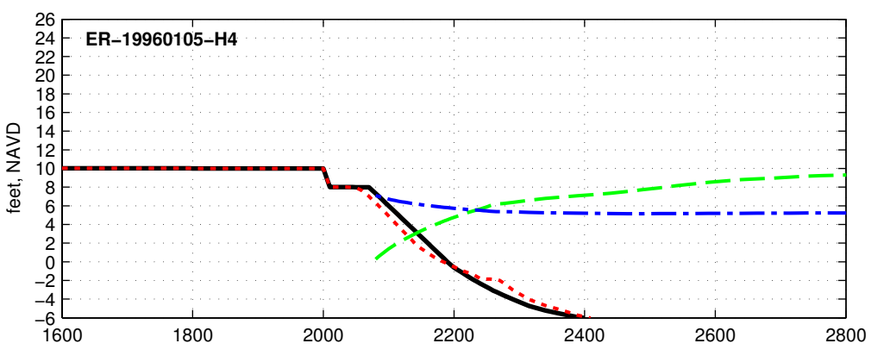


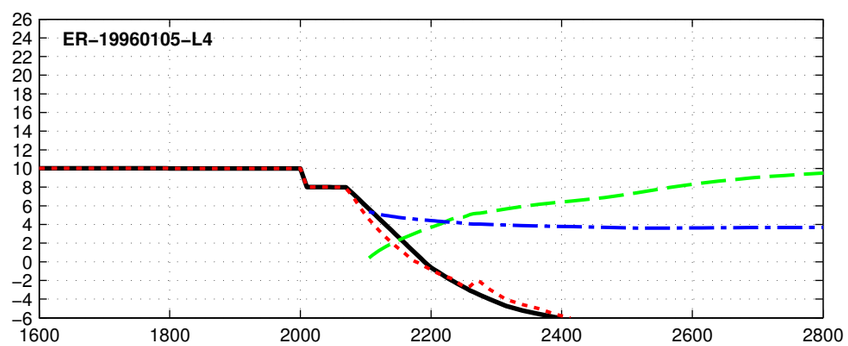


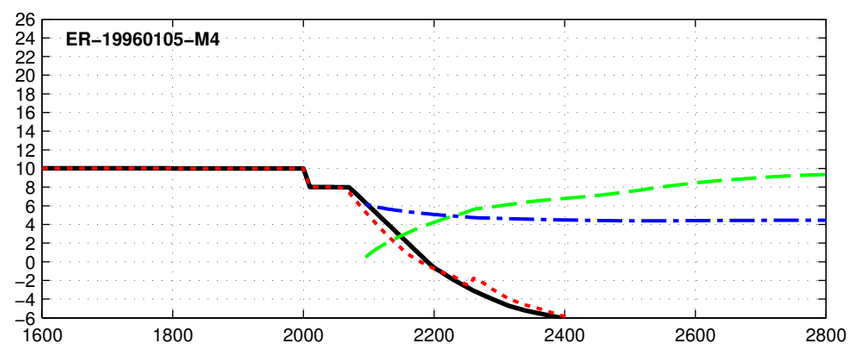






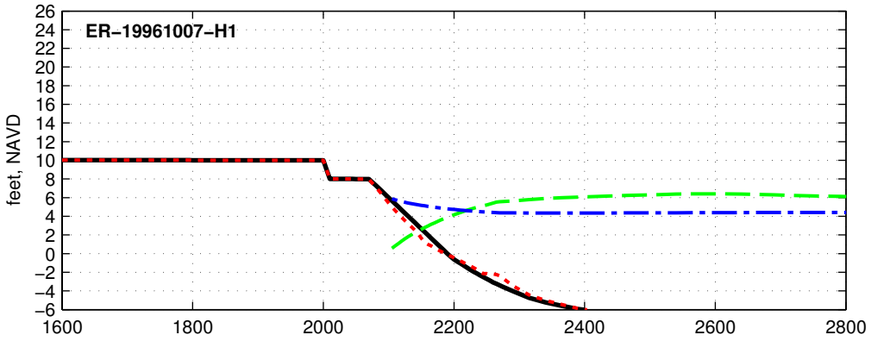


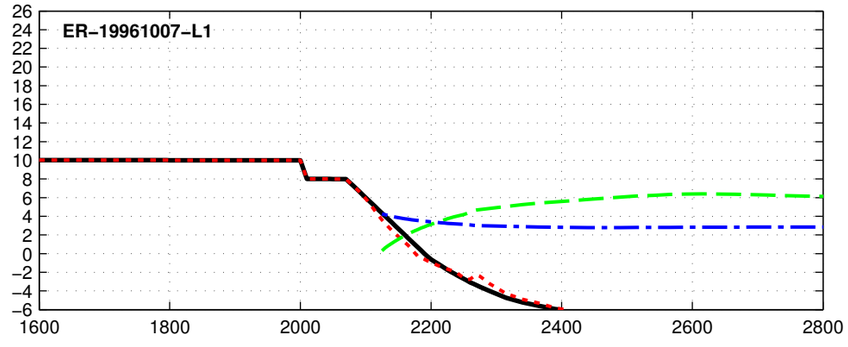


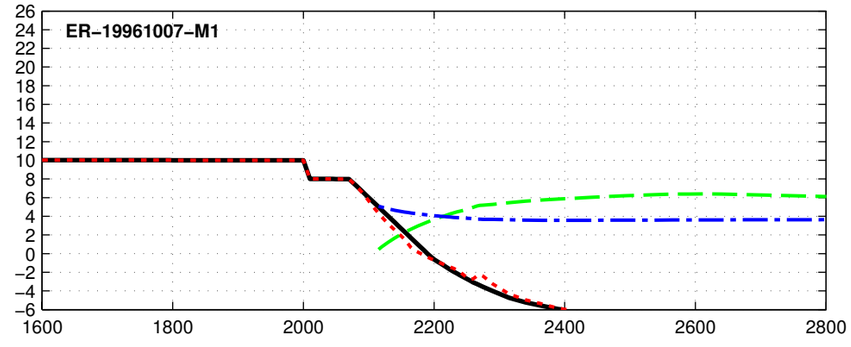


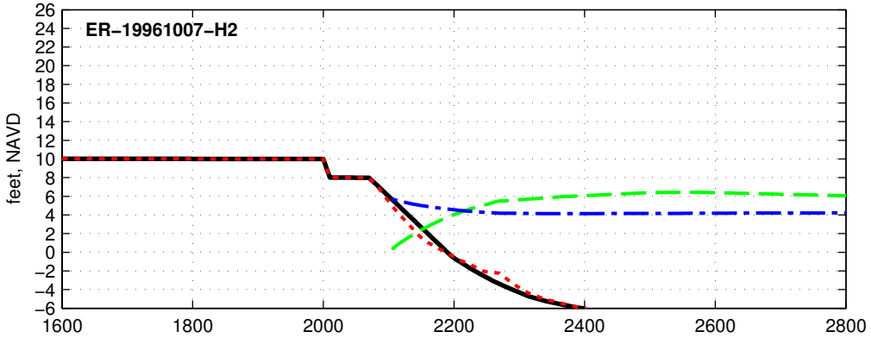
Initial Final Max Hs Max Water Level

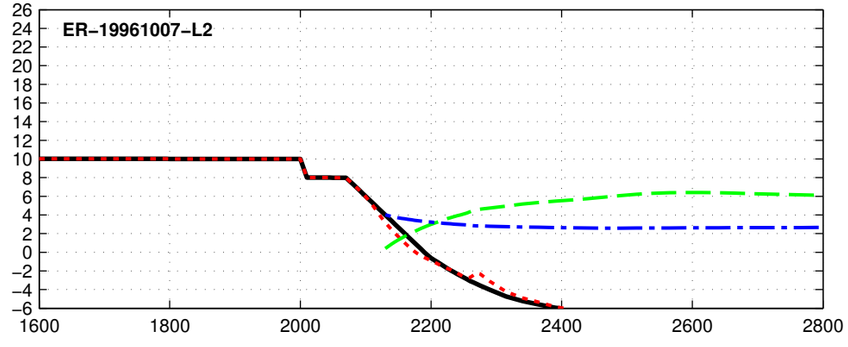
Dune R2T1-10.0-000-060 - ER-19961007

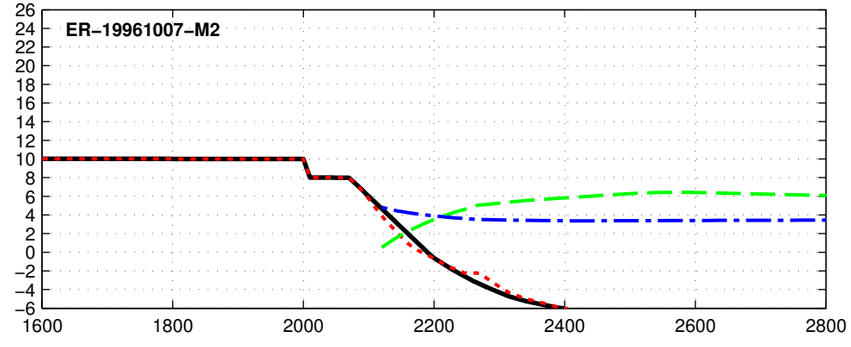


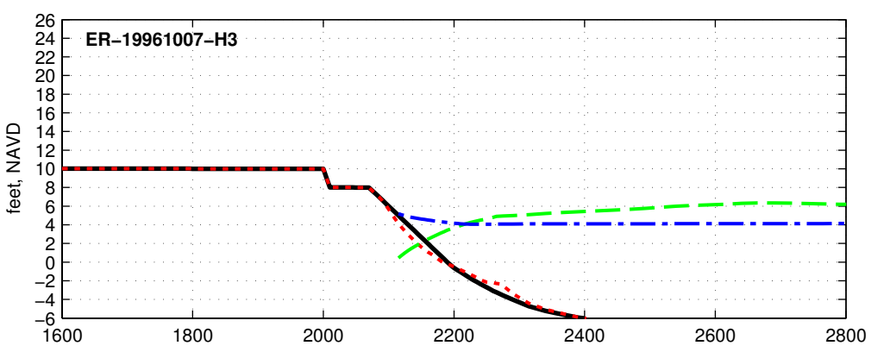


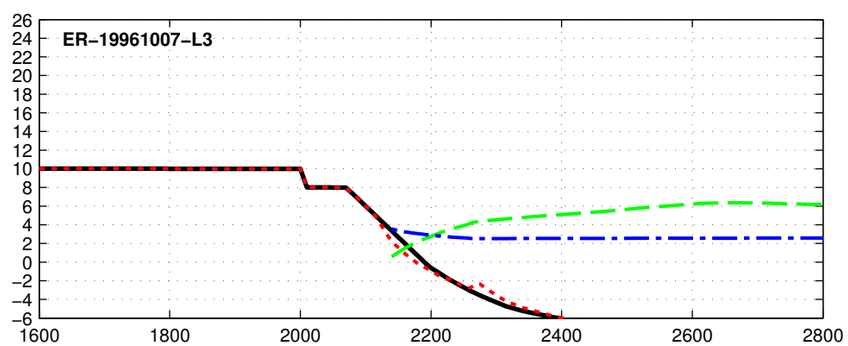


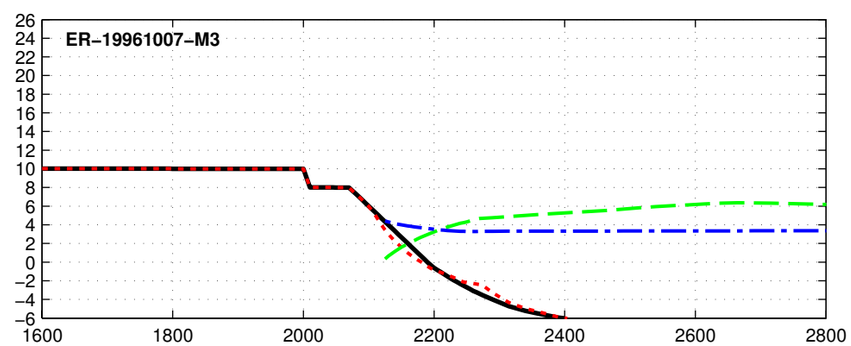


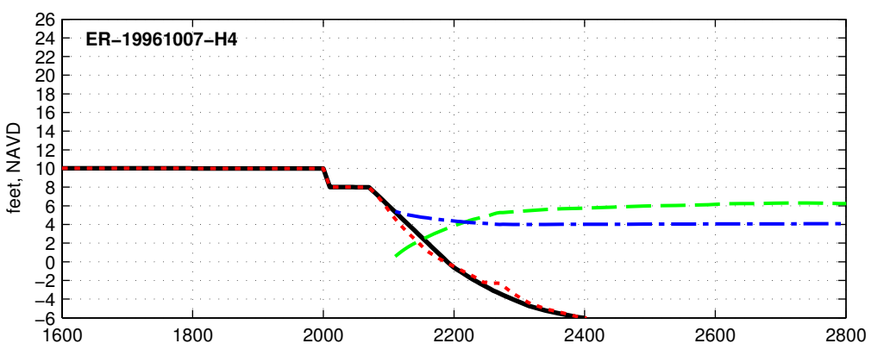


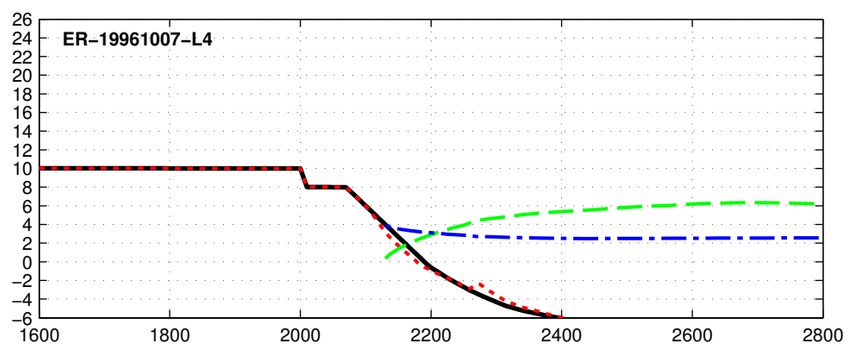


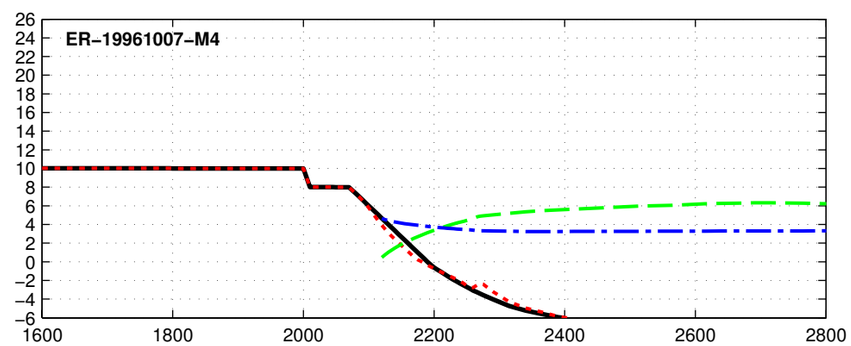






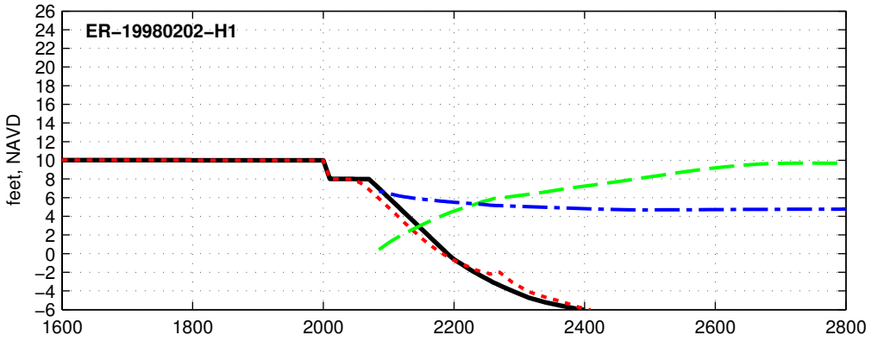


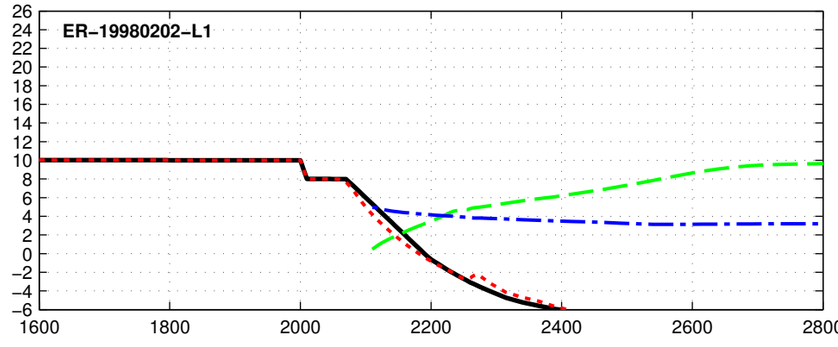


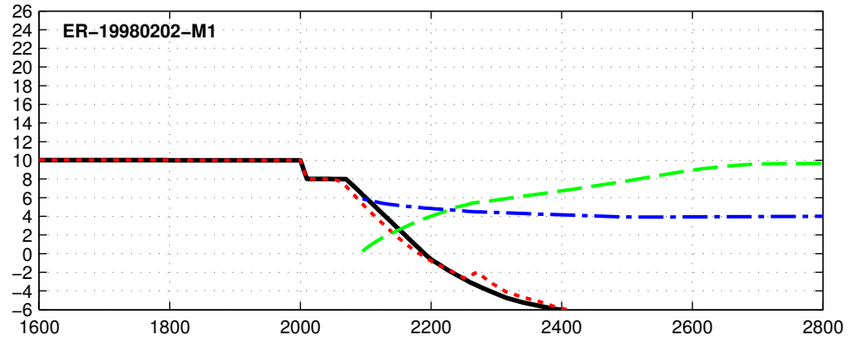


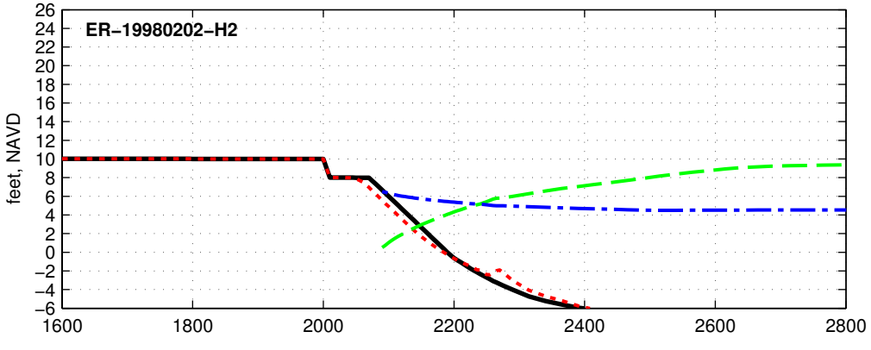
Initial Final Max Hs Max Water Level

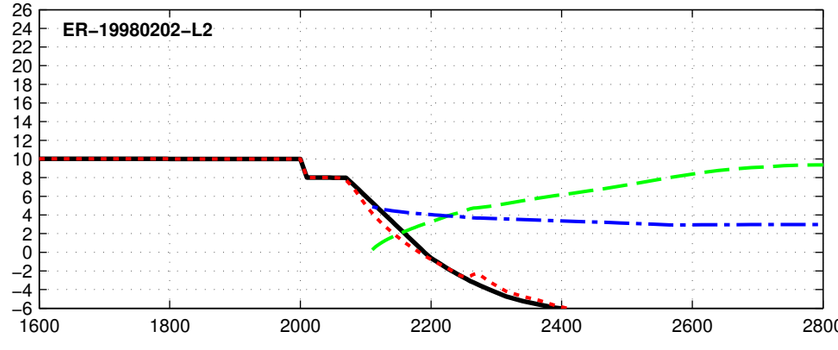
Dune R2T1-10.0-000-060 - ER-19980202

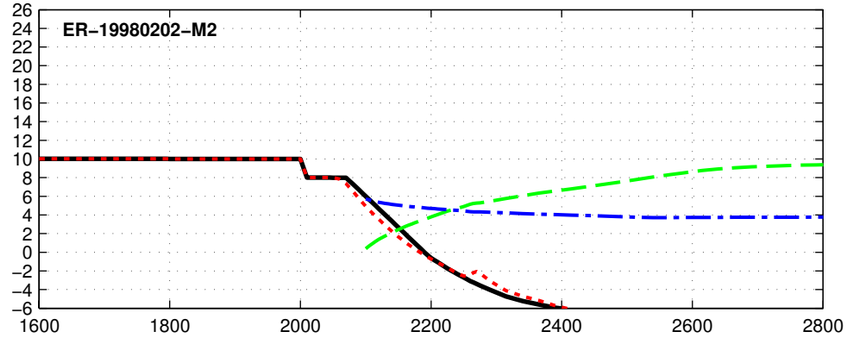


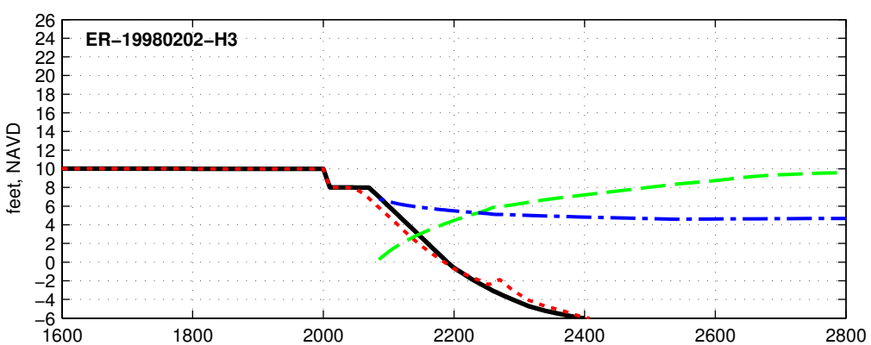


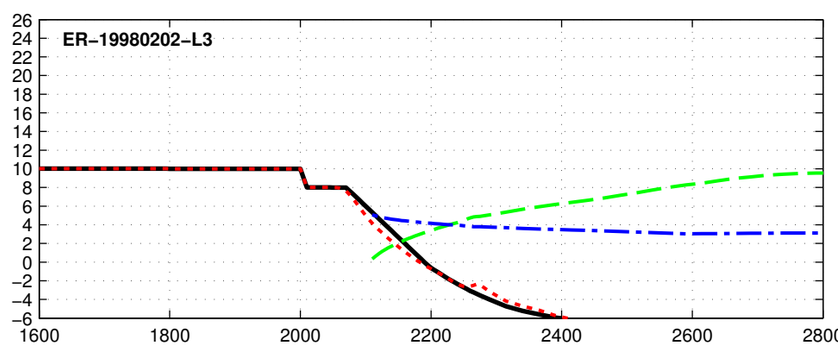


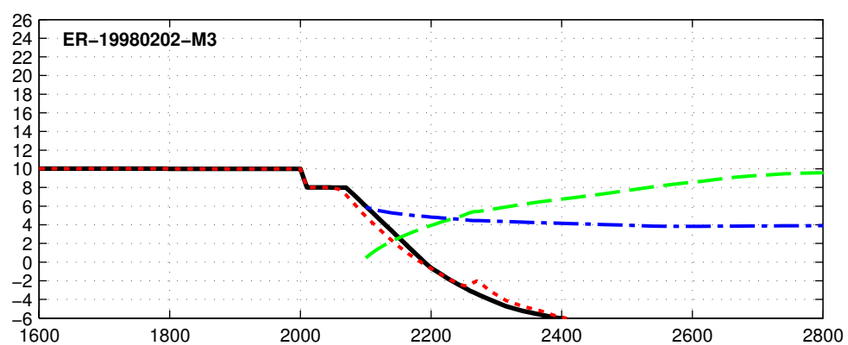


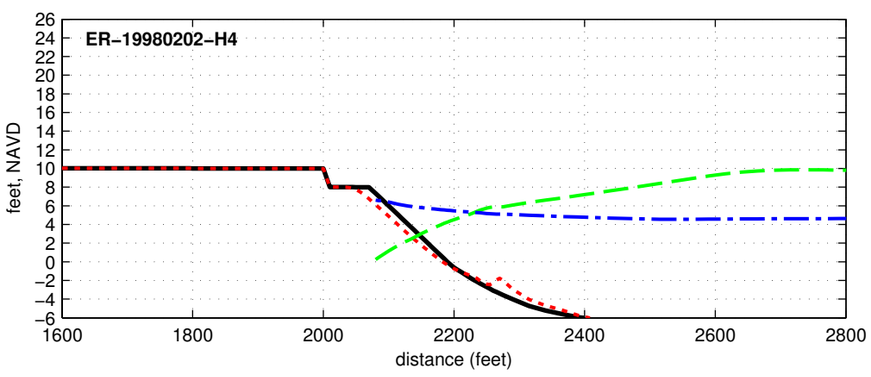


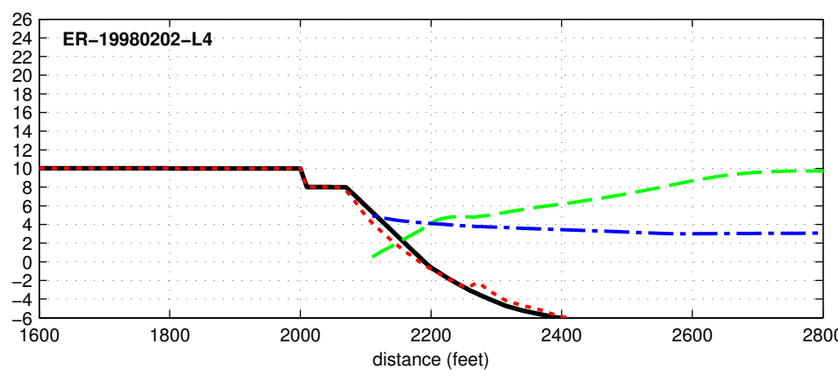


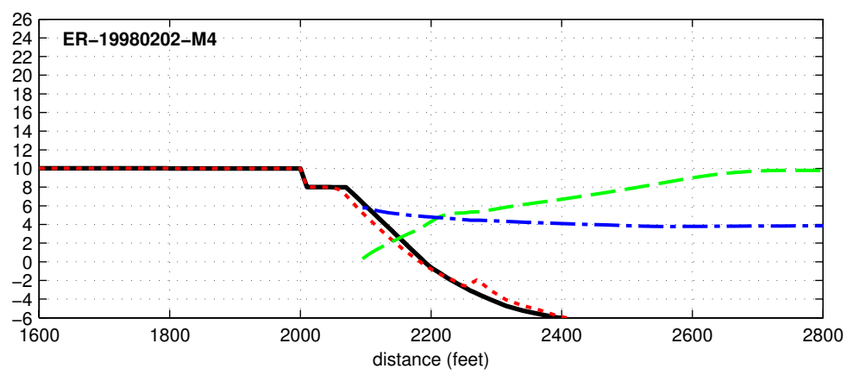






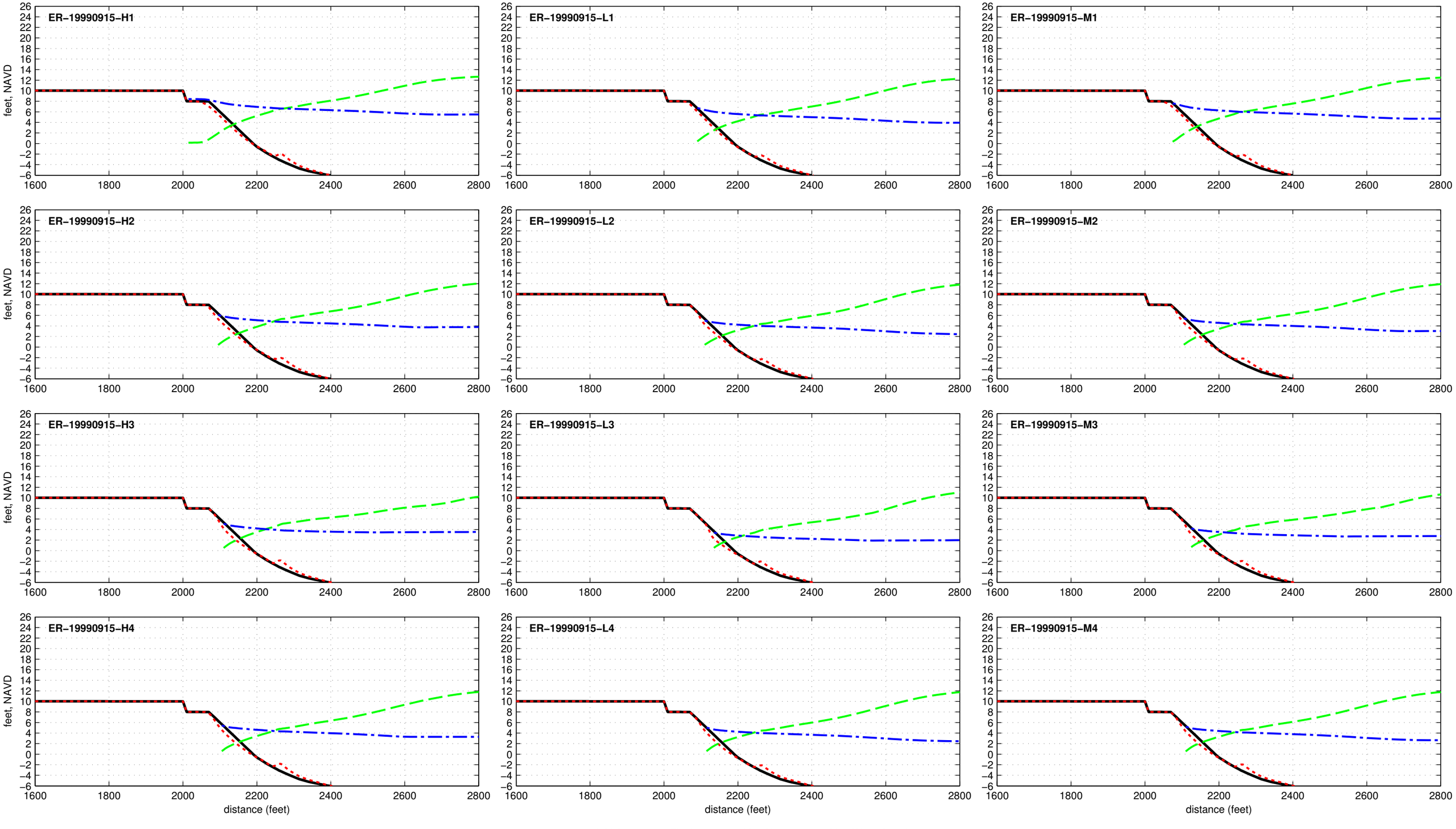




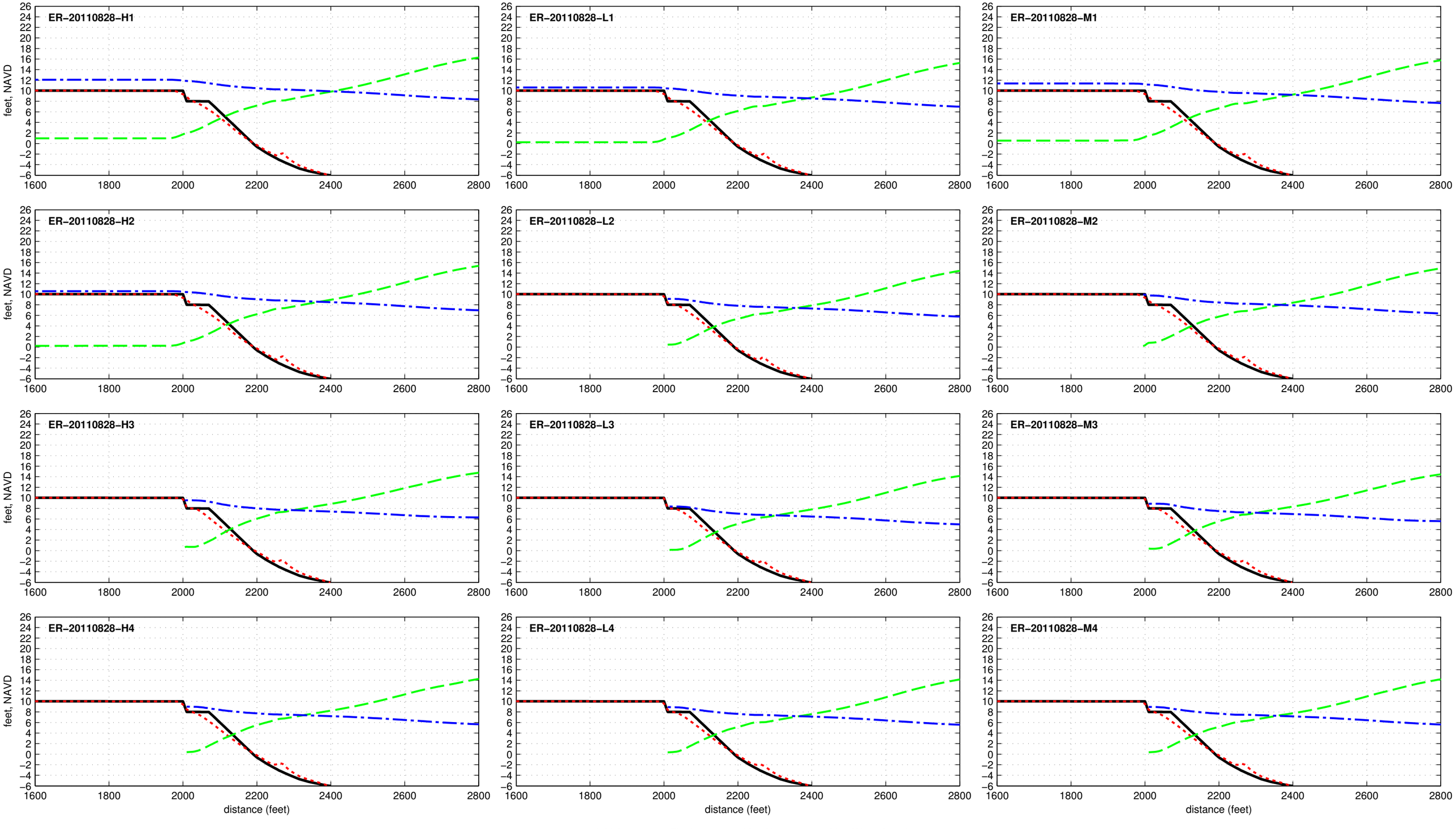


Initial Final Max Hs Max Water Level

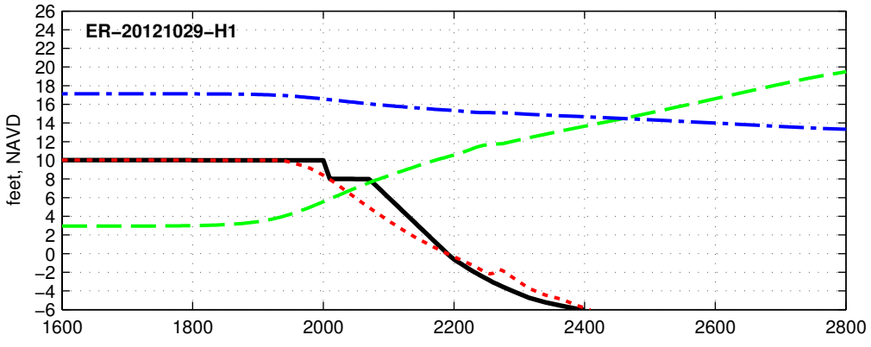
Dune R2T1-10.0-000-060 - ER-19990915

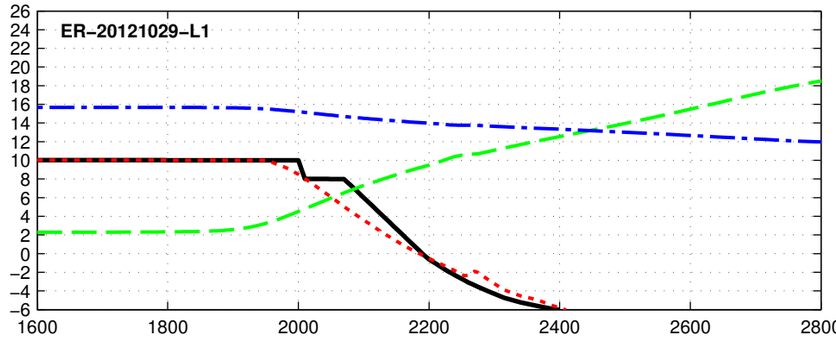


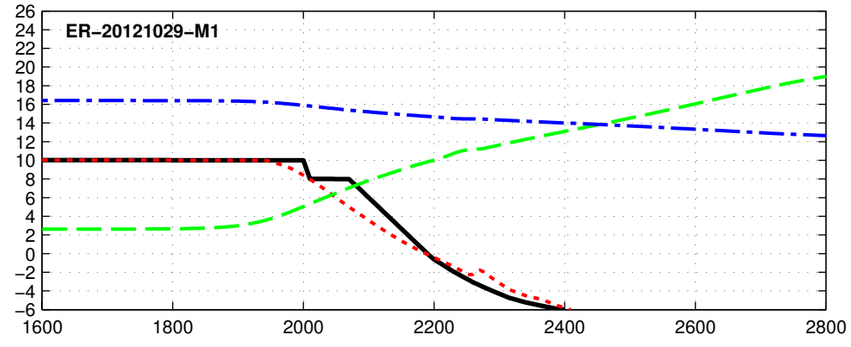
Dune R2T1-10.0-000-060 - ER-20110828

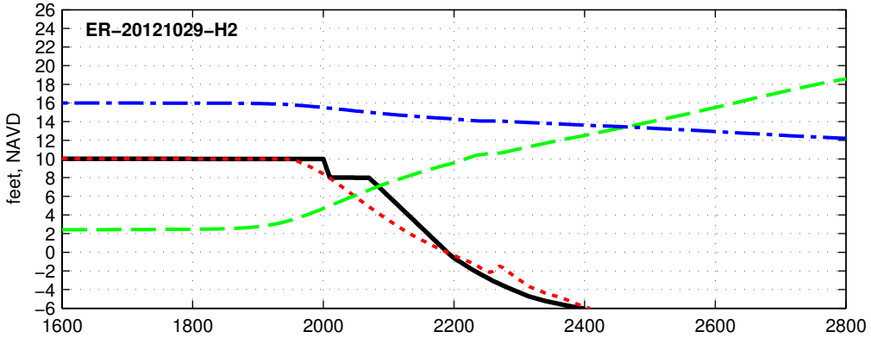


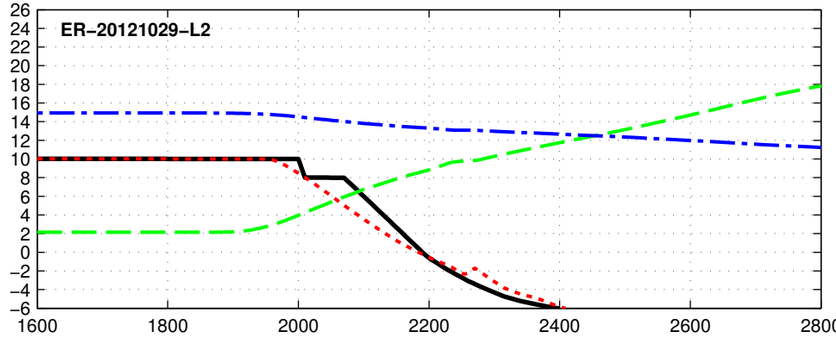
Dune R2T1-10.0-000-060 - ER-20121029

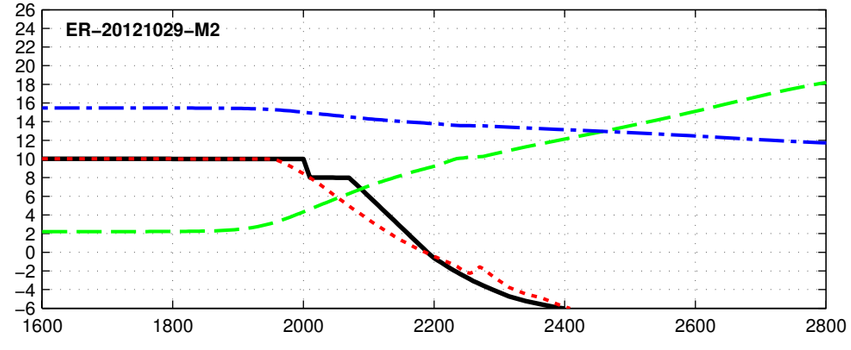


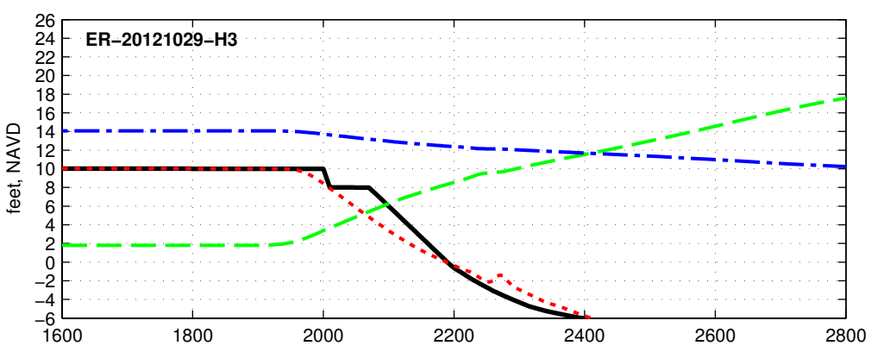


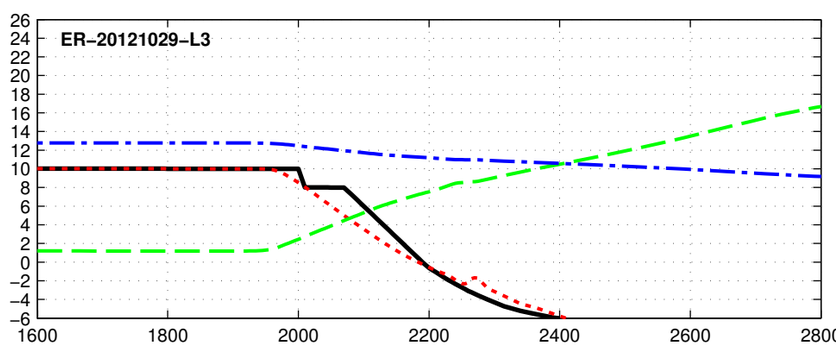


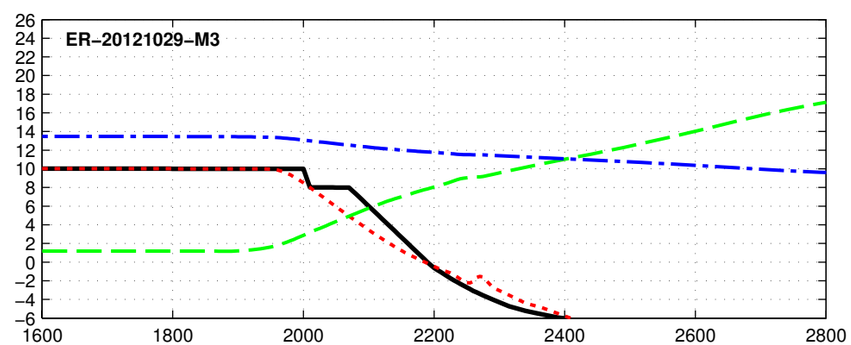


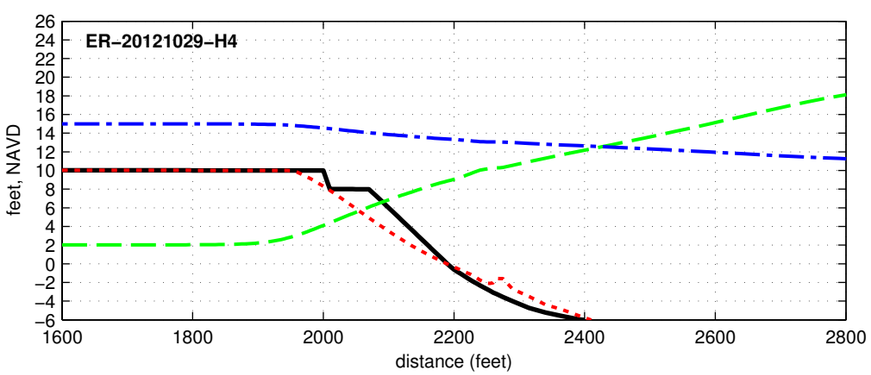


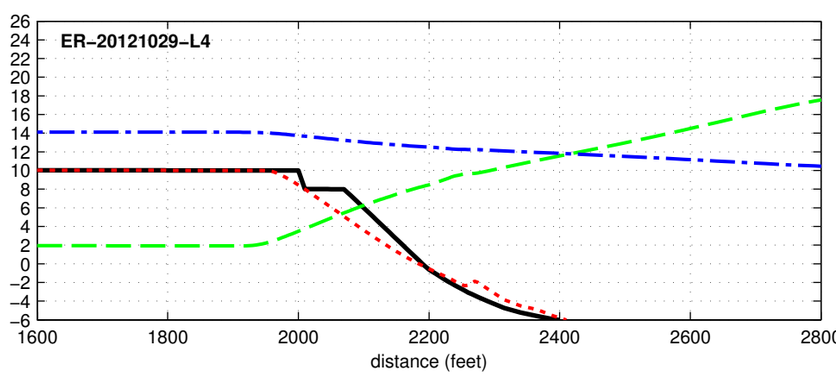


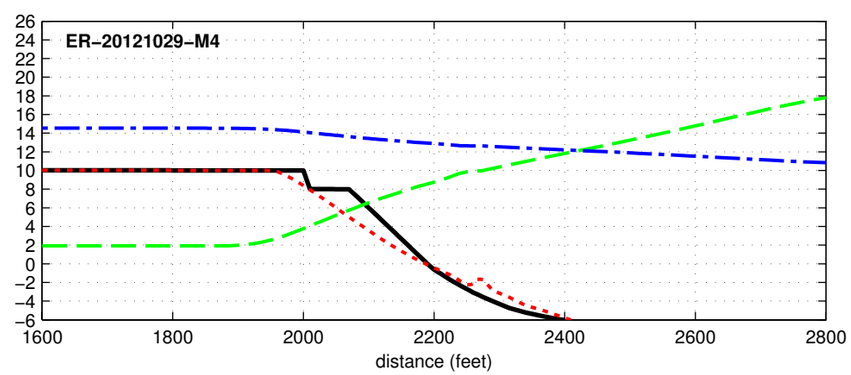








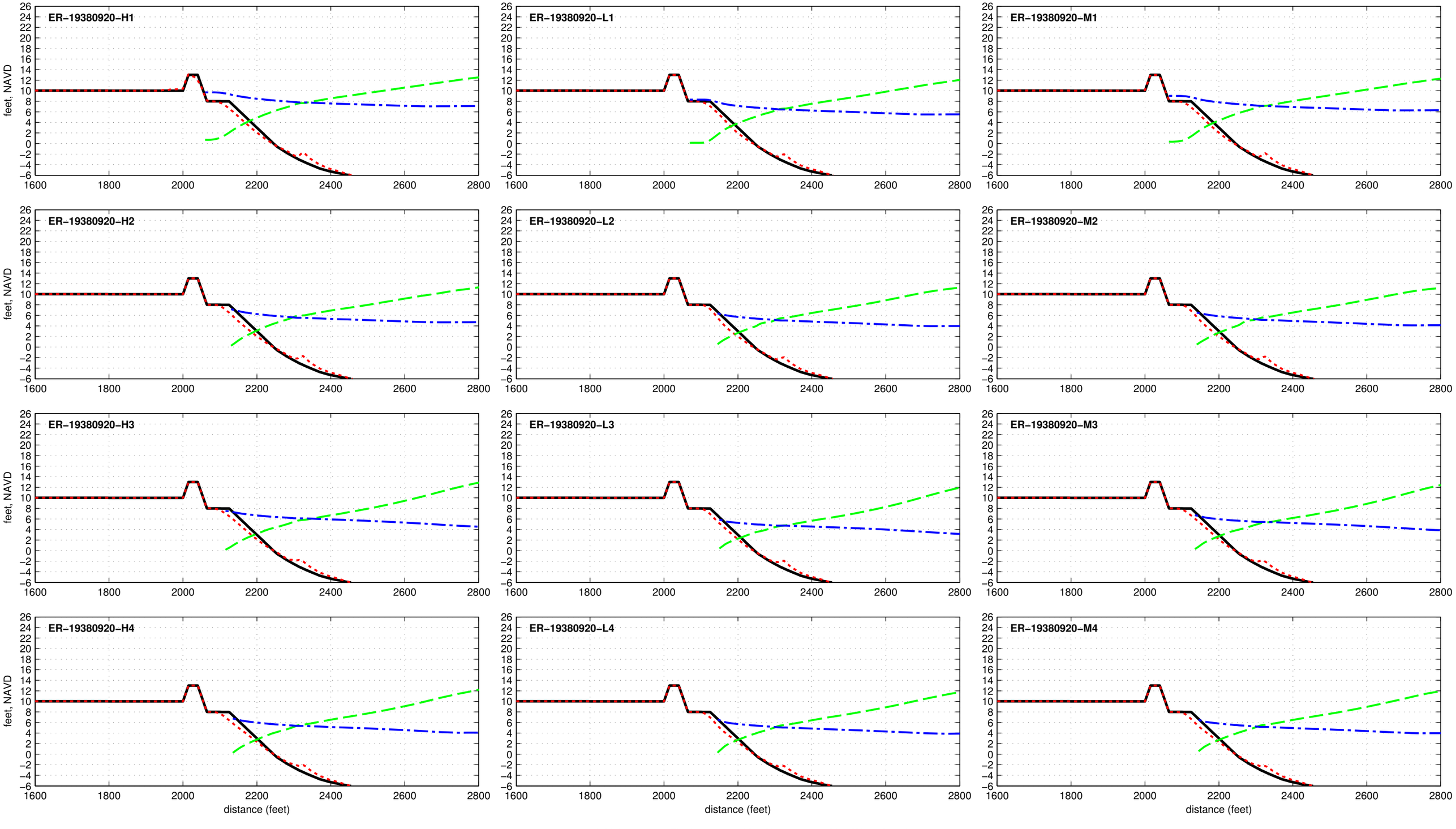




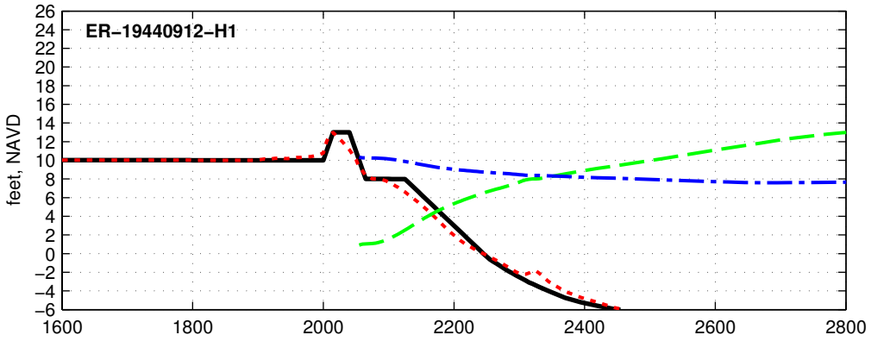
Initial Final Max Hs Max Water Level

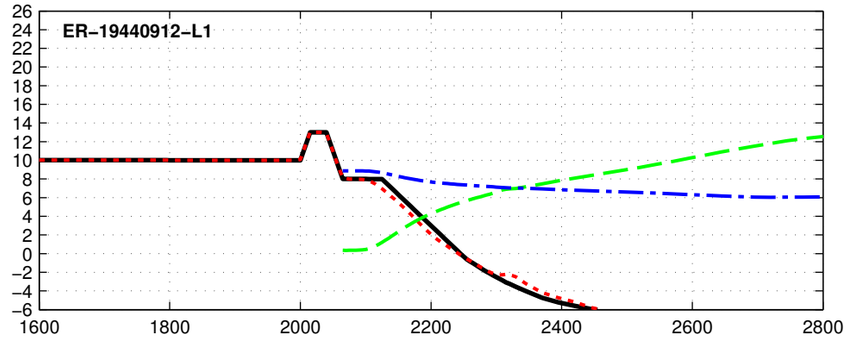
R2T1_13.0_025_060 - DUNE

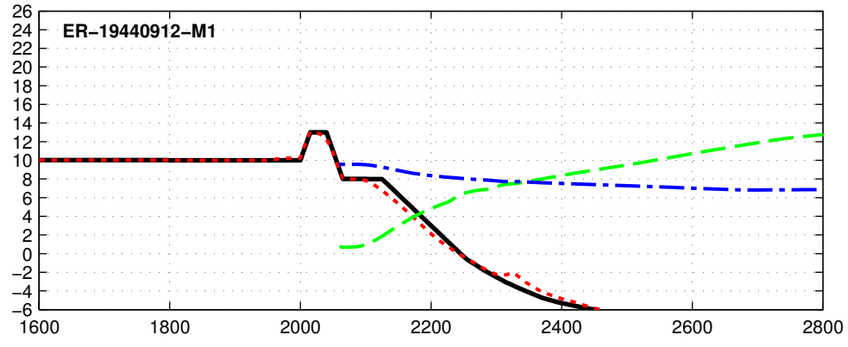
Dune R2T1-13.0-025-060 - ER-19380920

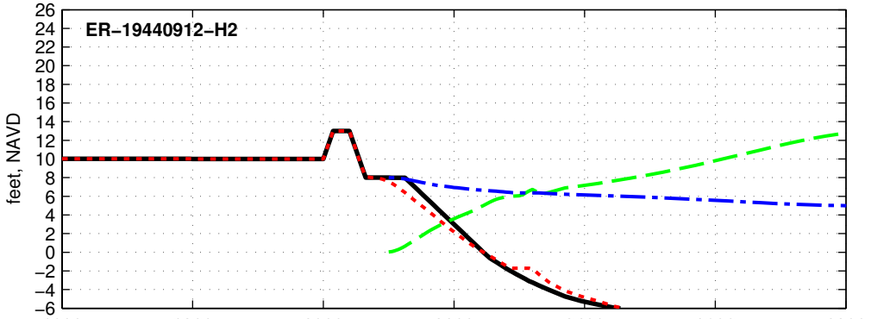


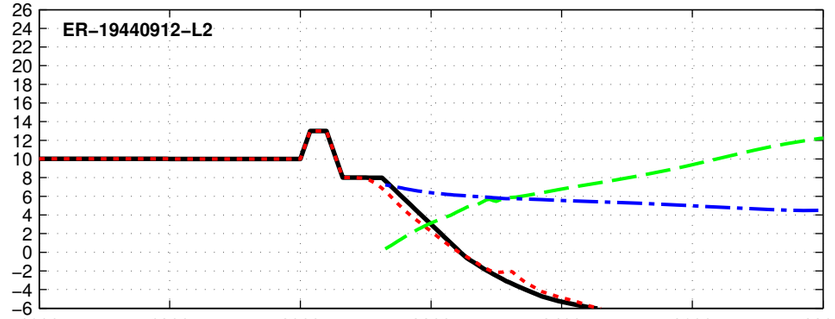
Dune R2T1–13.0–025–060 – ER–19440912

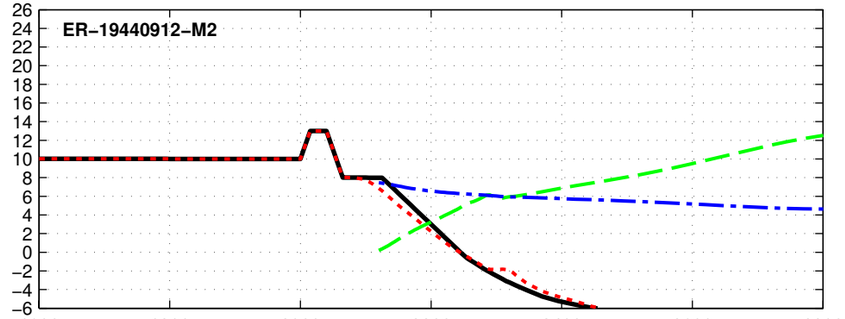


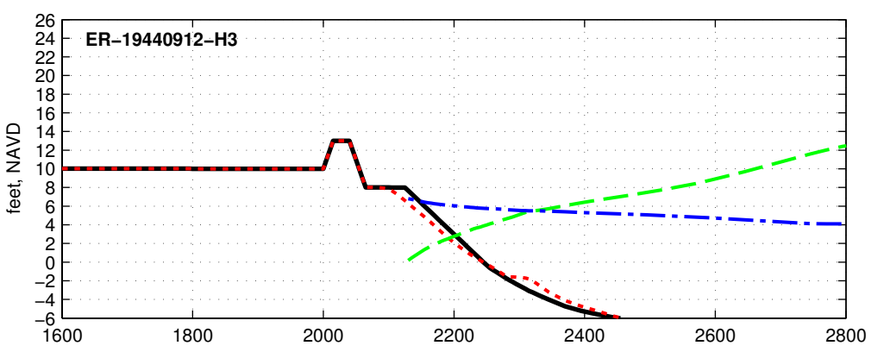


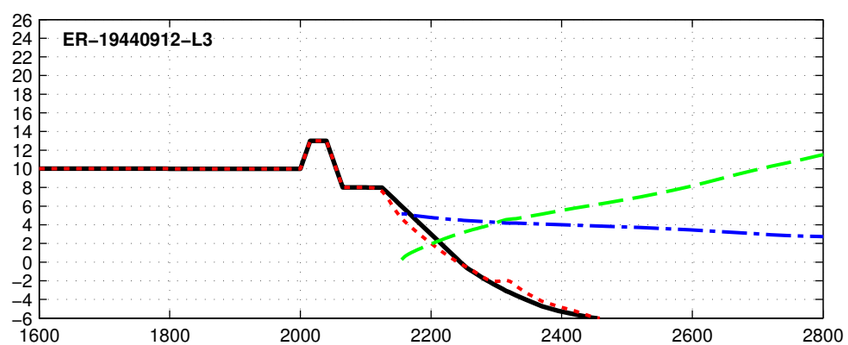


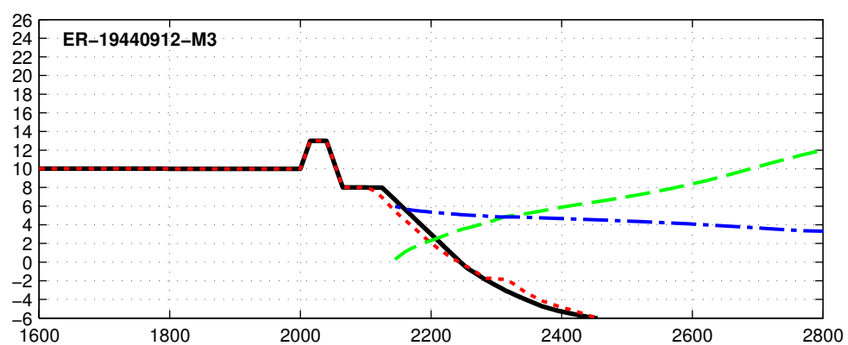


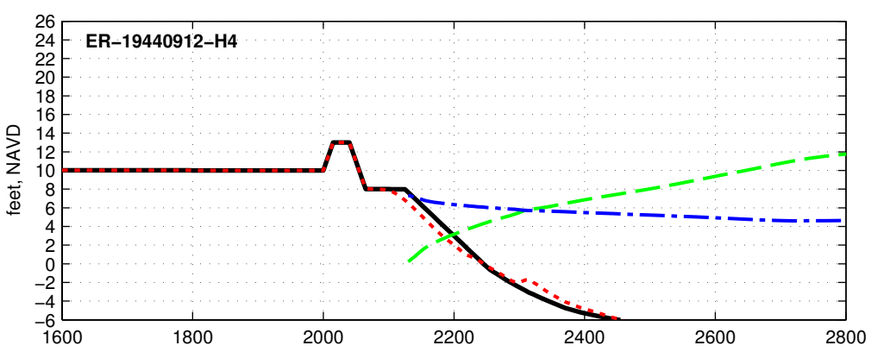


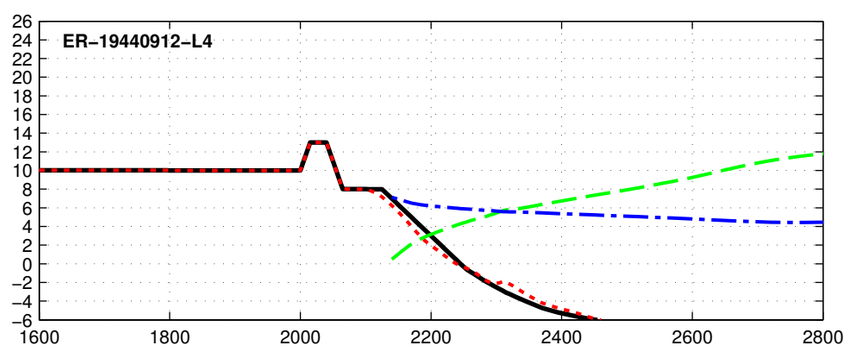


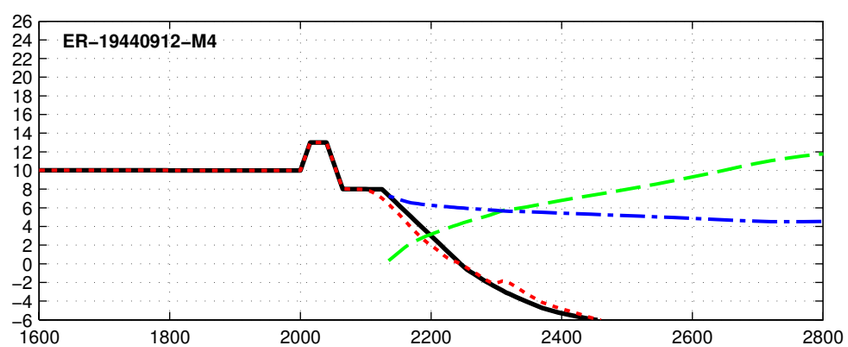






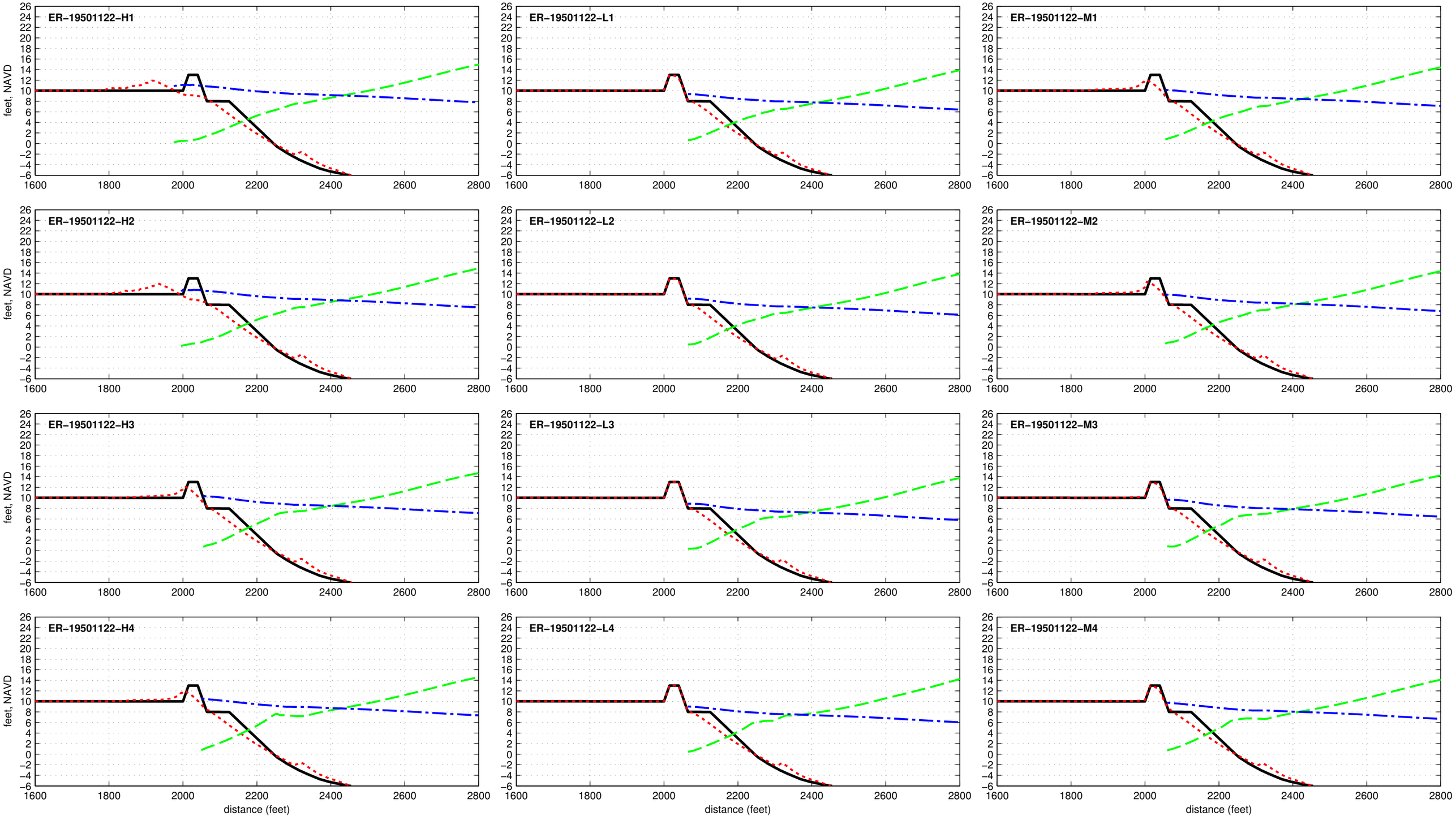




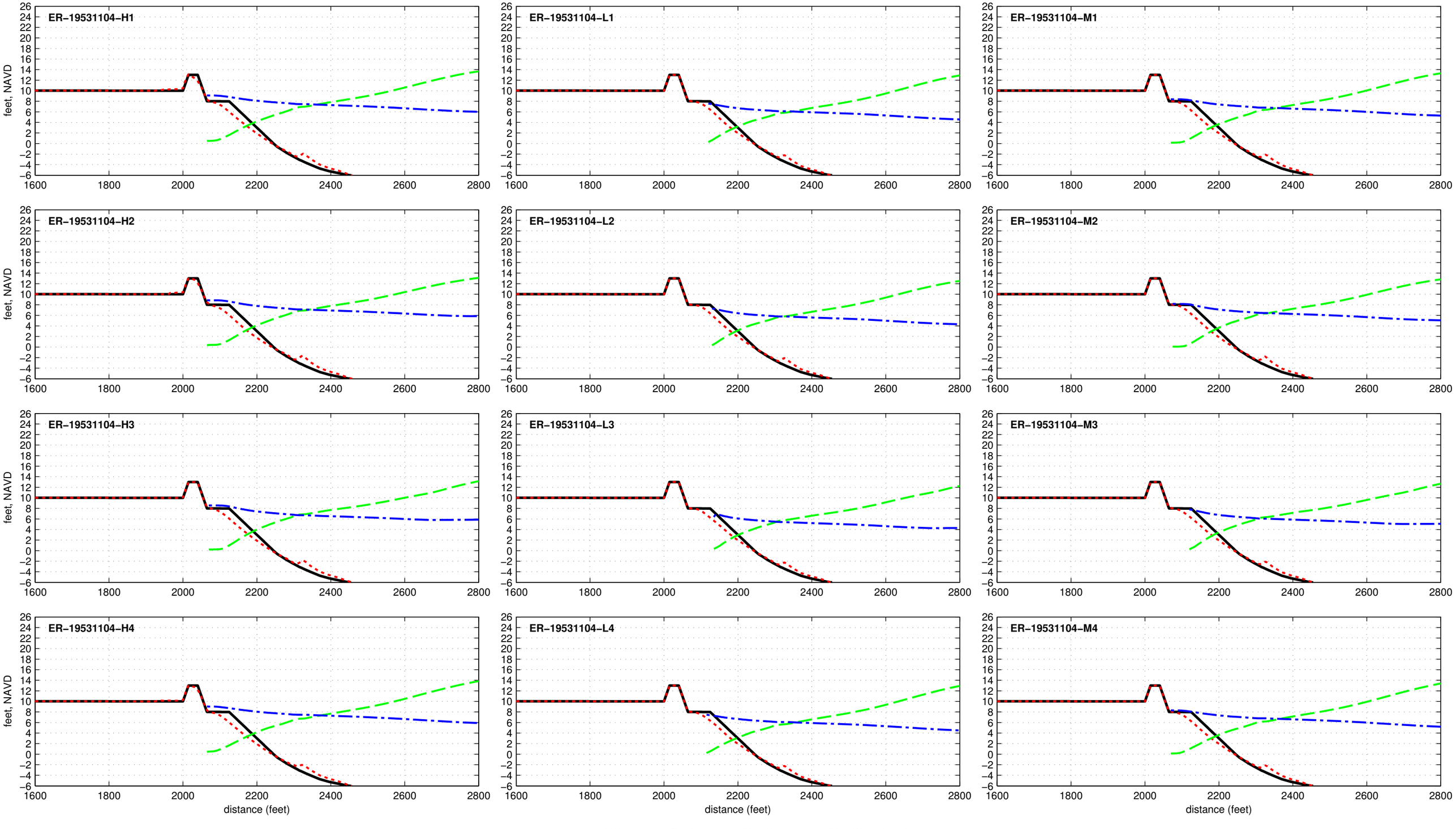


Initial Final Max Hs Max Water Level

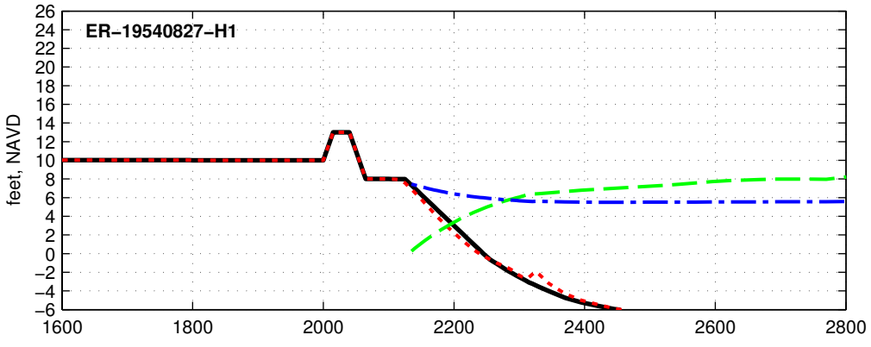
Dune R2T1-13.0-025-060 - ER-19501122

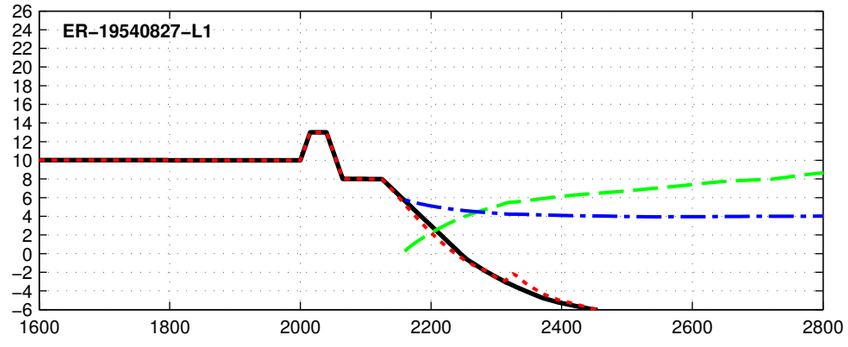


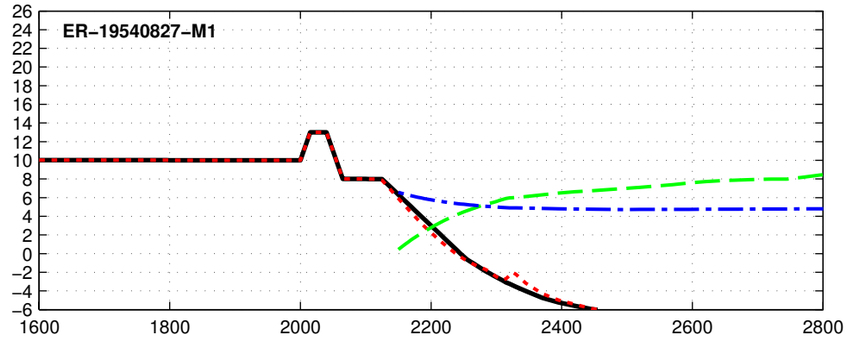
Dune R2T1-13.0-025-060 - ER-19531104

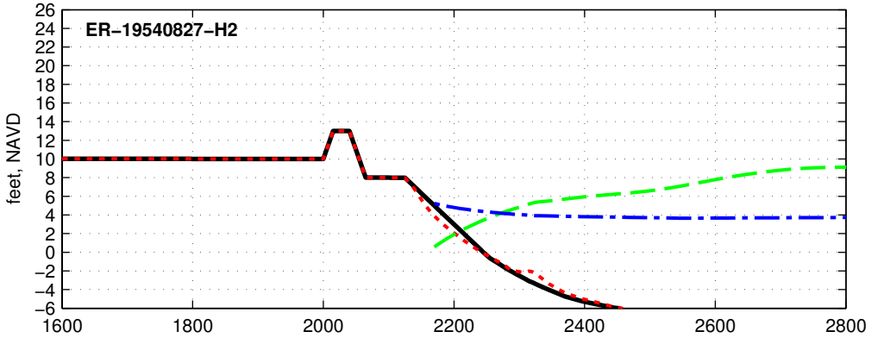


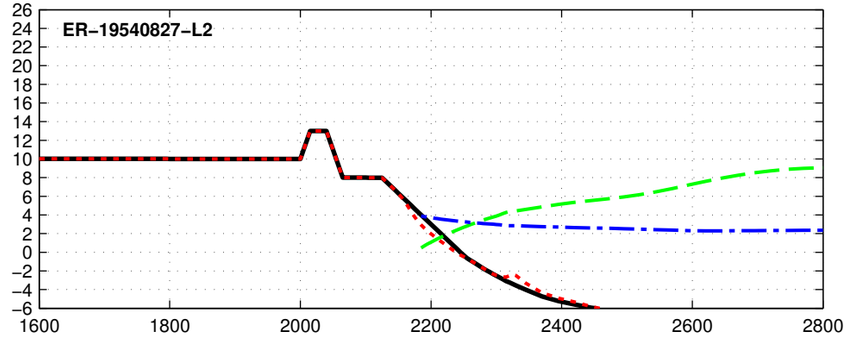
Dune R2T1–13.0–025–060 – ER–19540827

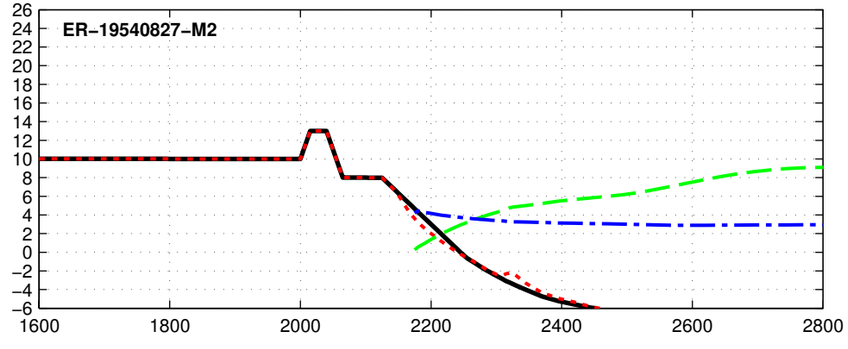


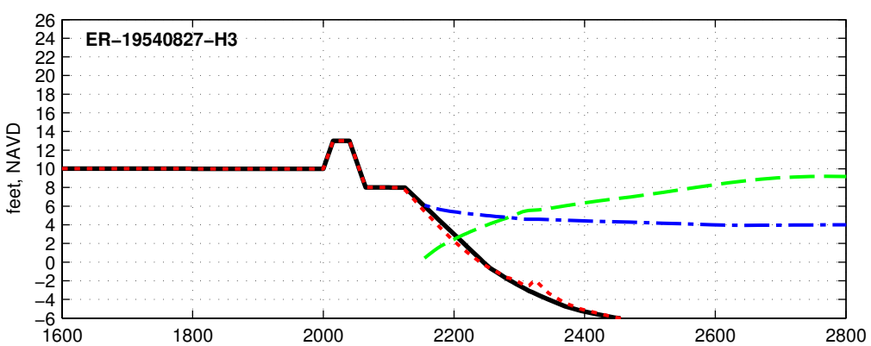


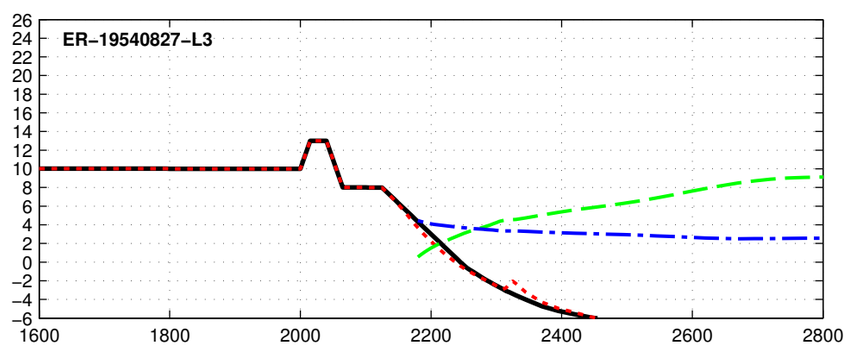


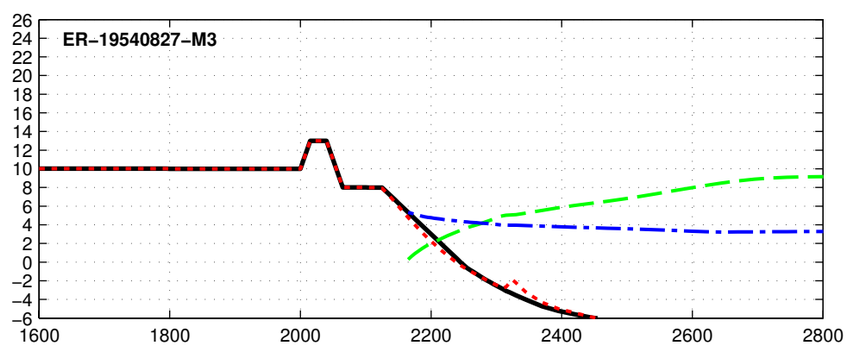


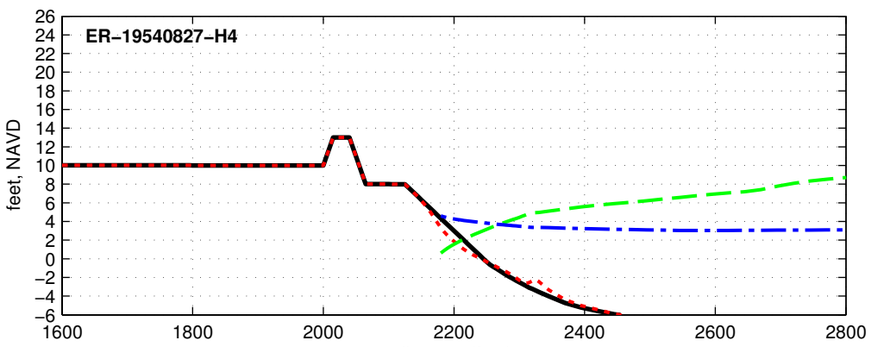


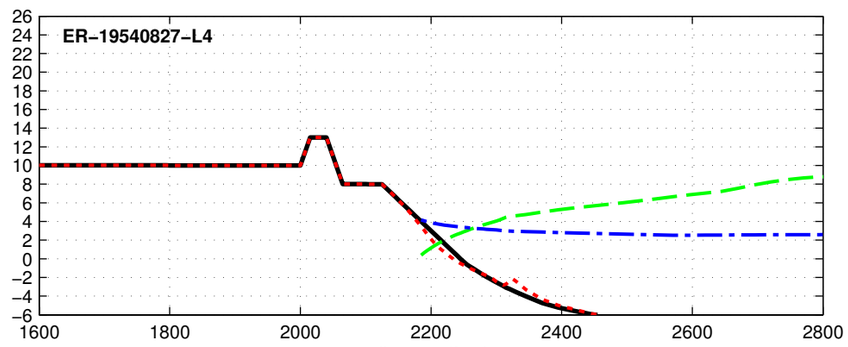


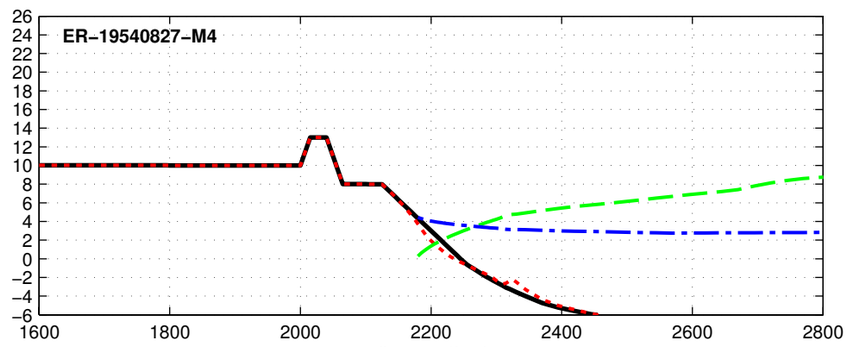






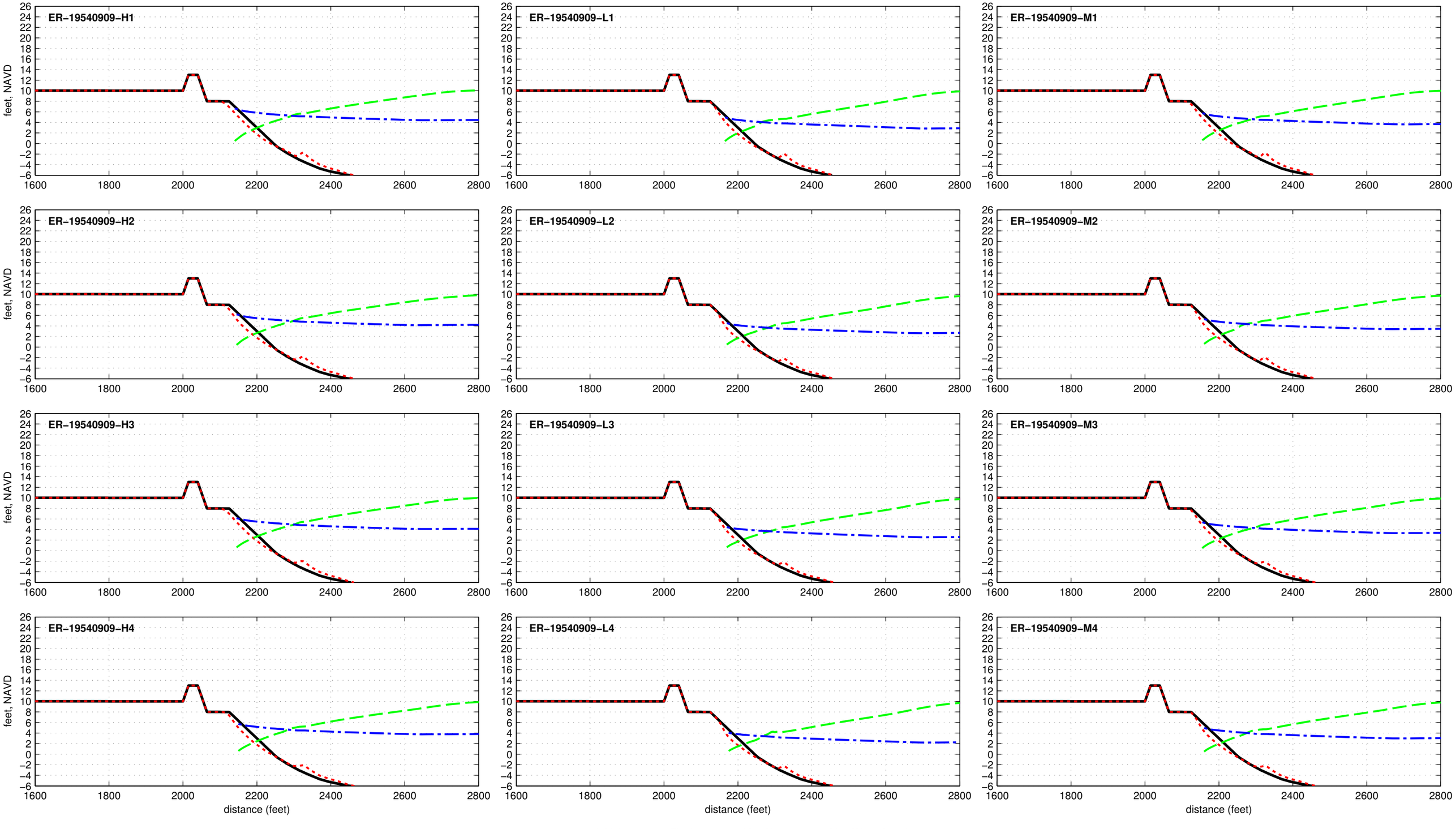




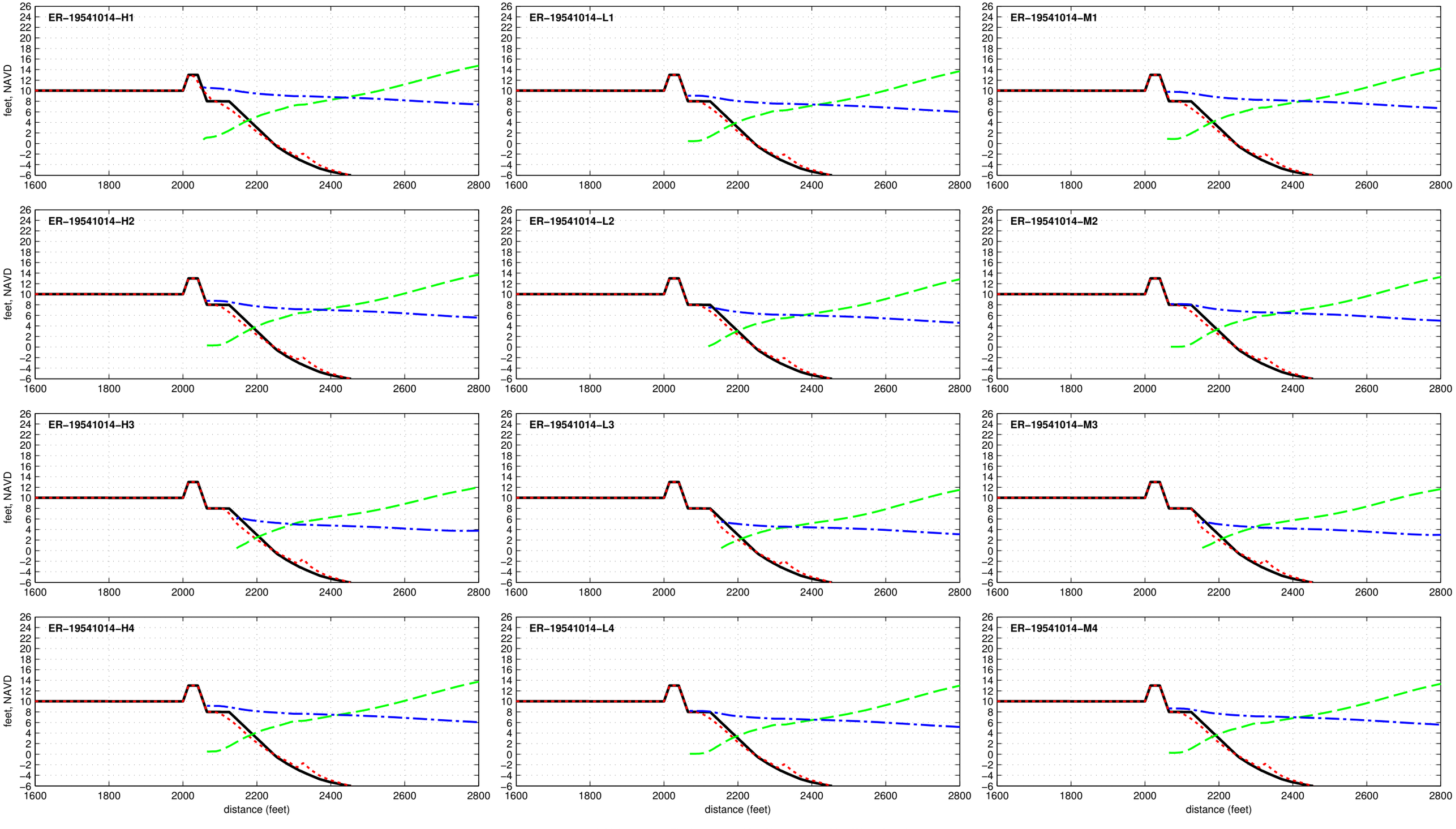


Initial Final Max Hs Max Water Level

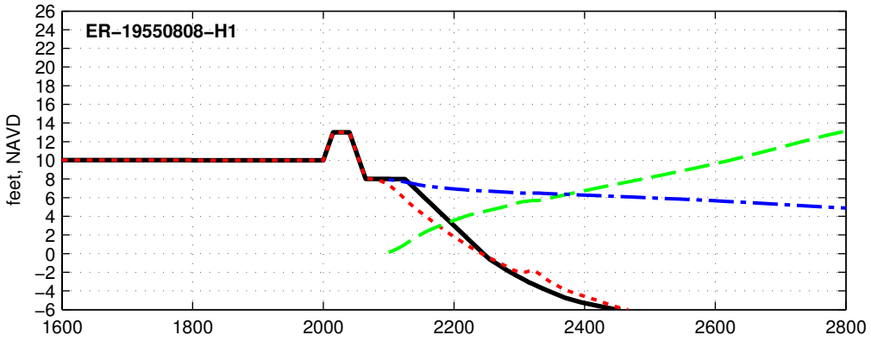
Dune R2T1–13.0–025–060 – ER–19540909

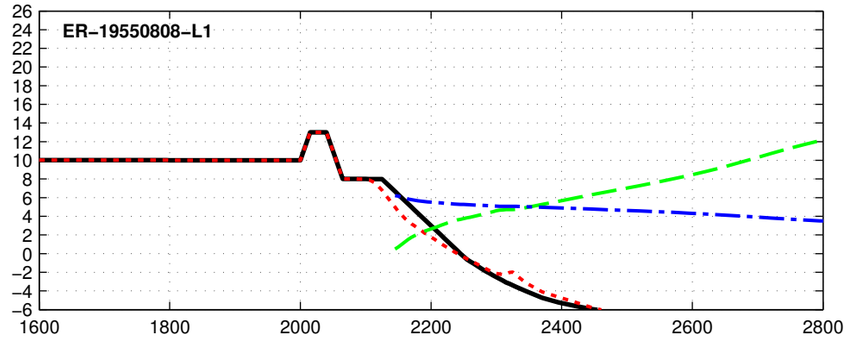


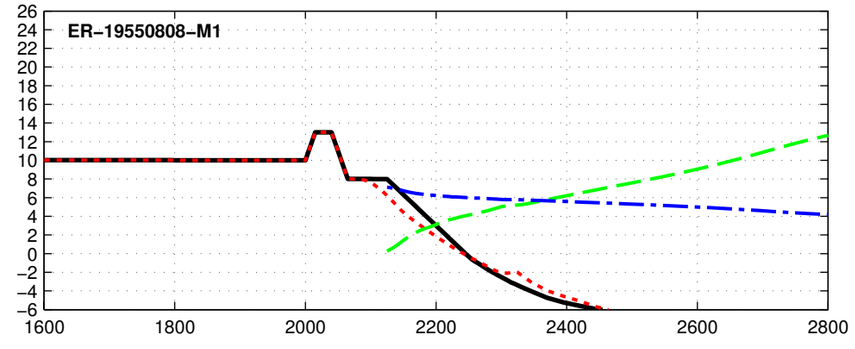
Dune R2T1-13.0-025-060 - ER-19541014

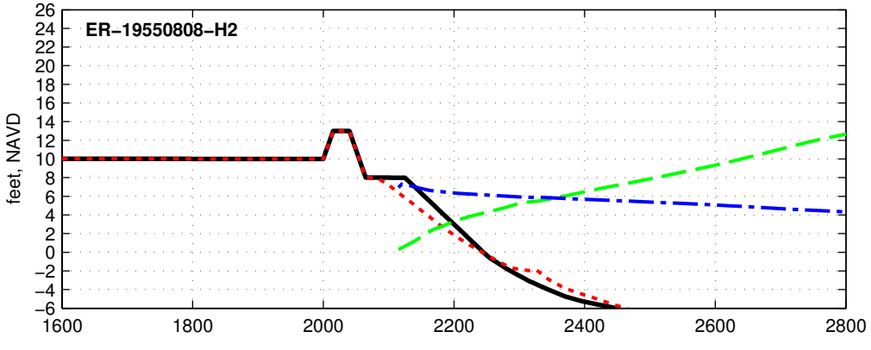


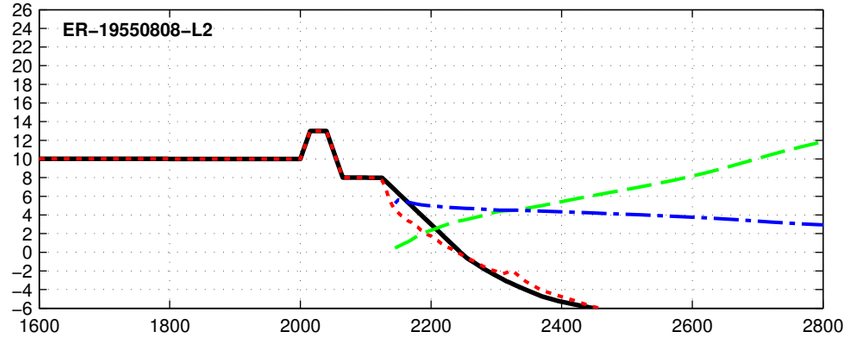
Dune R2T1-13.0-025-060 - ER-19550808

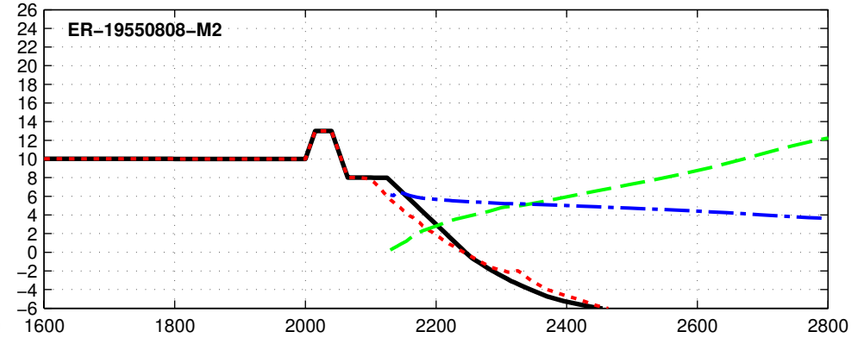


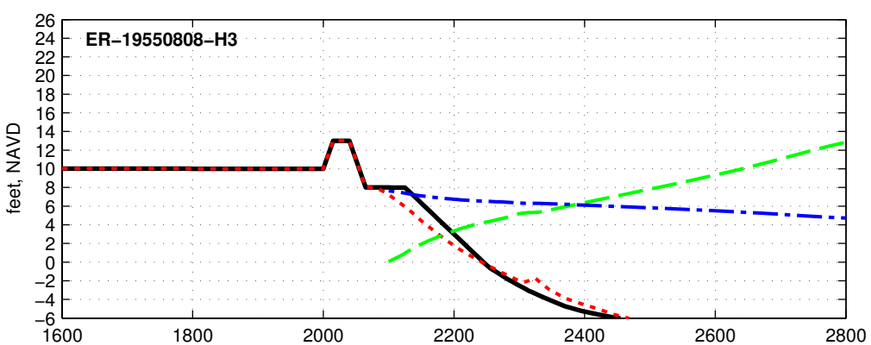


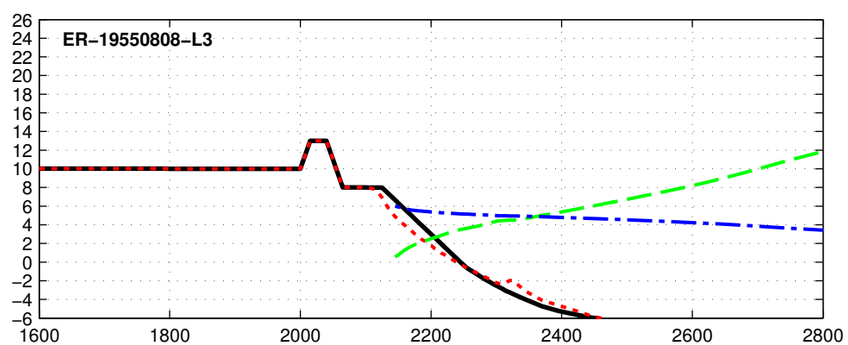


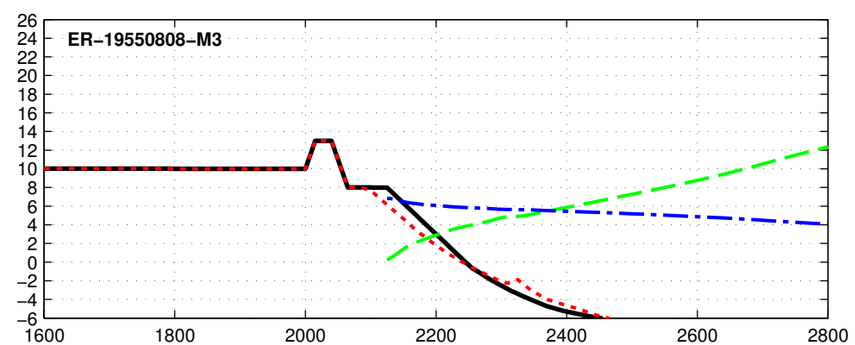


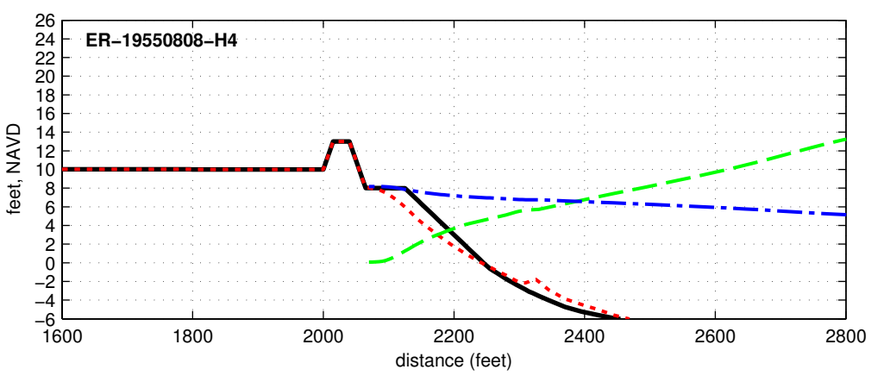


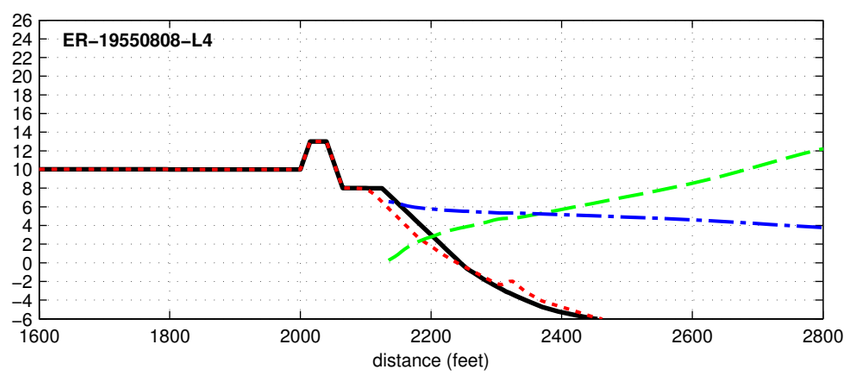


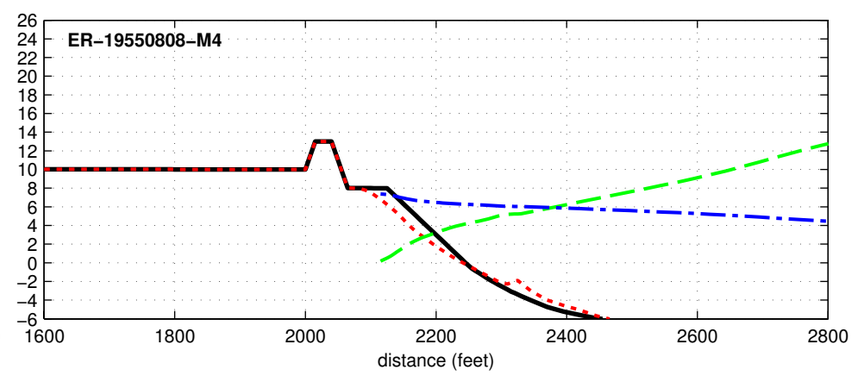






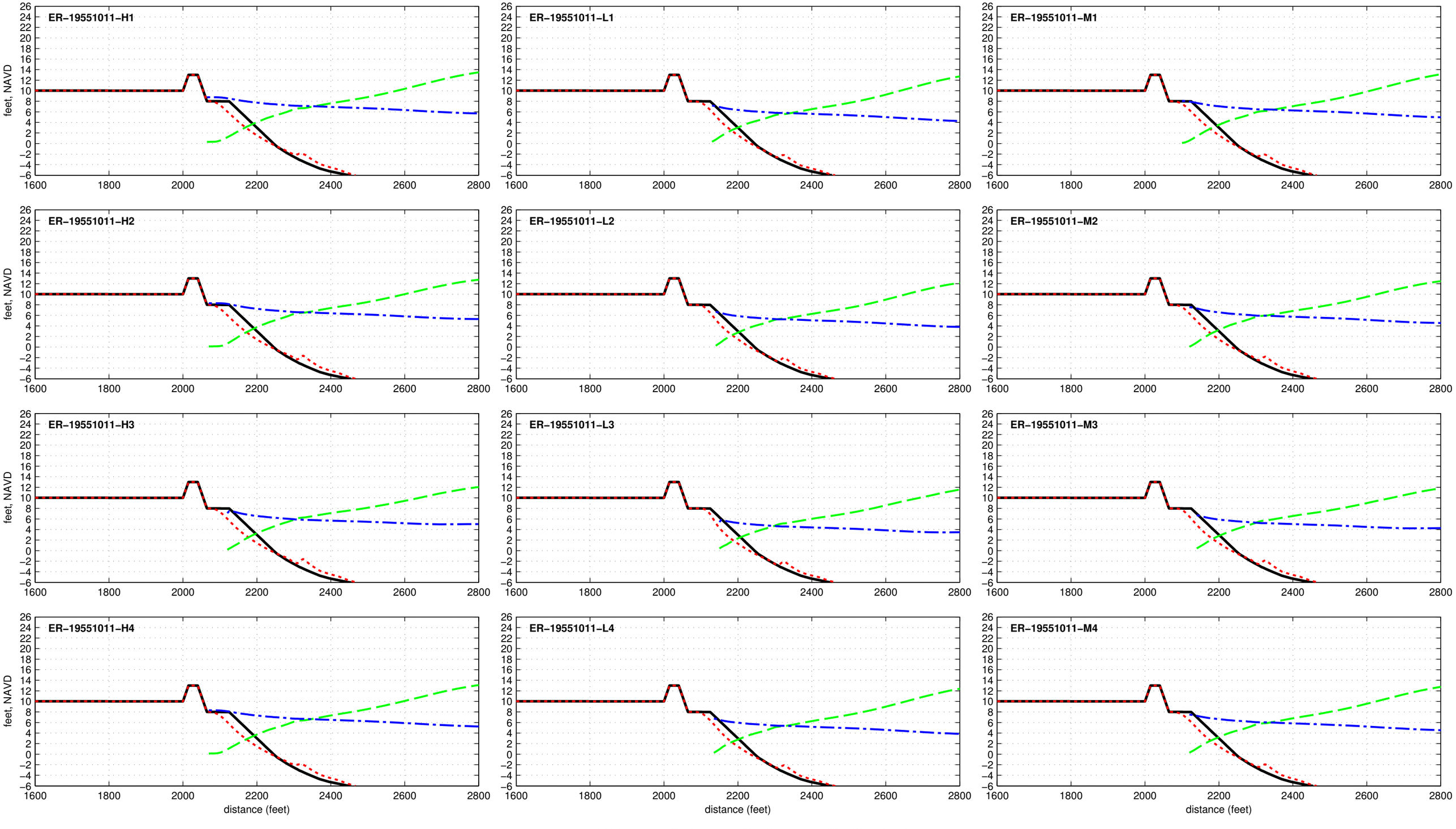




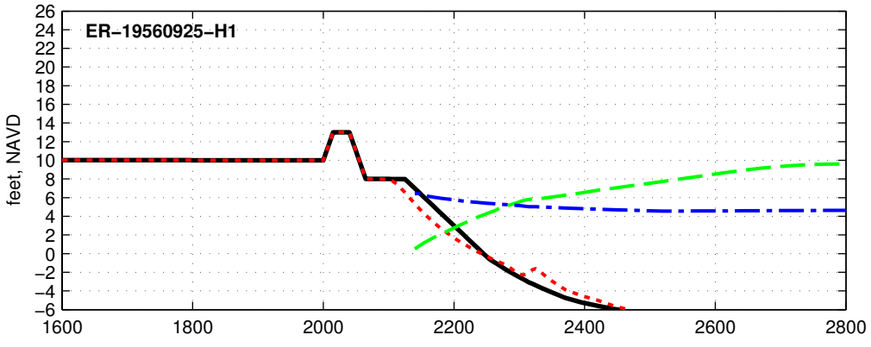


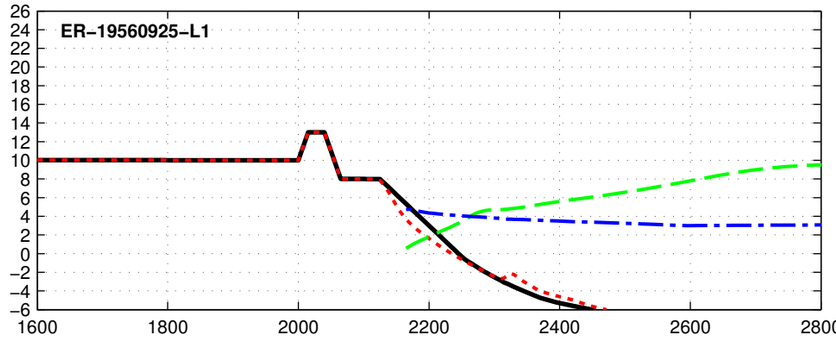
Initial Final Max Hs Max Water Level

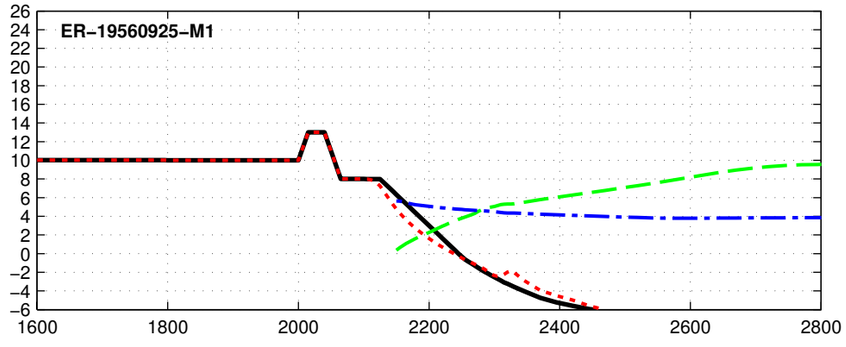
Dune R2T1-13.0-025-060 - ER-19551011

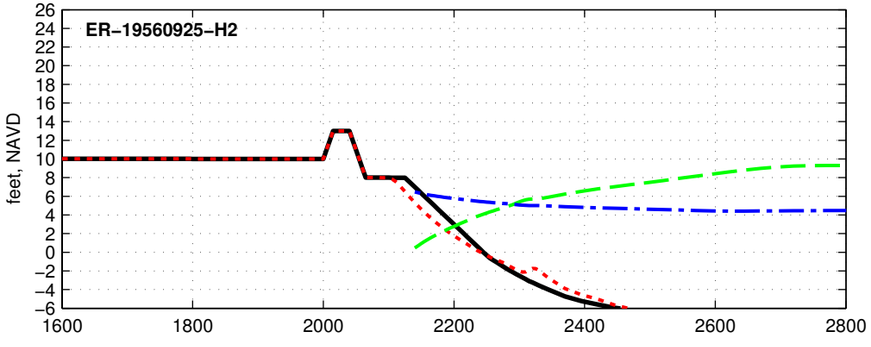


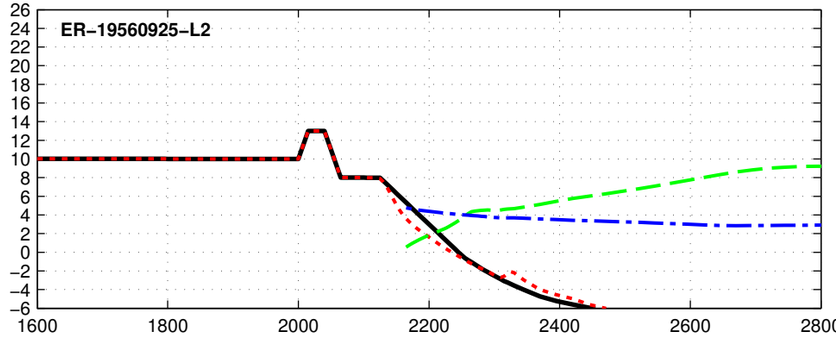
Dune R2T1-13.0-025-060 - ER-19560925

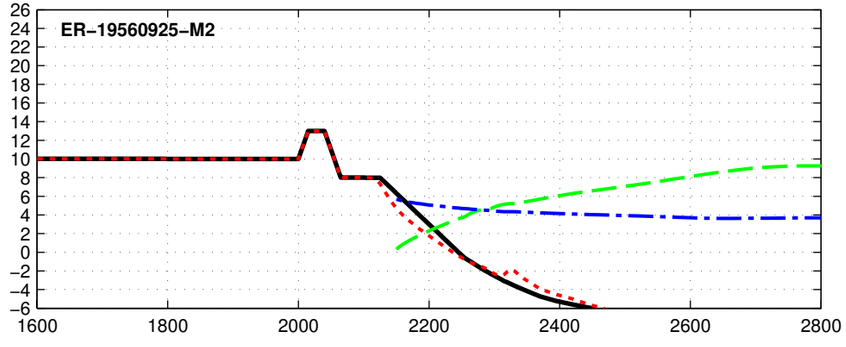


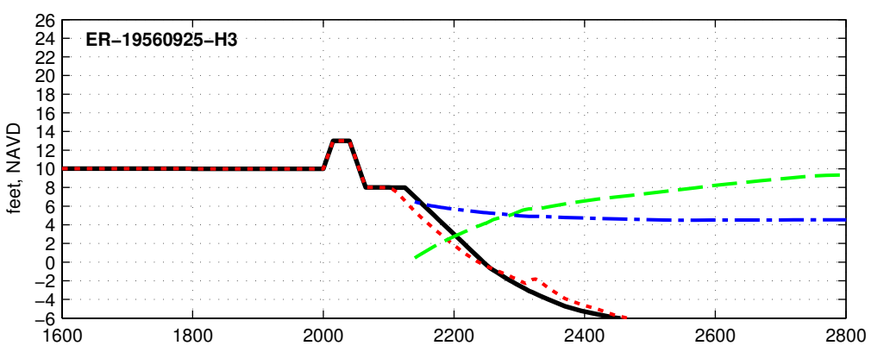


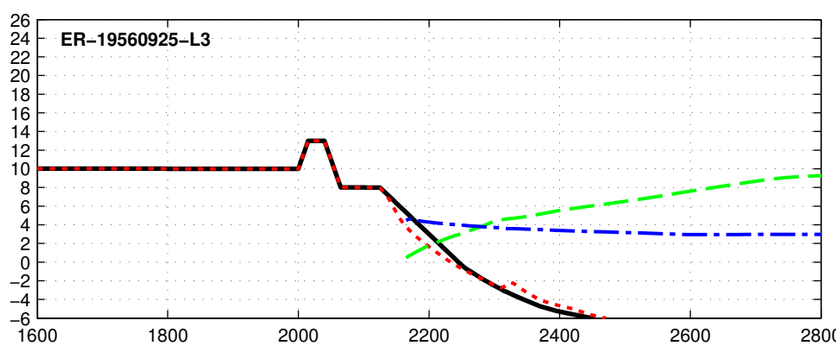


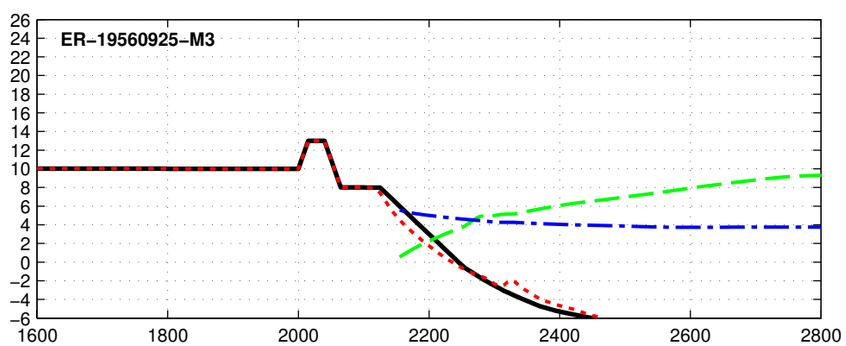


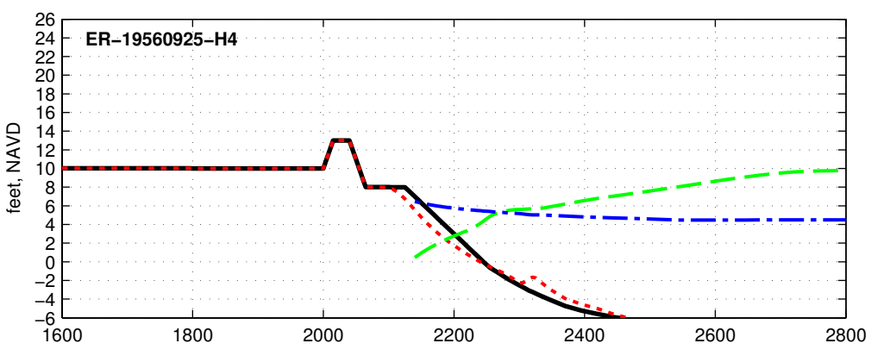


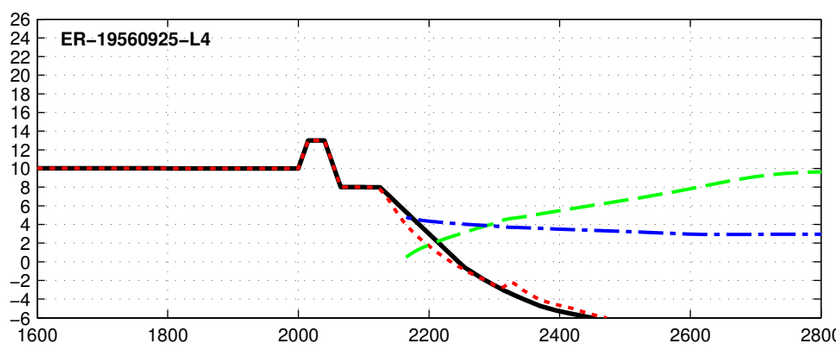


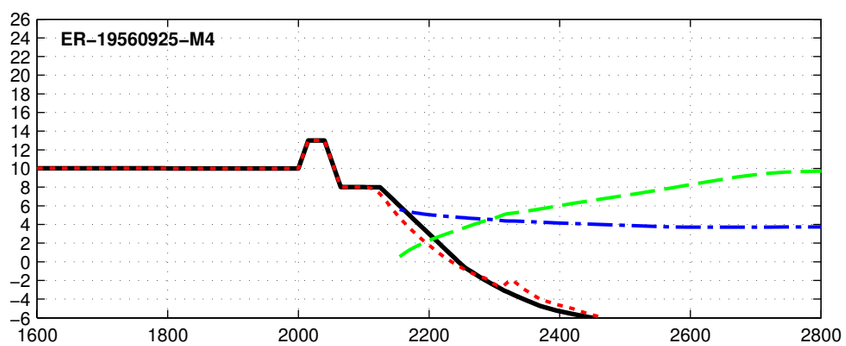






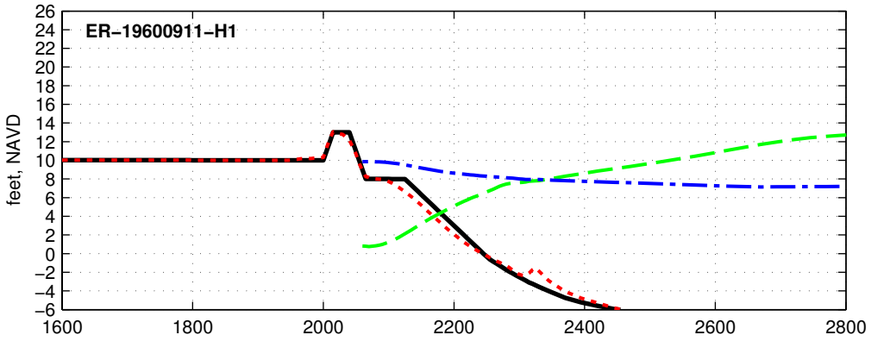


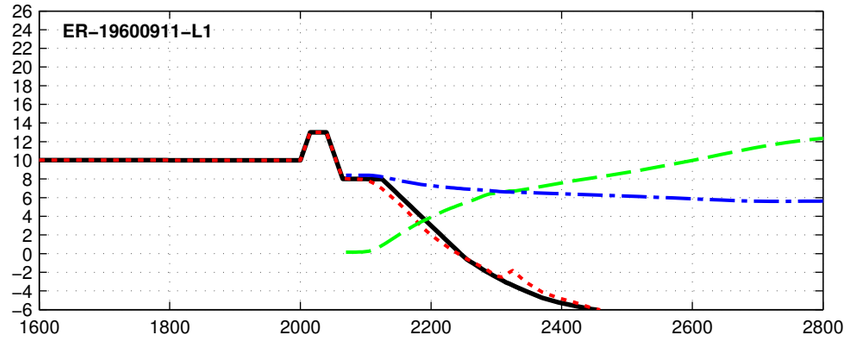


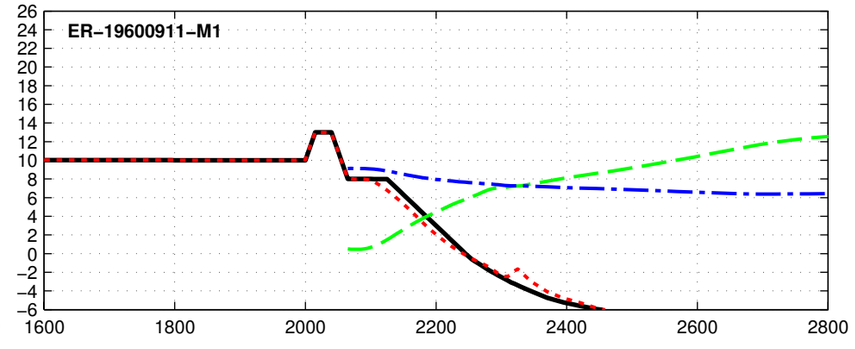


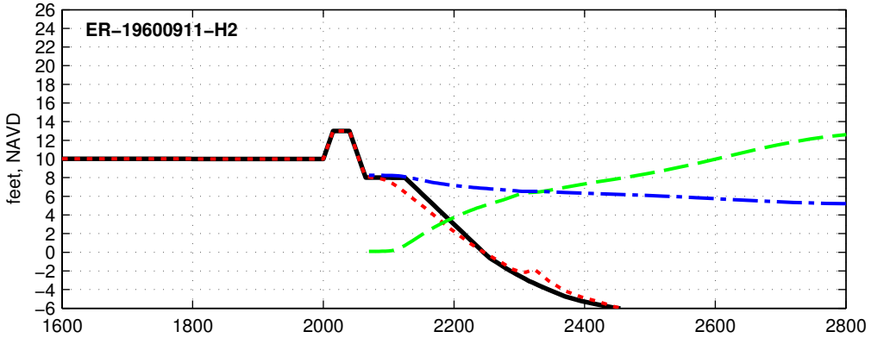
Initial Final Max Hs Max Water Level

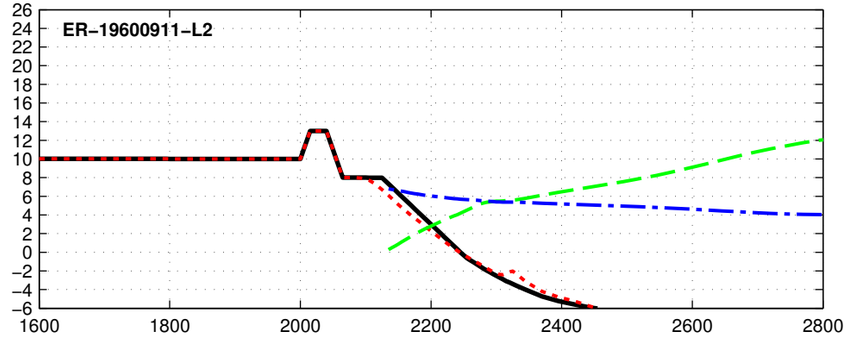
Dune R2T1-13.0-025-060 - ER-19600911

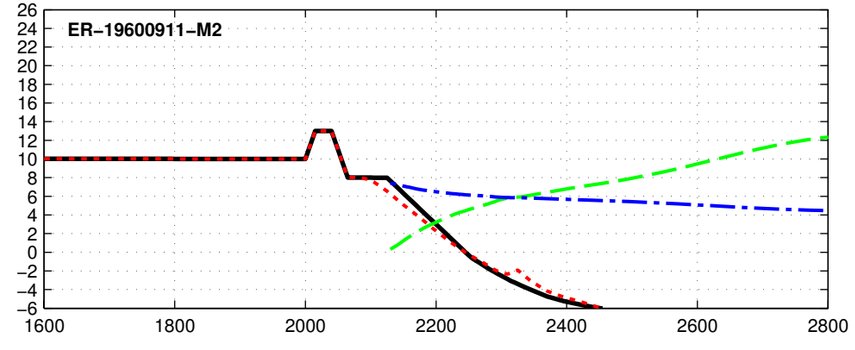


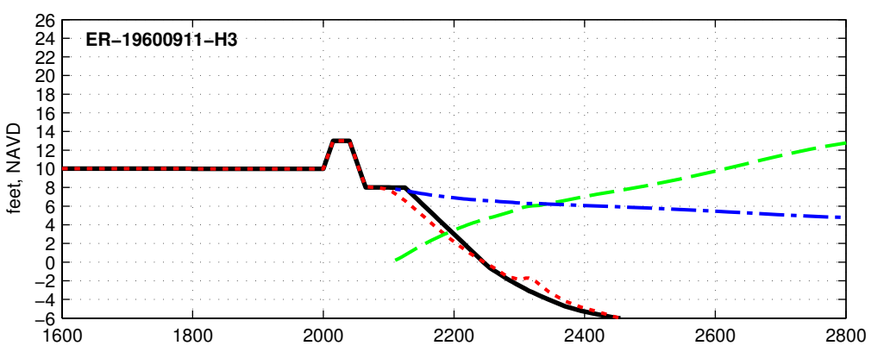


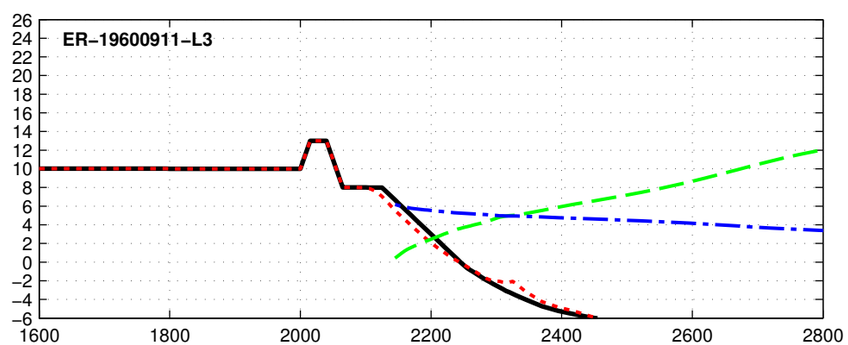


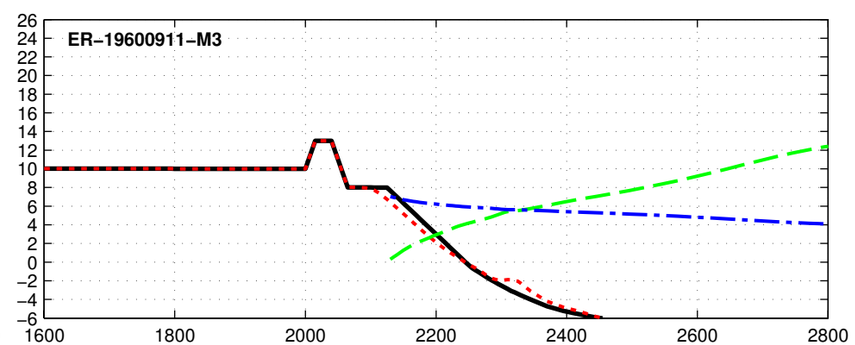


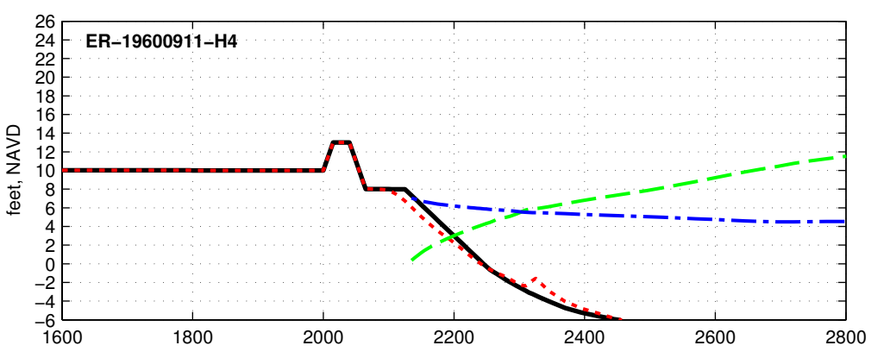


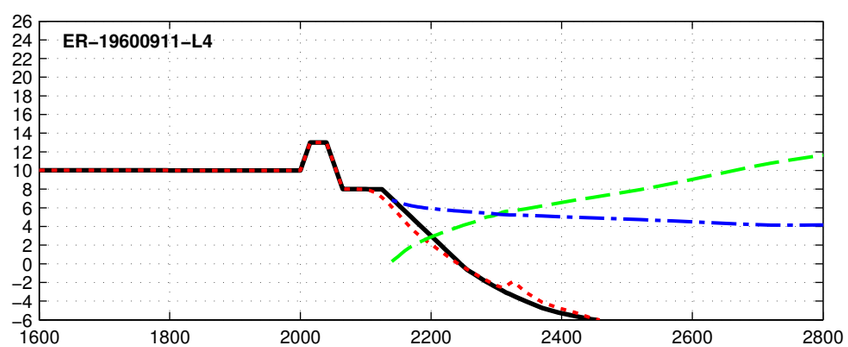


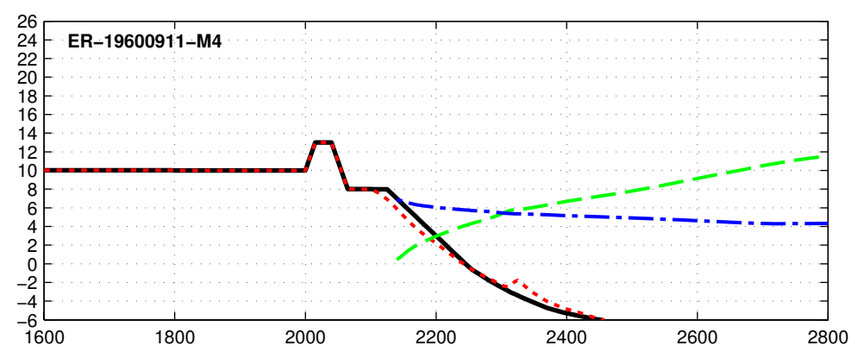






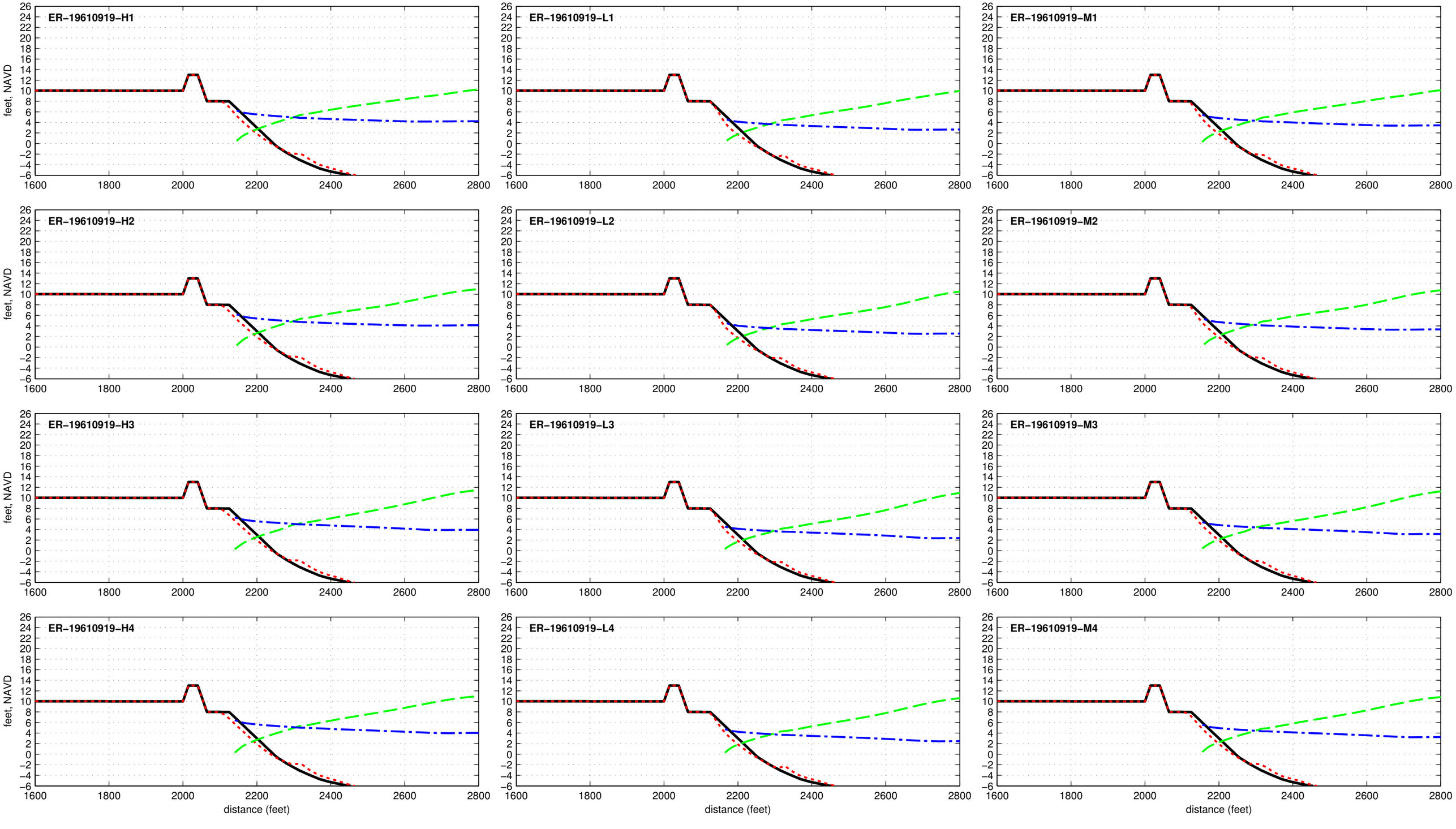




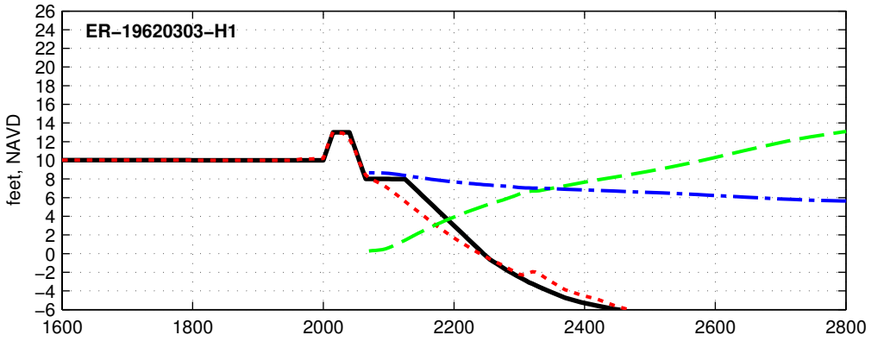


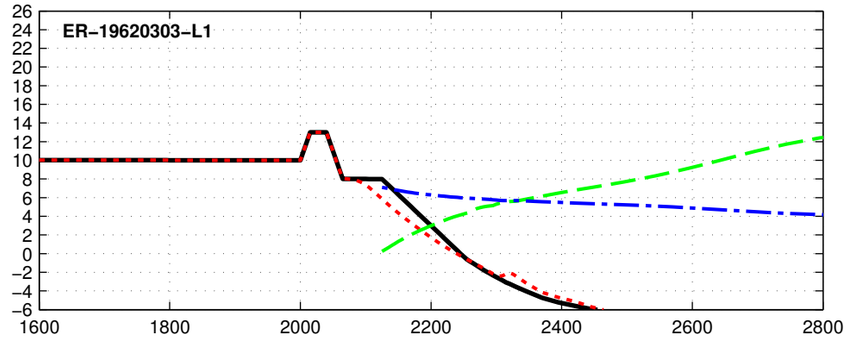
Initial Final Max Hs Max Water Level

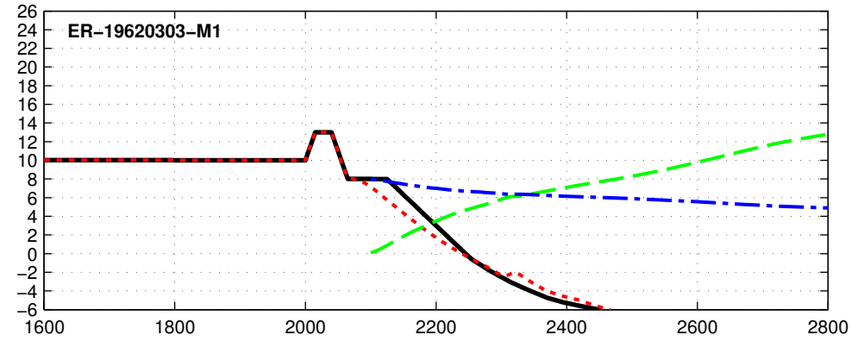
Dune R2T1-13.0-025-060 - ER-19610919

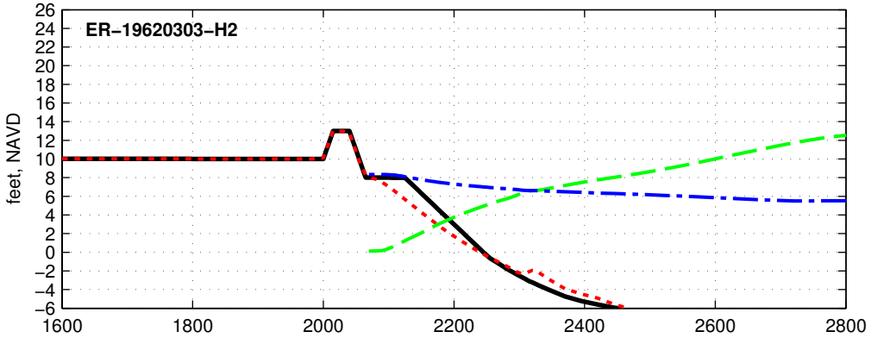


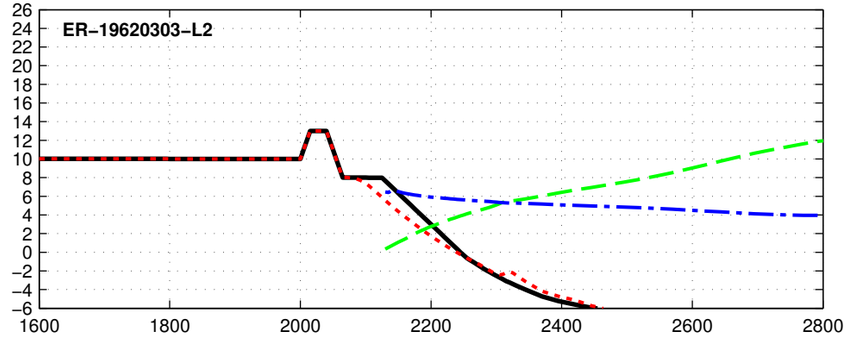
Dune R2T1-13.0-025-060 - ER-19620303

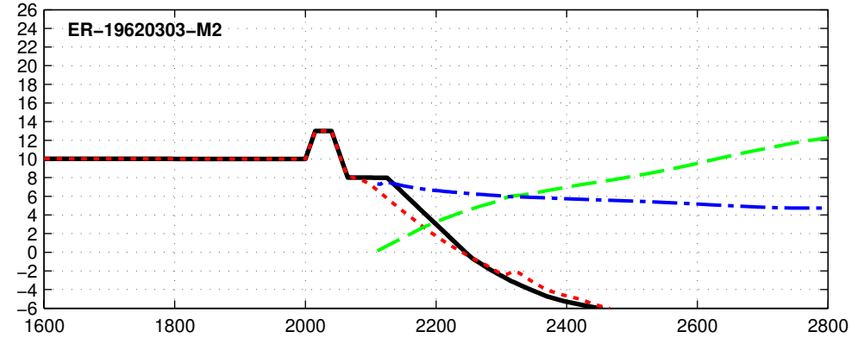


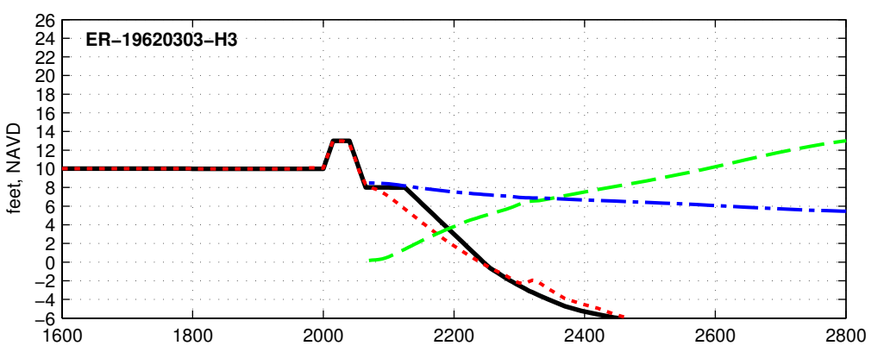


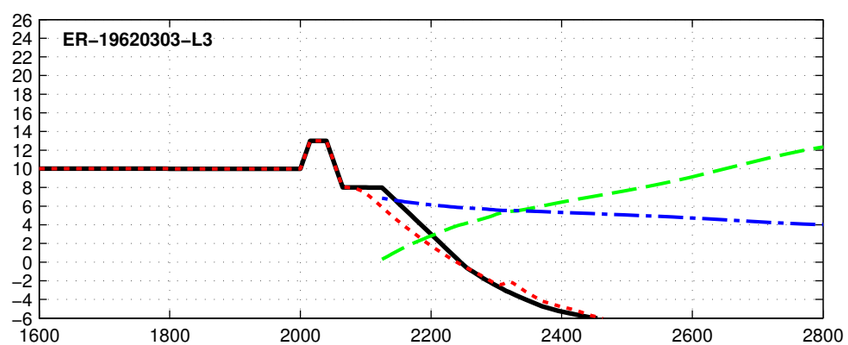


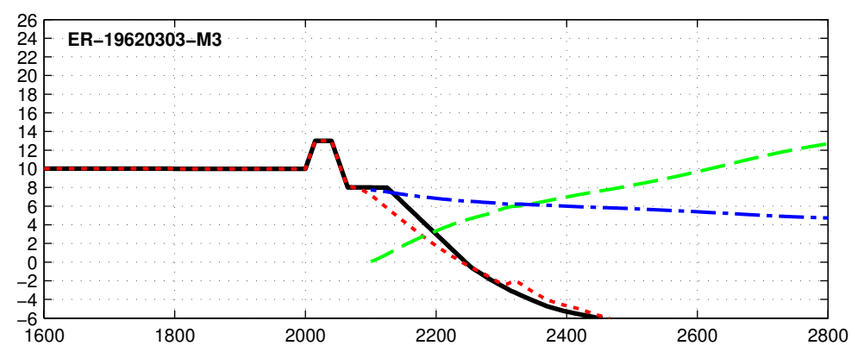


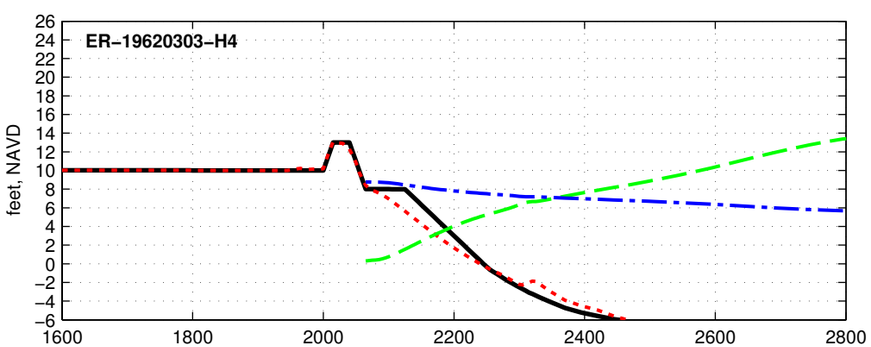


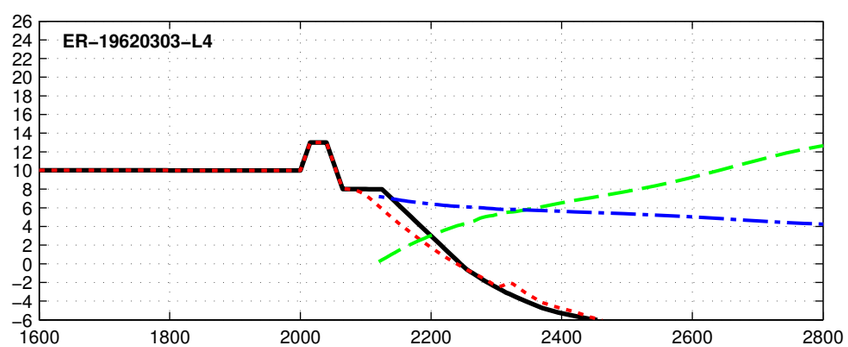


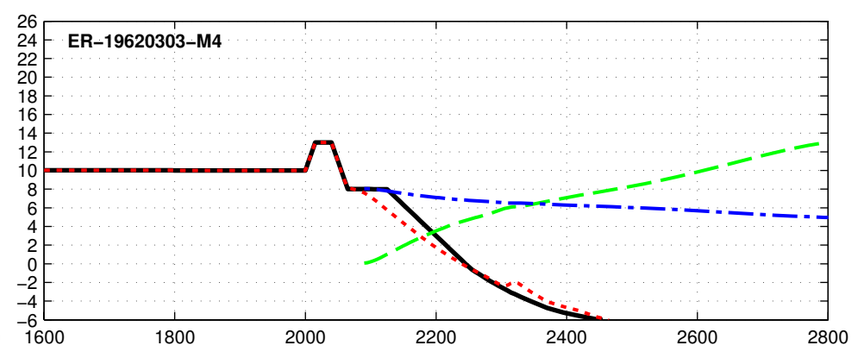






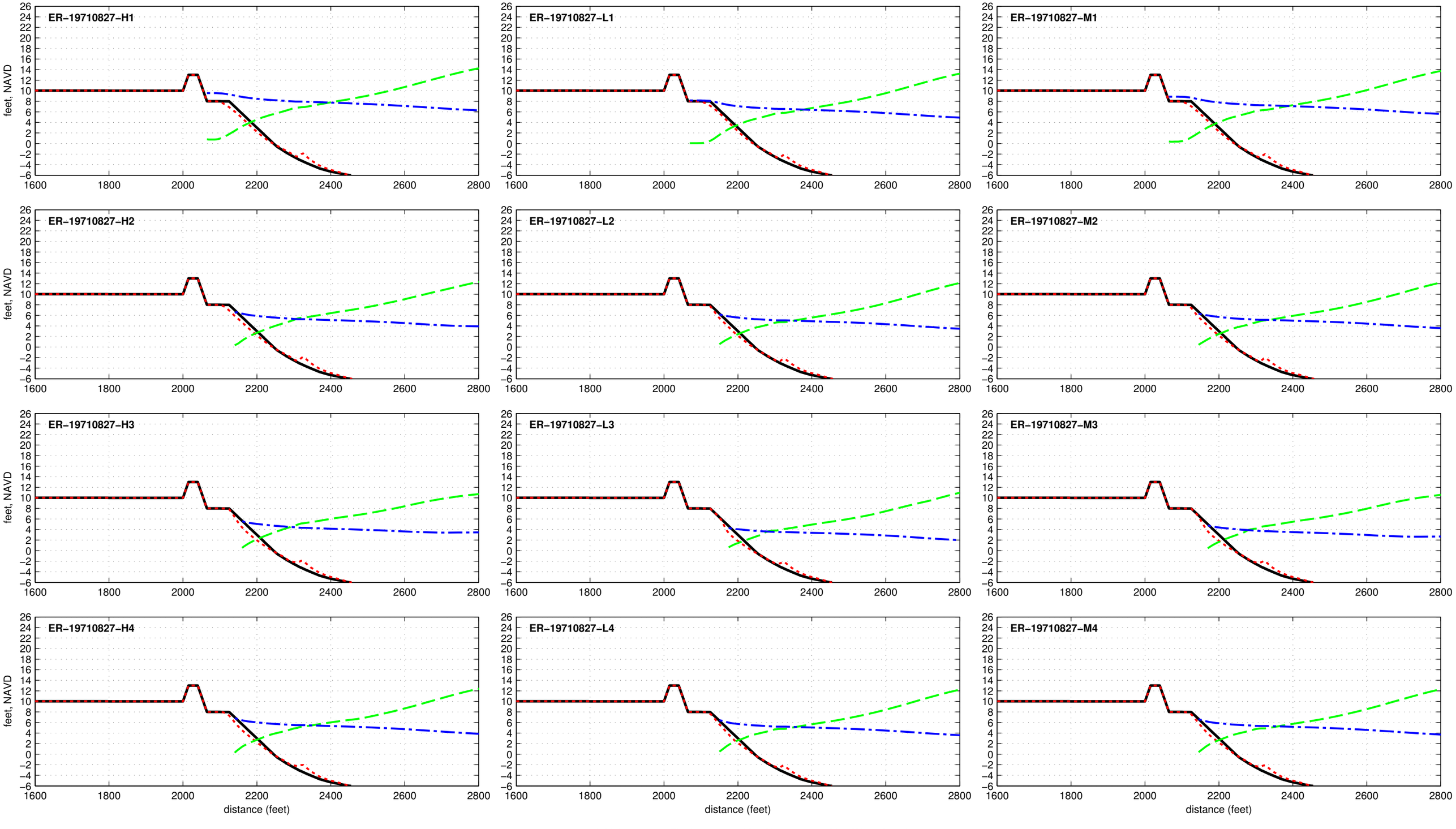




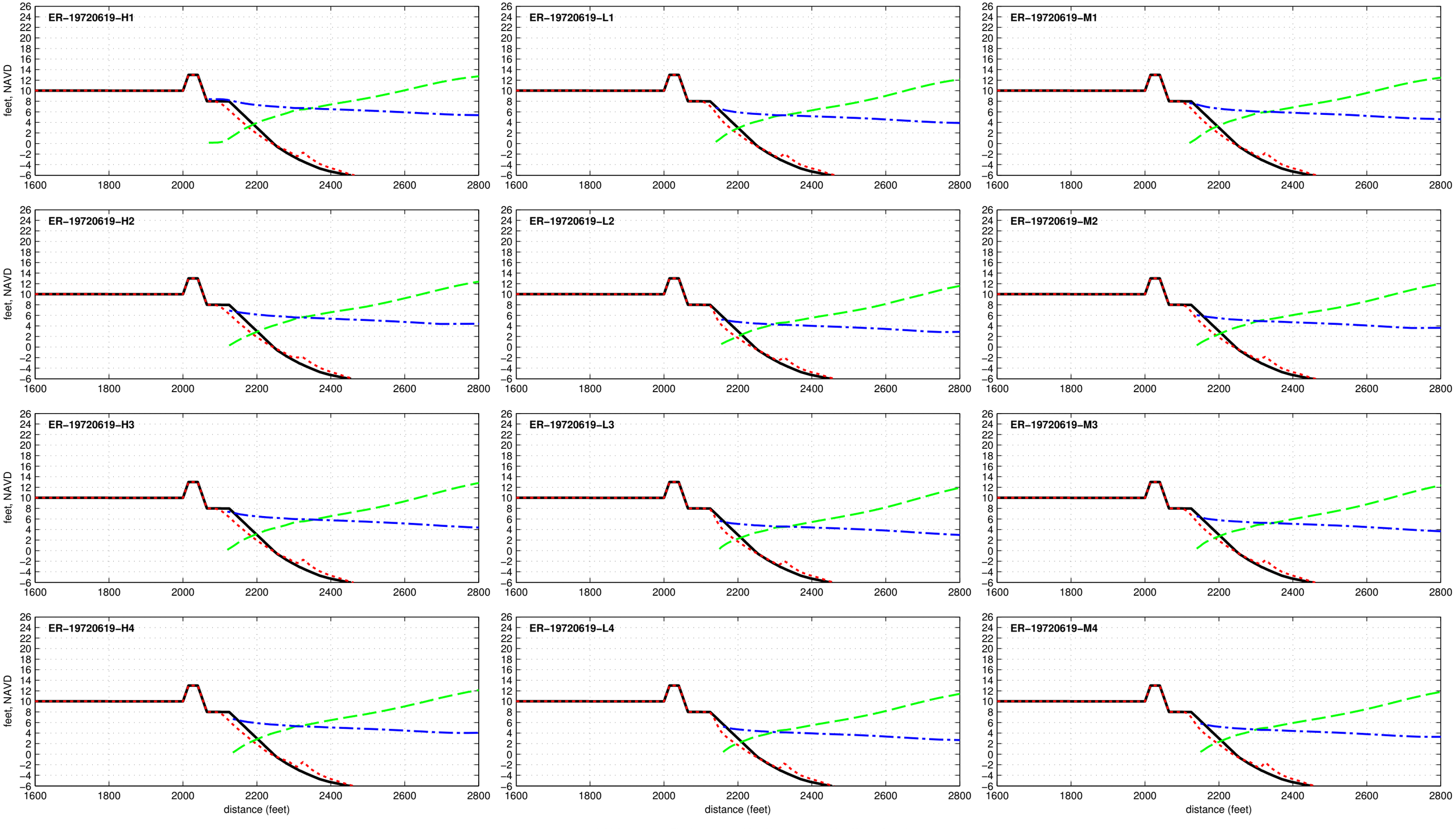


Initial Final Max Hs Max Water Level

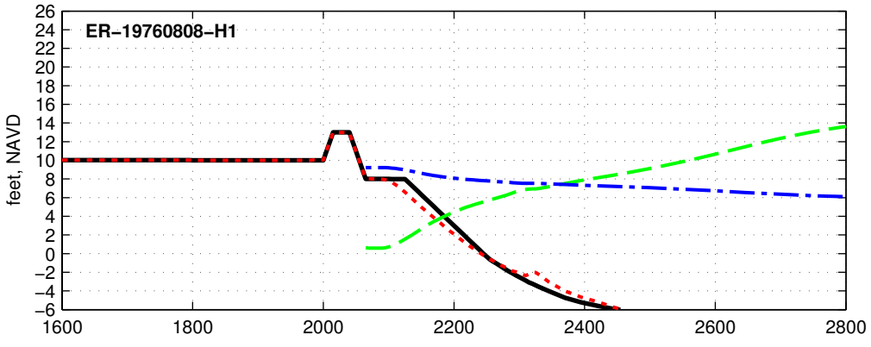
Dune R2T1–13.0–025–060 – ER–19710827

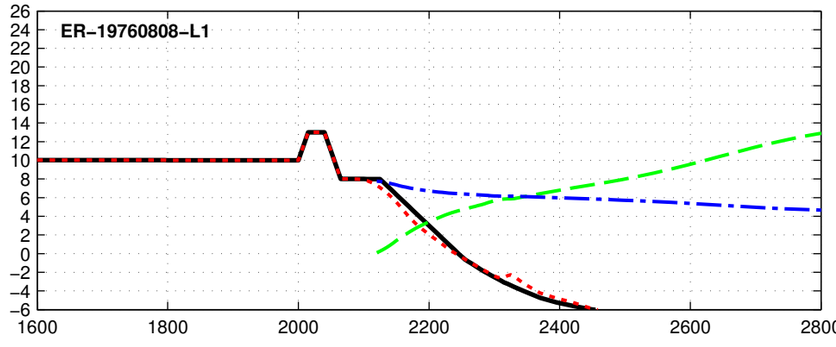


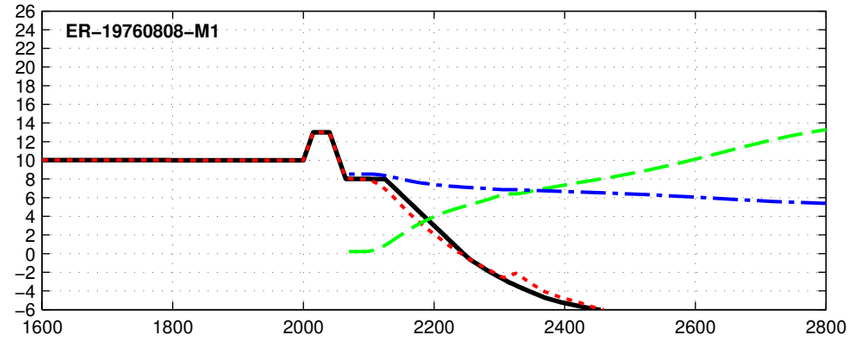
Dune R2T1-13.0-025-060 - ER-19720619

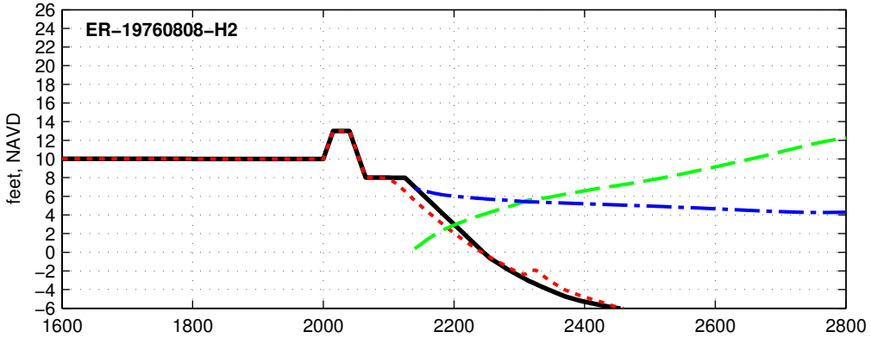


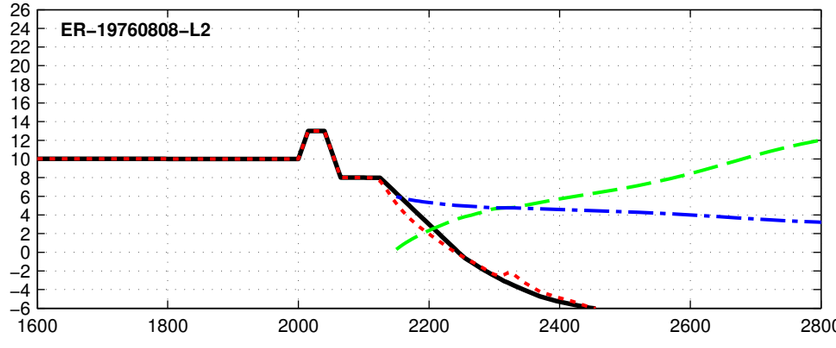
Dune R2T1-13.0-025-060 - ER-19760808

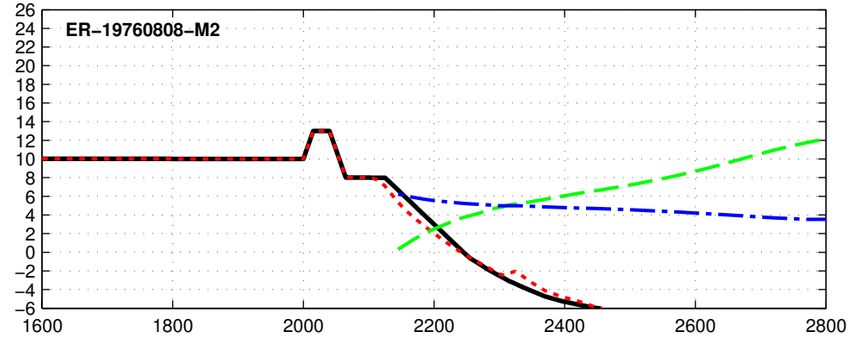


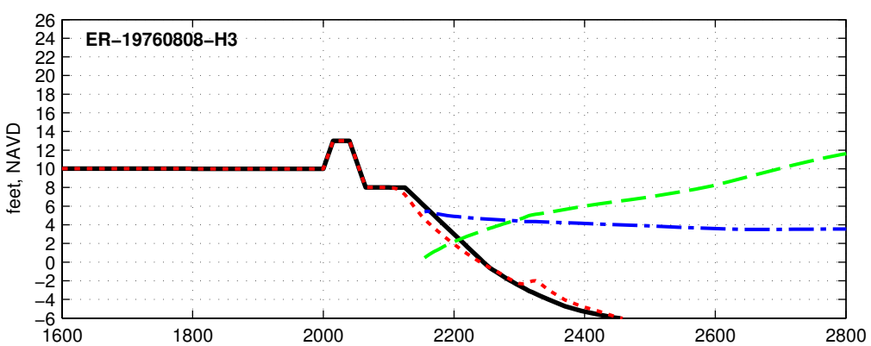


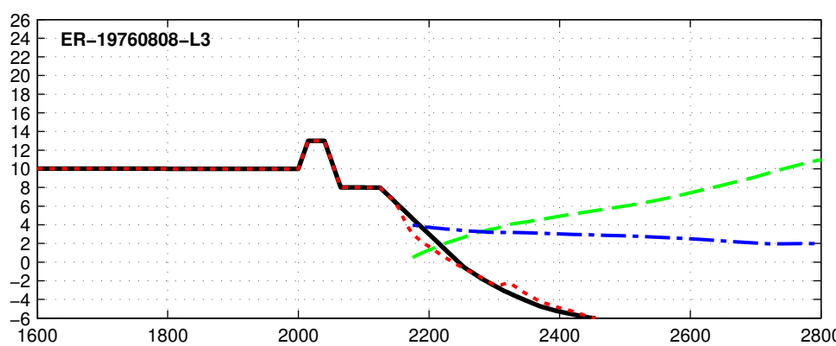


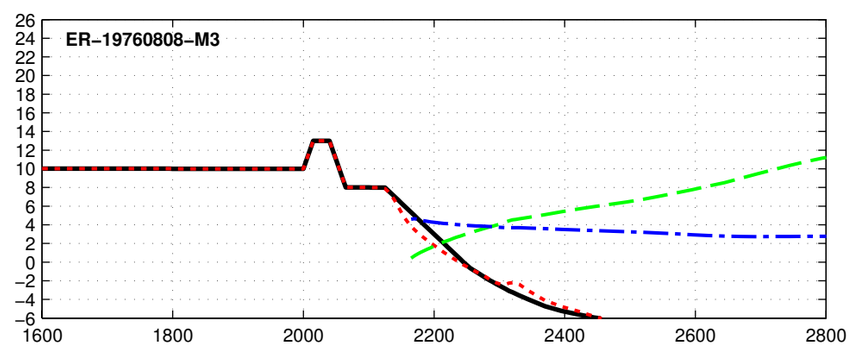


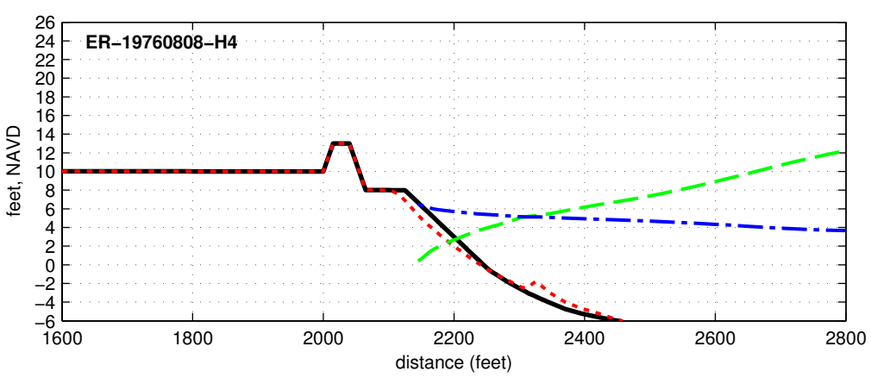


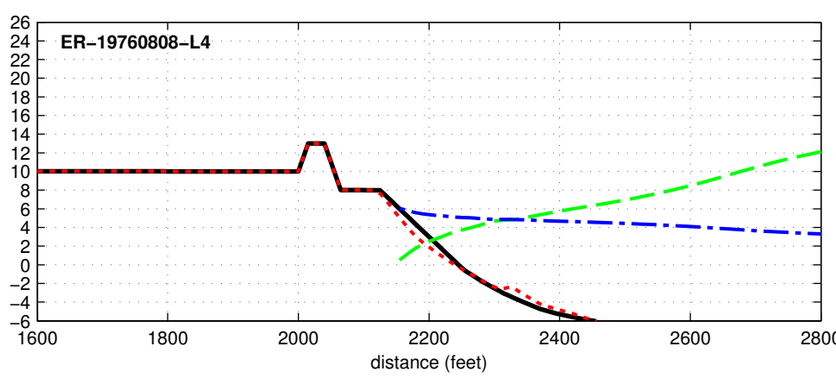


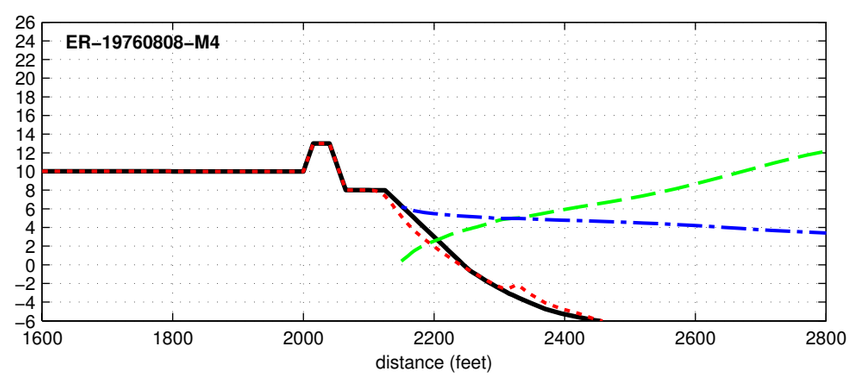






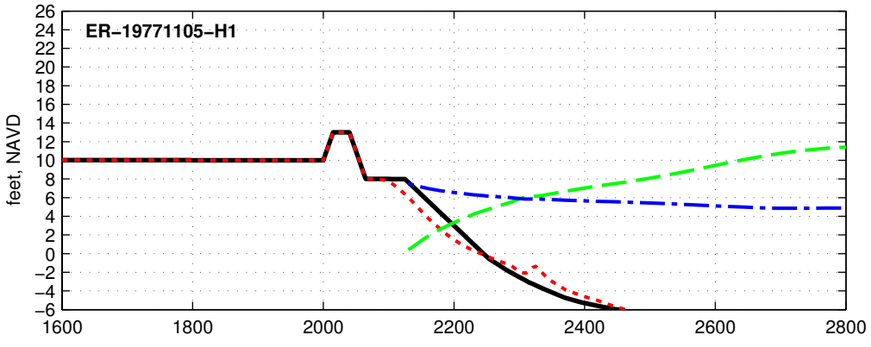


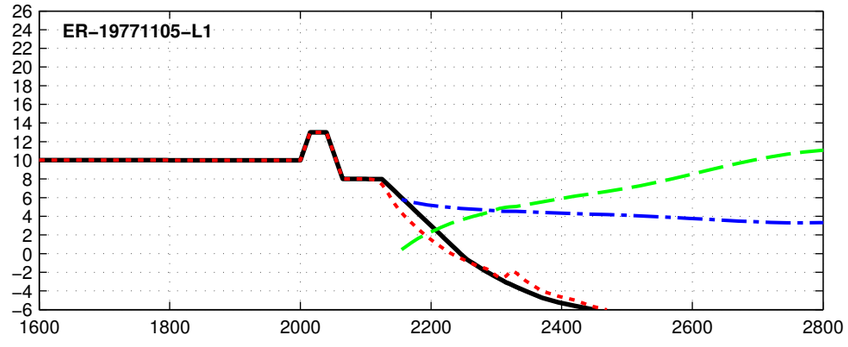


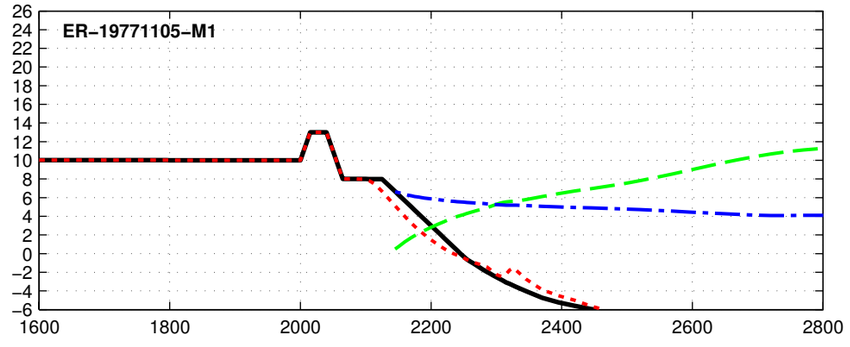


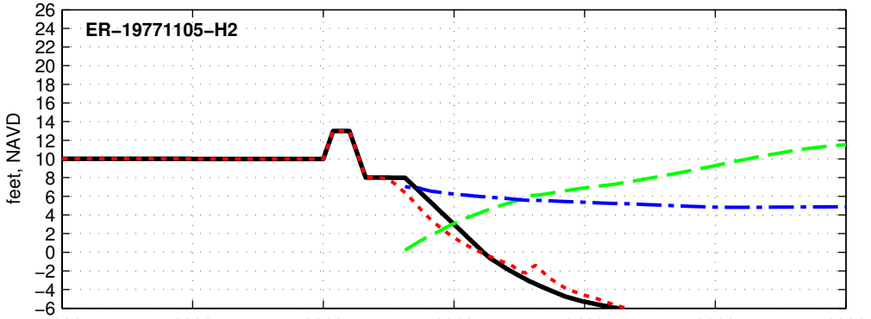
Initial Final Max Hs Max Water Level

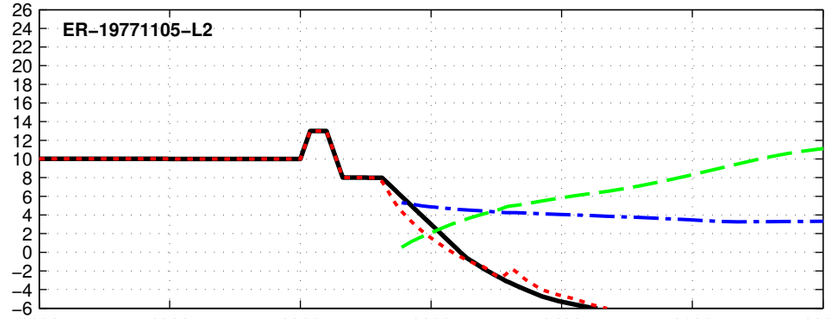
Dune R2T1-13.0-025-060 - ER-19771105

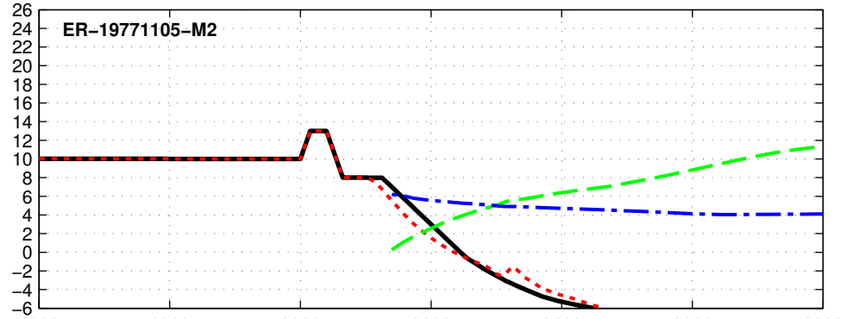


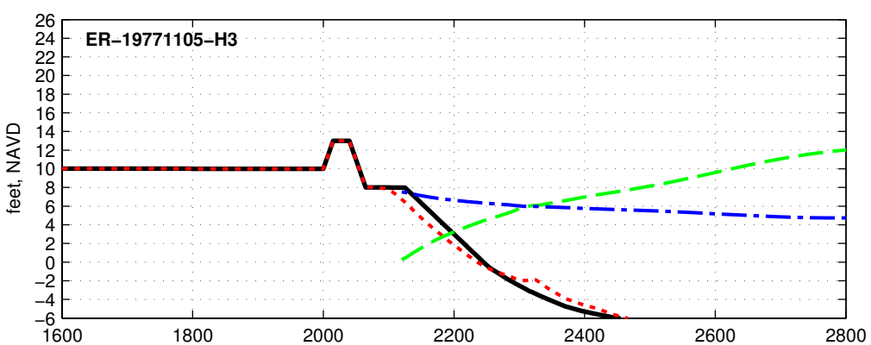


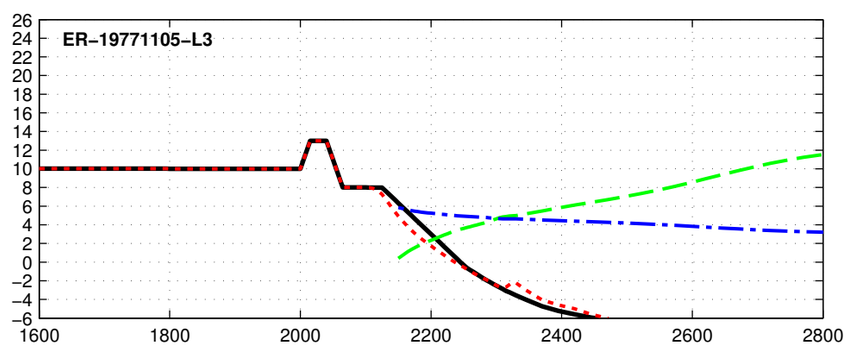


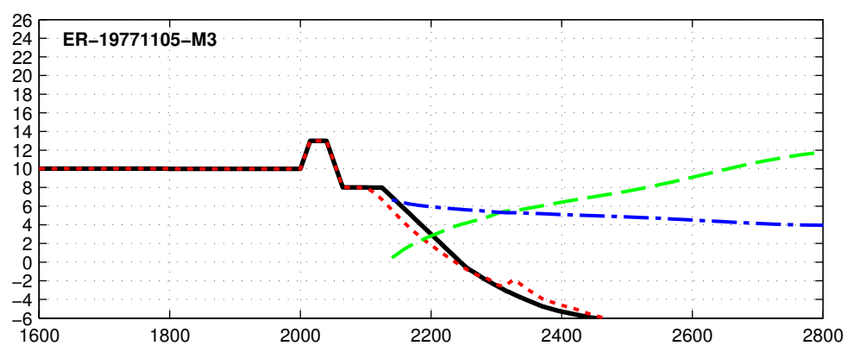


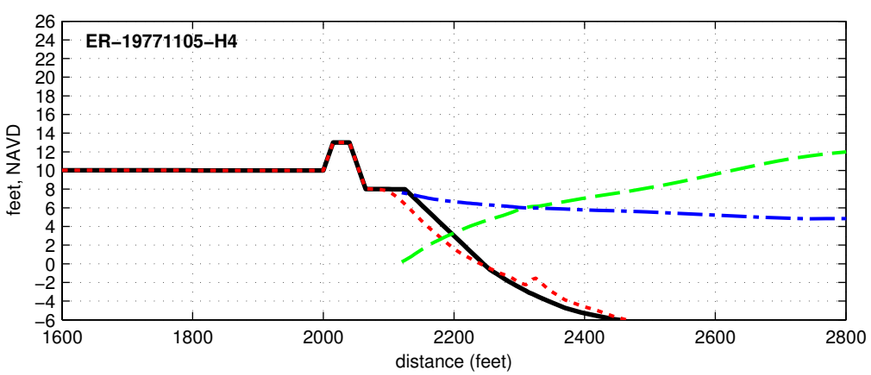


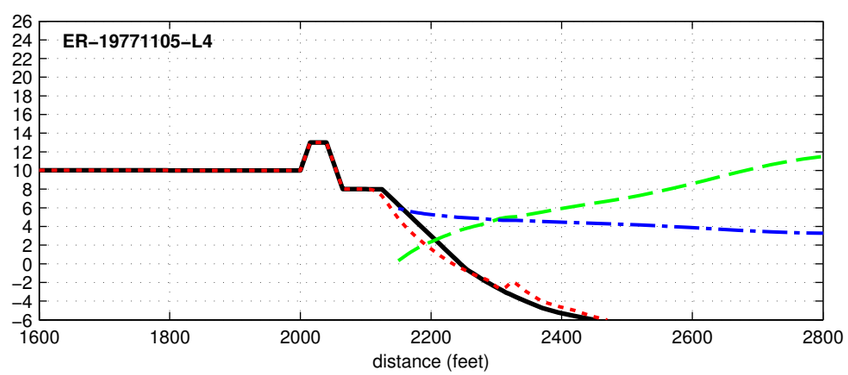


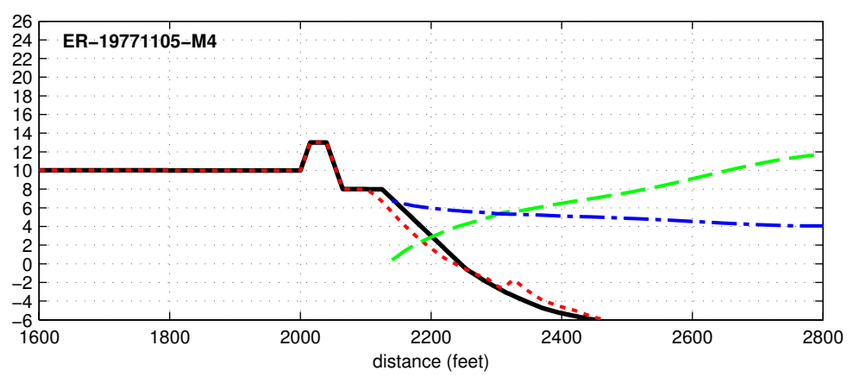






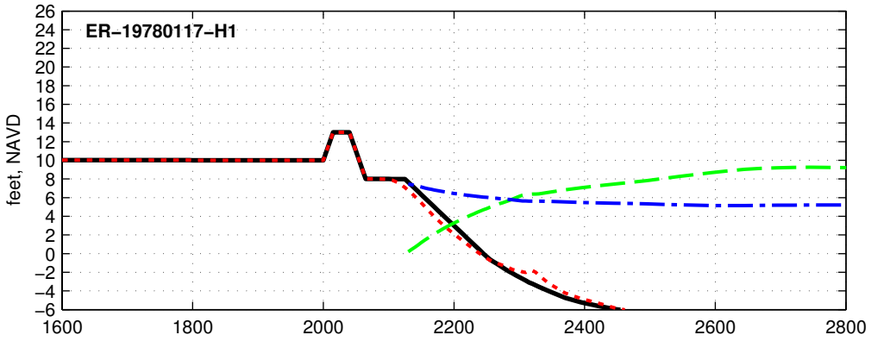


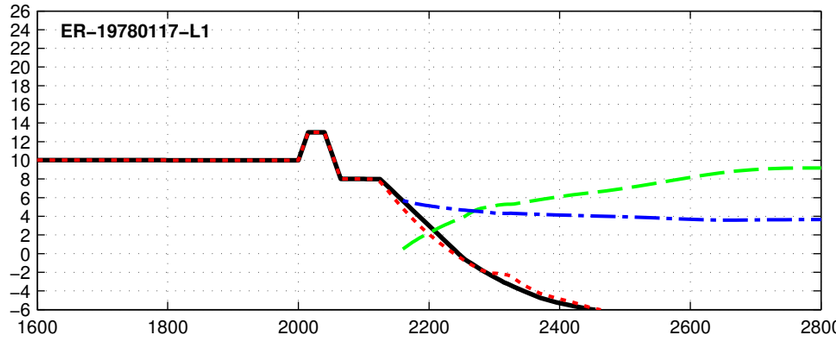


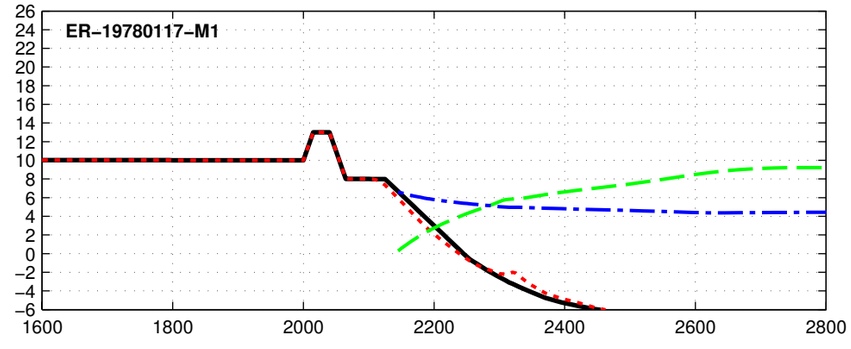


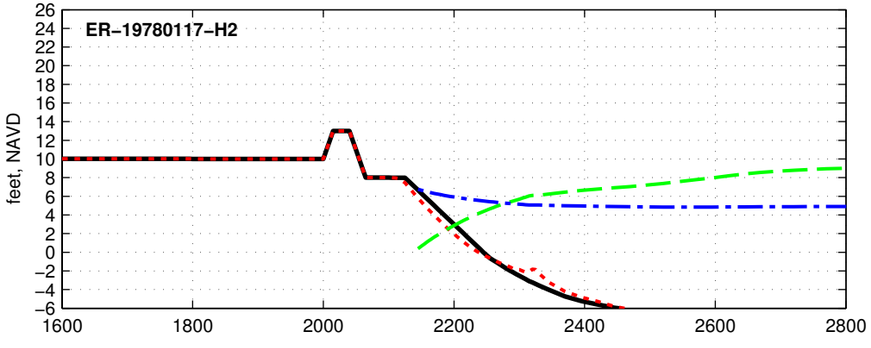
Initial Final Max Hs Max Water Level

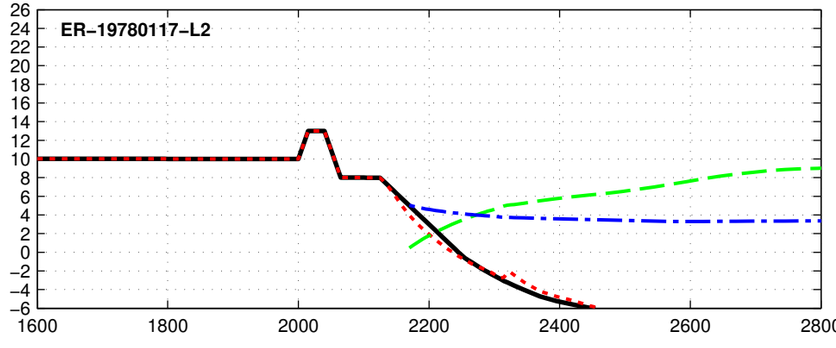
Dune R2T1–13.0–025–060 – ER–19780117

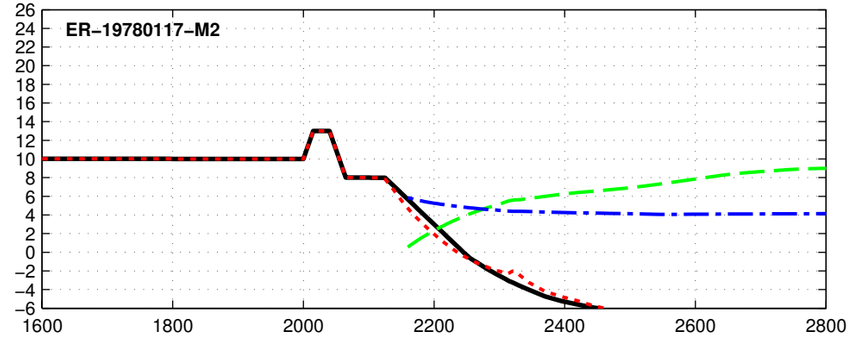


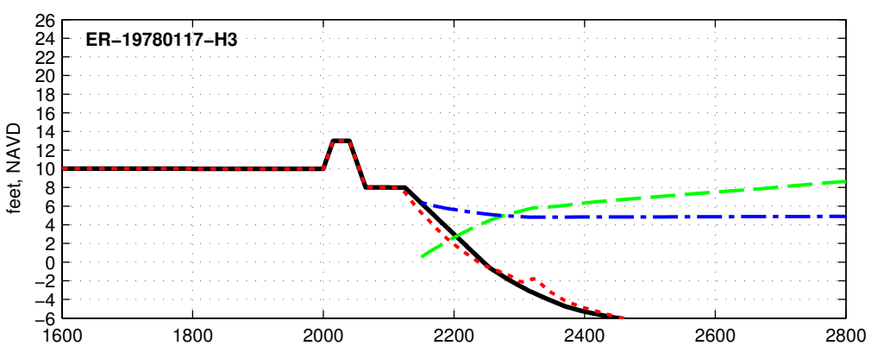


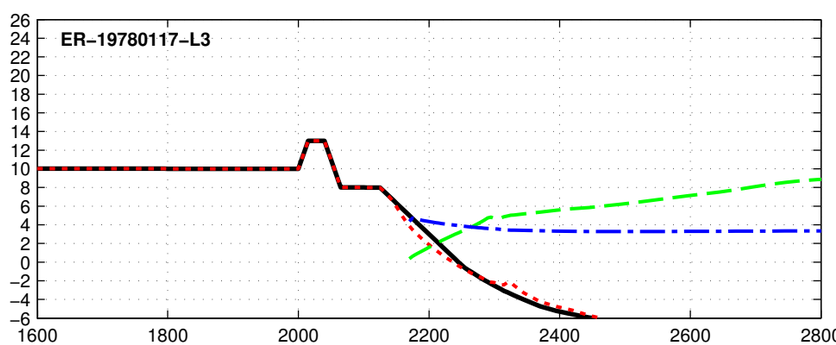


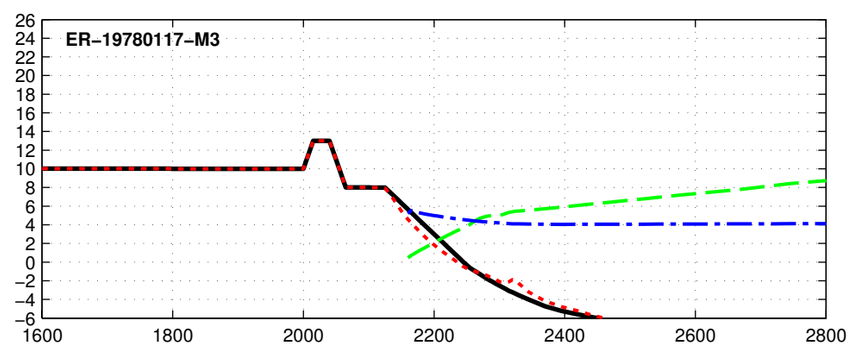


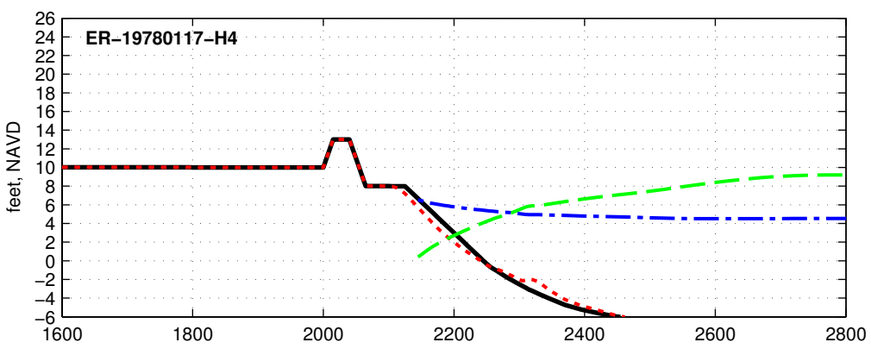


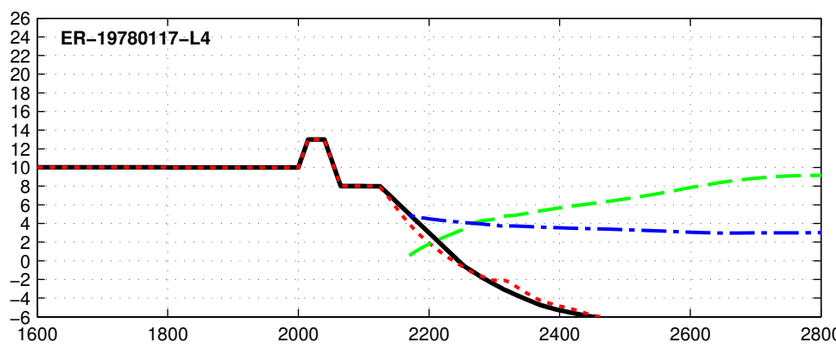


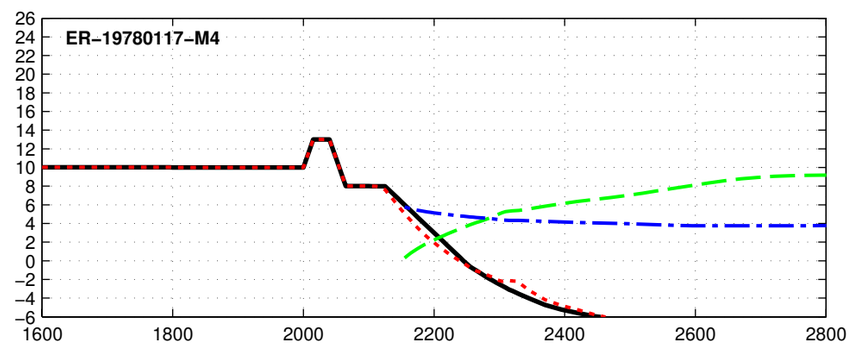






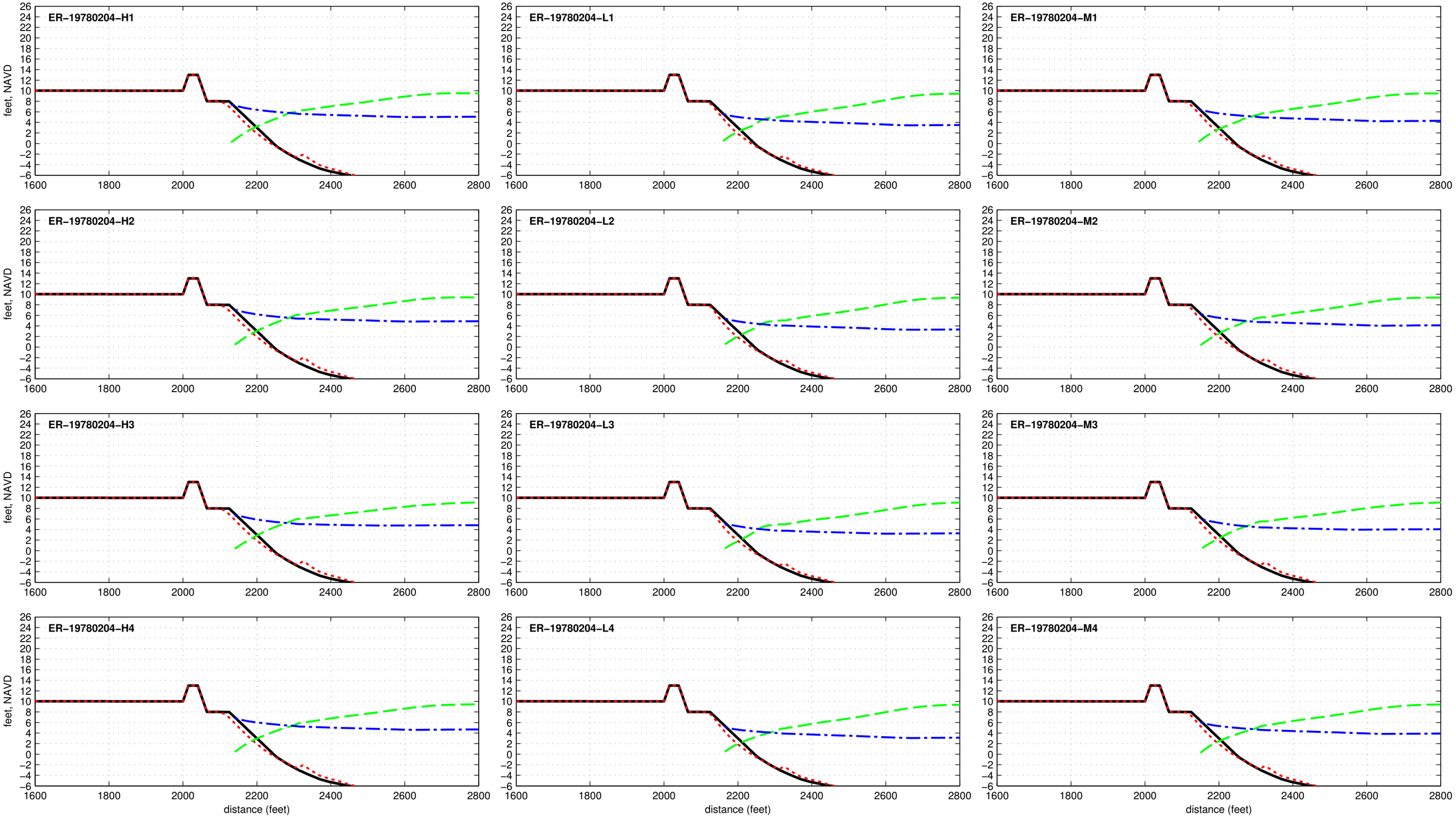




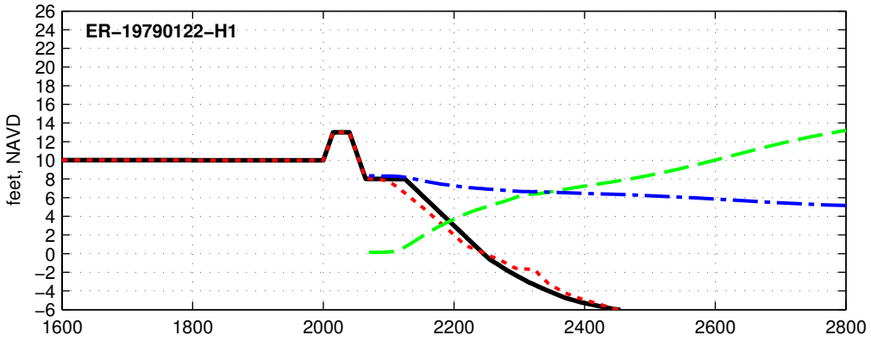


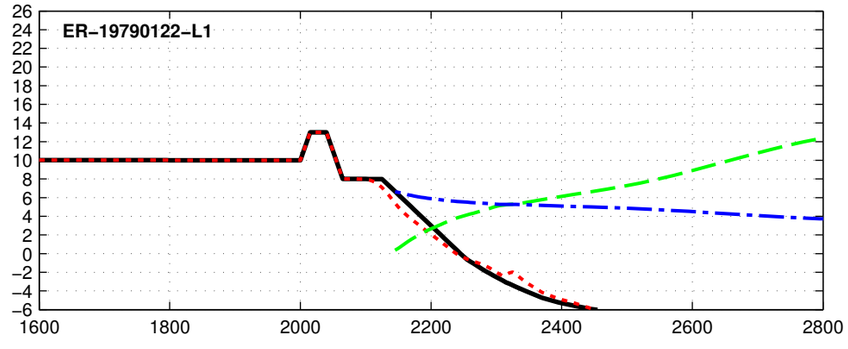
Initial Final Max Hs Max Water Level

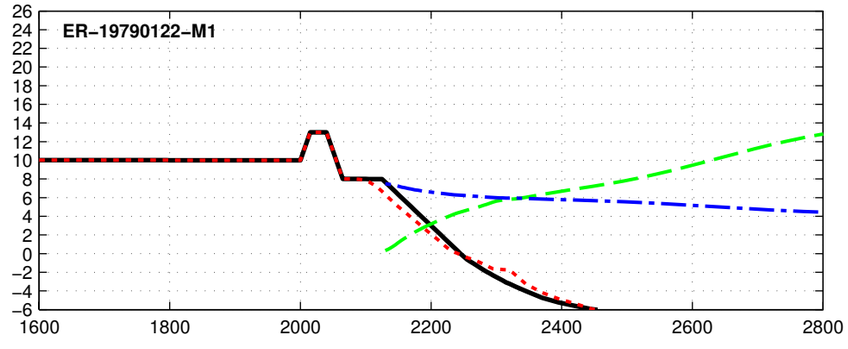
Dune R2T1–13.0–025–060 – ER–19780204

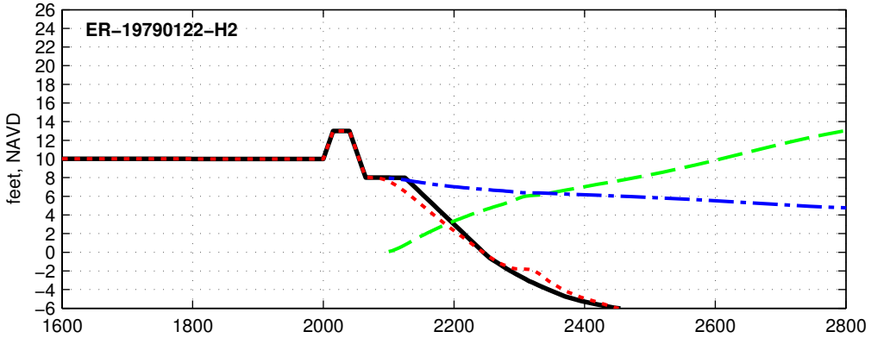


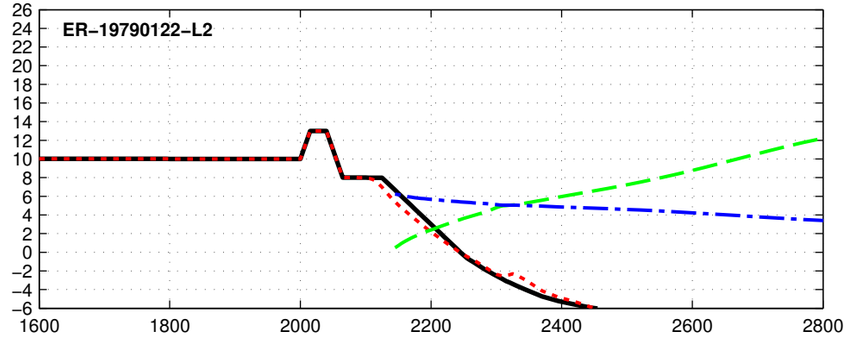
Dune R2T1–13.0–025–060 – ER–19790122

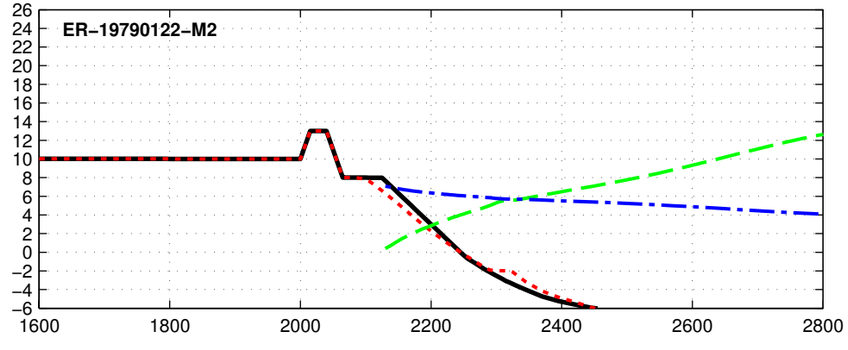


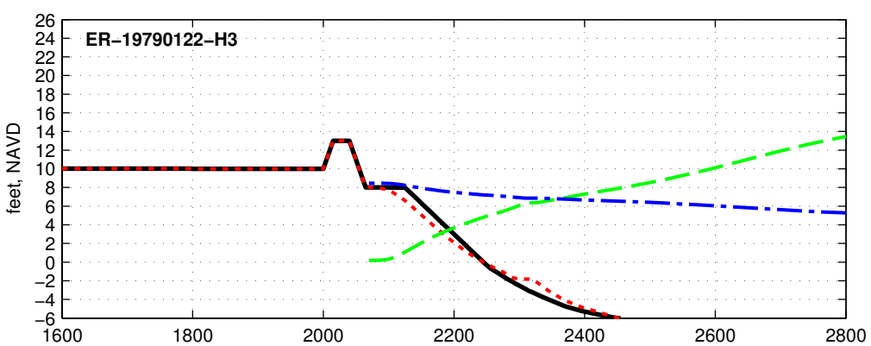


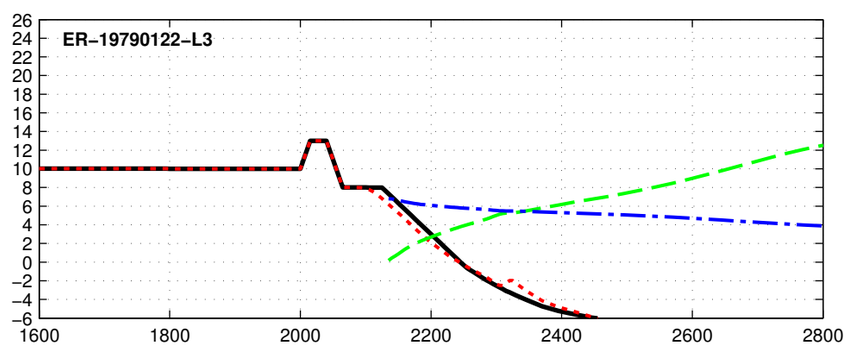


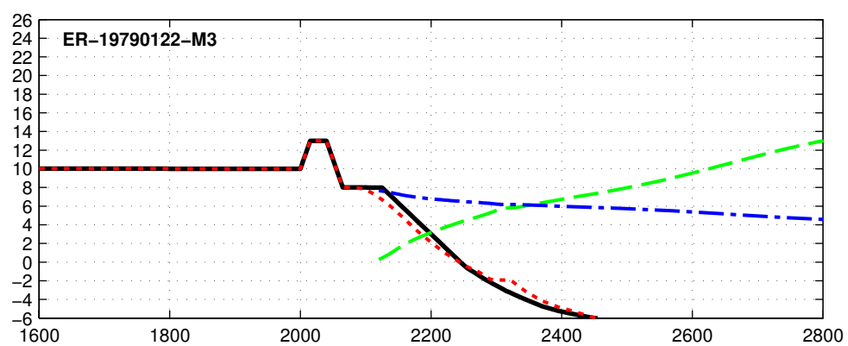


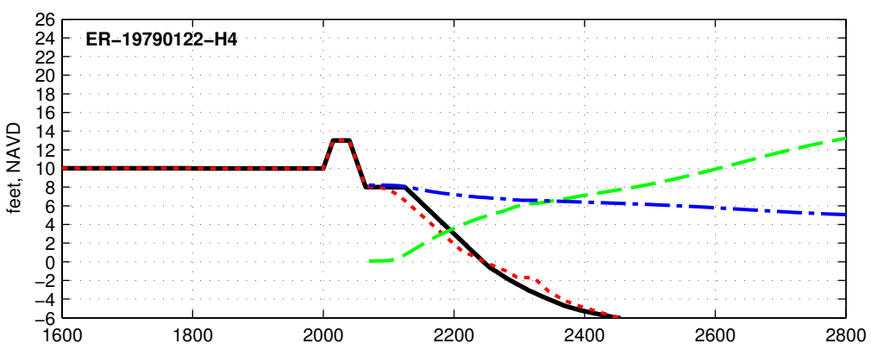


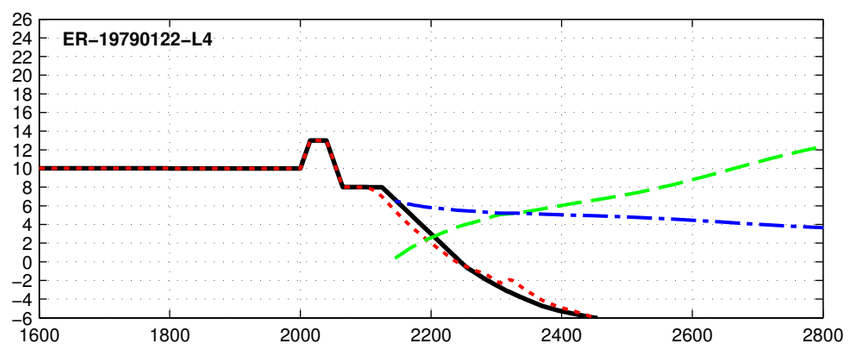


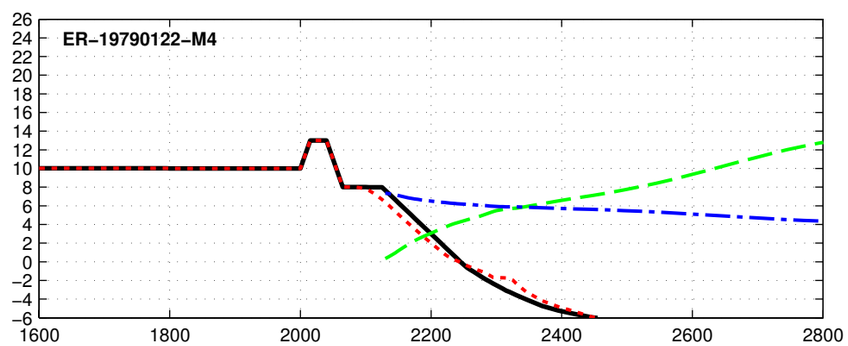






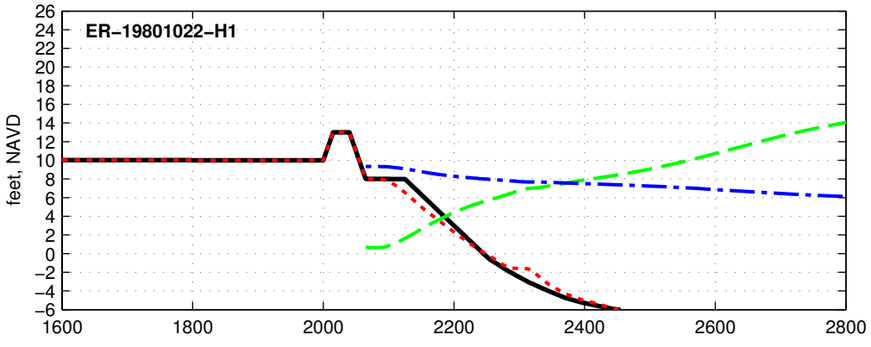


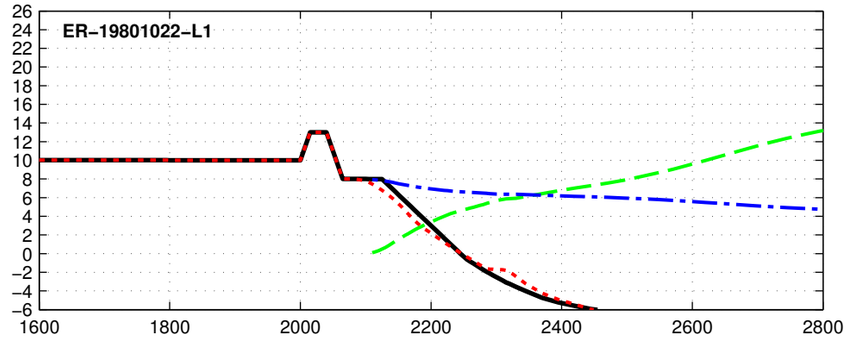


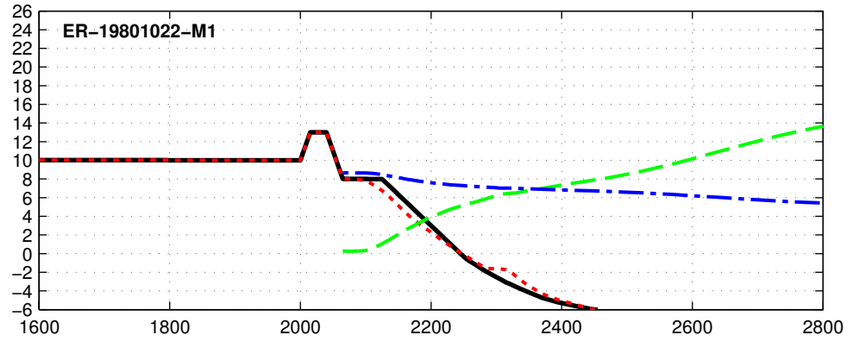


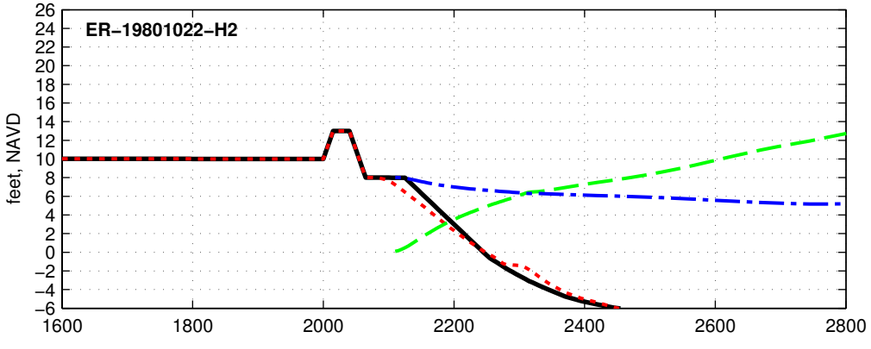
Initial Final Max Hs Max Water Level

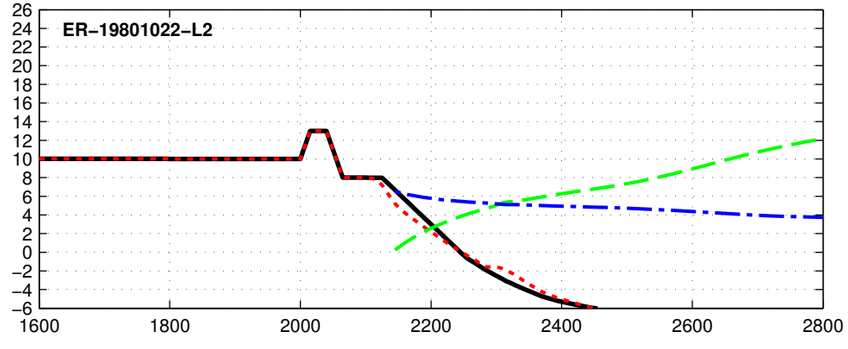
Dune R2T1–13.0–025–060 – ER–19801022

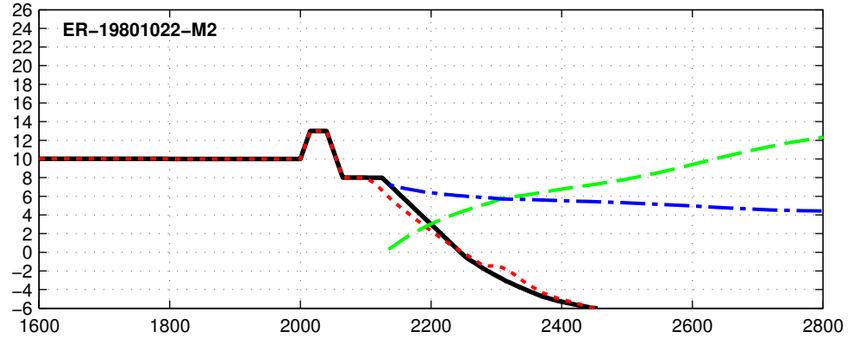


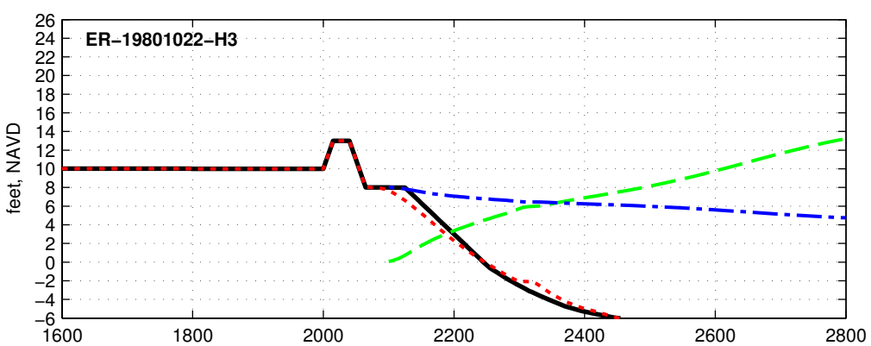


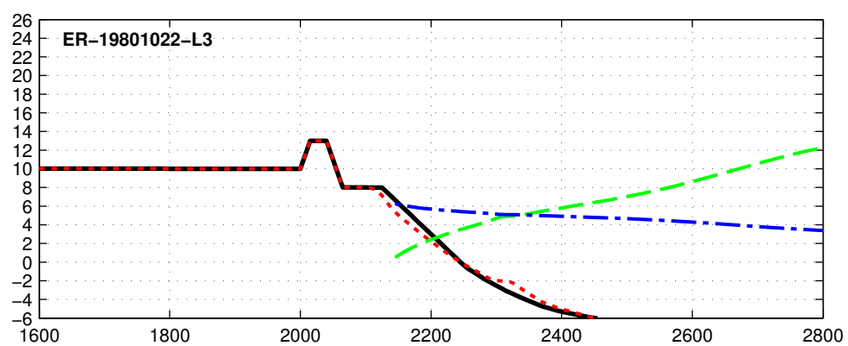


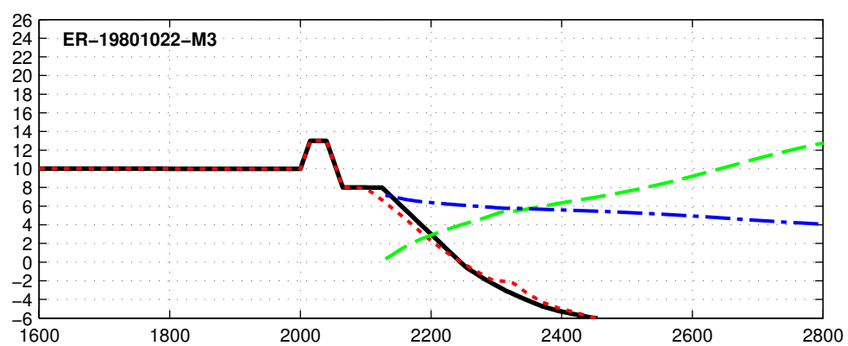


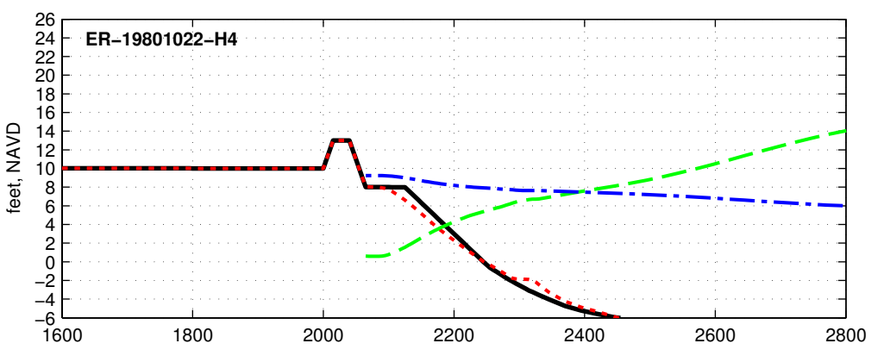


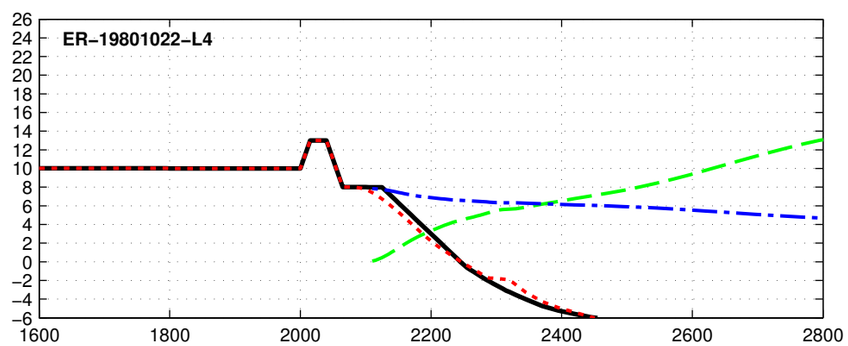


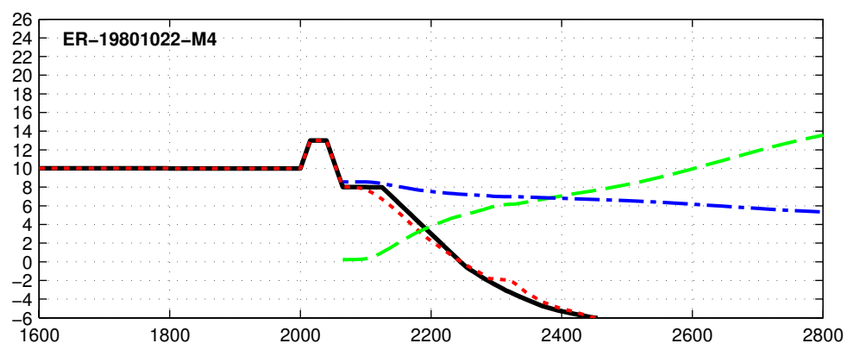






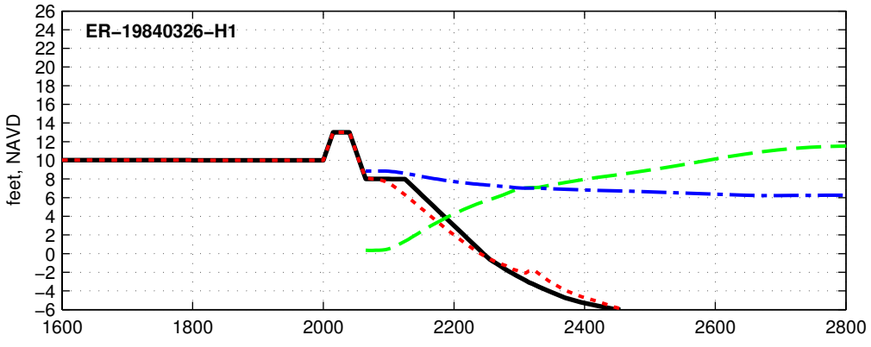


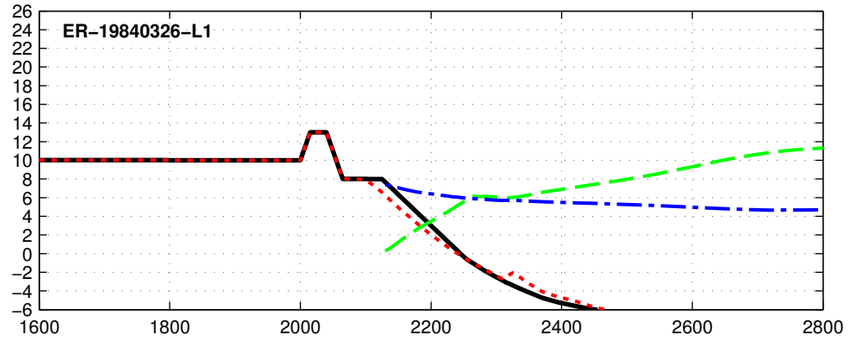


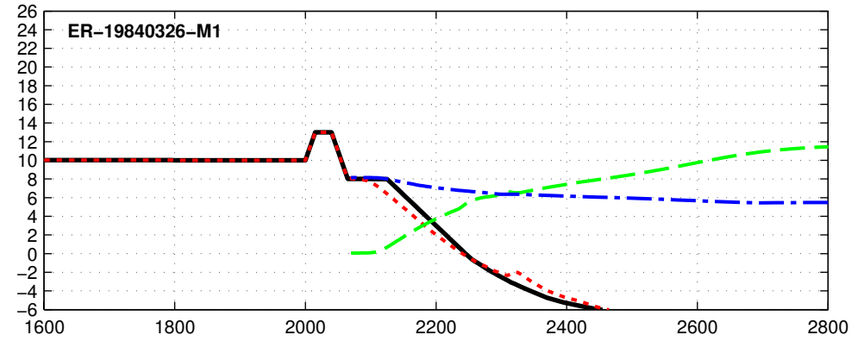


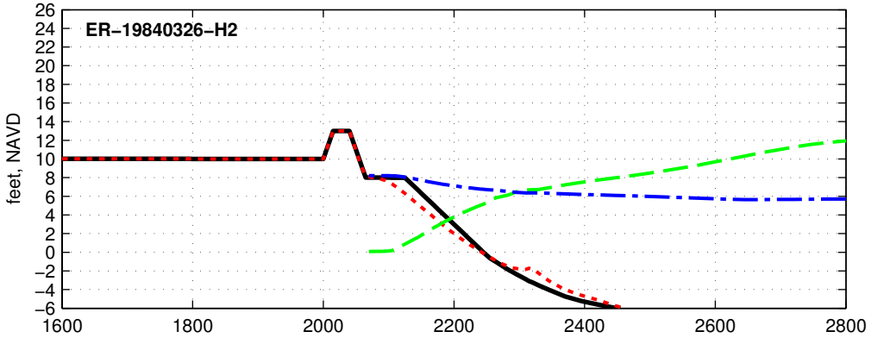
Initial Final Max Hs Max Water Level

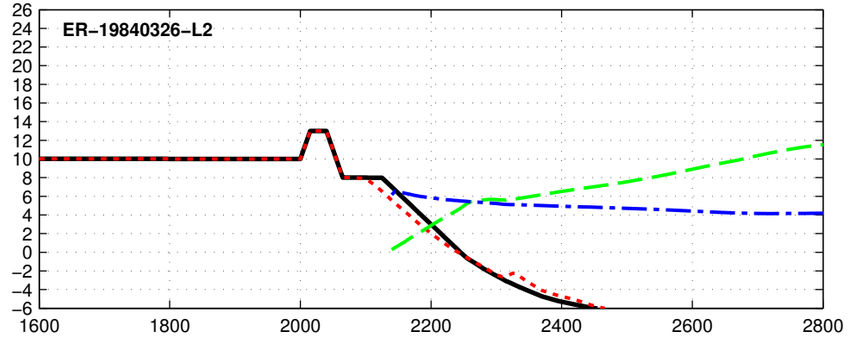
Dune R2T1-13.0-025-060 - ER-19840326

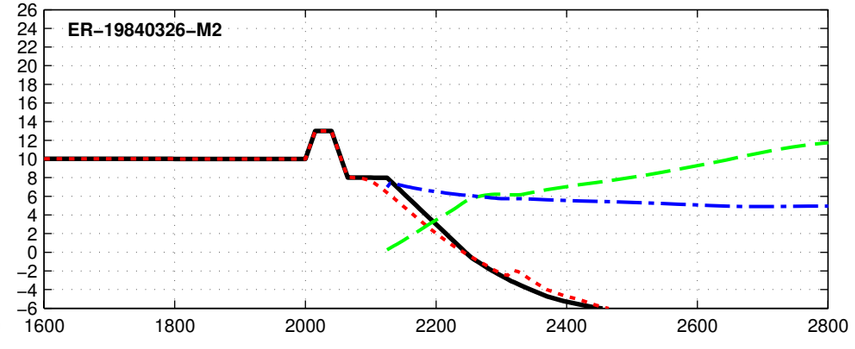


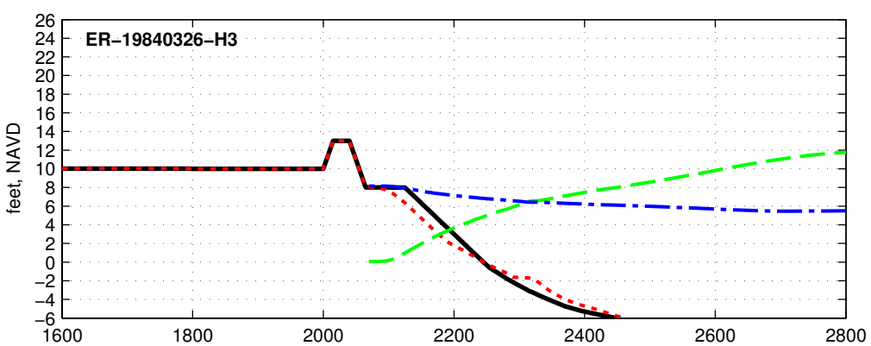


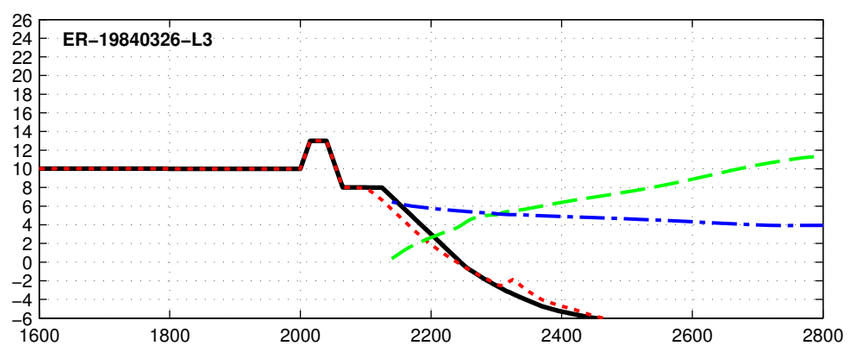


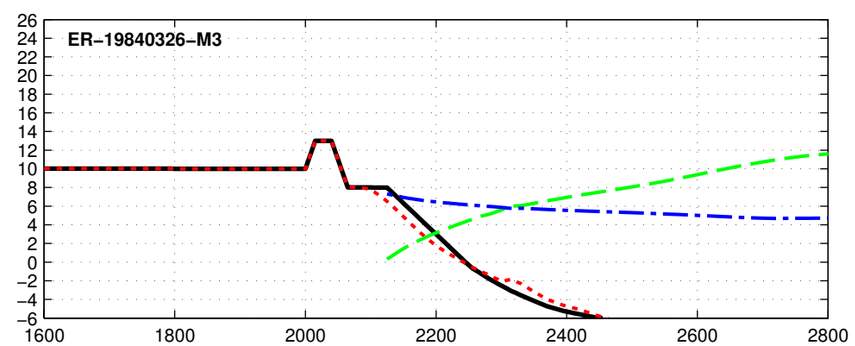


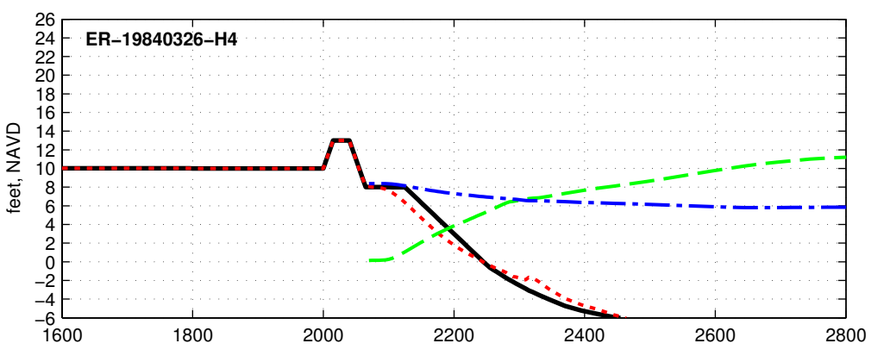


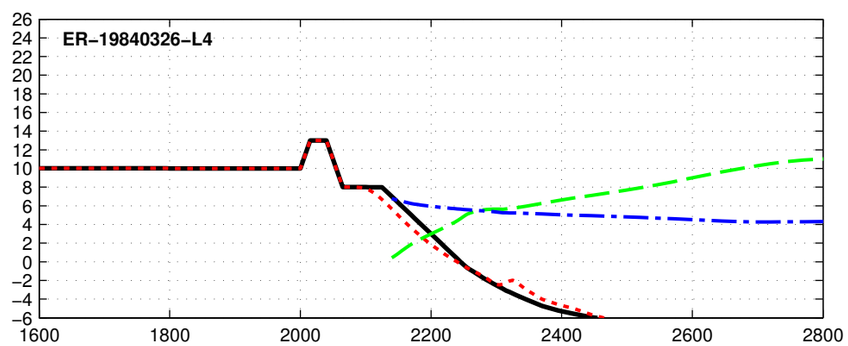


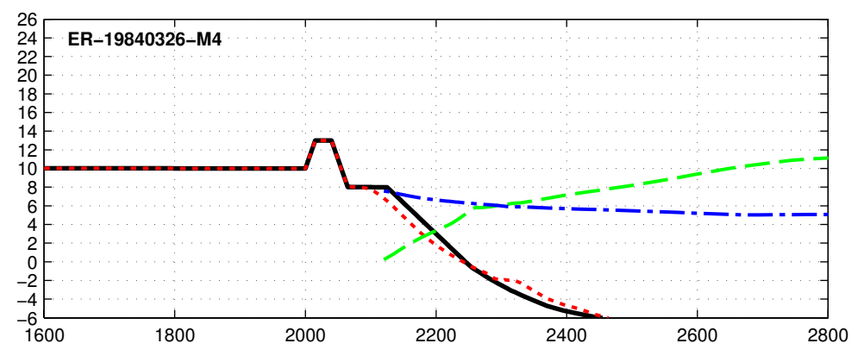






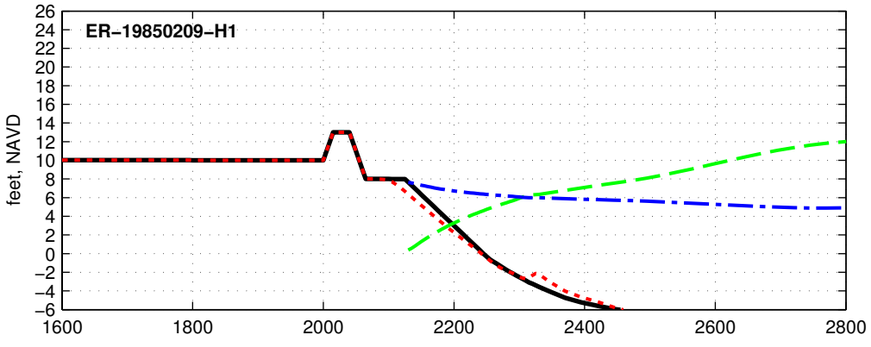


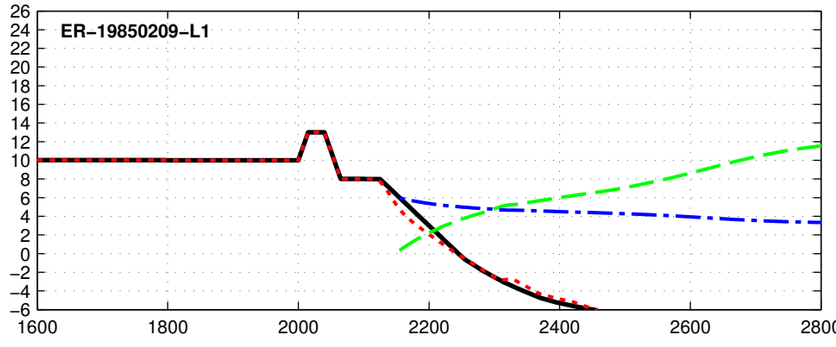


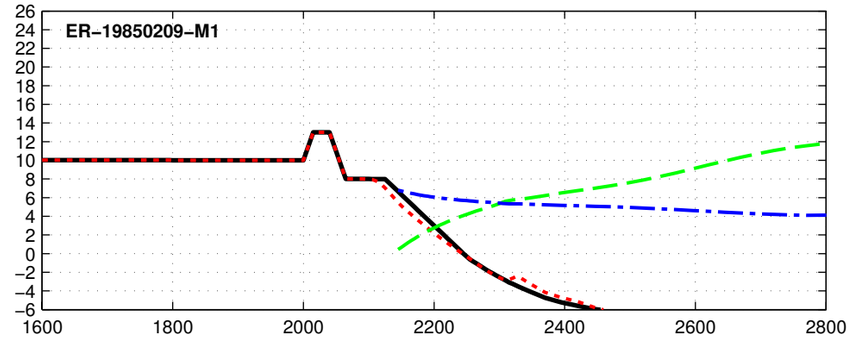


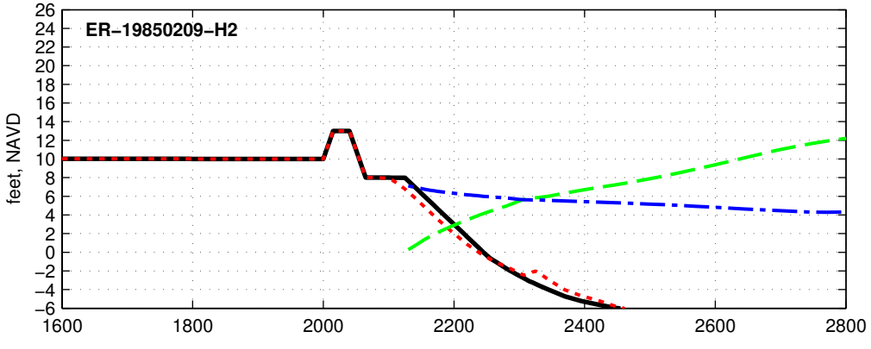
Initial Final Max Hs Max Water Level

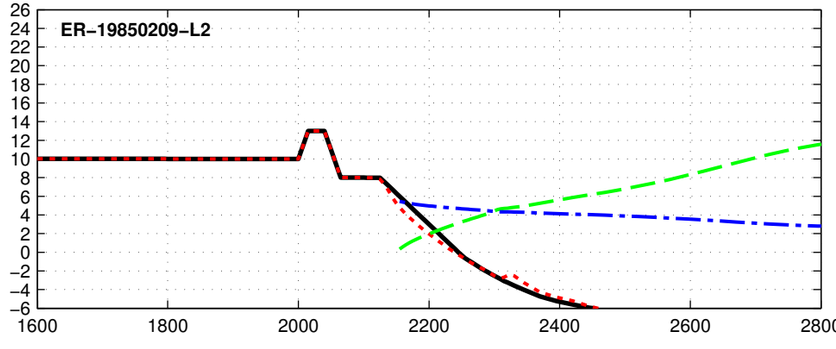
Dune R2T1-13.0-025-060 - ER-19850209

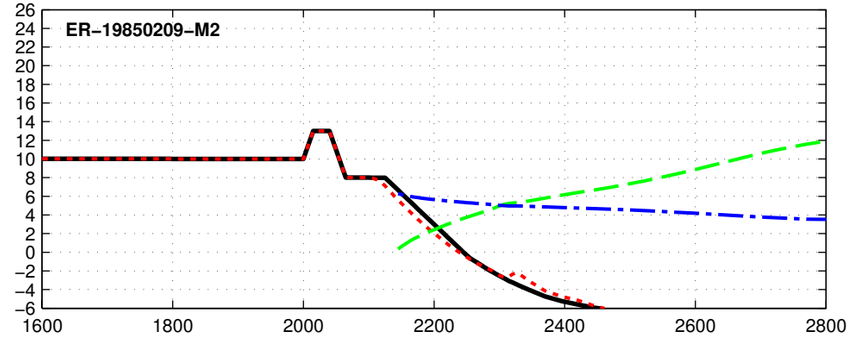


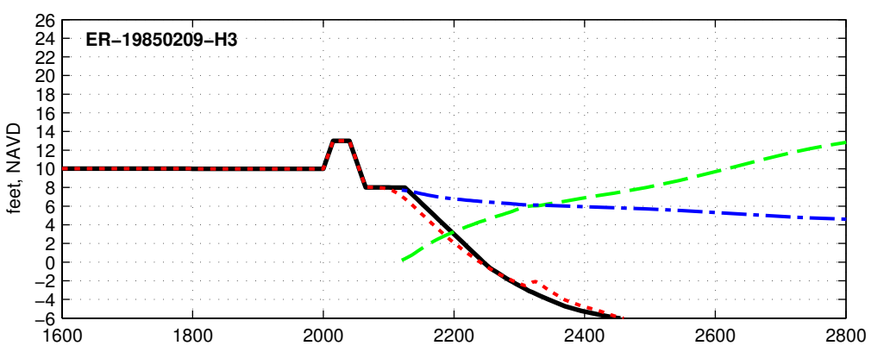


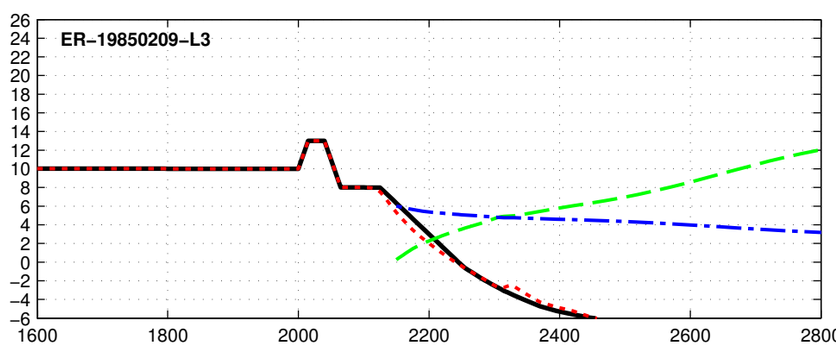


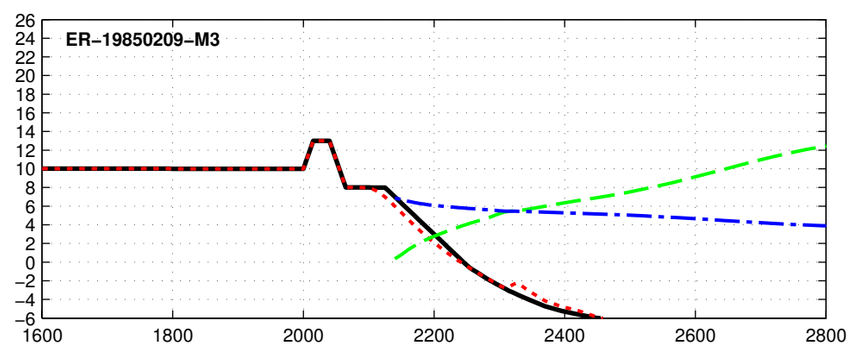


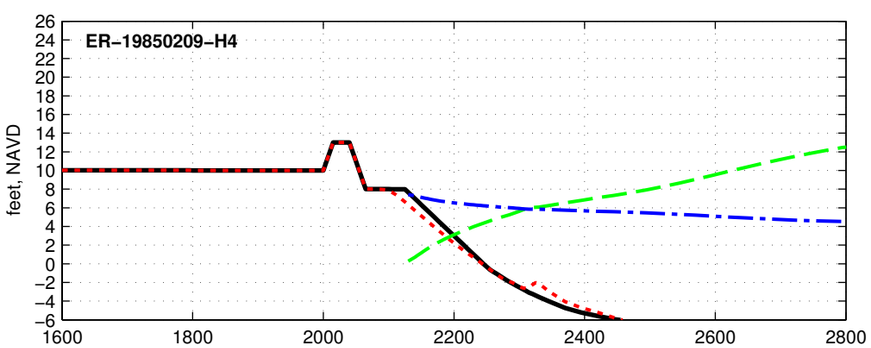


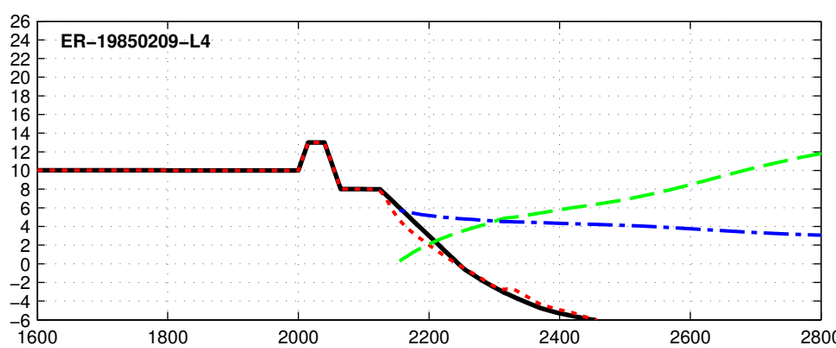


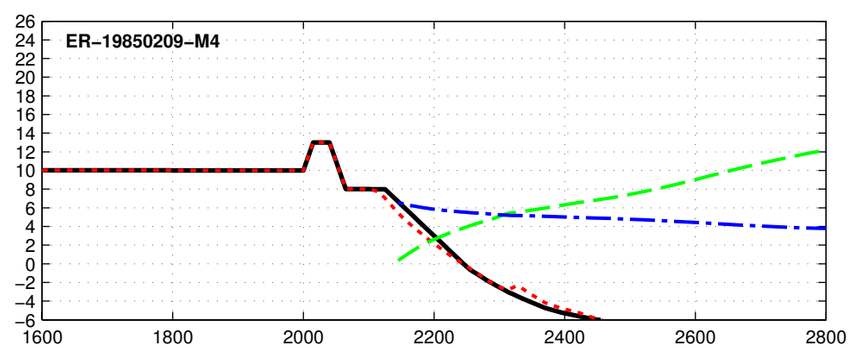






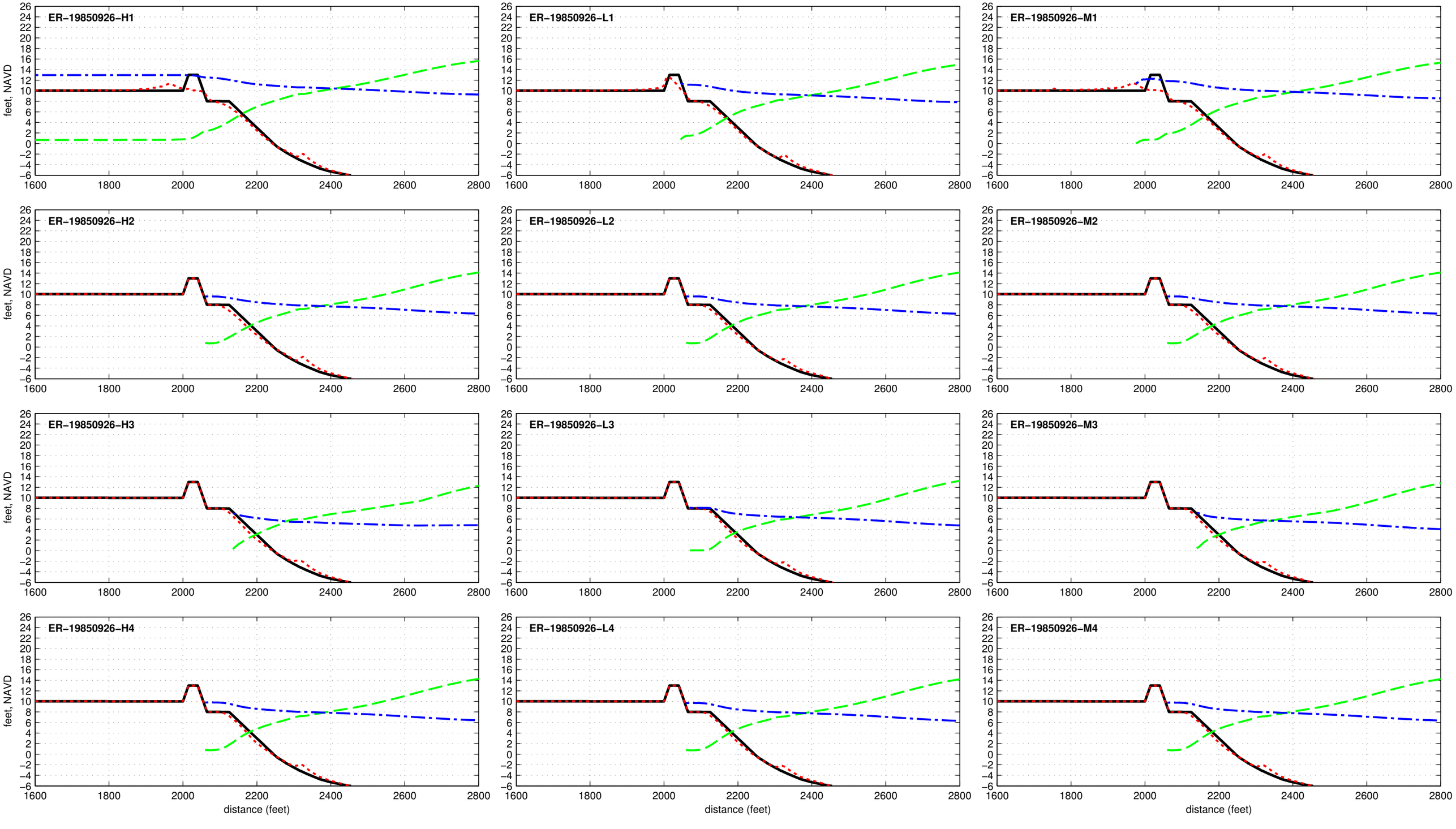




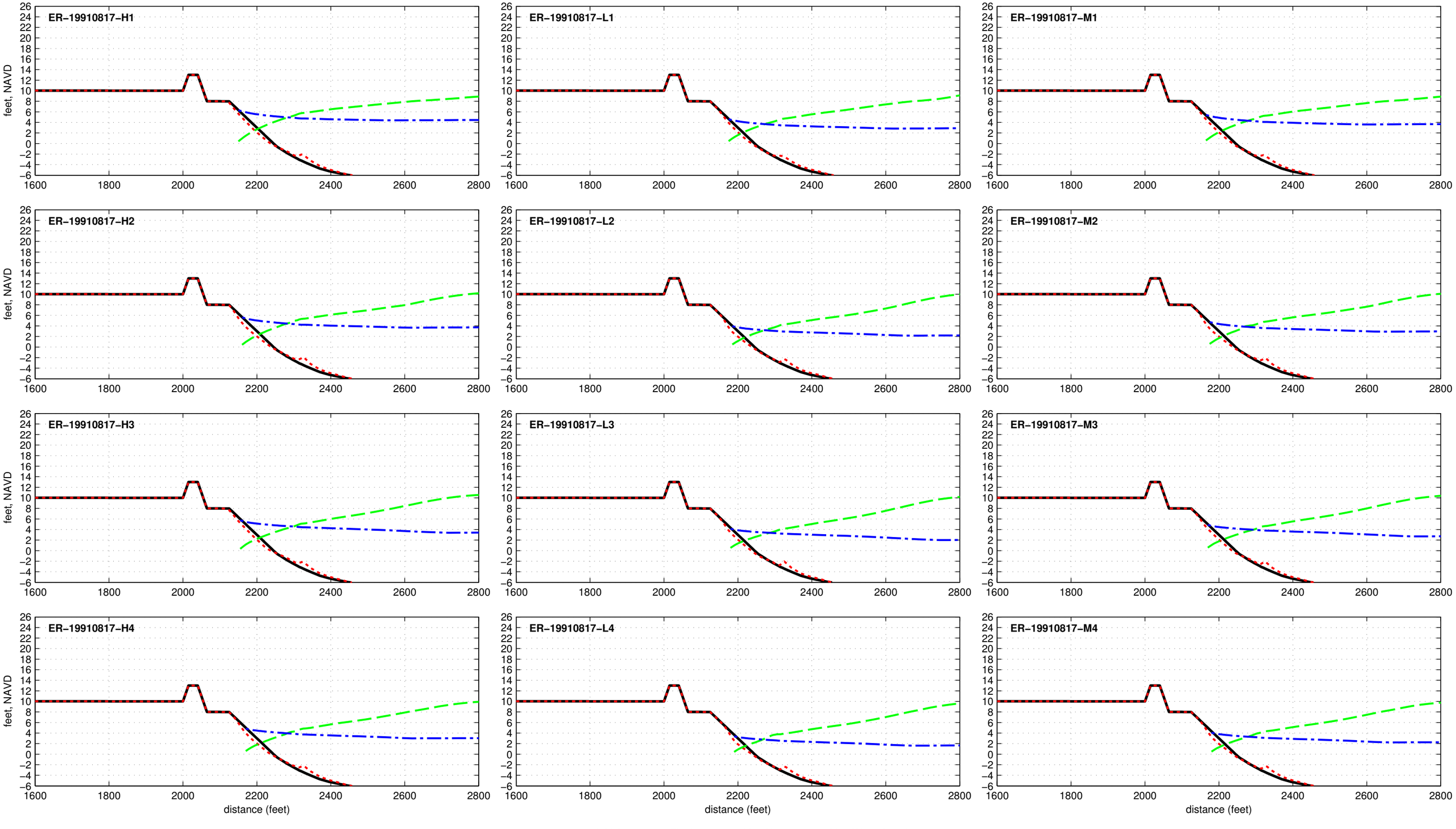


Initial Final Max Hs Max Water Level

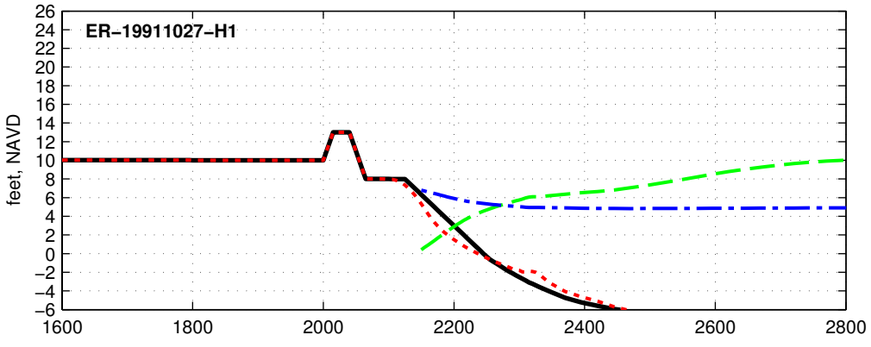
Dune R2T1-13.0-025-060 - ER-19850926

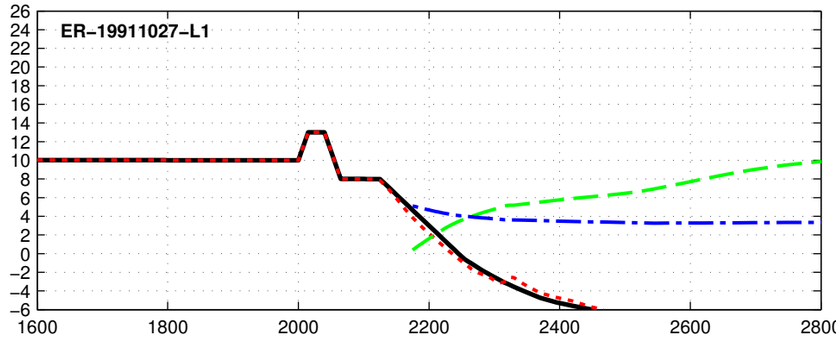


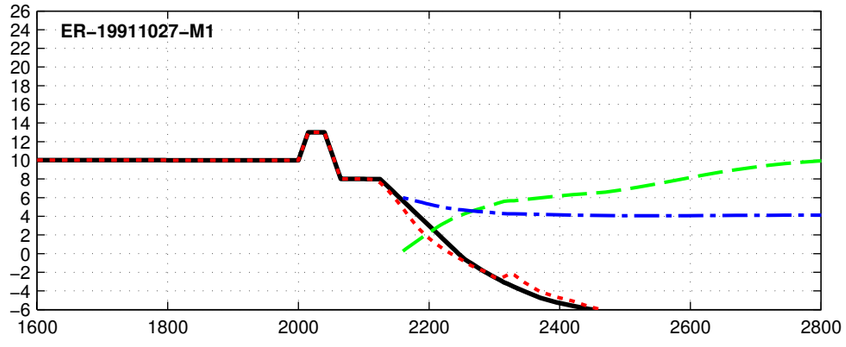
Dune R2T1–13.0–025–060 – ER–19910817

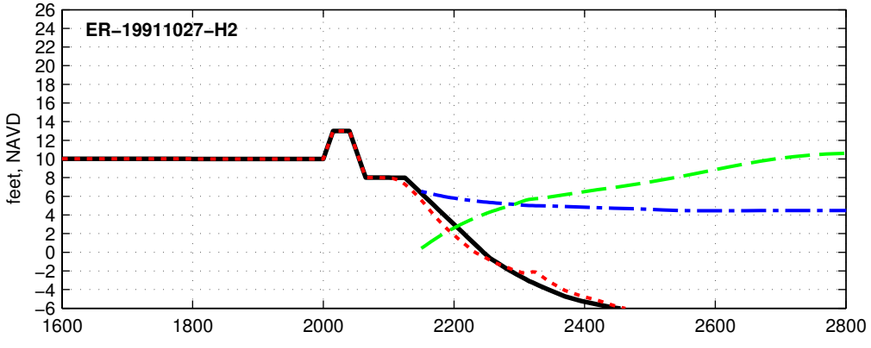


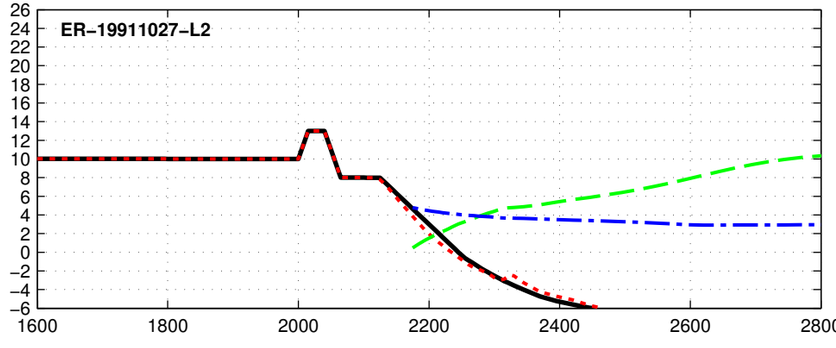
Dune R2T1-13.0-025-060 - ER-19911027

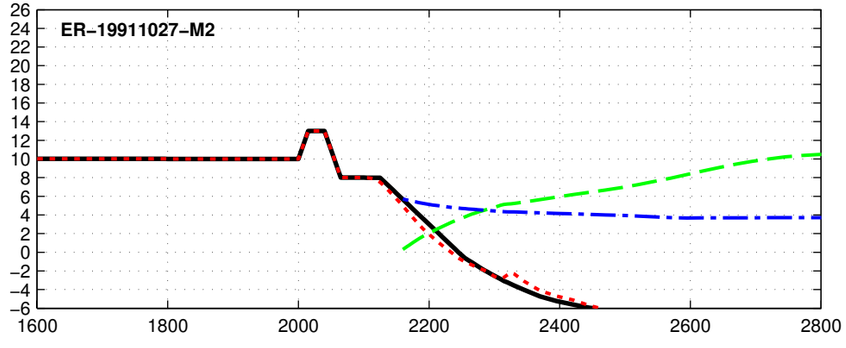


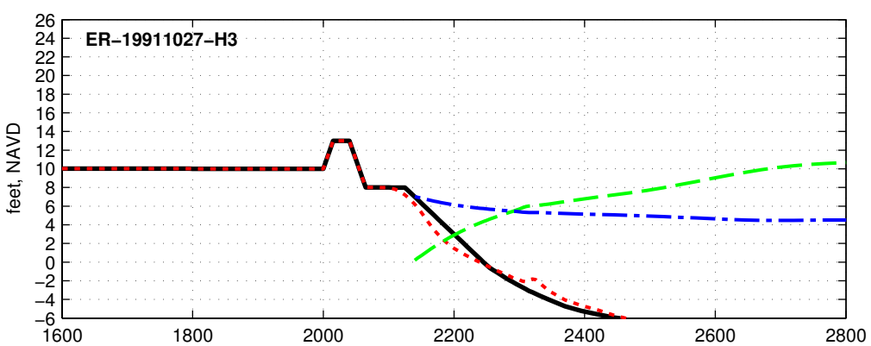


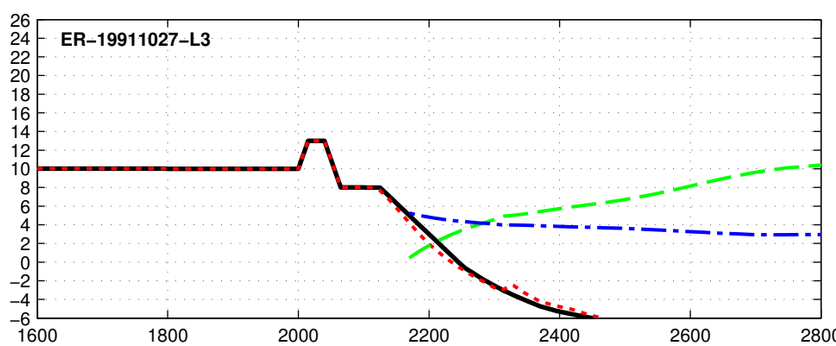


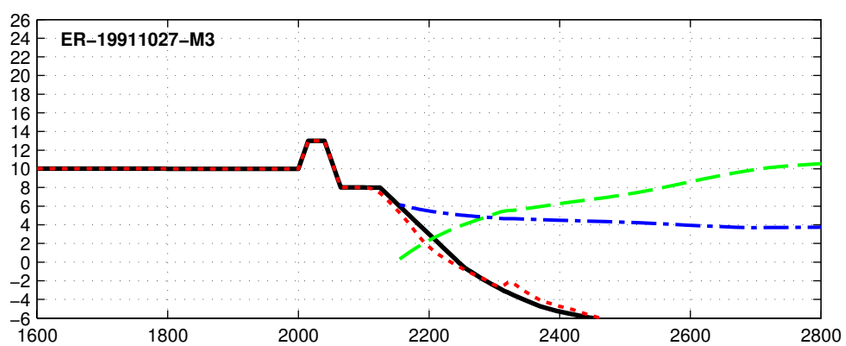


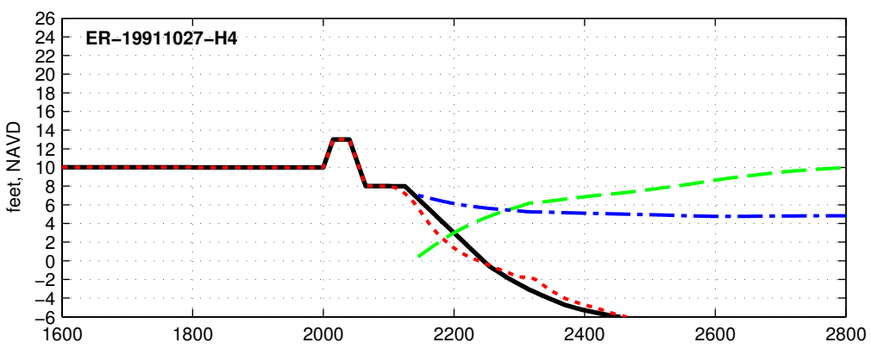


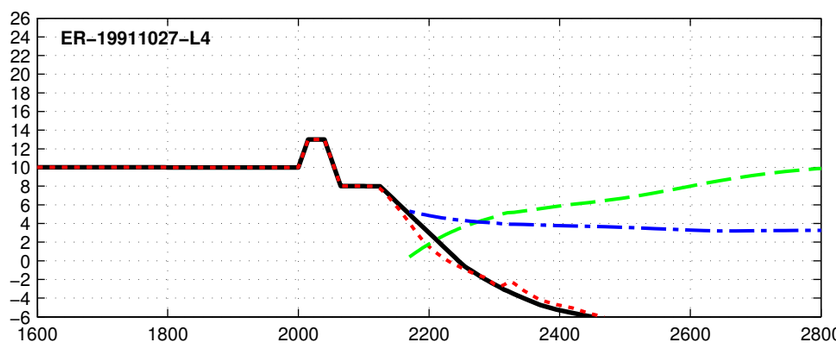


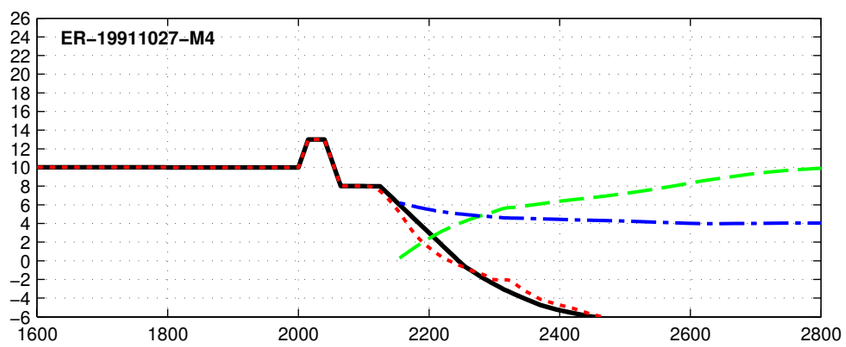






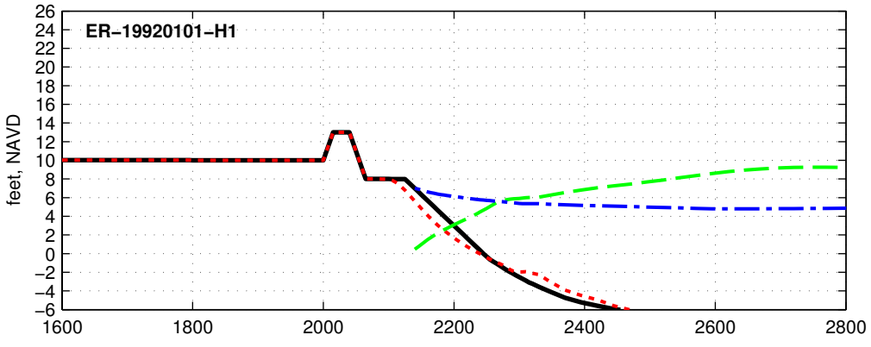


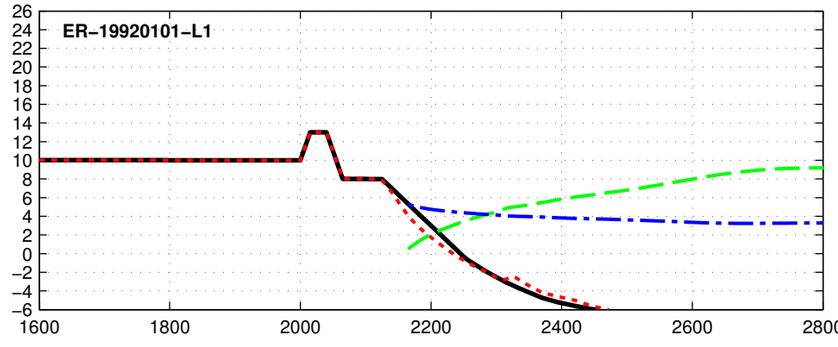


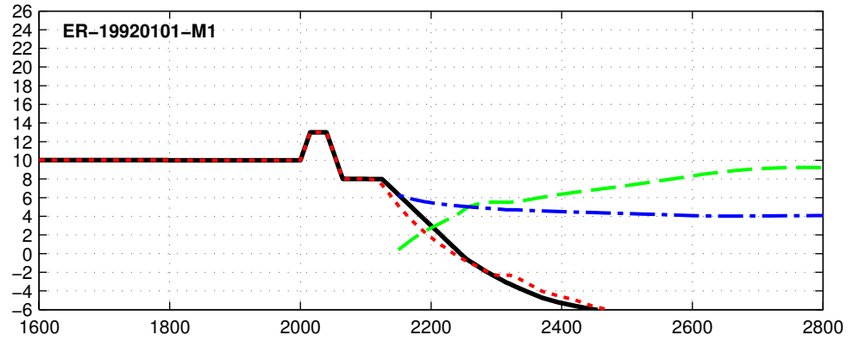


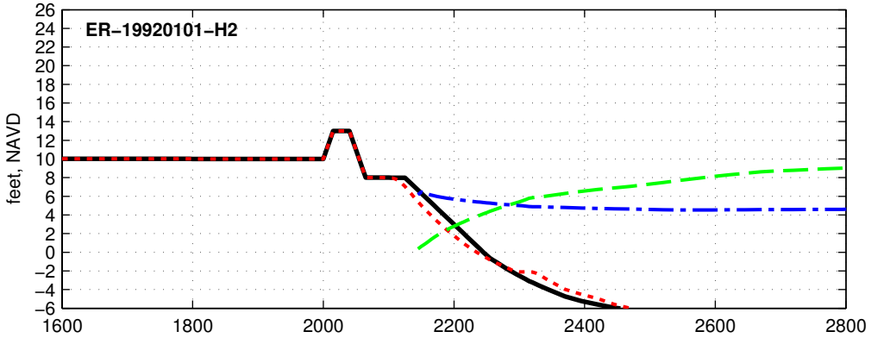
Initial Final Max Hs Max Water Level

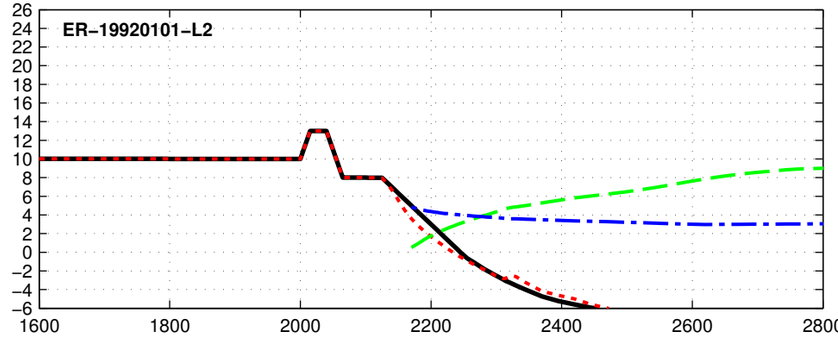
Dune R2T1-13.0-025-060 - ER-19920101

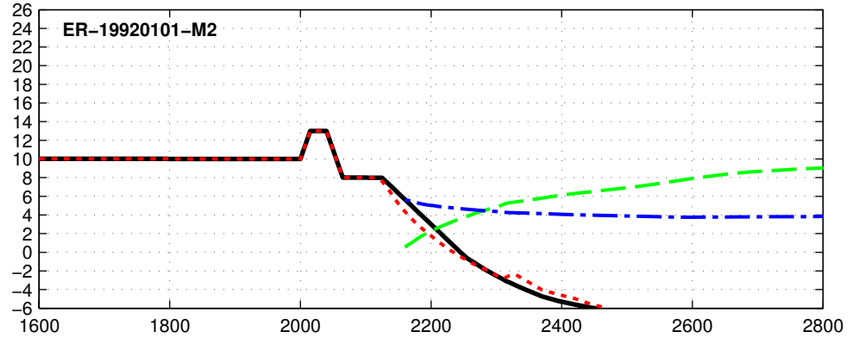


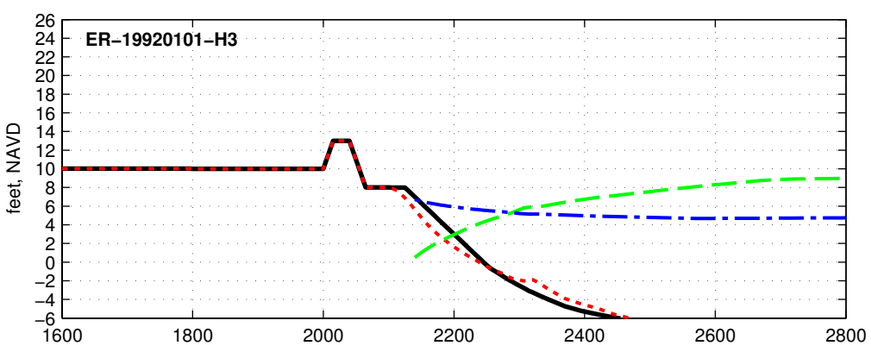


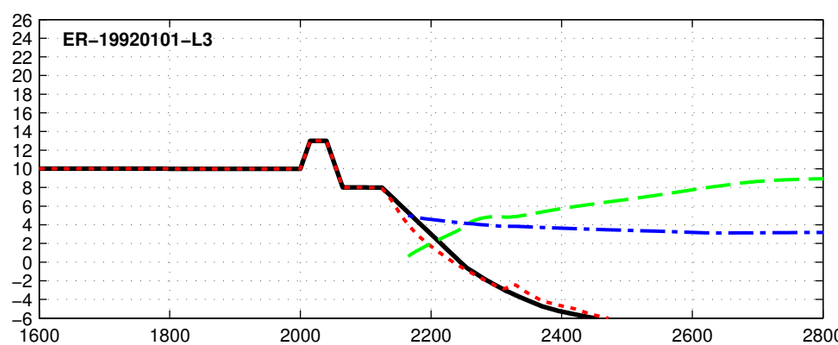


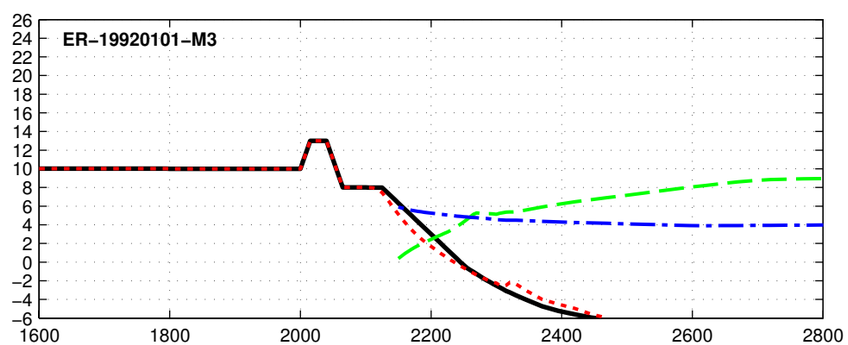


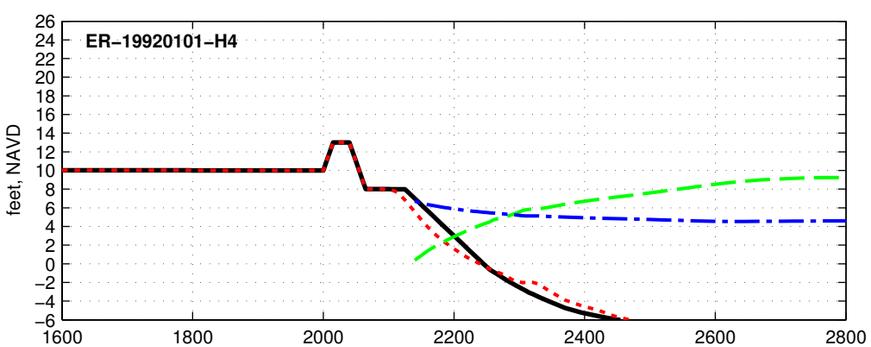


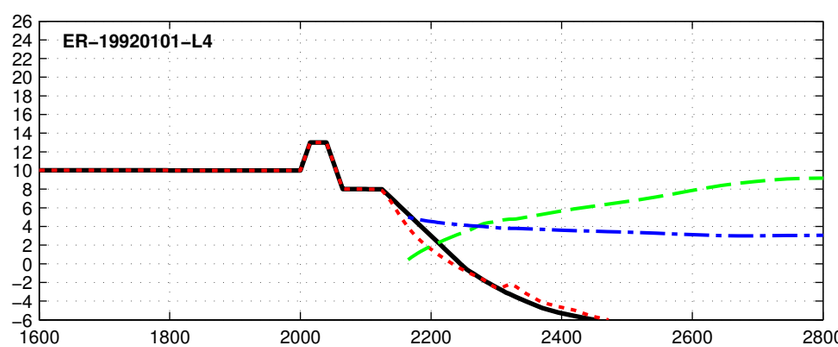


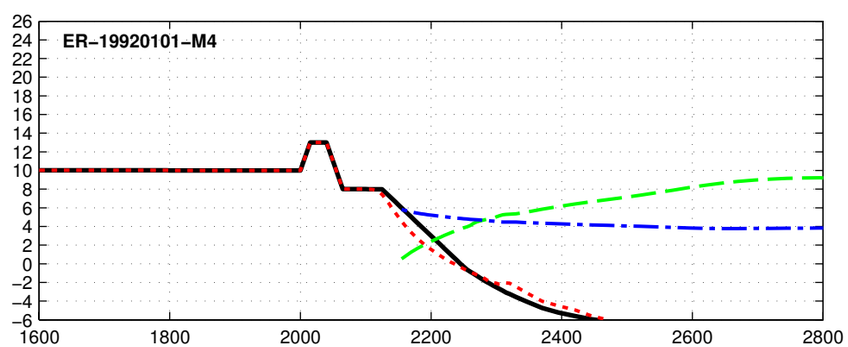










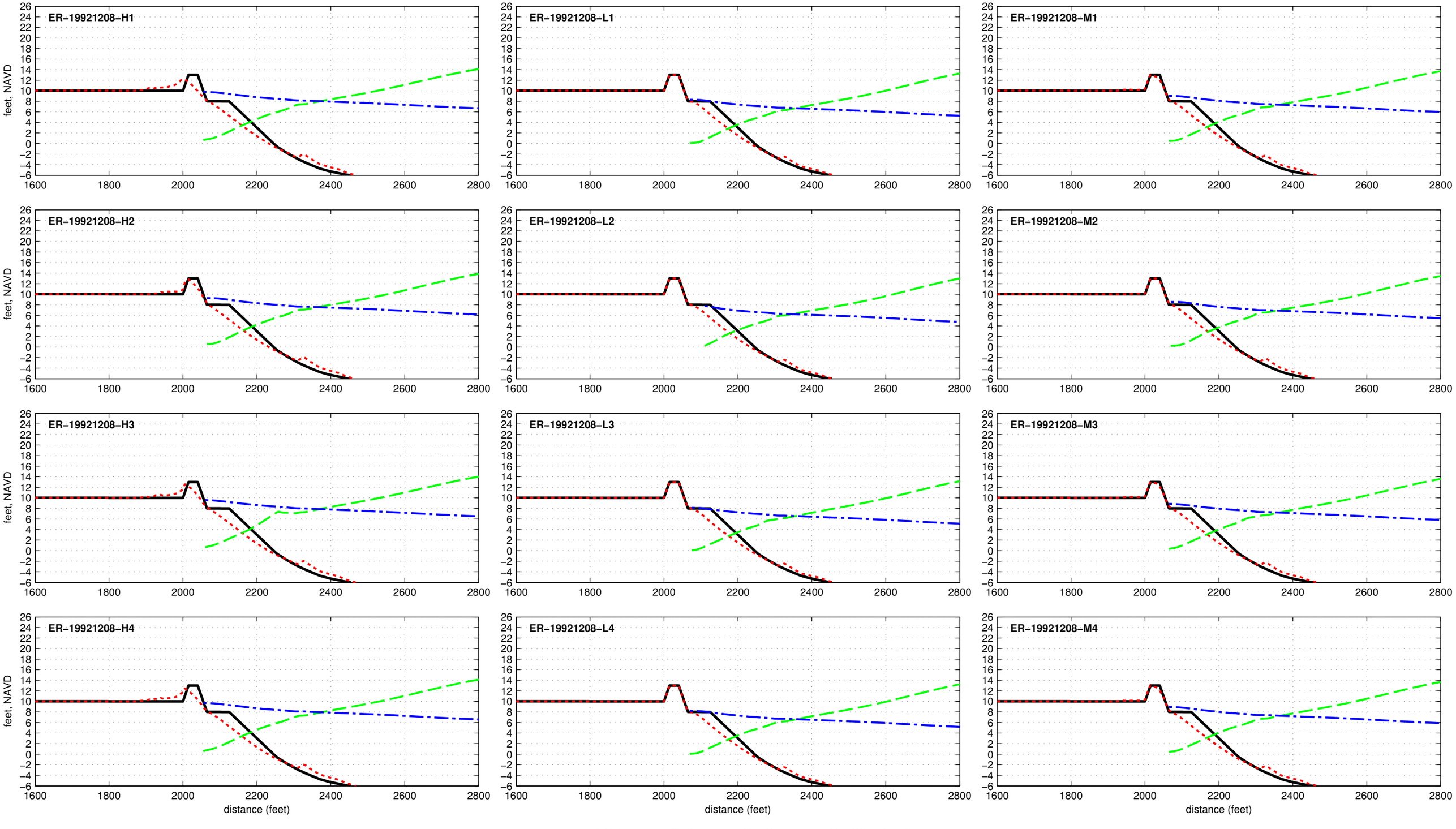


feet, NAVD

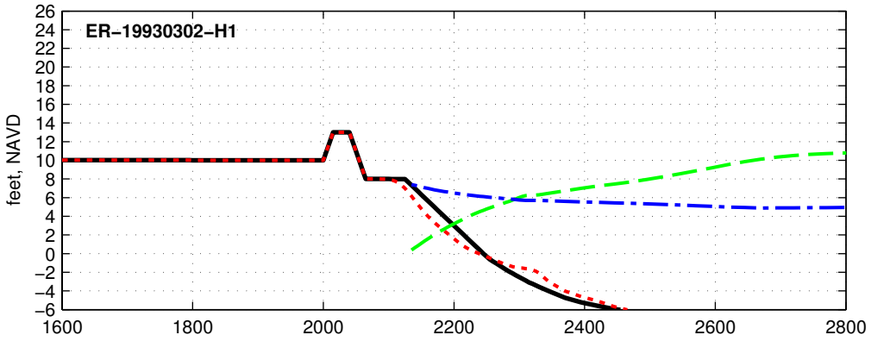
distance (feet)

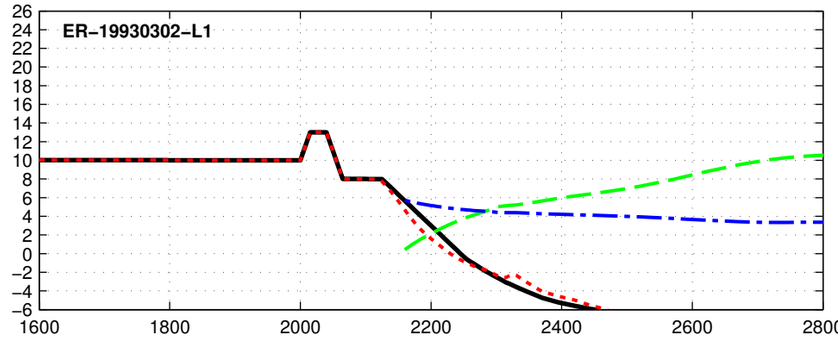
Initial Final Max Hs Max Water Level

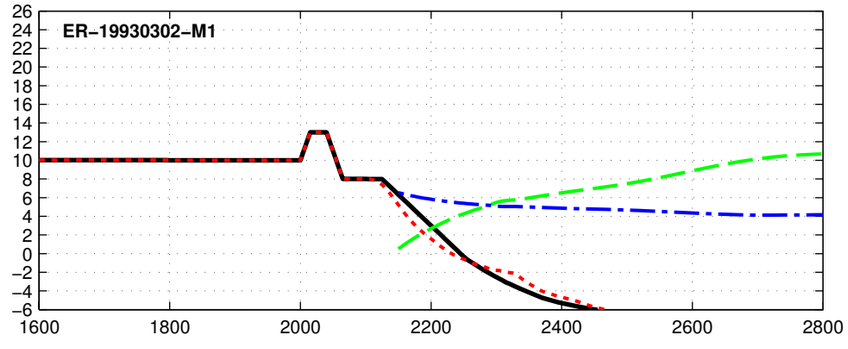
Dune R2T1-13.0-025-060 - ER-19921208

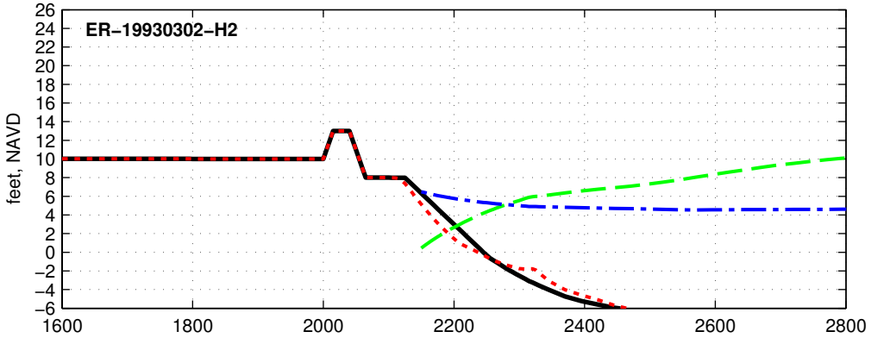


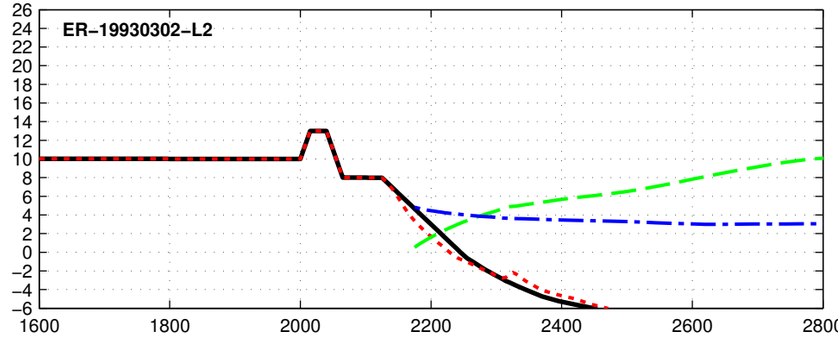
Dune R2T1-13.0-025-060 - ER-19930302

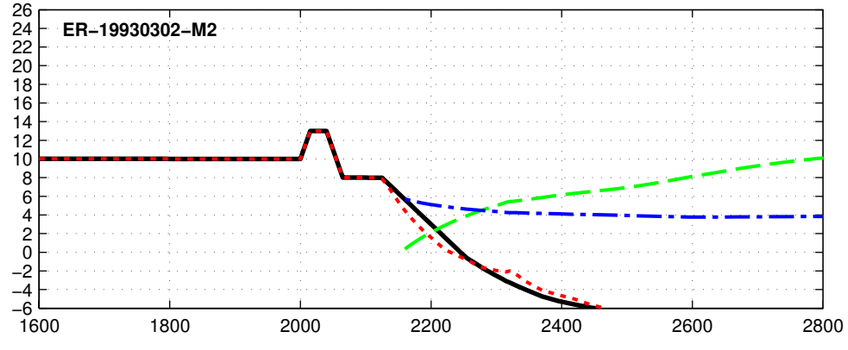


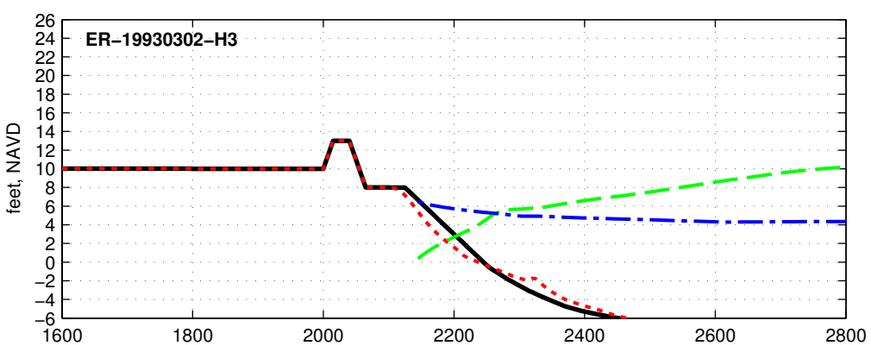


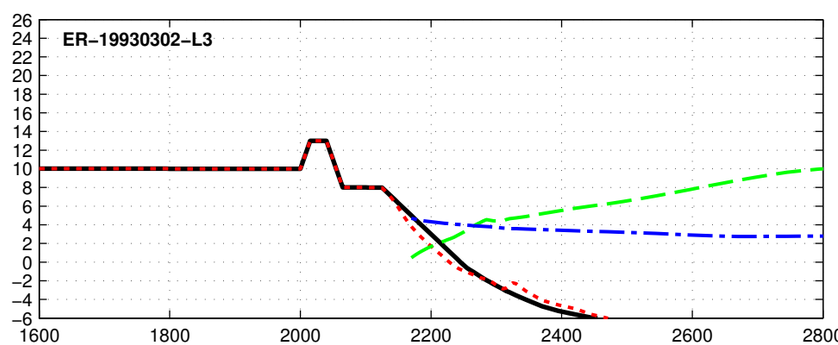


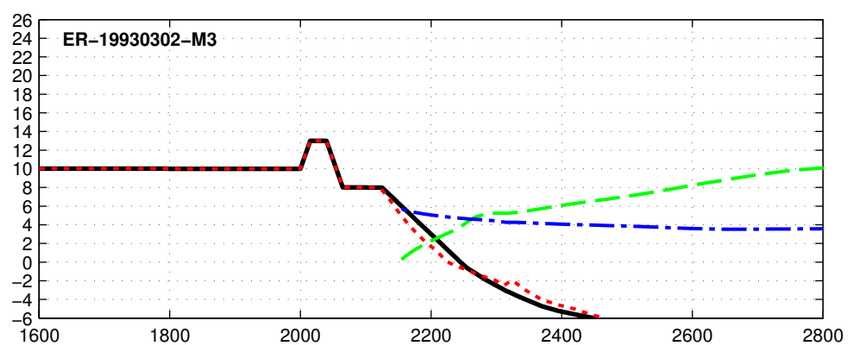


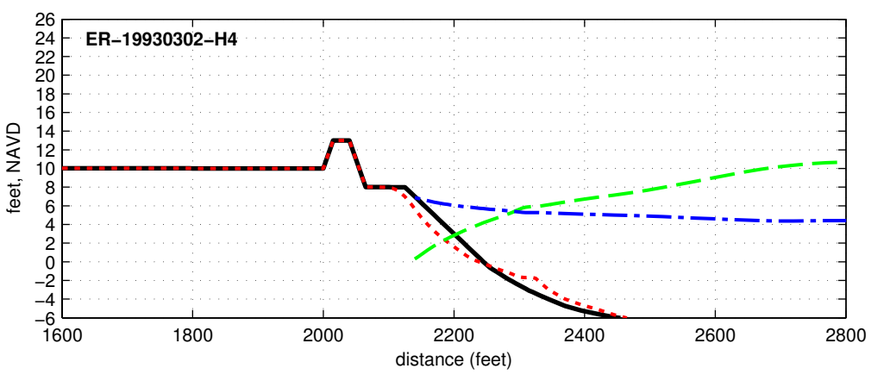


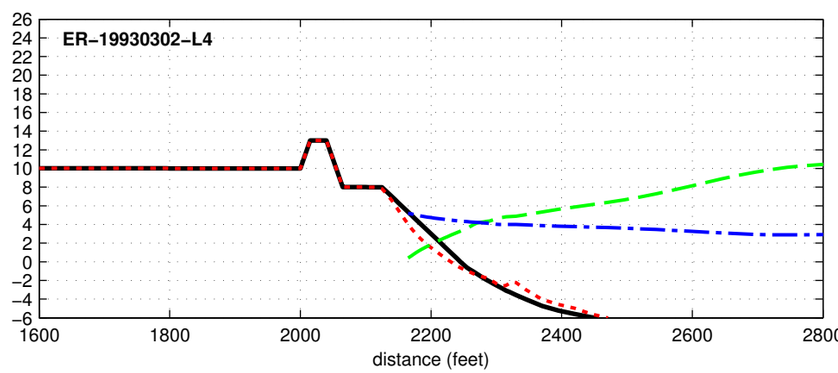


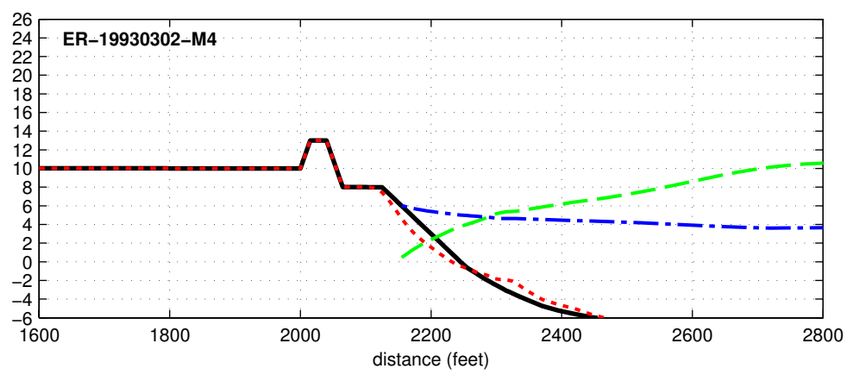






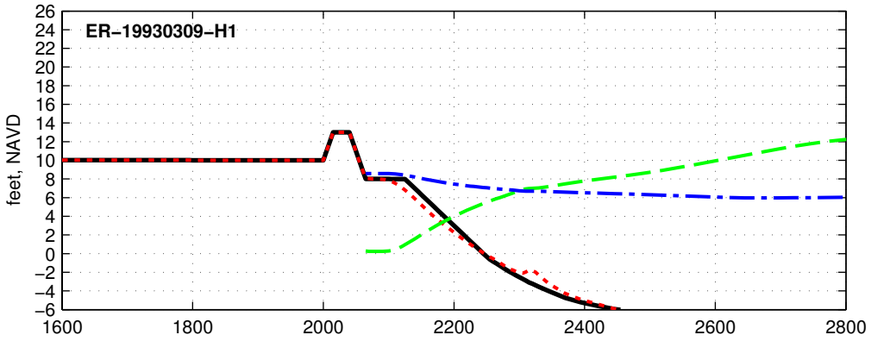


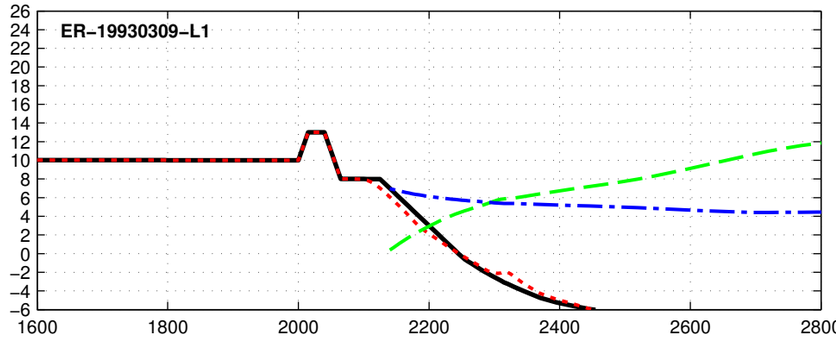


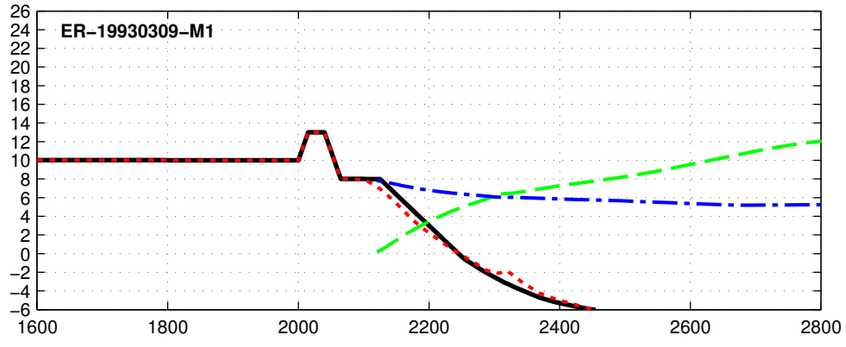


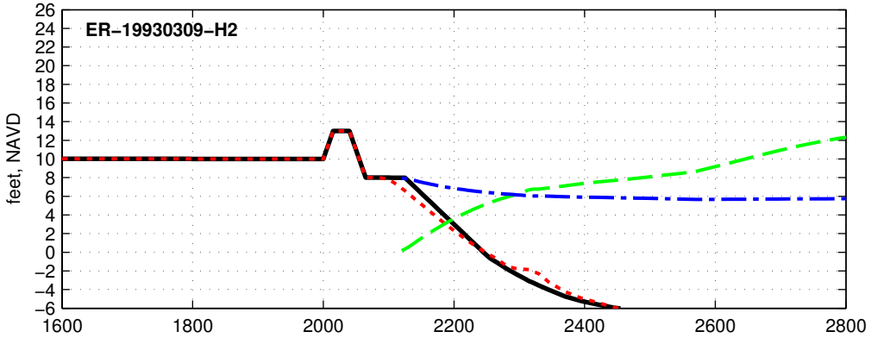
Initial Final Max Hs Max Water Level

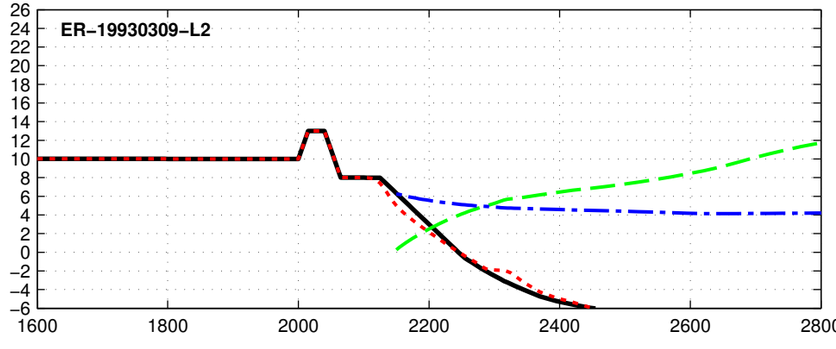
Dune R2T1−13.0−025−060 − ER−19930309

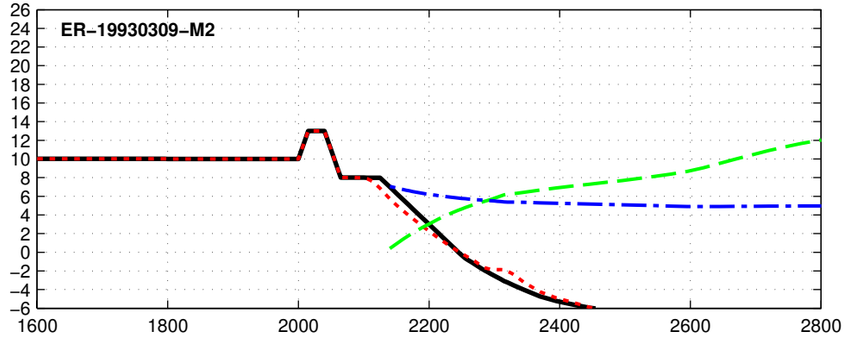


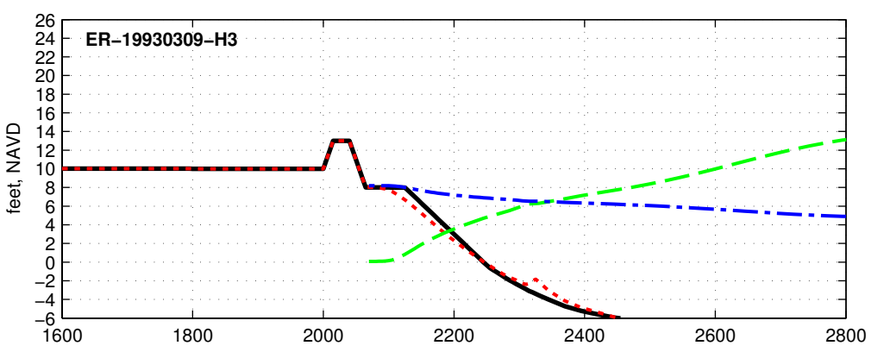


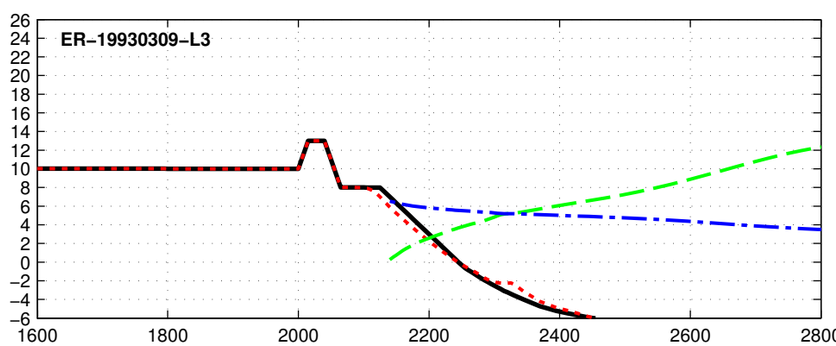


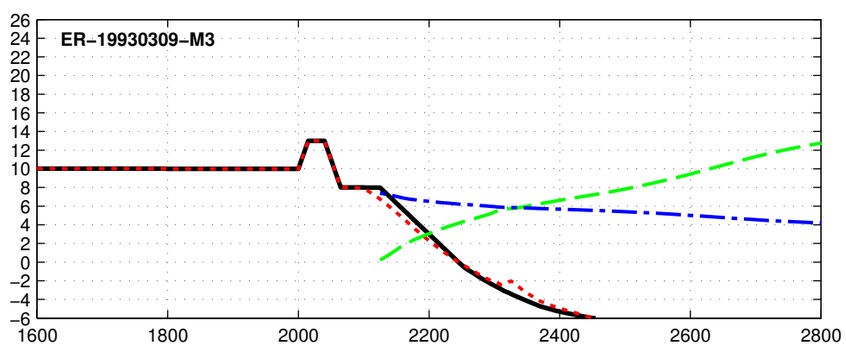


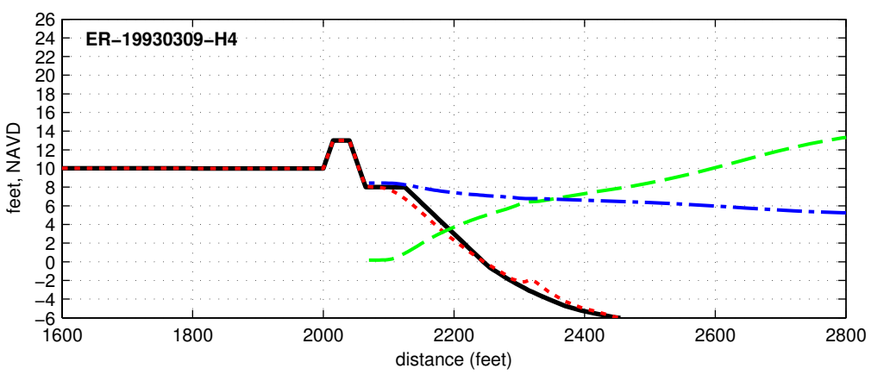


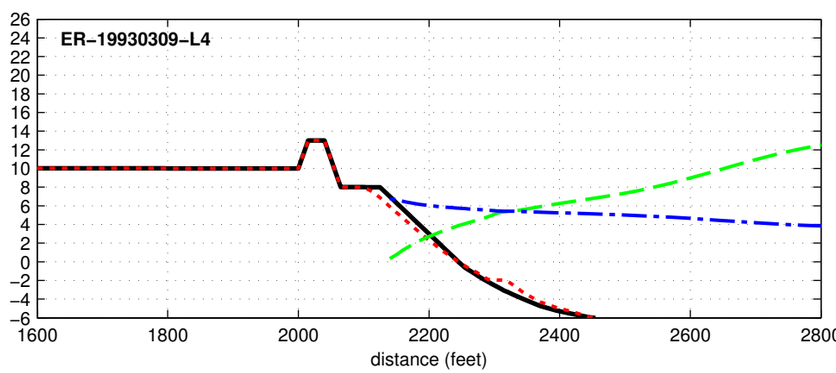


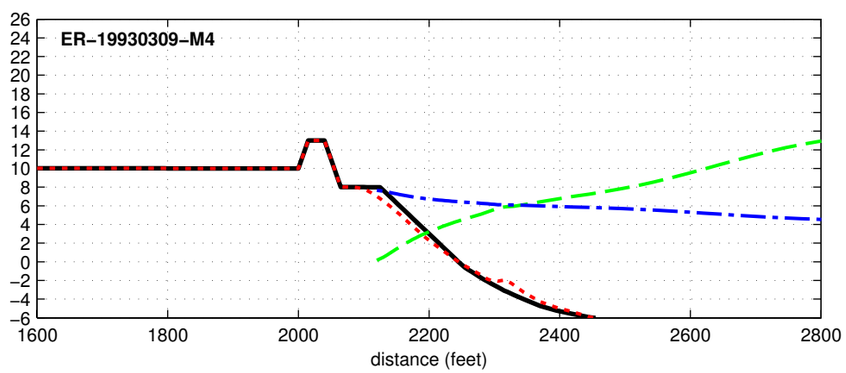






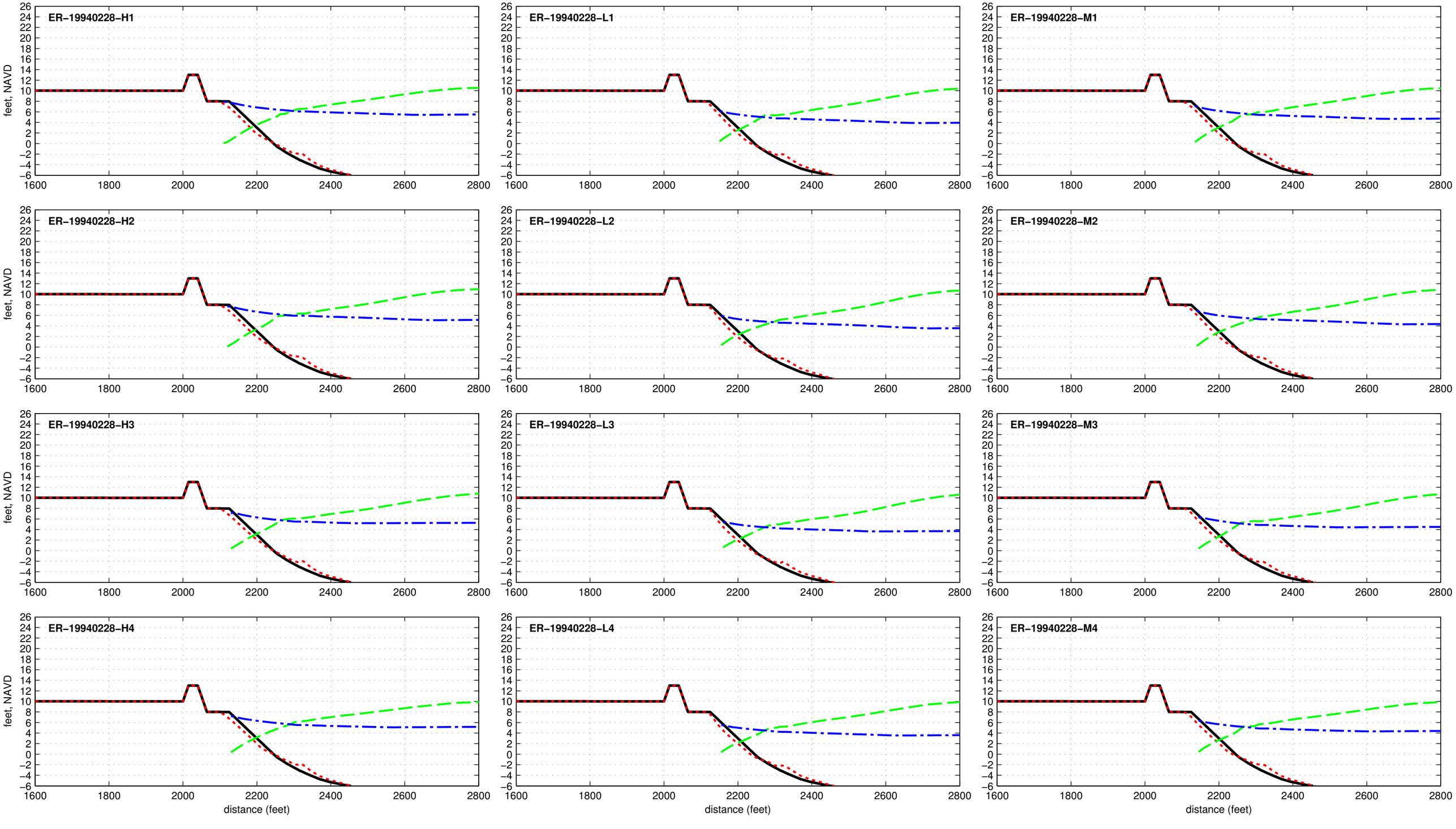




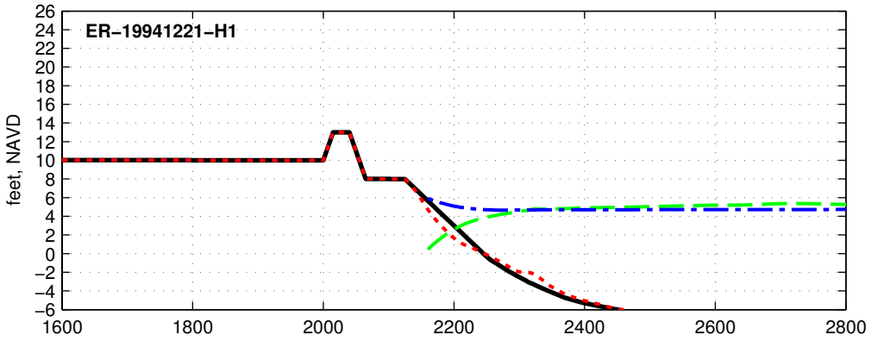


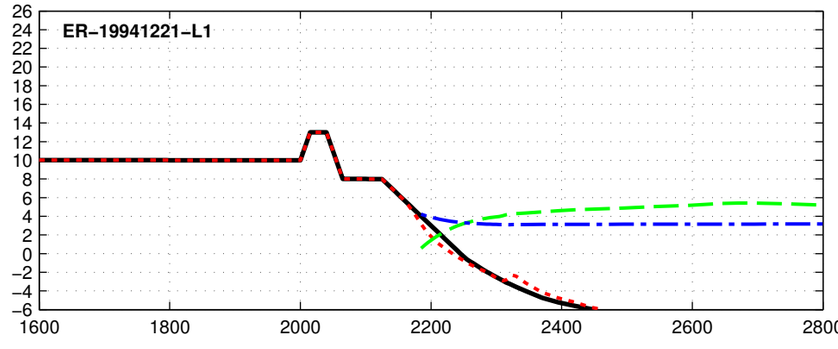
Initial Final Max Hs Max Water Level

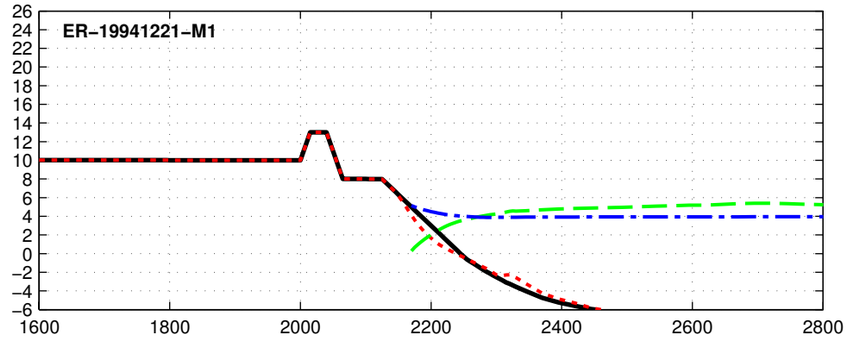
Dune R2T1–13.0–025–060 – ER–19940228

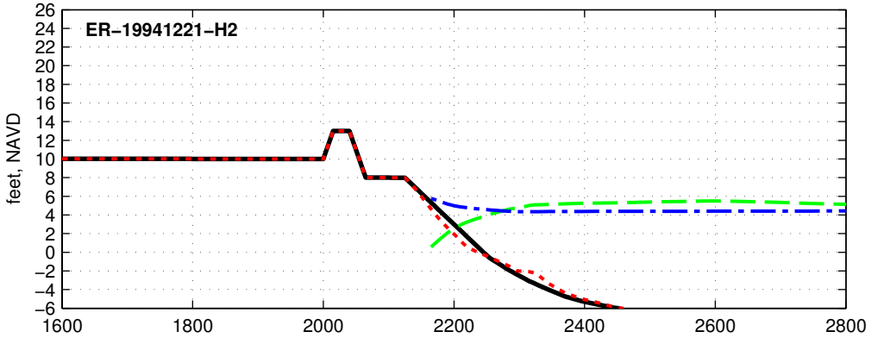


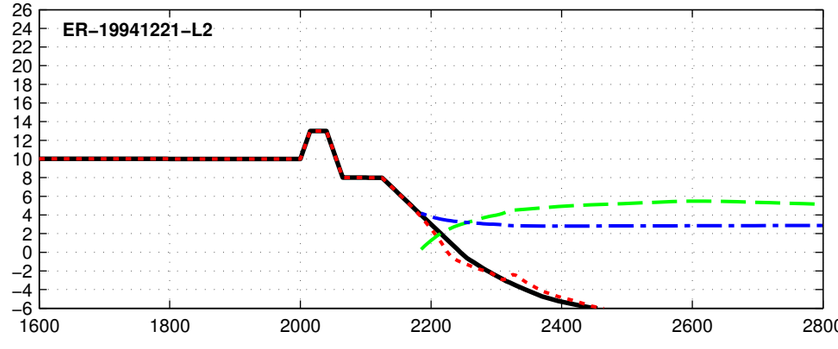
Dune R2T1-13.0-025-060 - ER-19941221

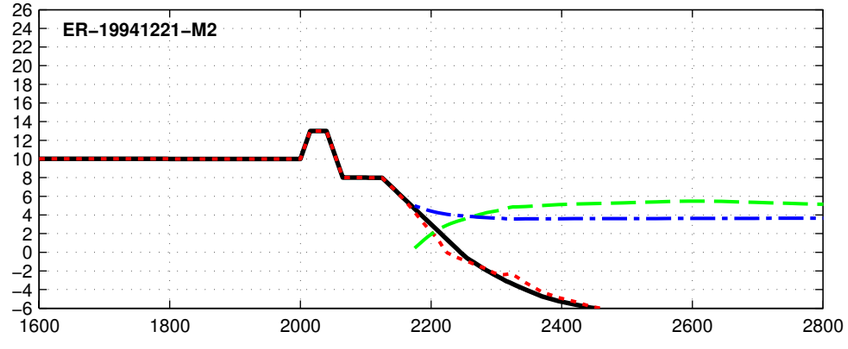


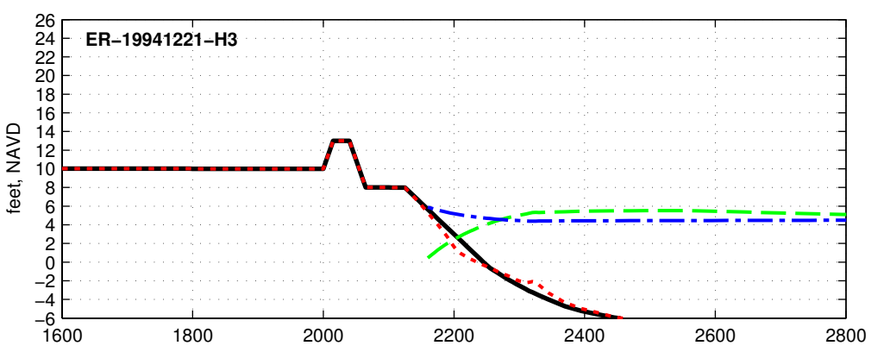


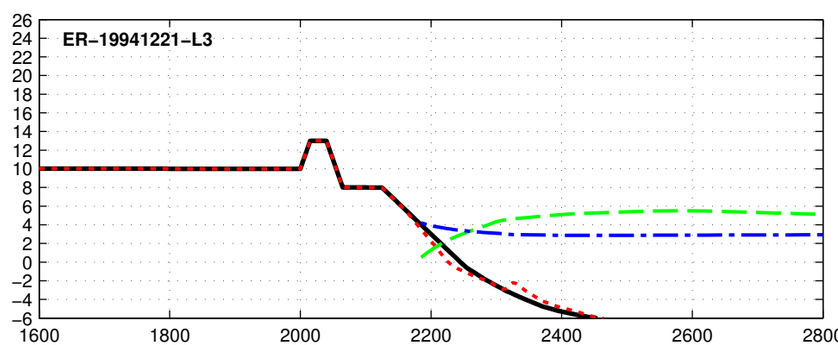


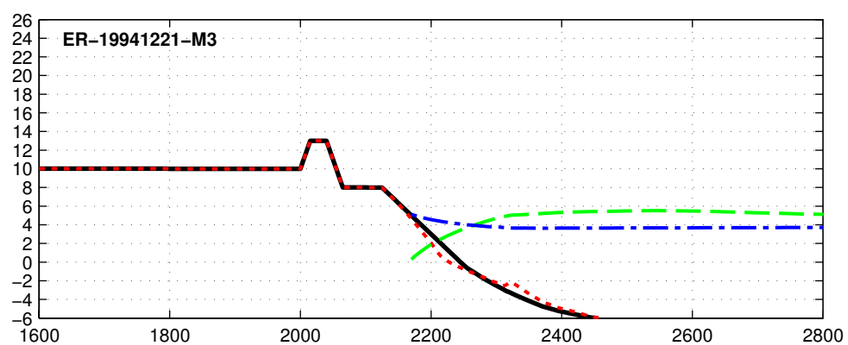


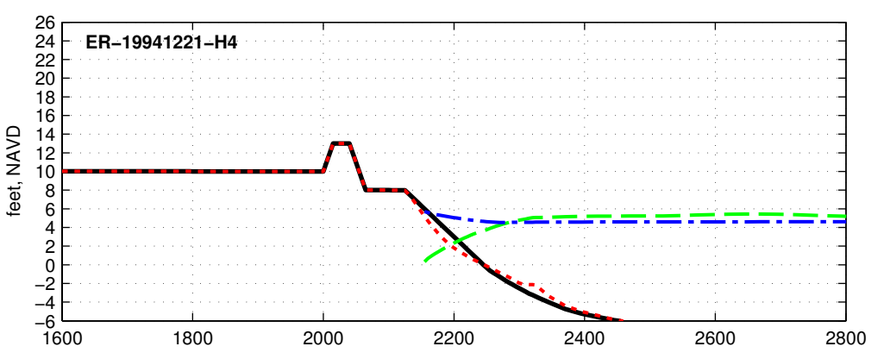


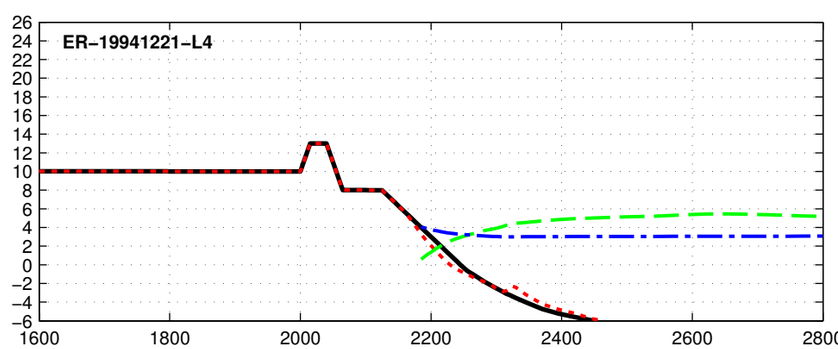


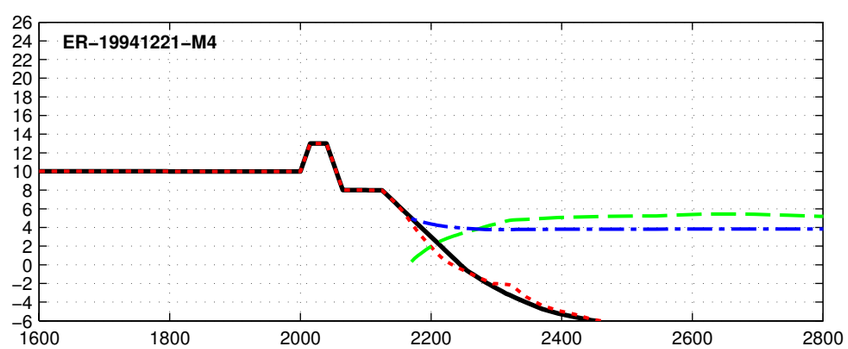






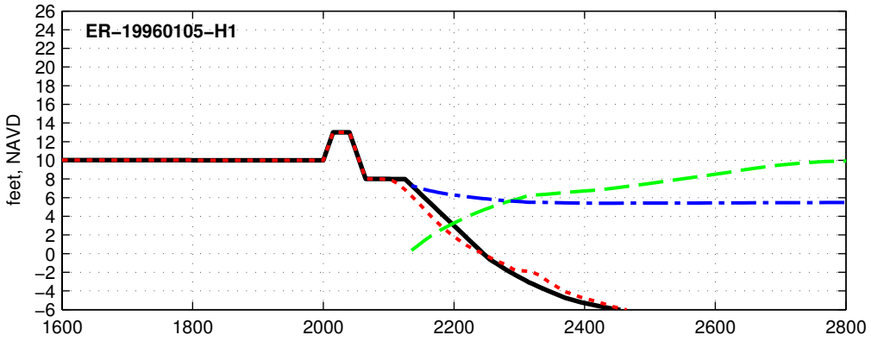


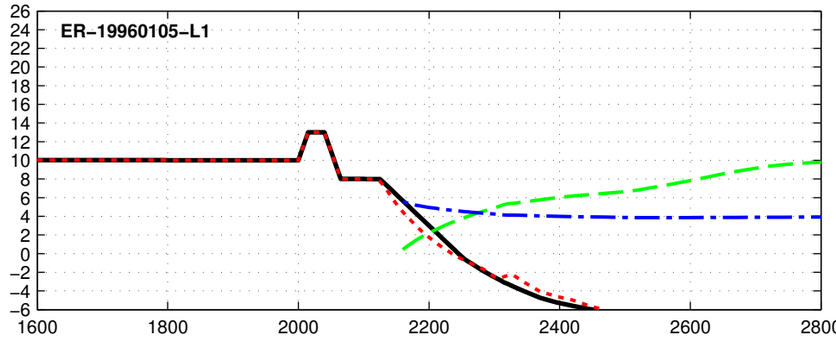


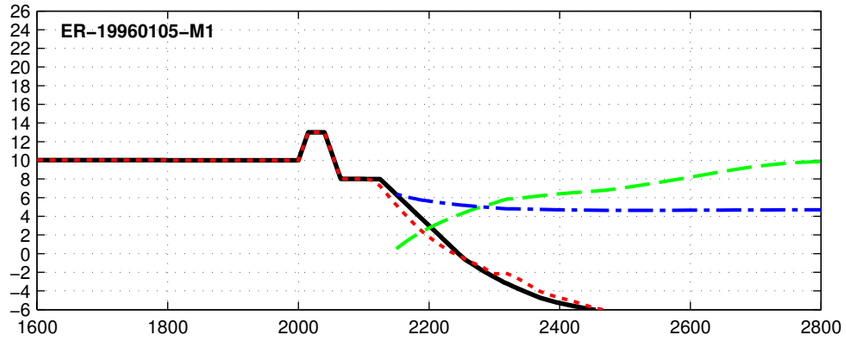


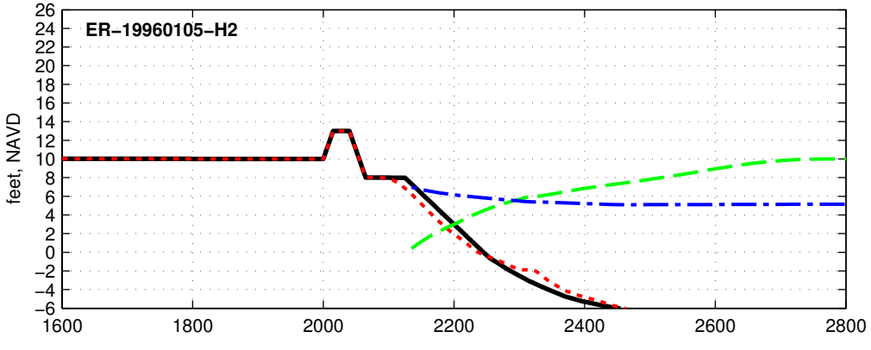
Initial Final Max Hs Max Water Level

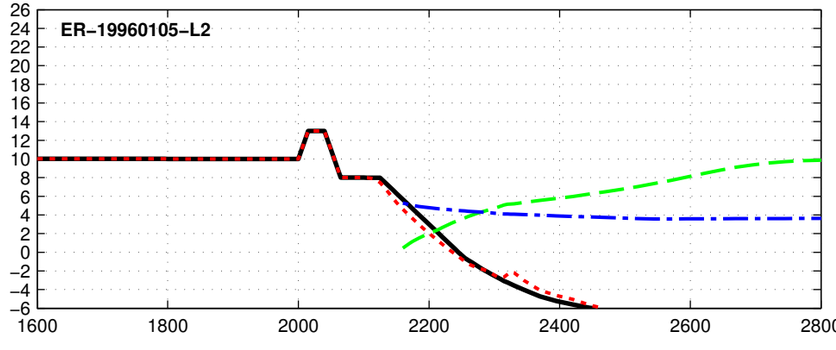
Dune R2T1-13.0-025-060 - ER-19960105

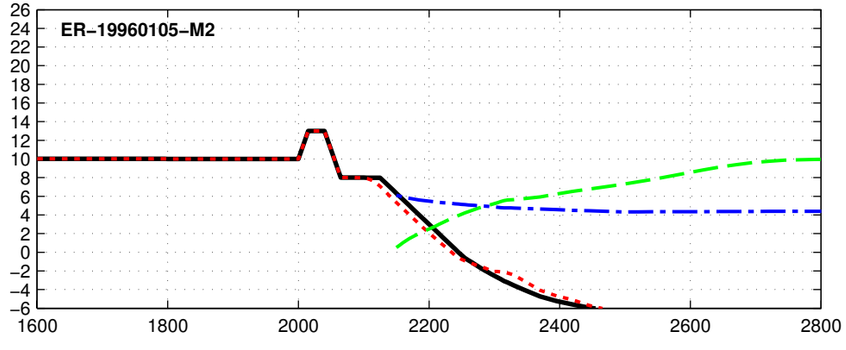


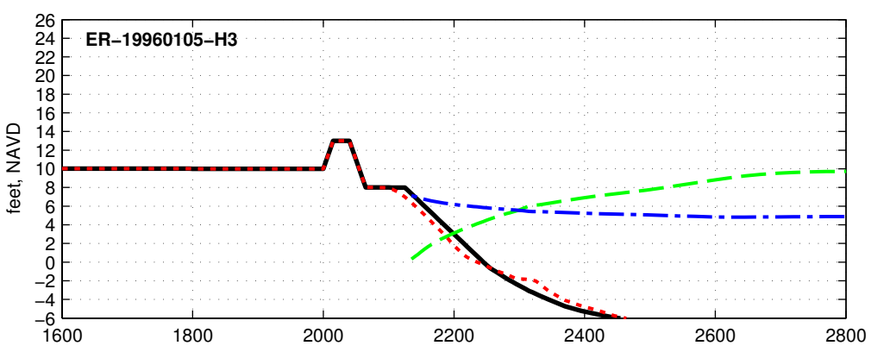


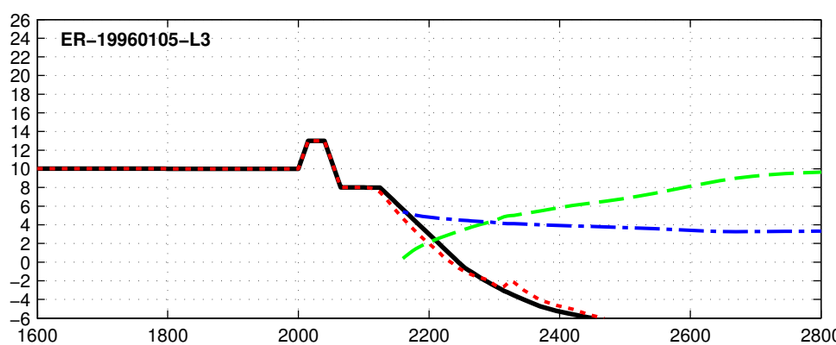


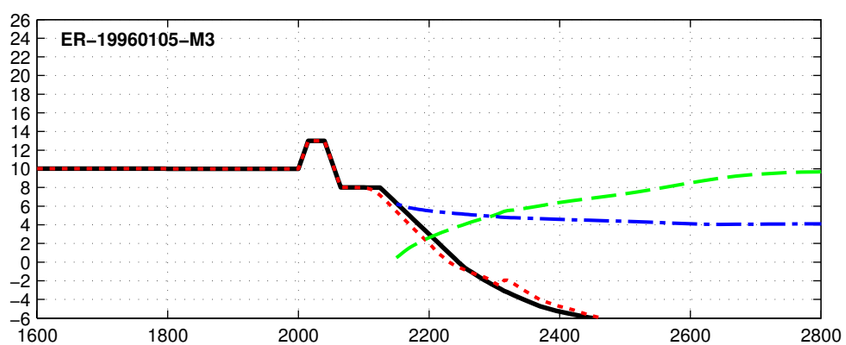


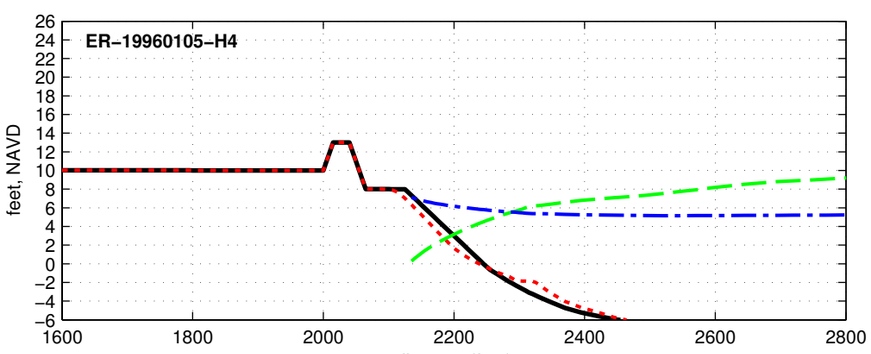


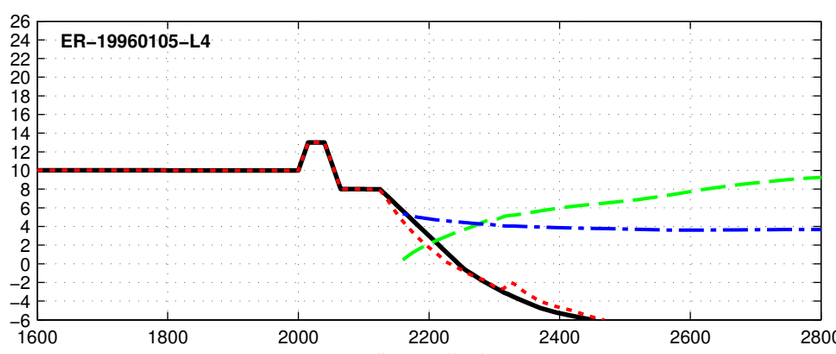


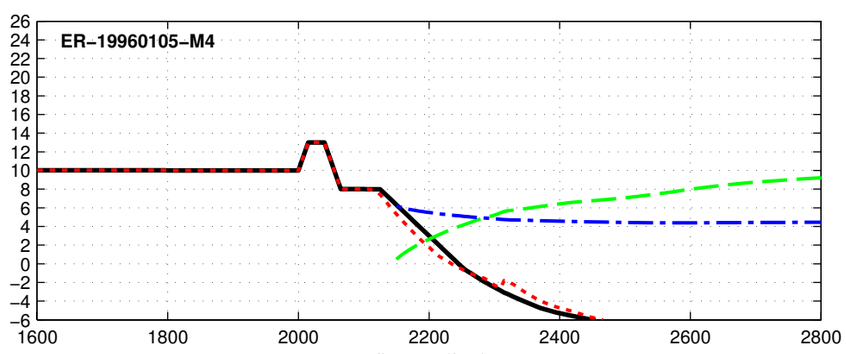






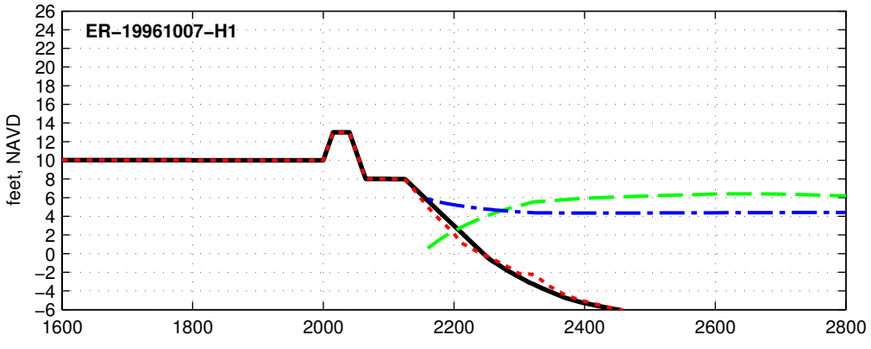


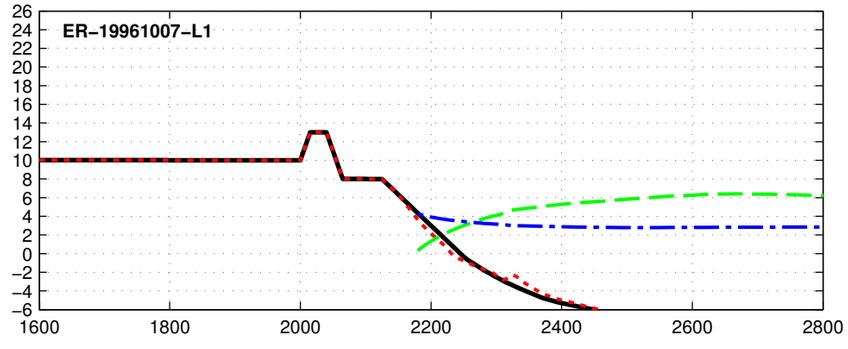


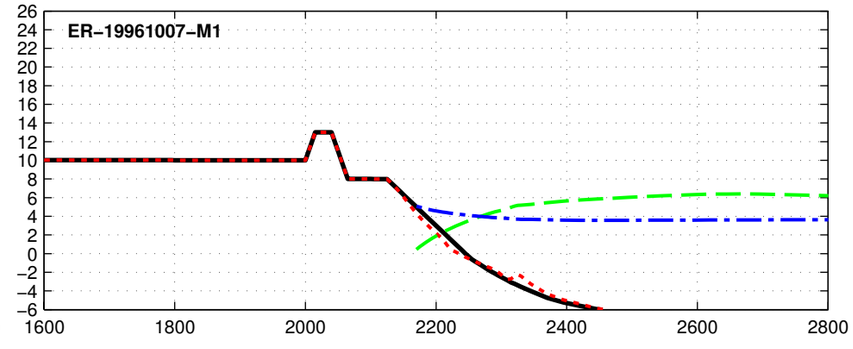


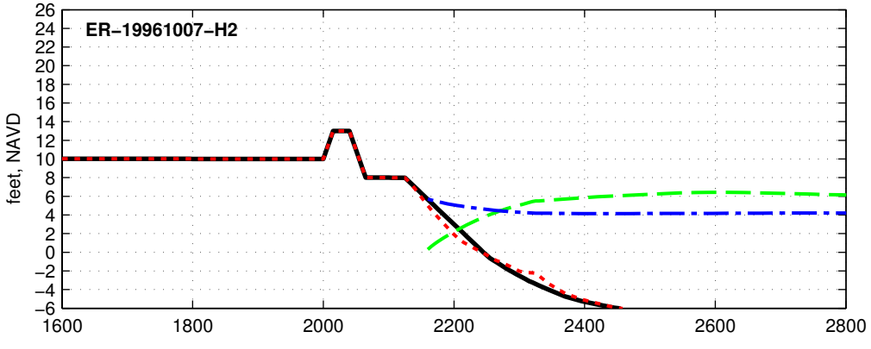
Initial Final Max Hs Max Water Level

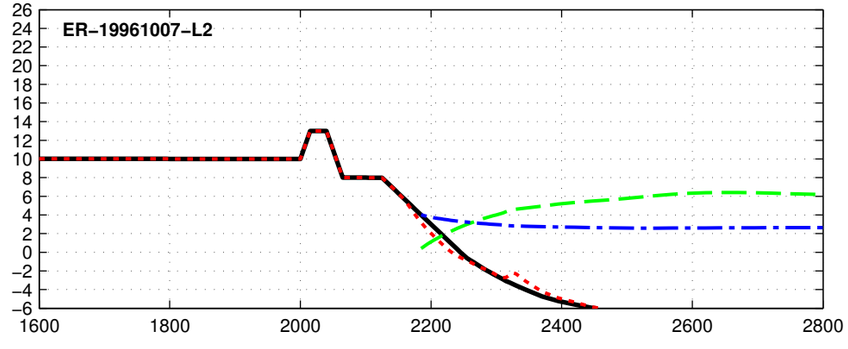
Dune R2T1-13.0-025-060 - ER-19961007

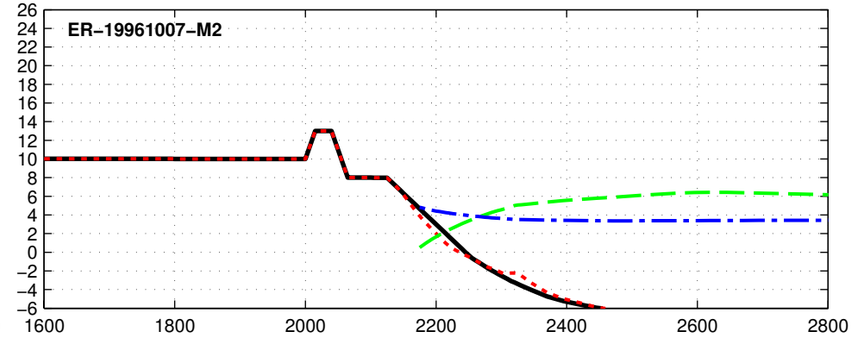


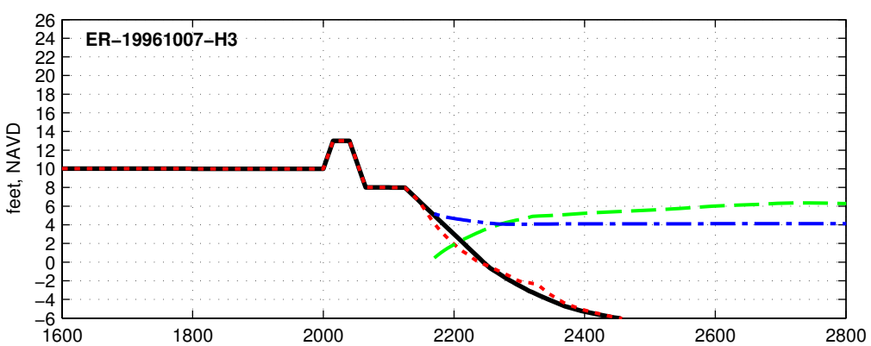


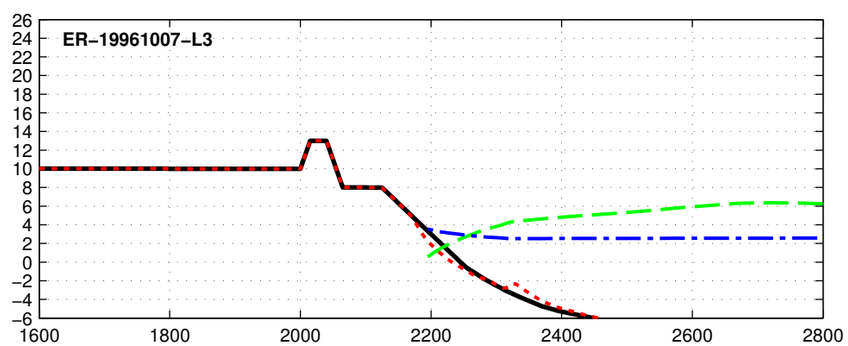


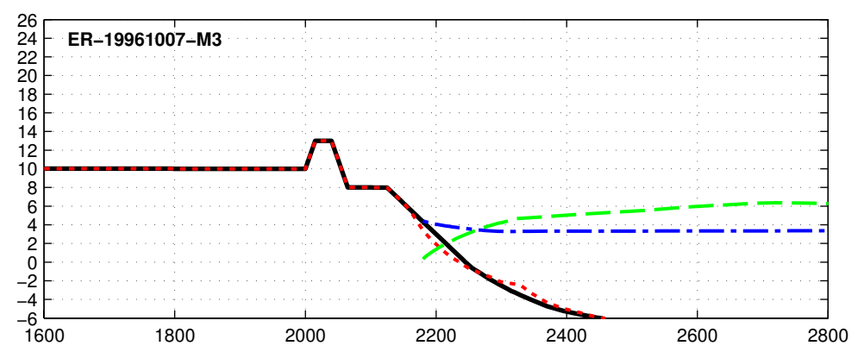


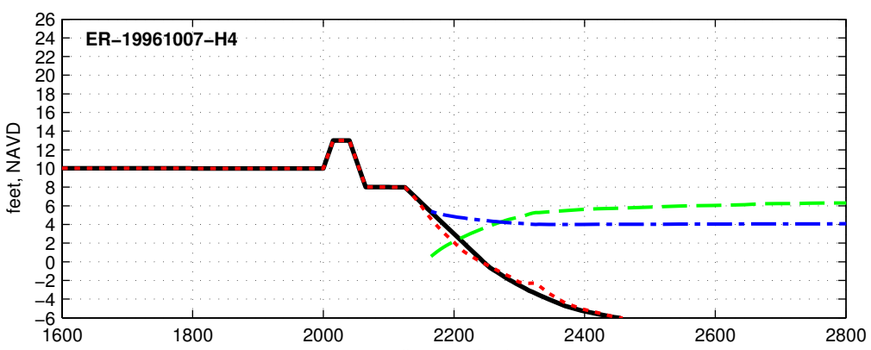


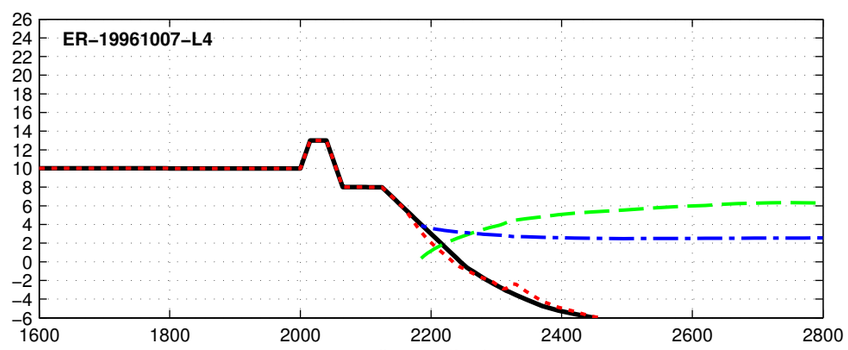


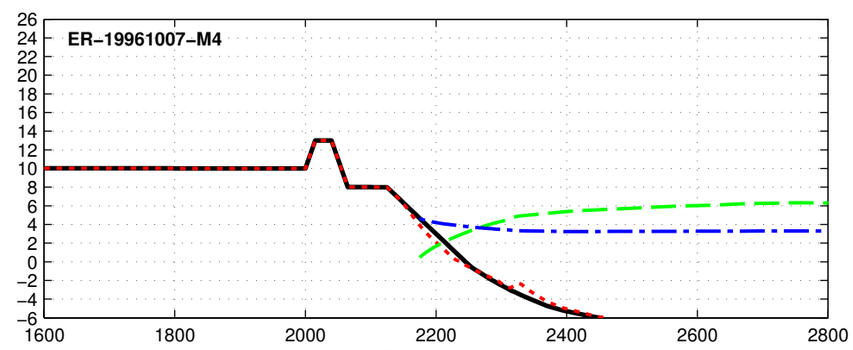






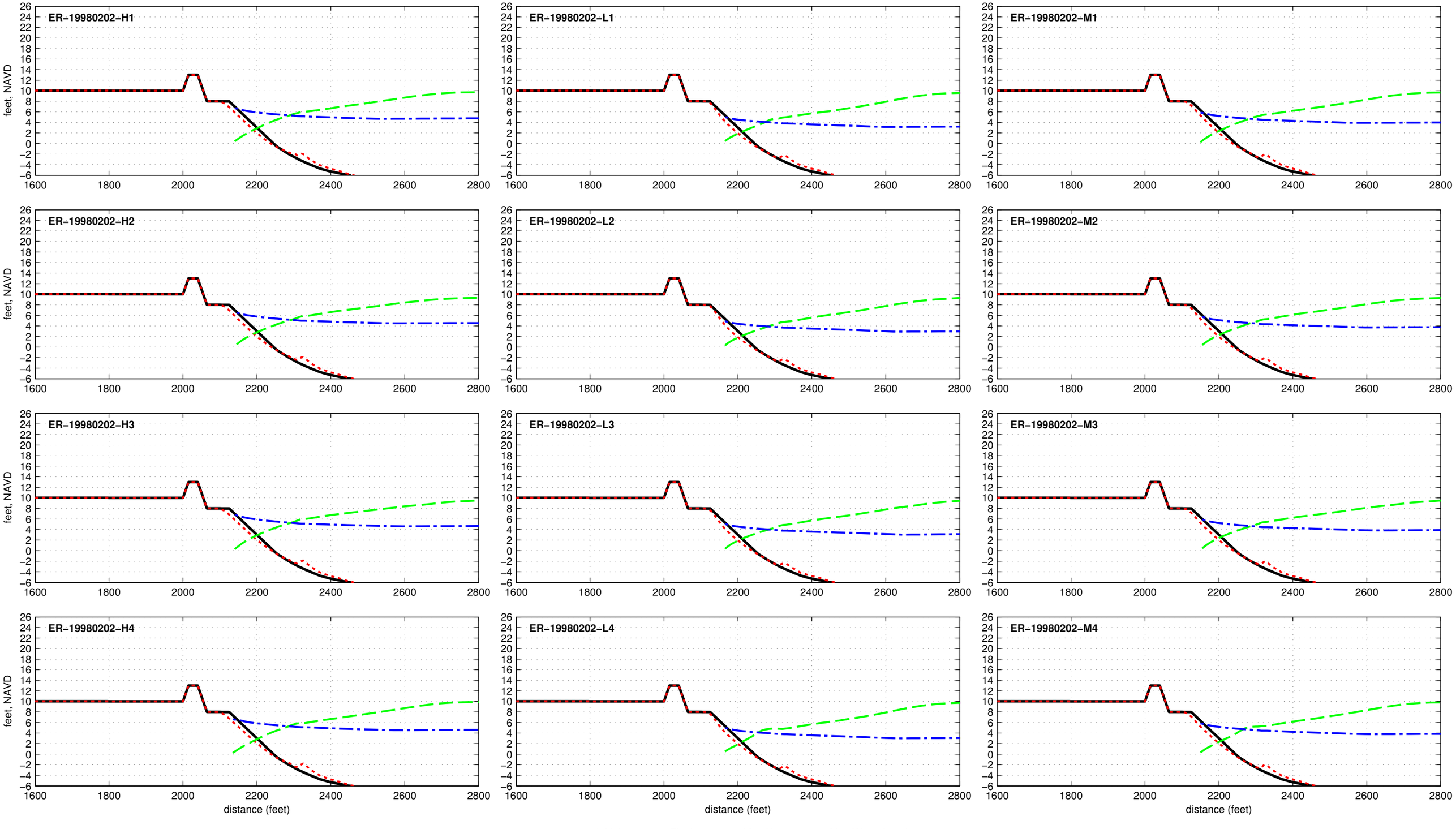




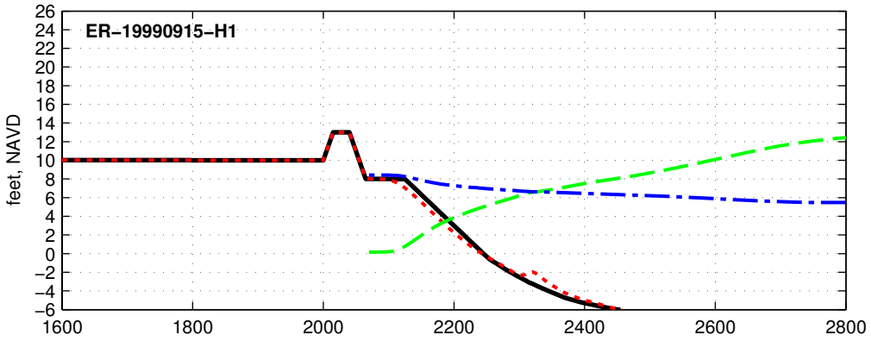


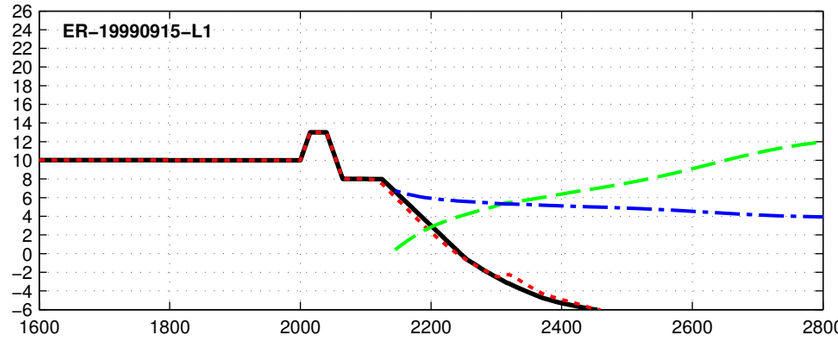
Initial Final Max Hs Max Water Level

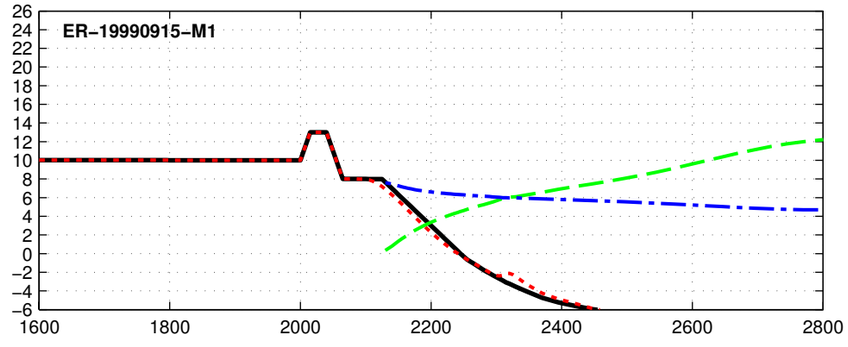
Dune R2T1–13.0–025–060 – ER–19980202

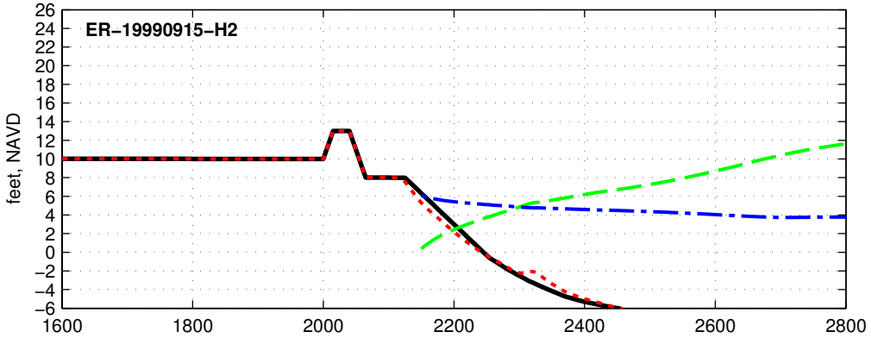


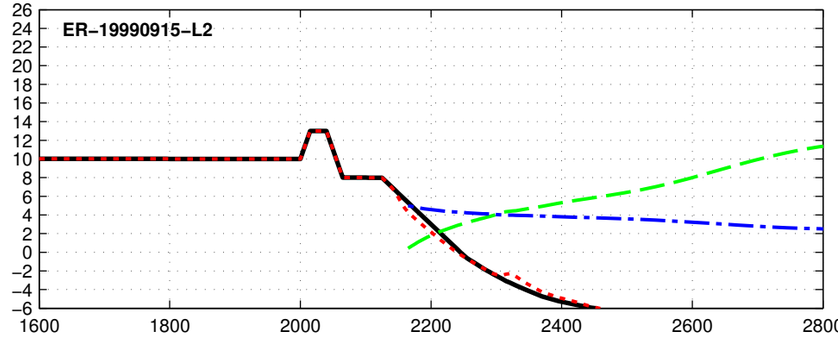
Dune R2T1-13.0-025-060 - ER-19990915

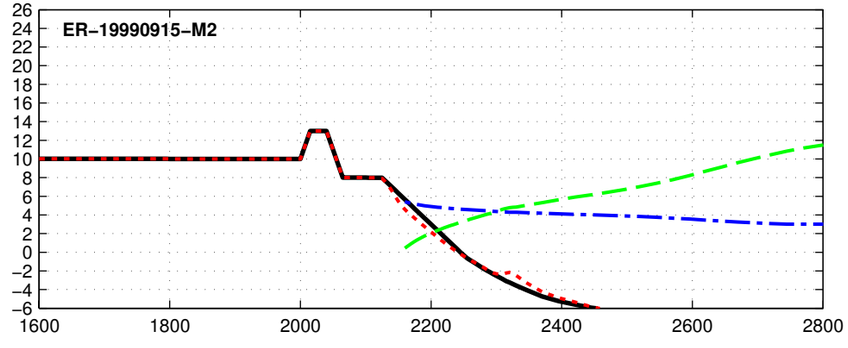


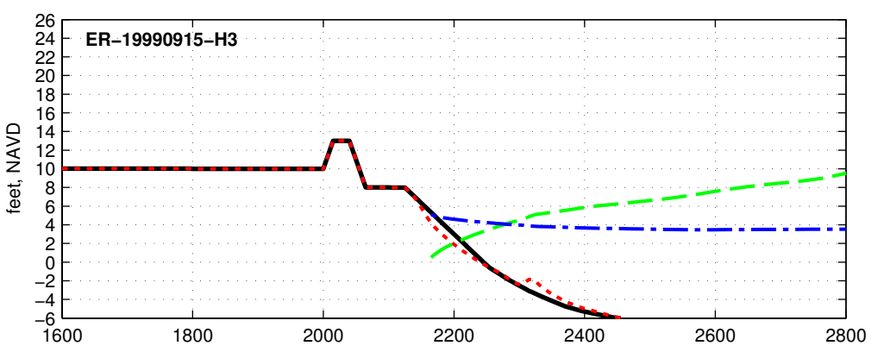


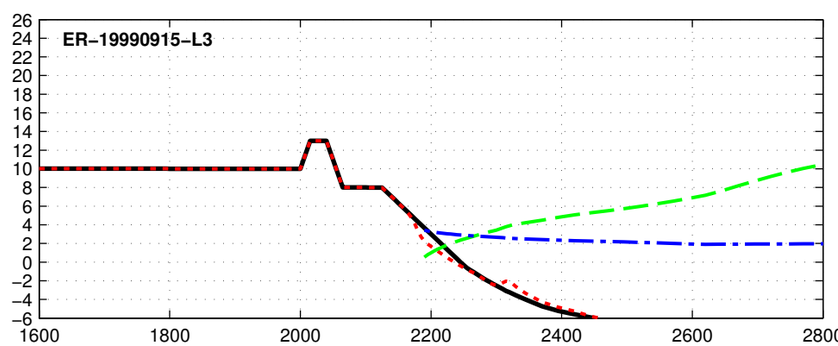


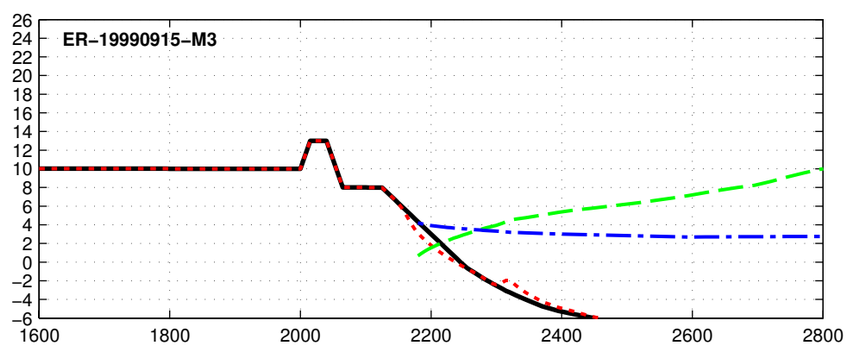


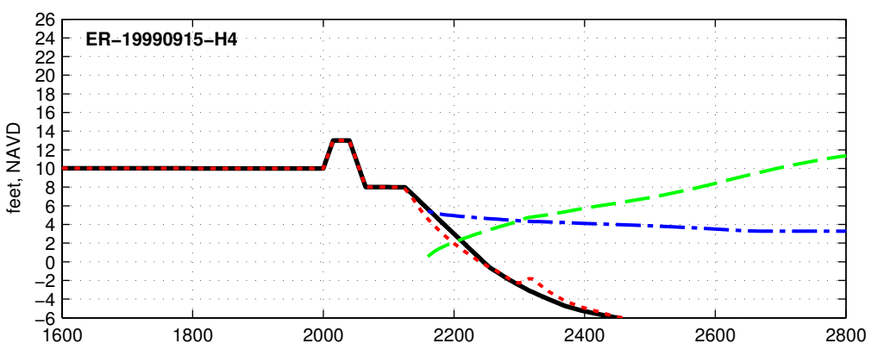


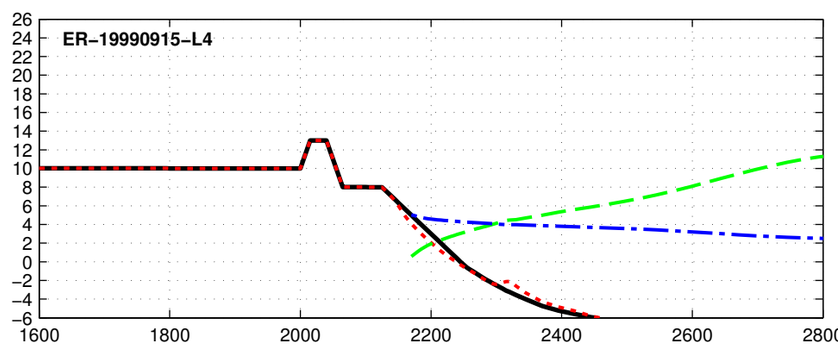


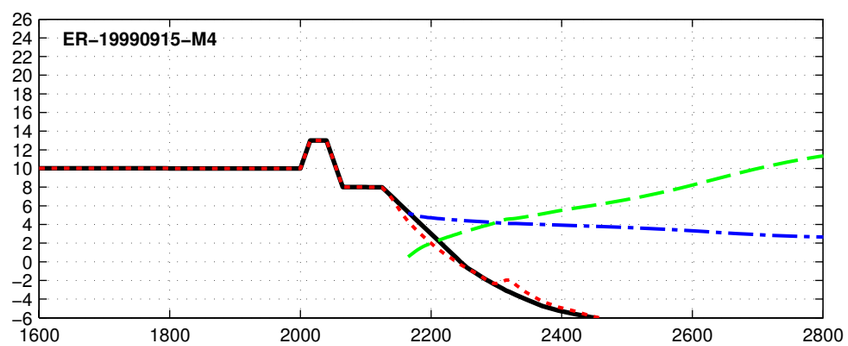






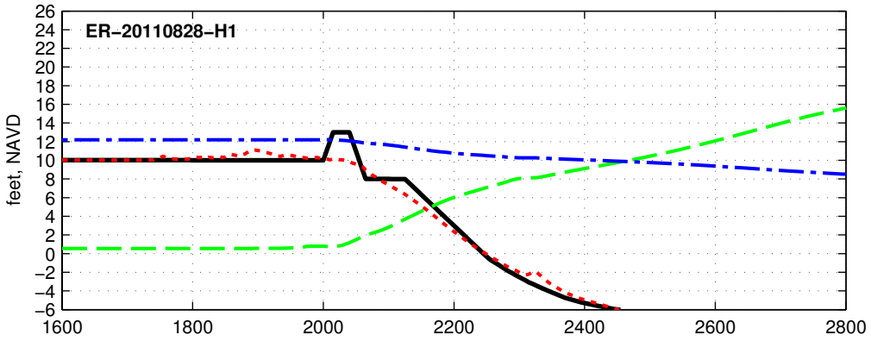


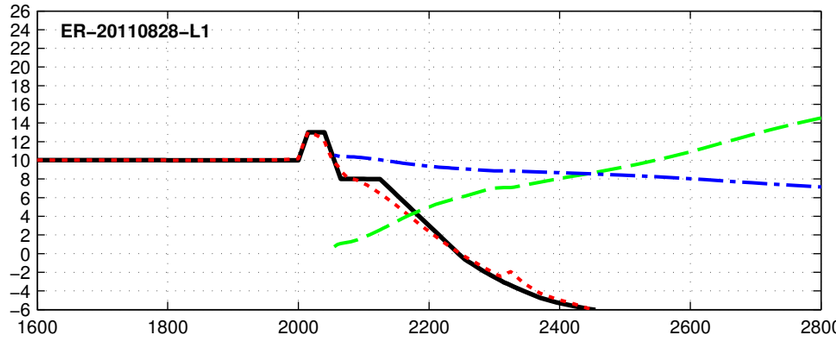


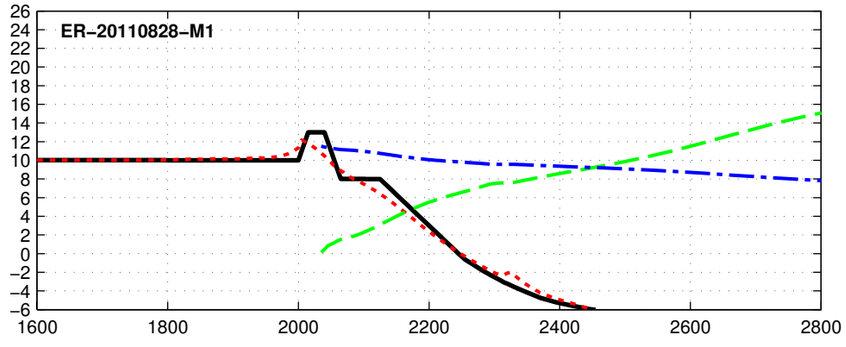


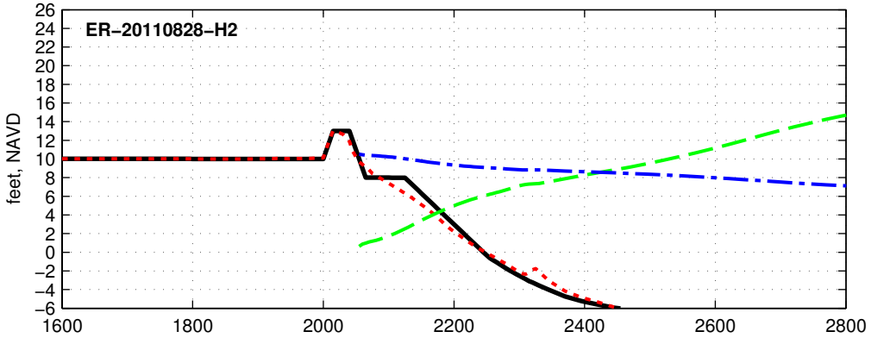
Initial Final Max Hs Max Water Level

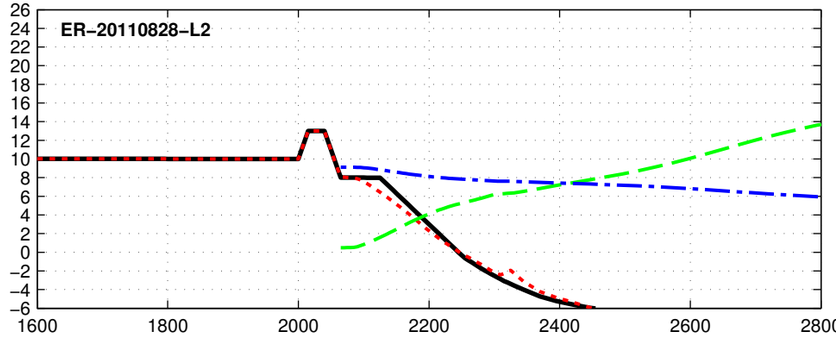
Dune R2T1-13.0-025-060 - ER-20110828

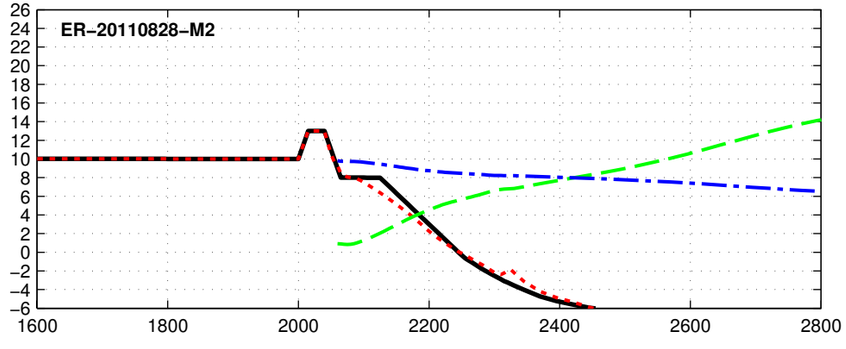


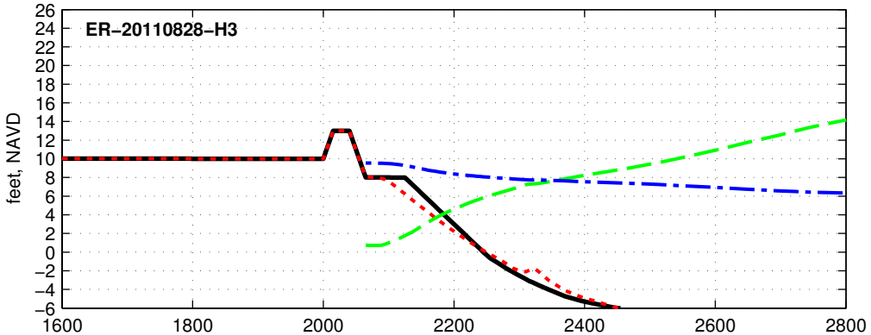


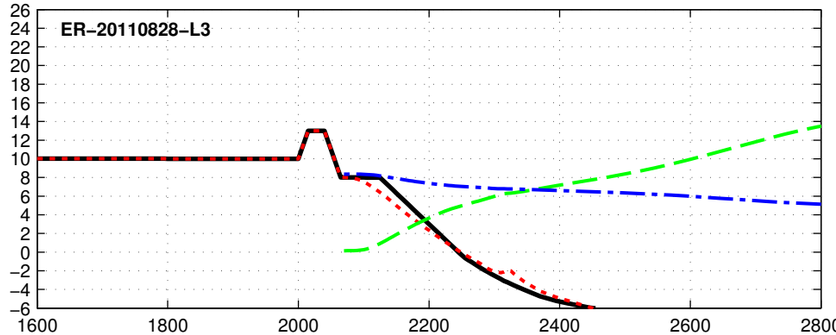


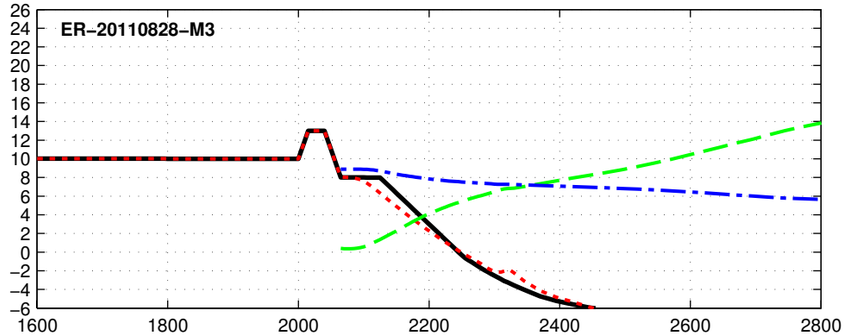


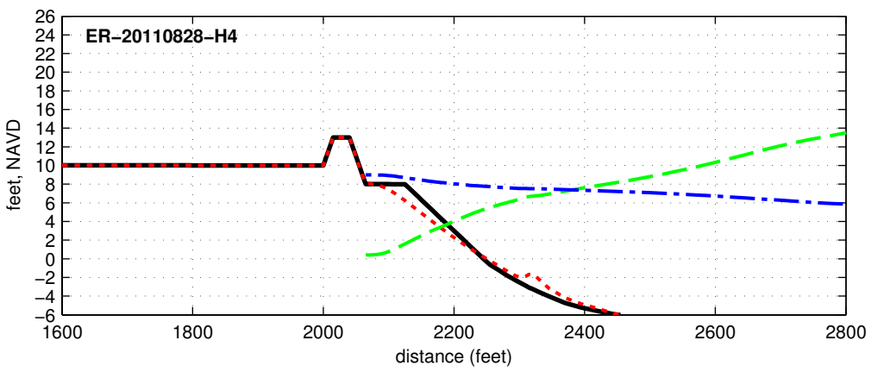


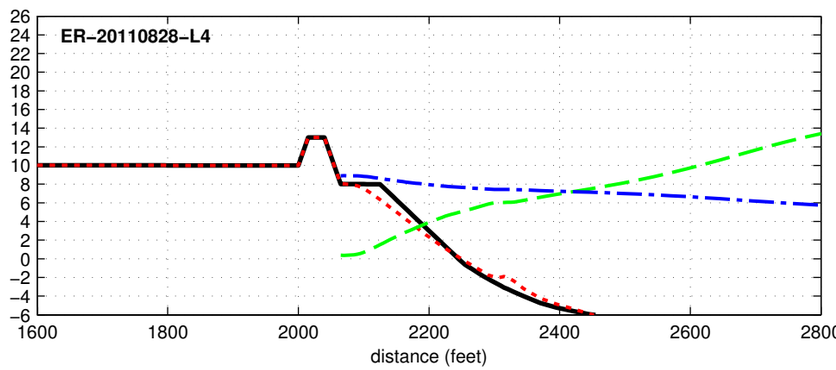


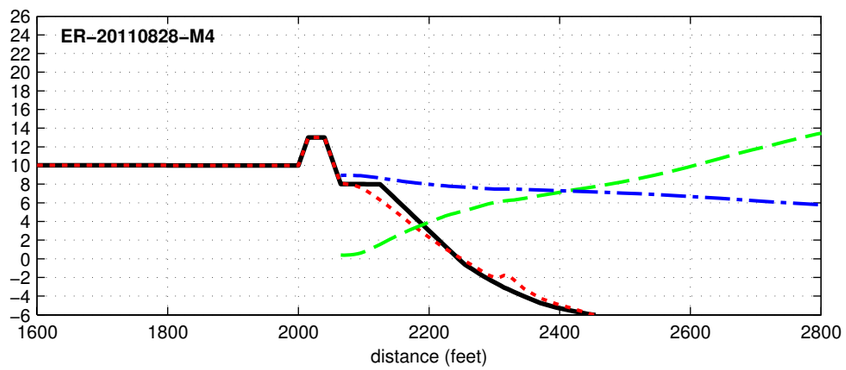






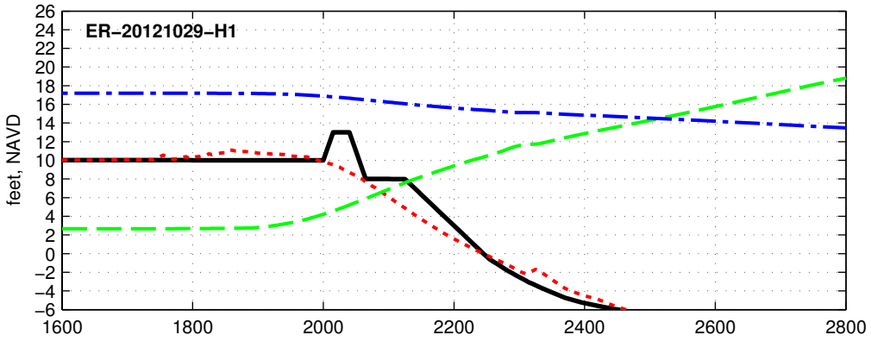


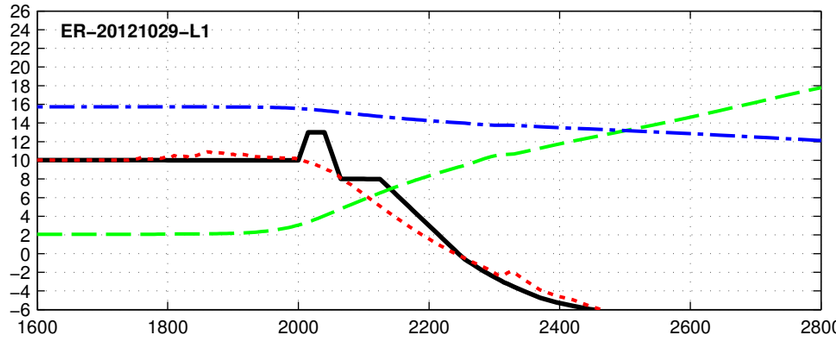


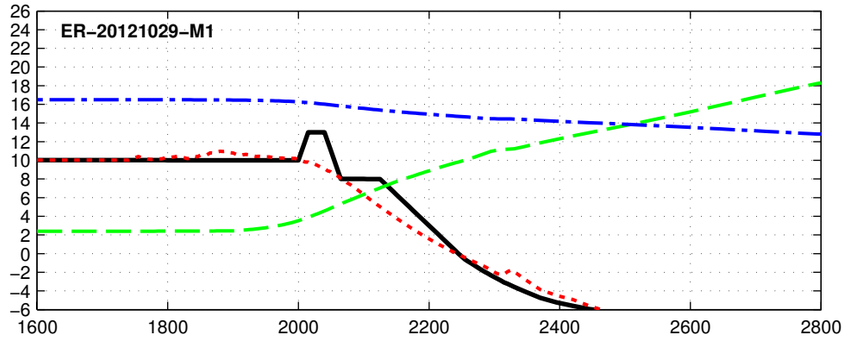


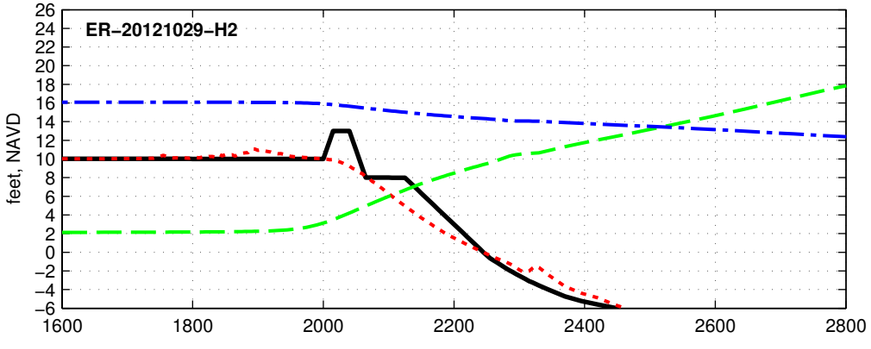
Initial Final Max Hs Max Water Level

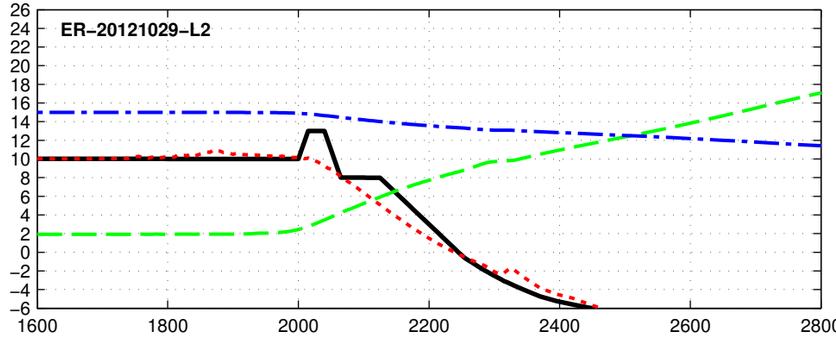
Dune R2T1–13.0–025–060 – ER–20121029

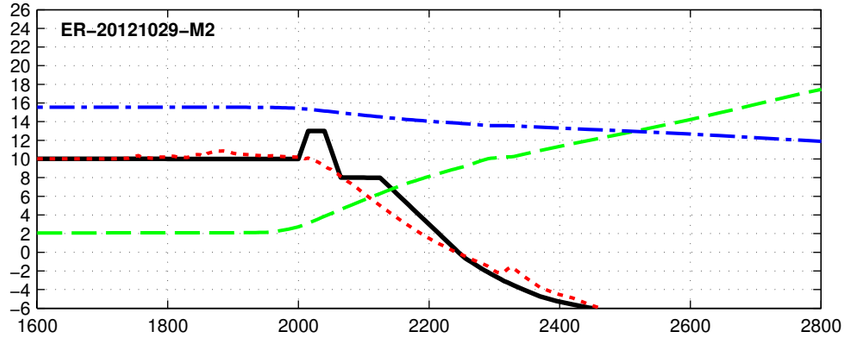


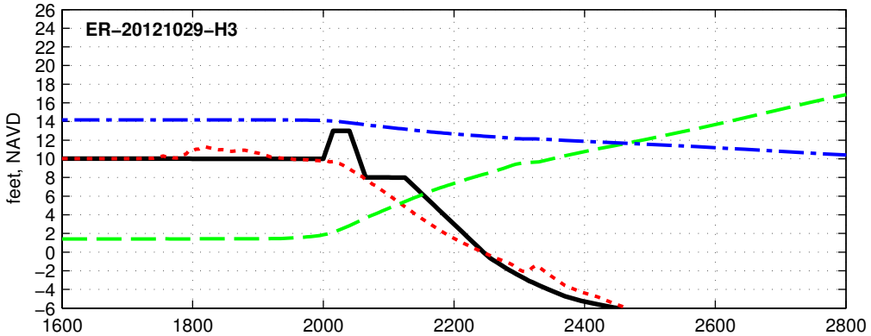


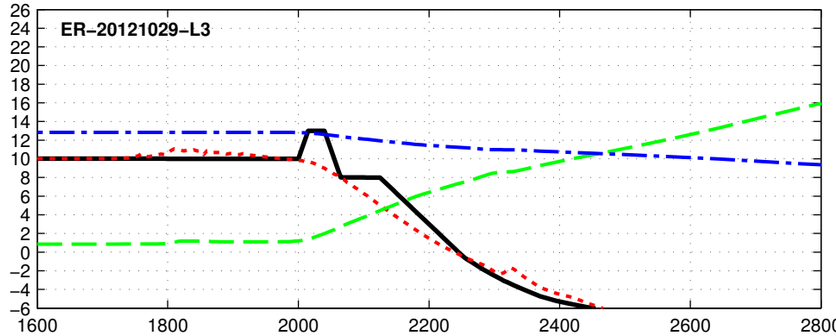


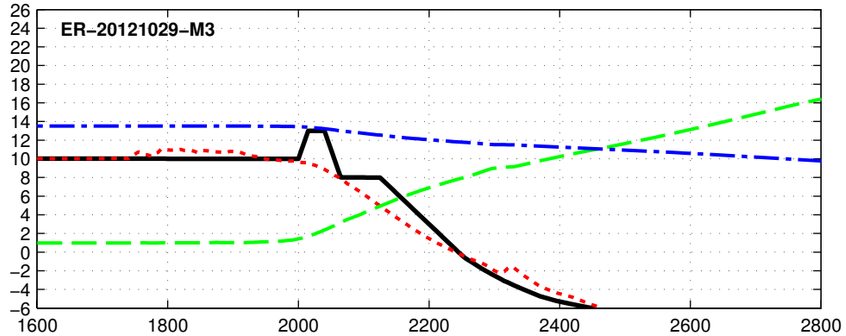


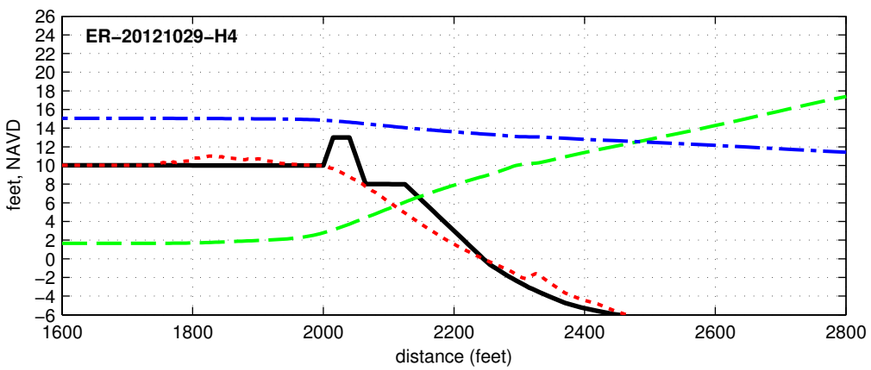


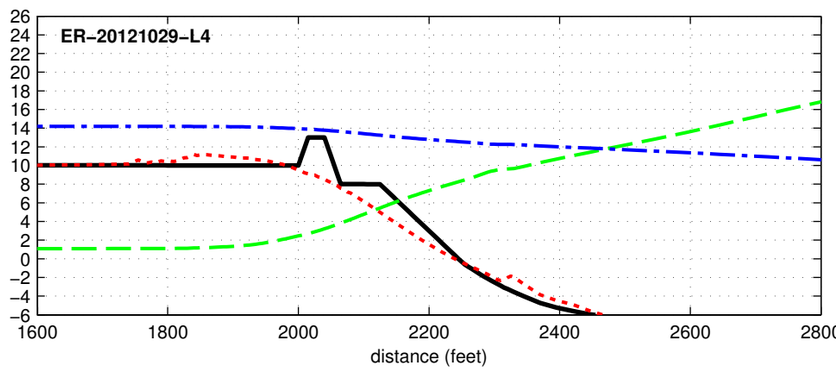


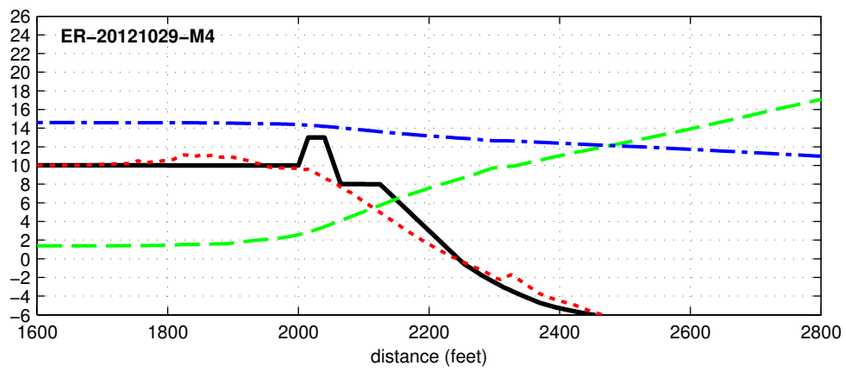








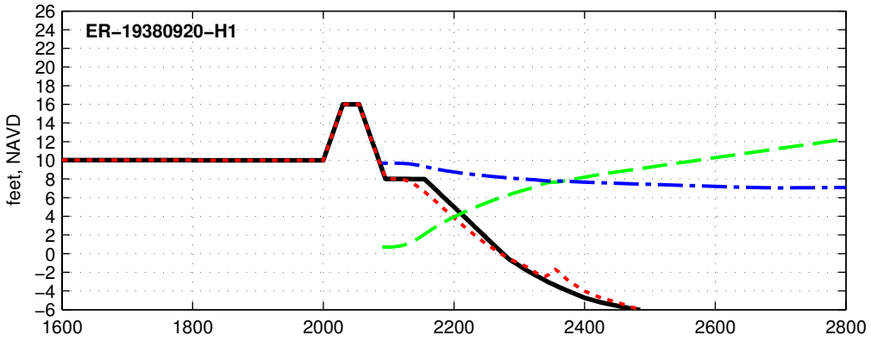


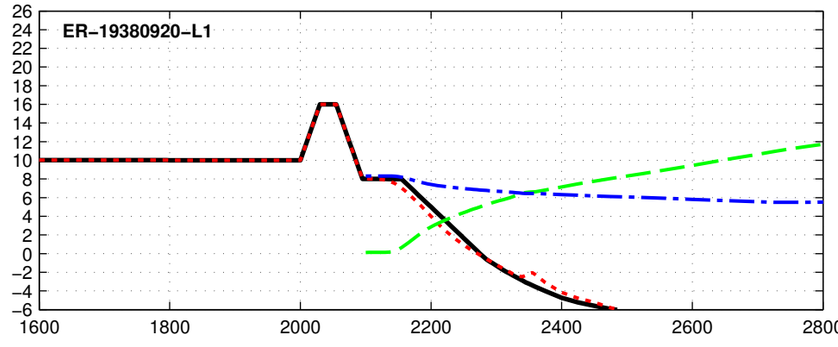


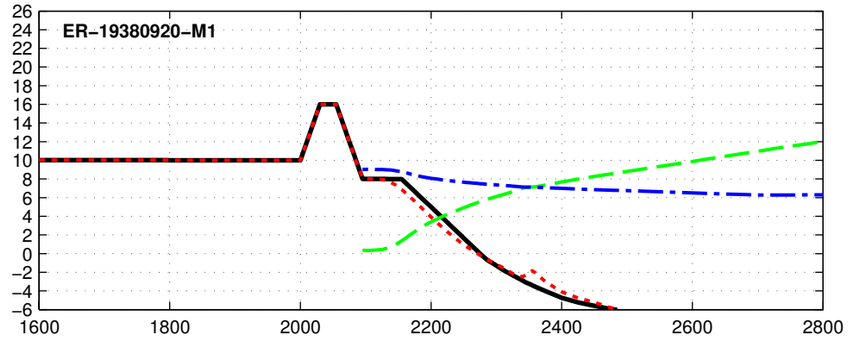
Initial Final Max Hs Max Water Level

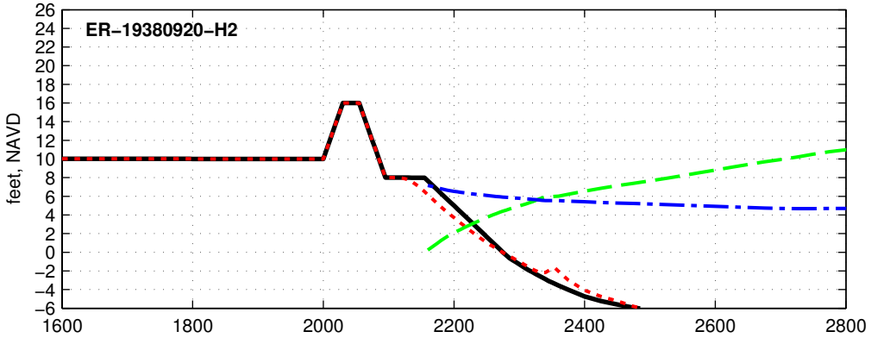
R2T1_16.0_025_060 – DUNE

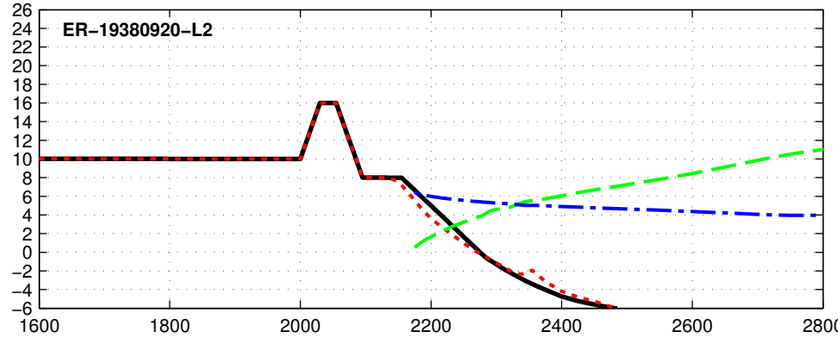
Dune R2T1-16.0-025-060 - ER-19380920

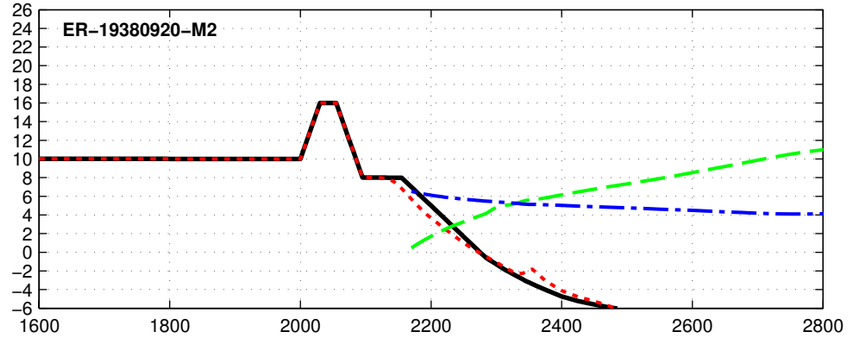


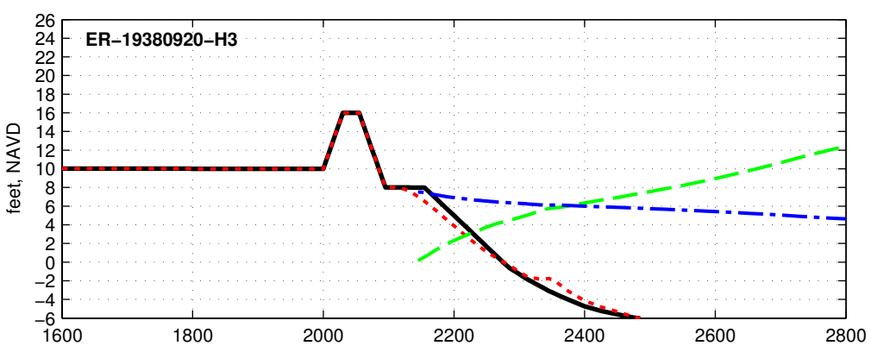


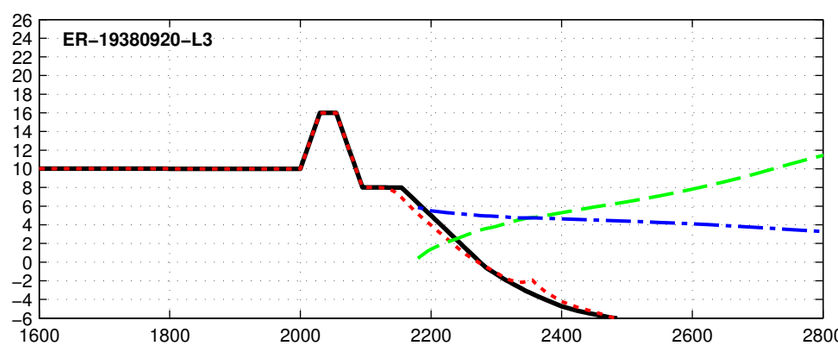


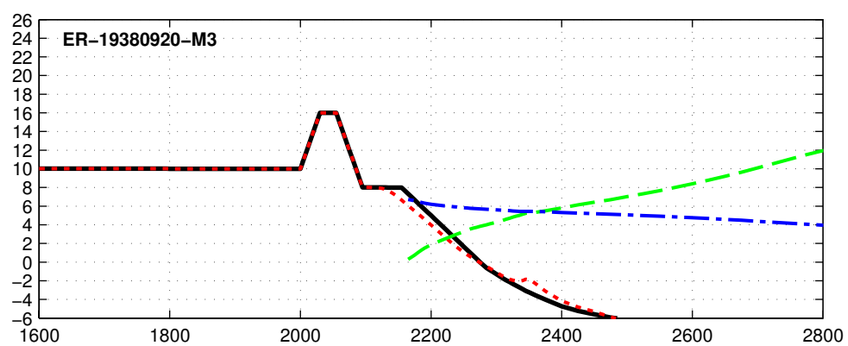


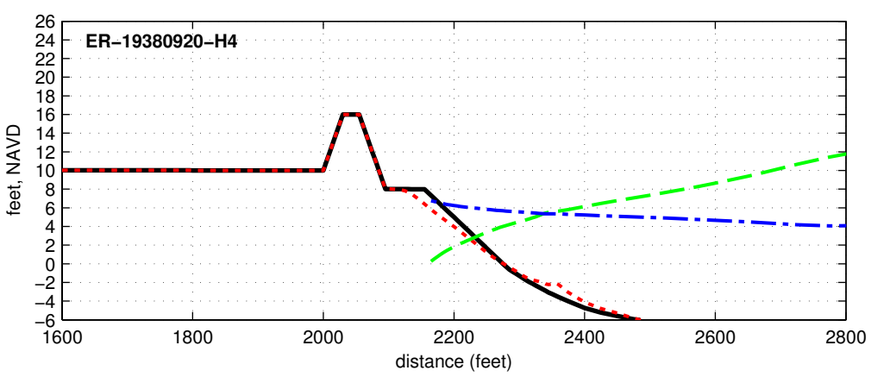


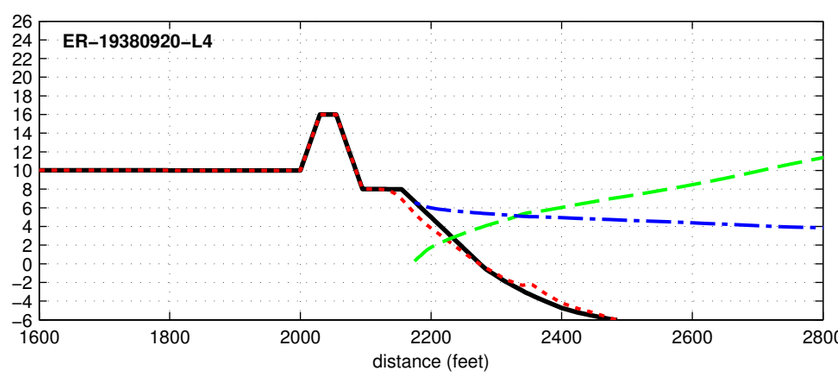


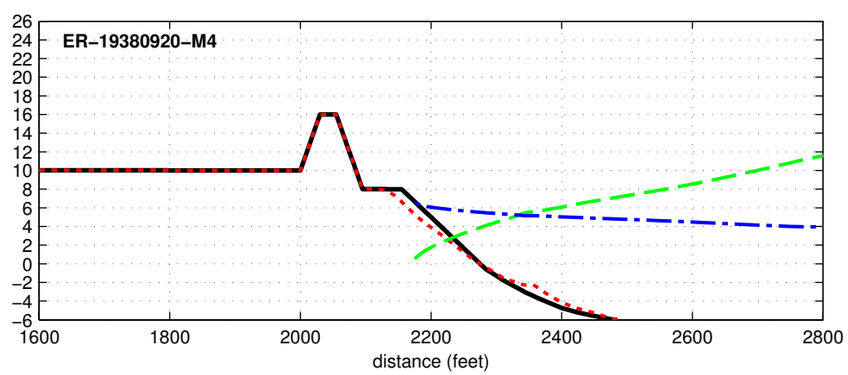






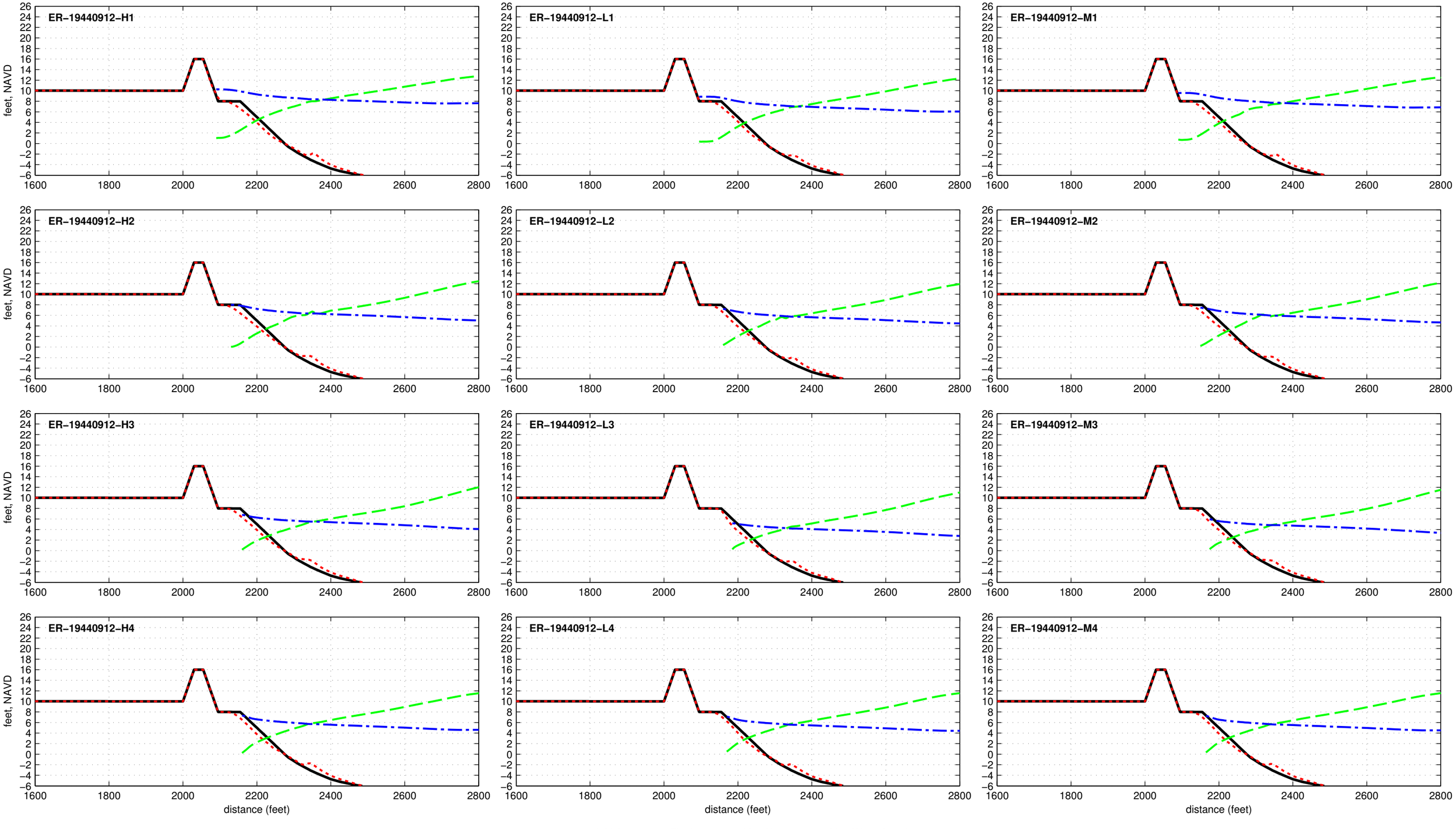




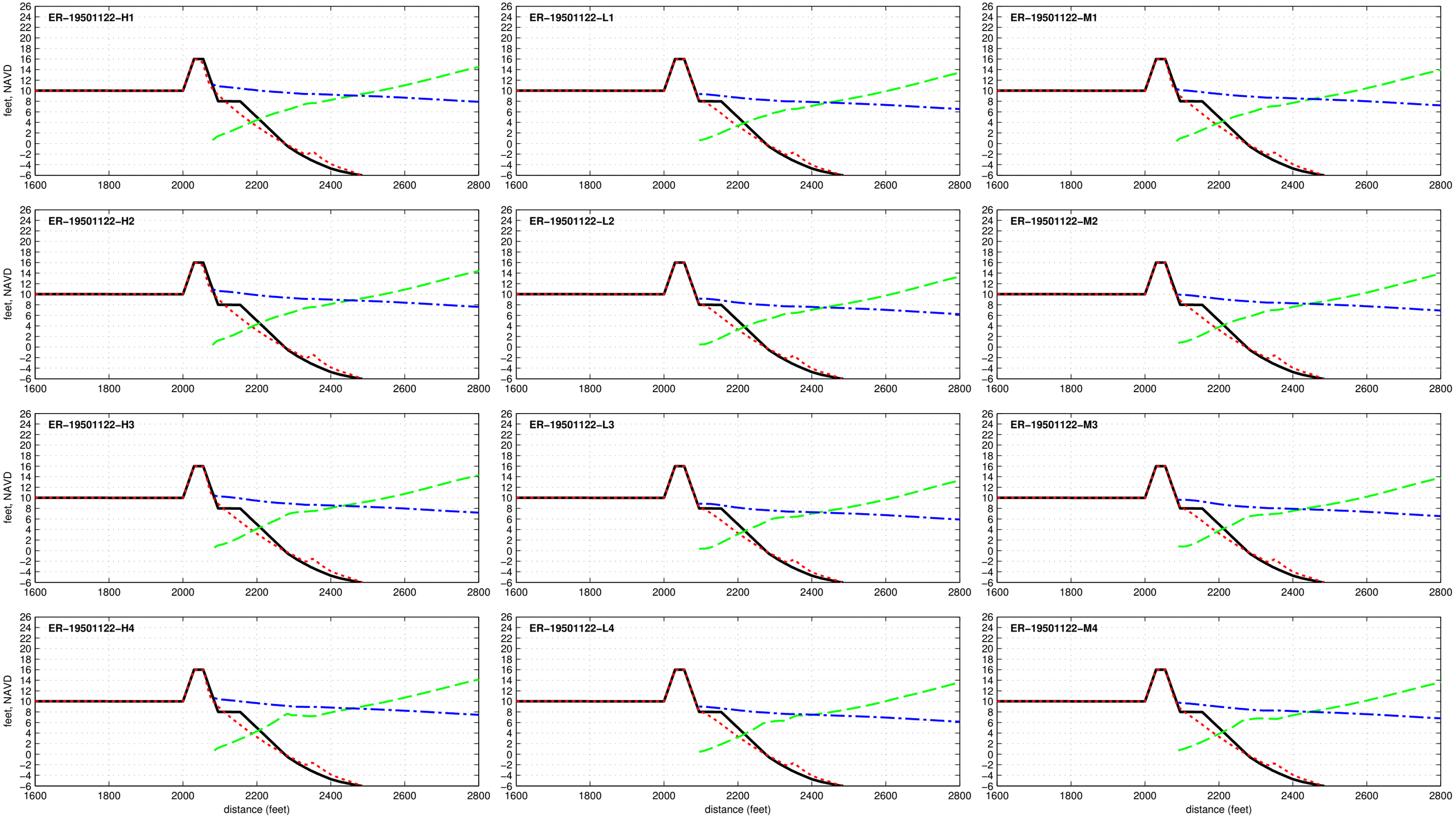


Initial Final Max Hs Max Water Level

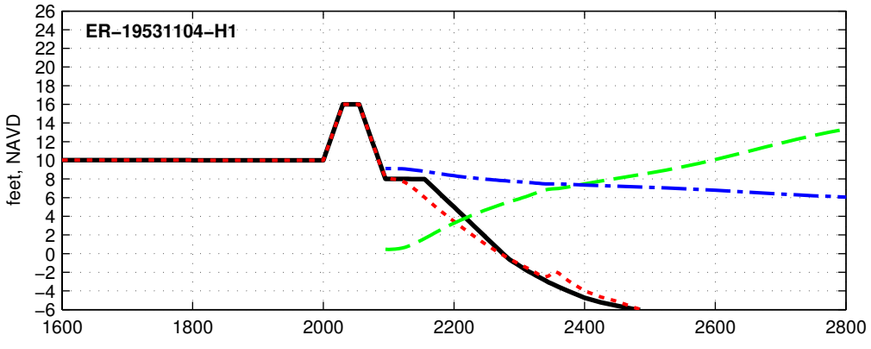
Dune R2T1-16.0-025-060 - ER-19440912

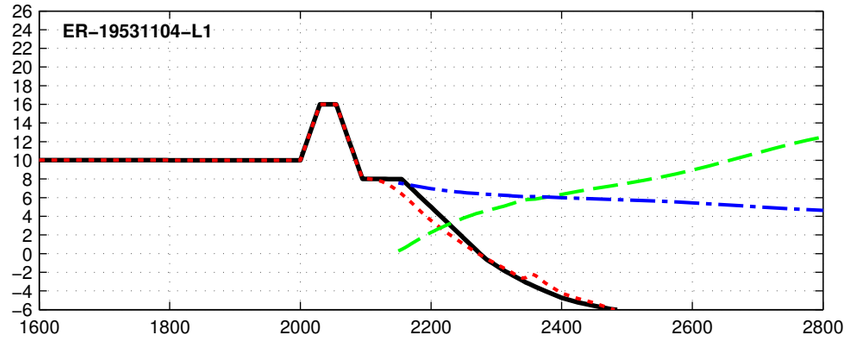


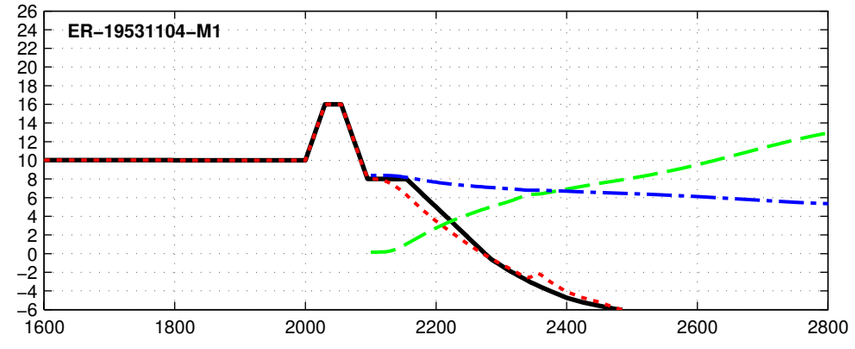
Dune R2T1-16.0-025-060 - ER-19501122

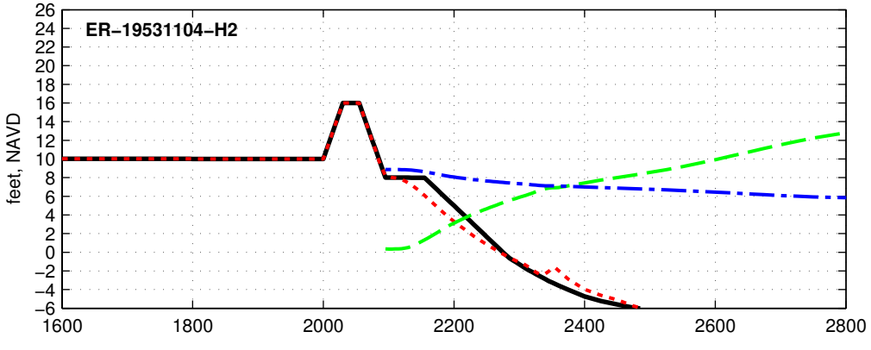


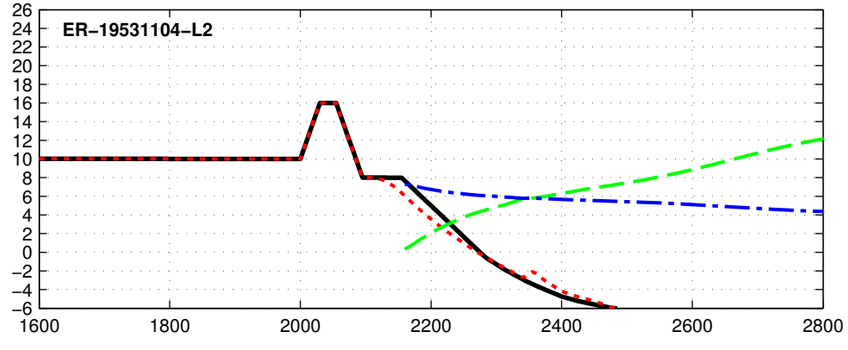
Dune R2T1-16.0-025-060 - ER-19531104

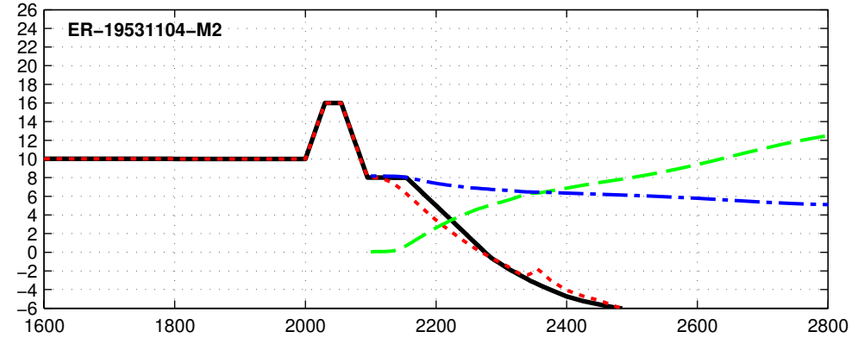


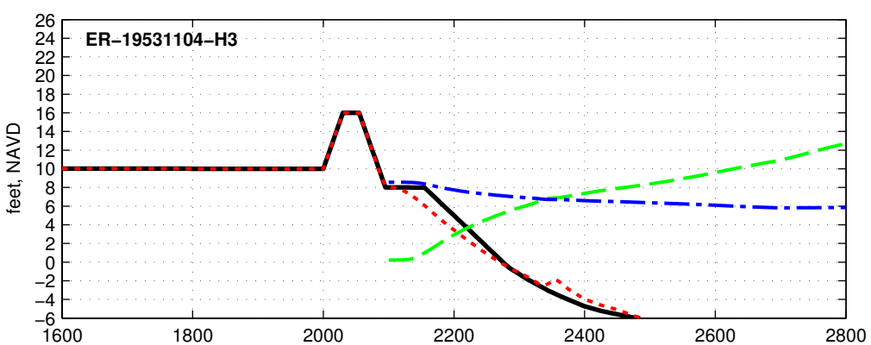


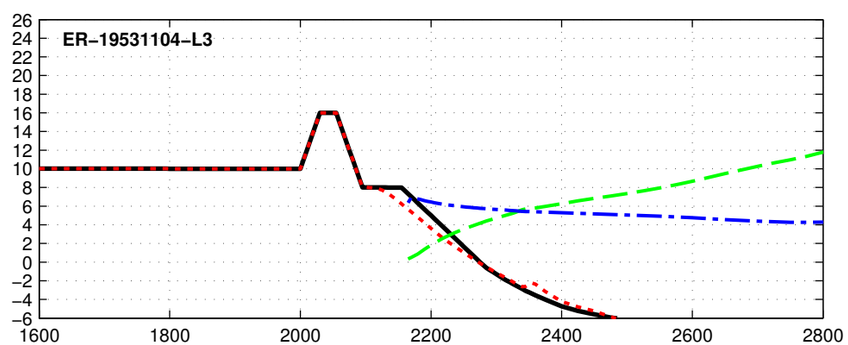


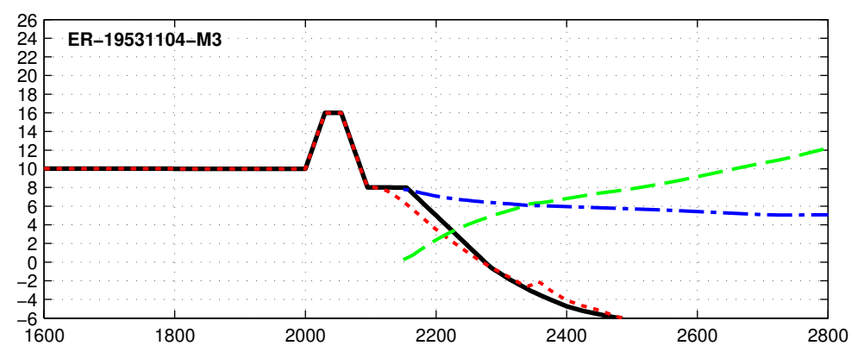


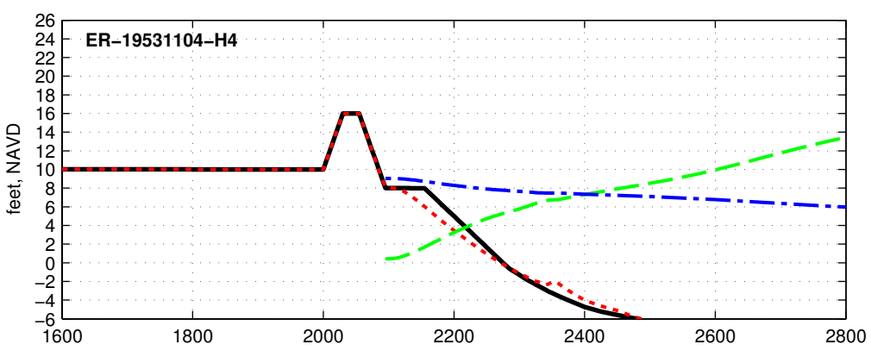


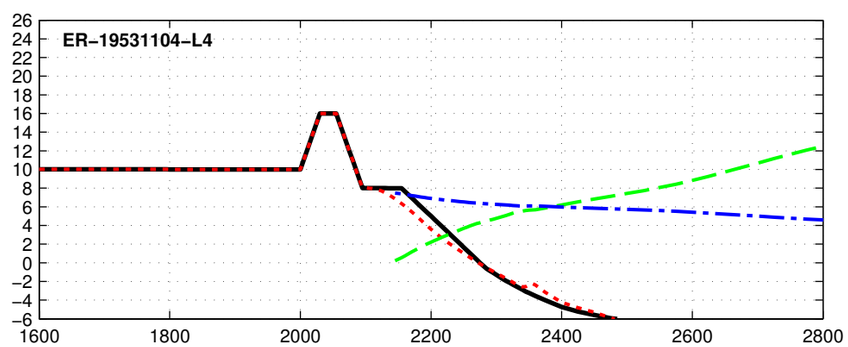


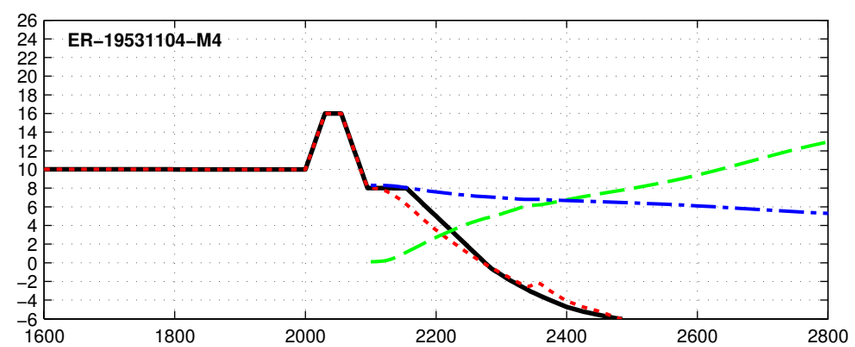






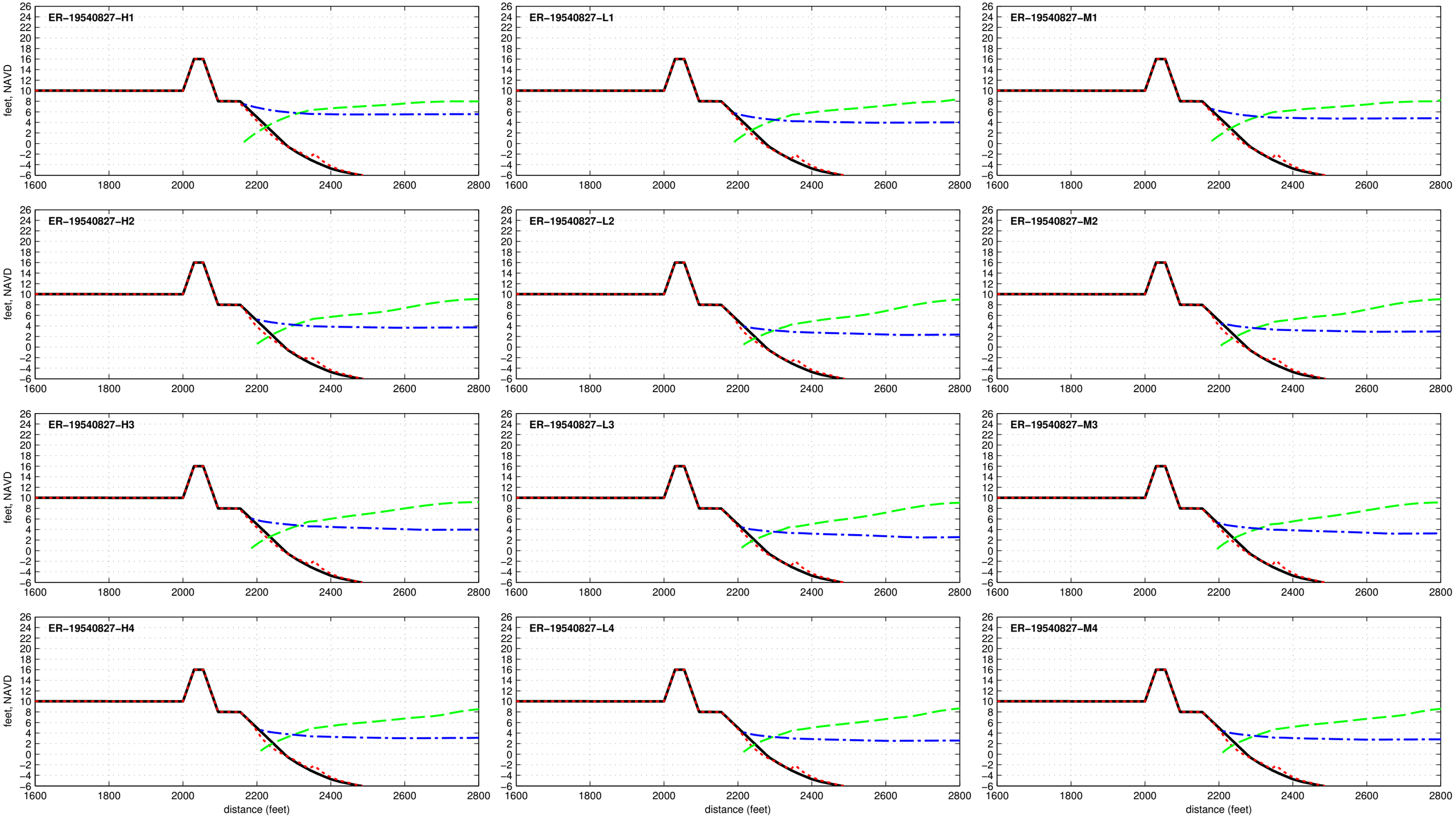




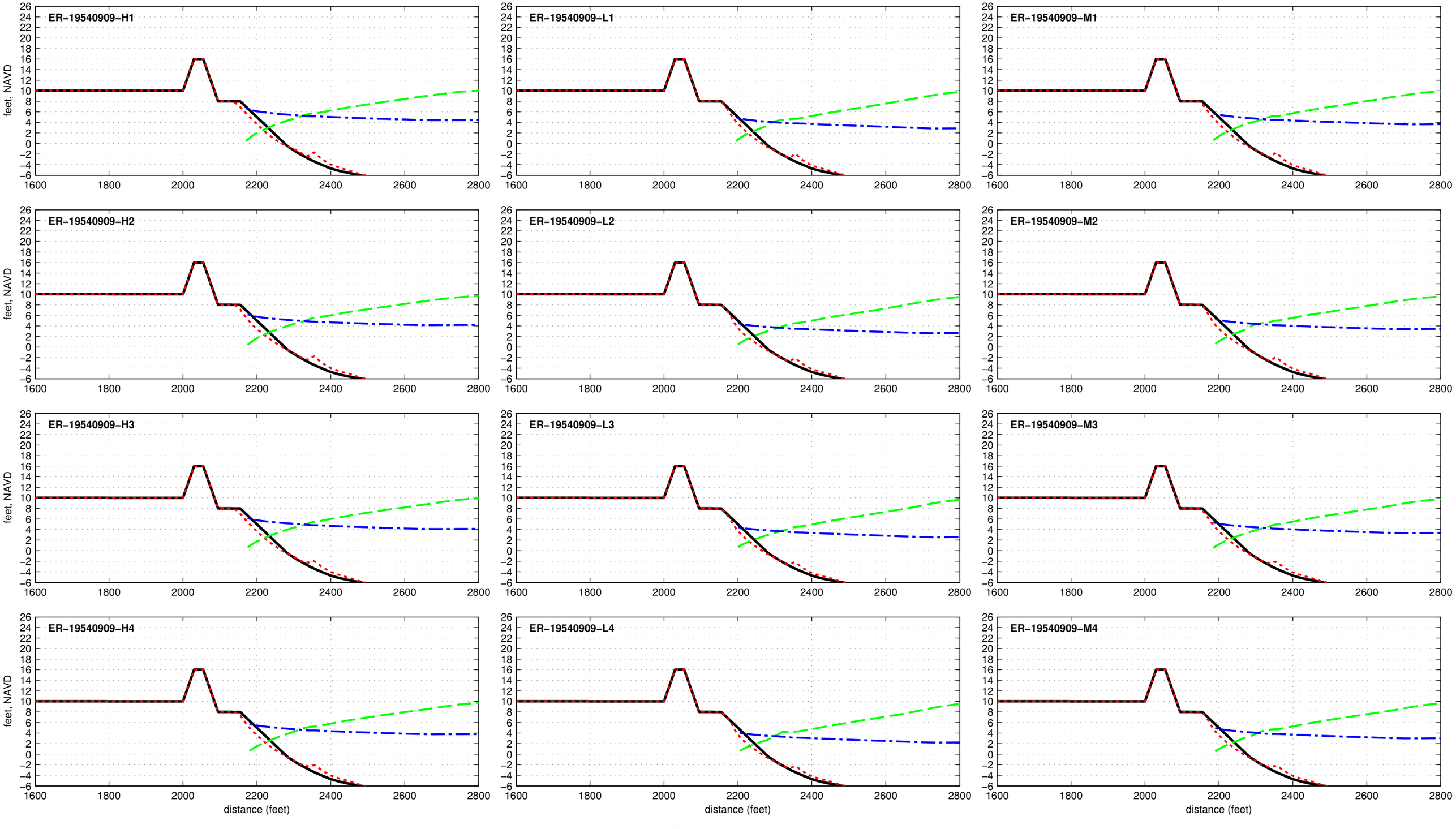


Initial Final Max Hs Max Water Level

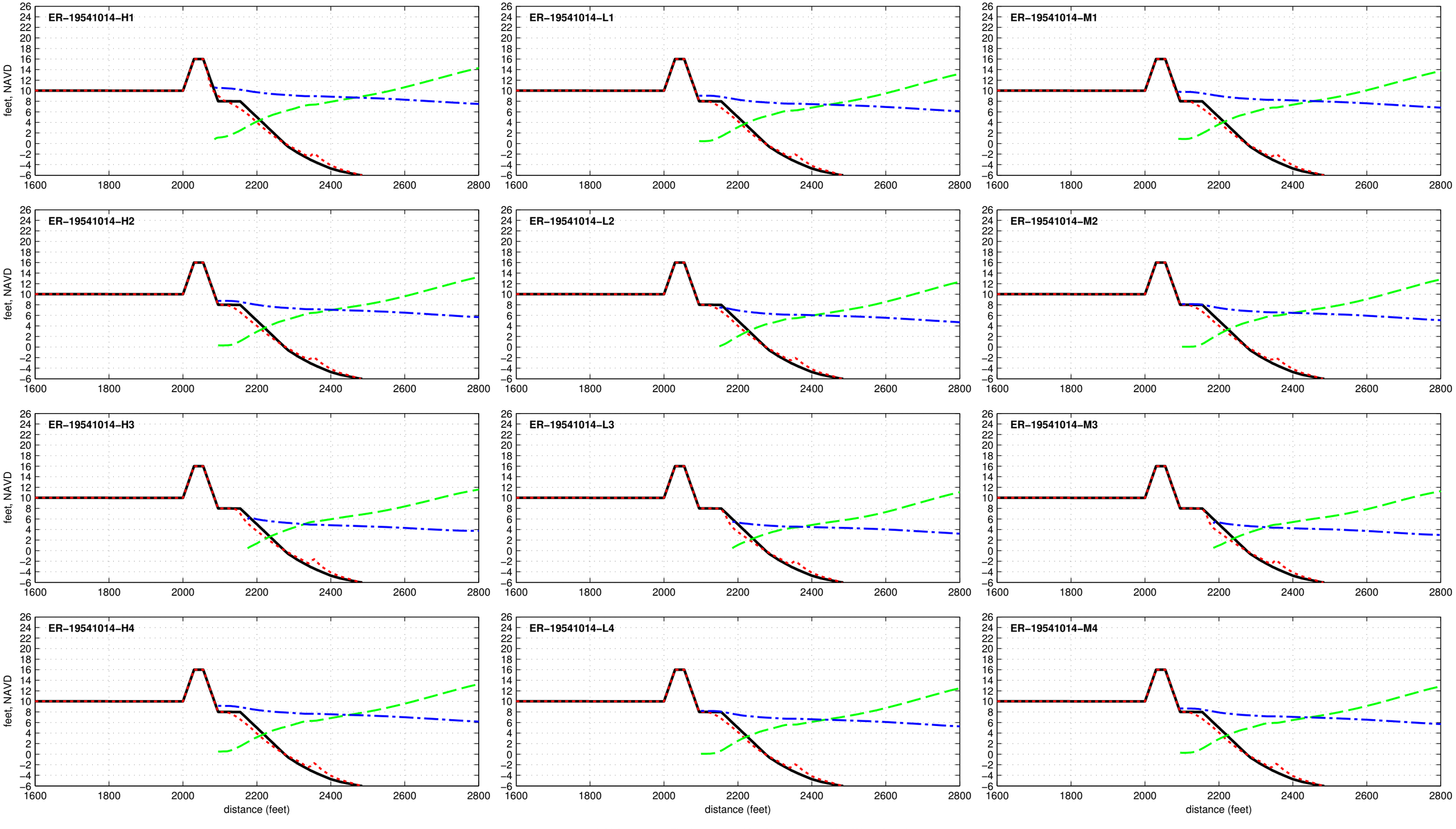
Dune R2T1-16.0-025-060 - ER-19540827



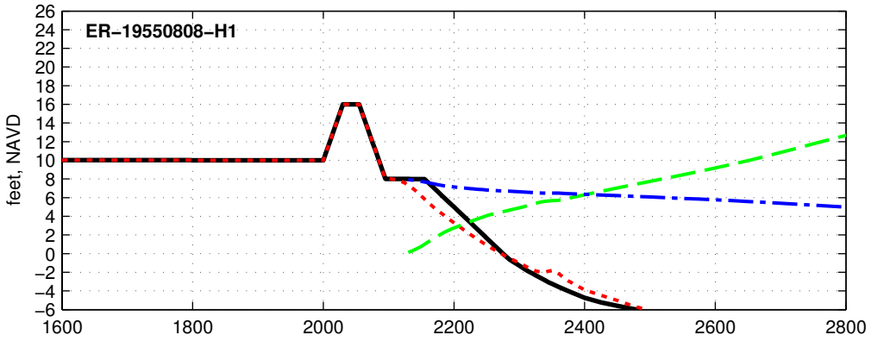
Dune R2T1-16.0-025-060 - ER-19540909

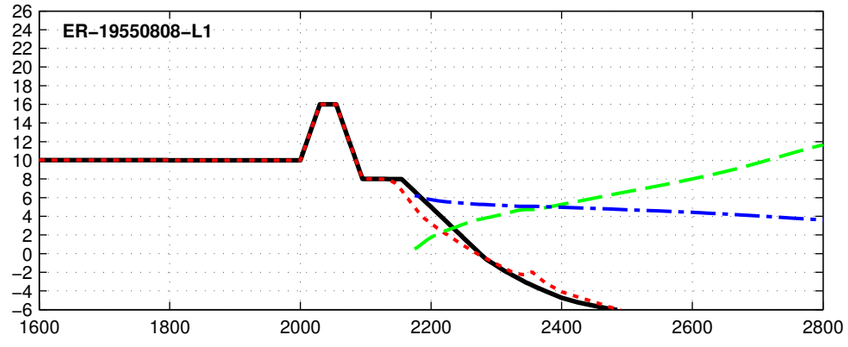


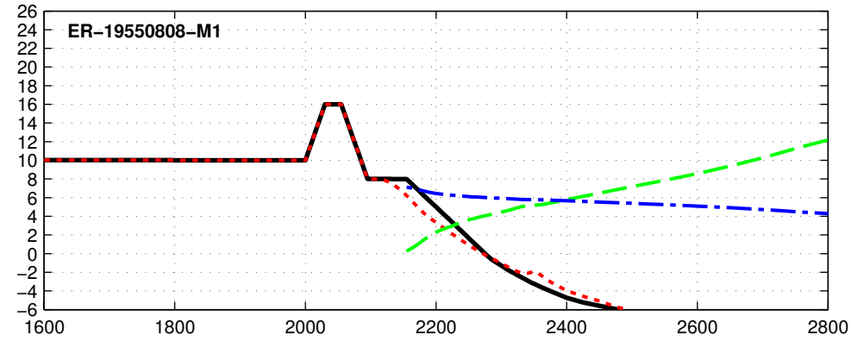
Dune R2T1-16.0-025-060 - ER-19541014

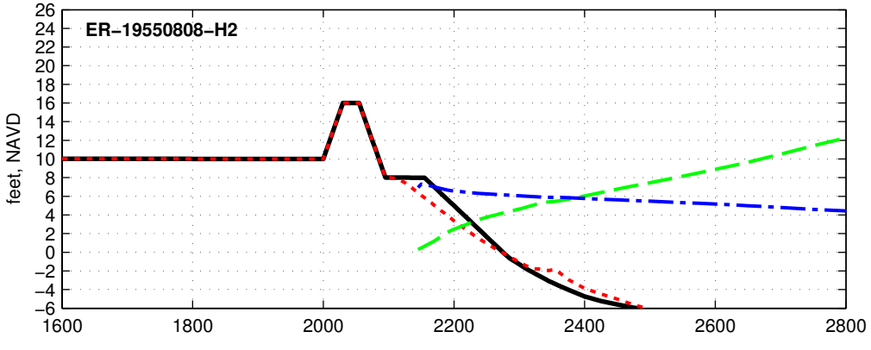


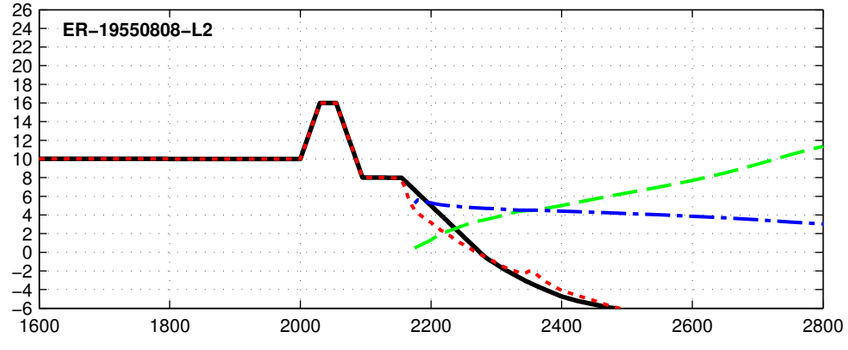
Dune R2T1-16.0-025-060 - ER-19550808

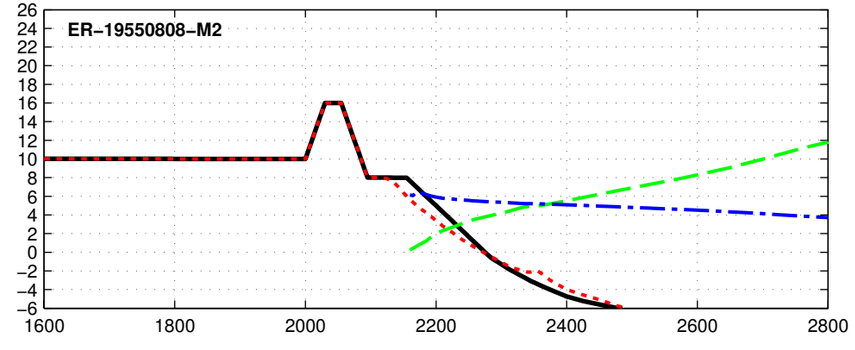


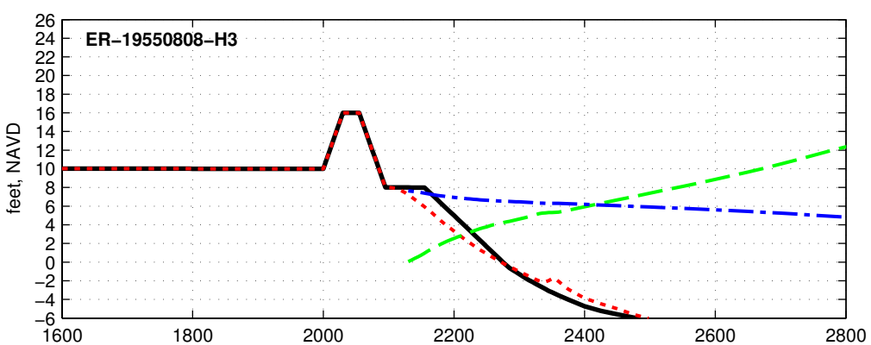


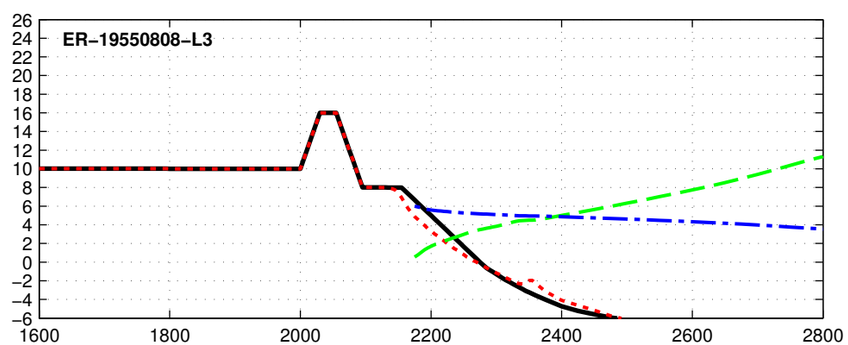


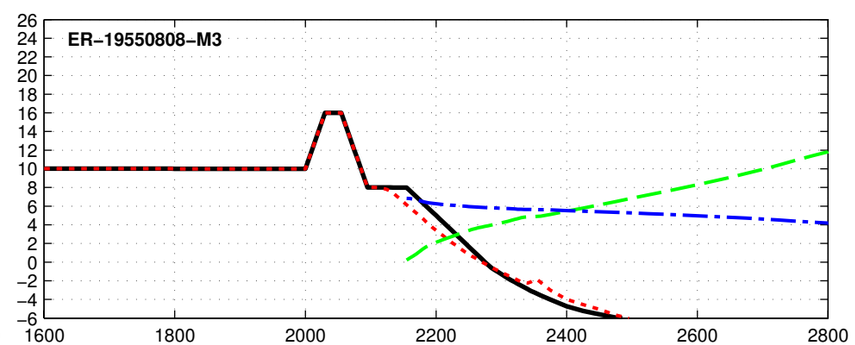


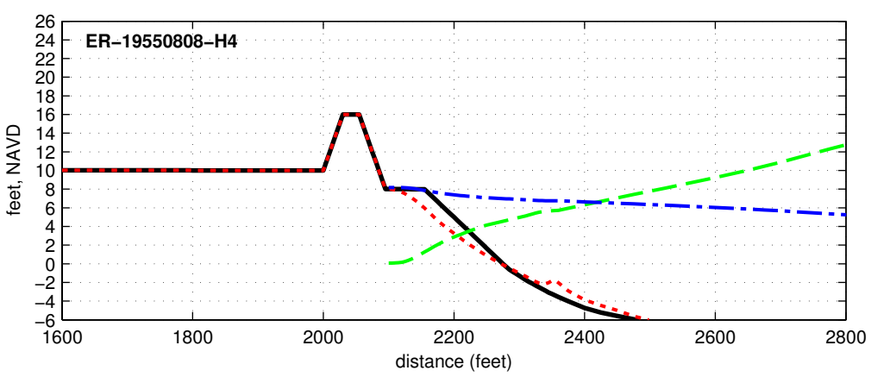


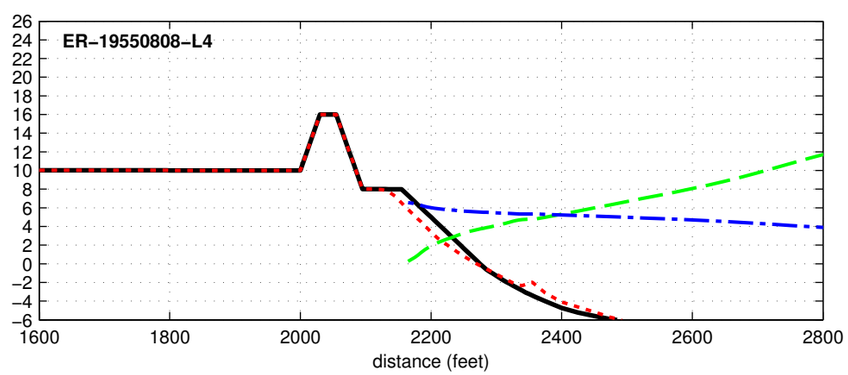


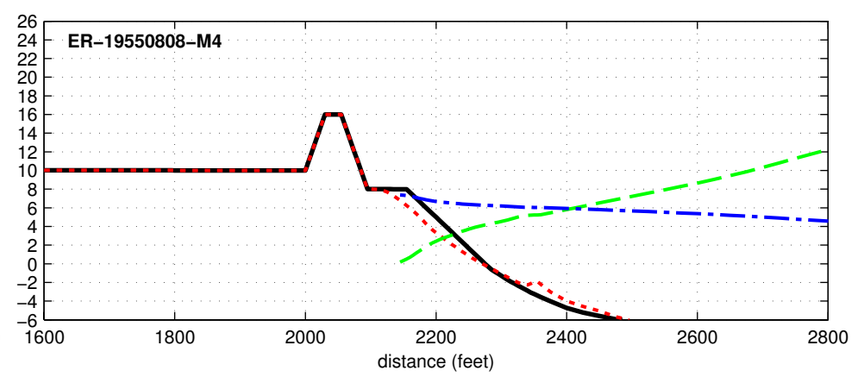






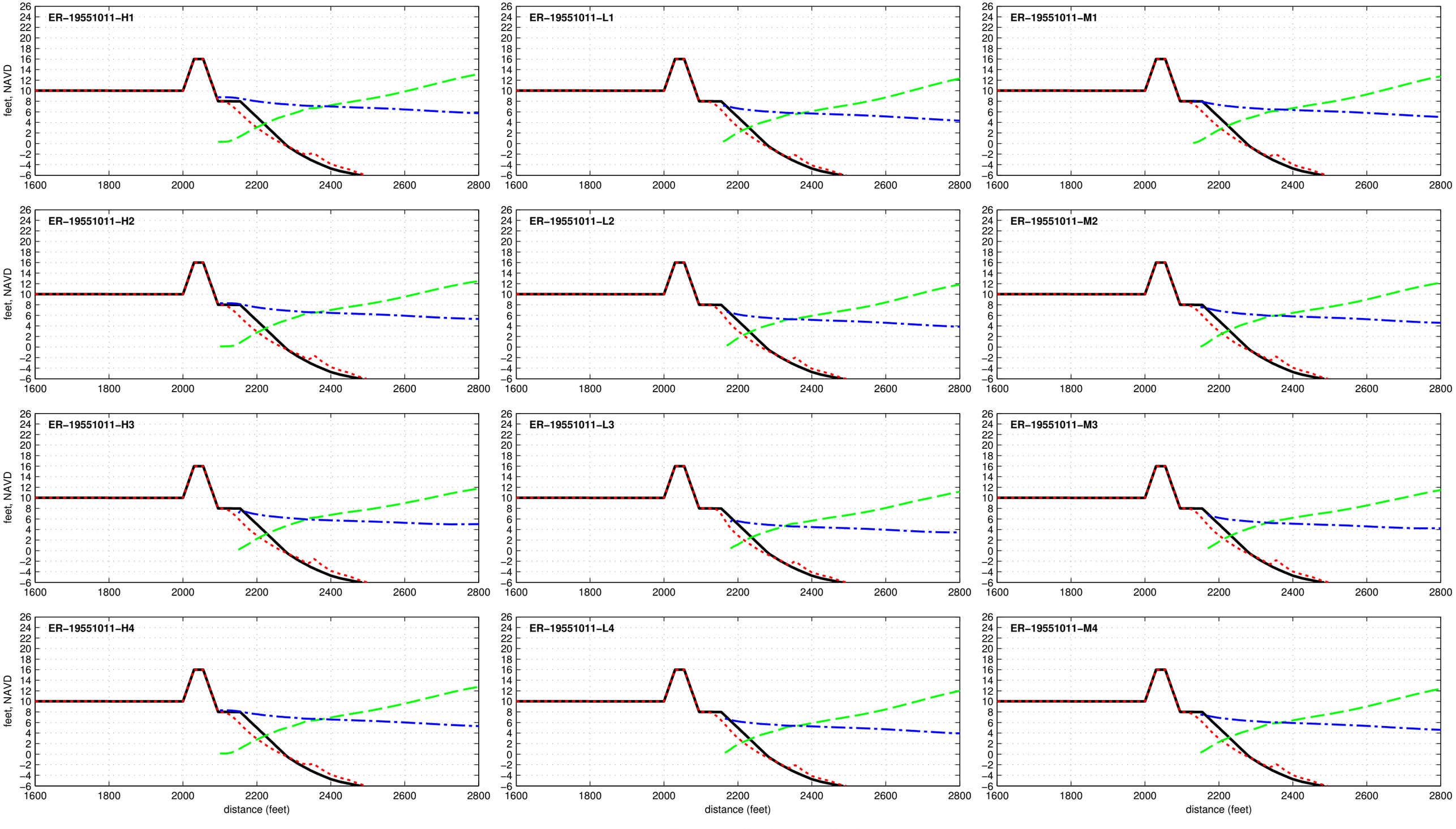




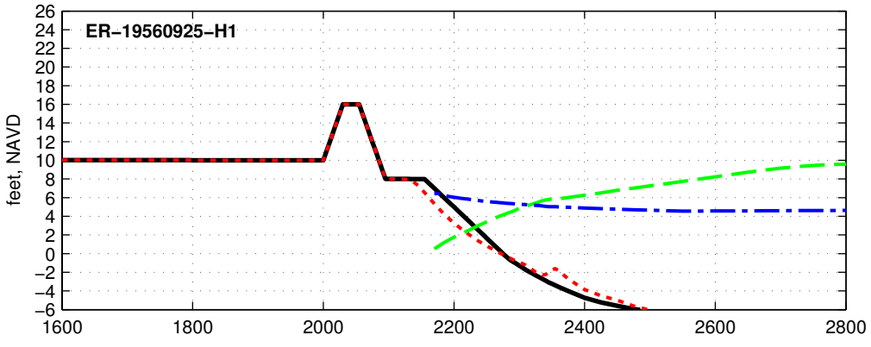


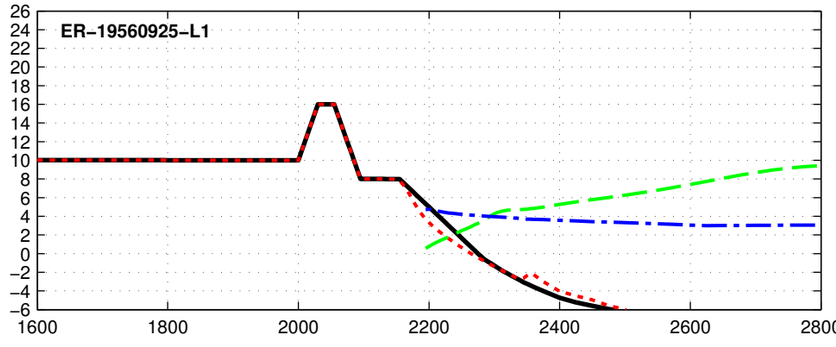
Initial Final Max Hs Max Water Level

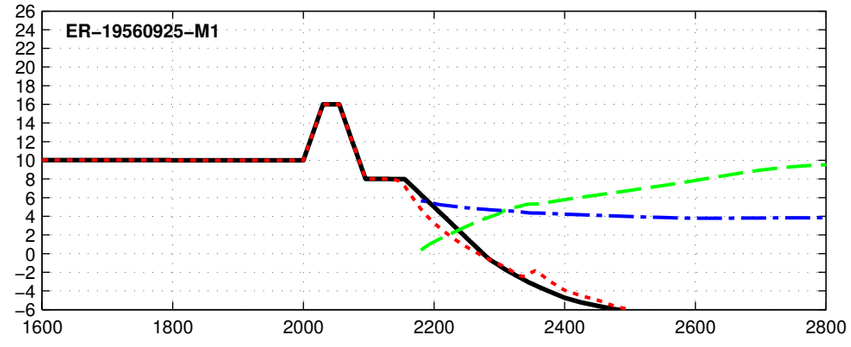
Dune R2T1-16.0-025-060 - ER-19551011

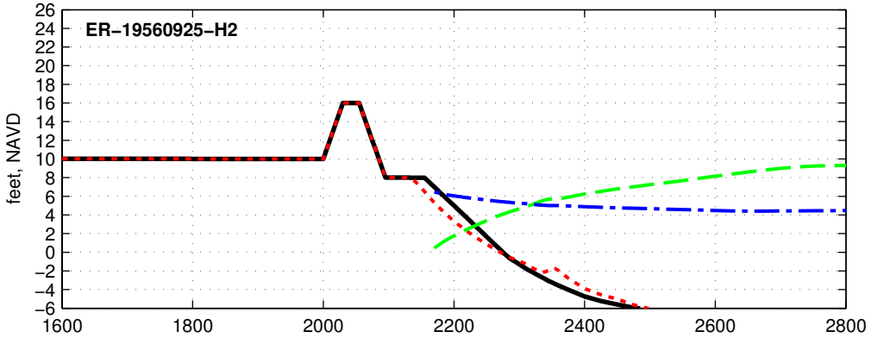


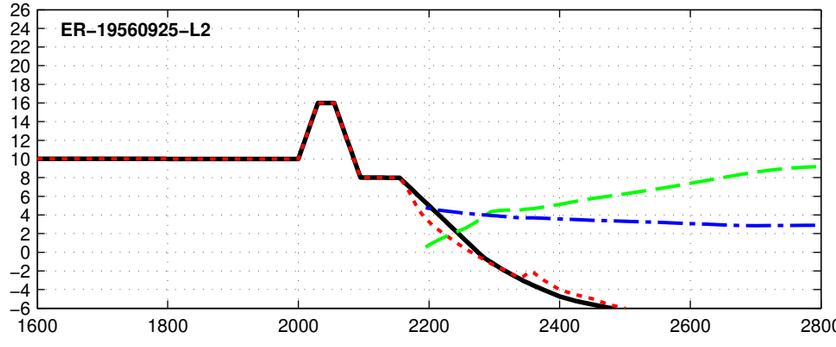
Dune R2T1-16.0-025-060 - ER-19560925

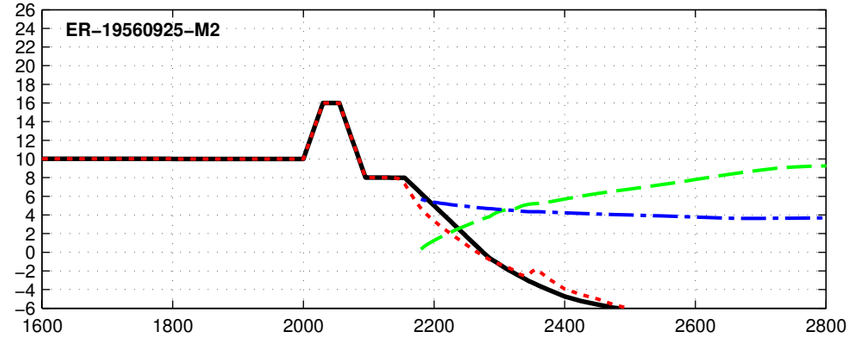


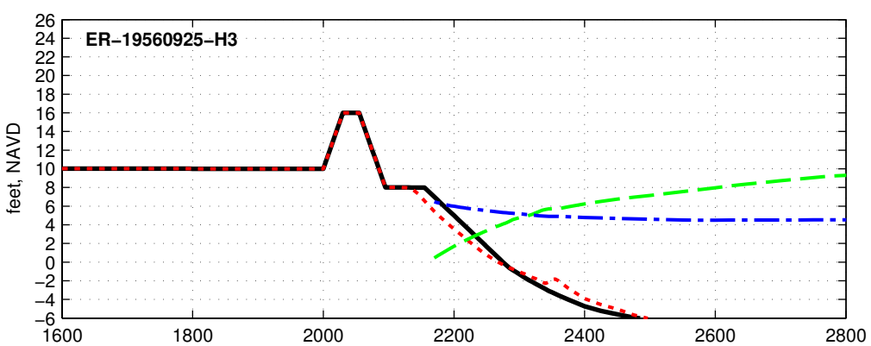


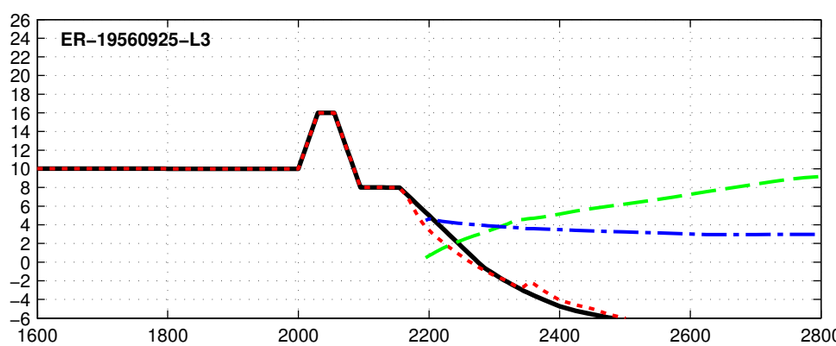


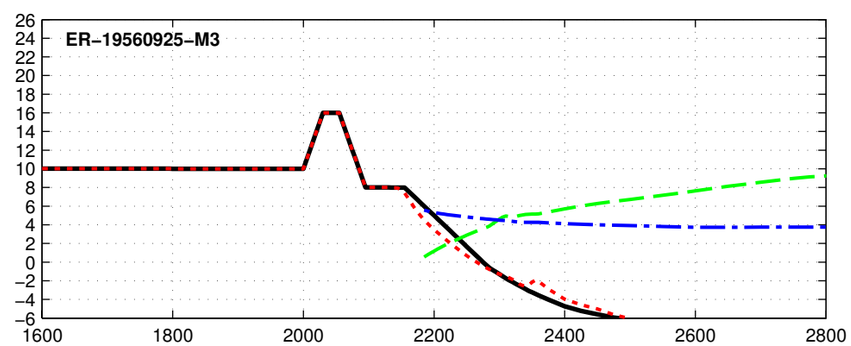


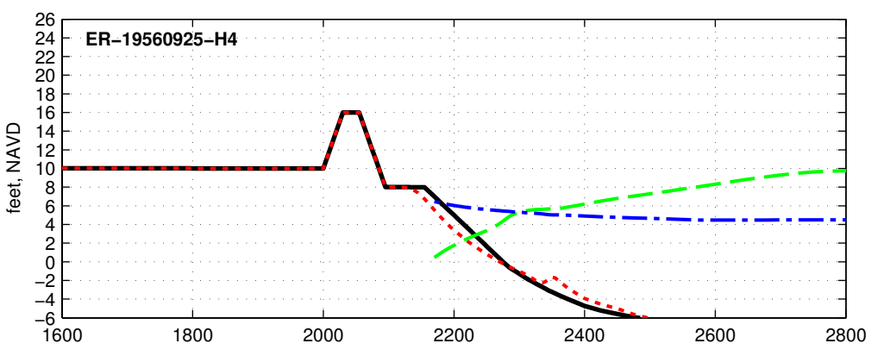


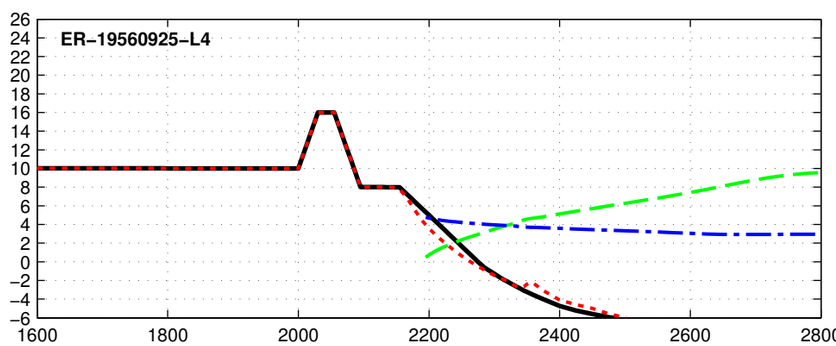


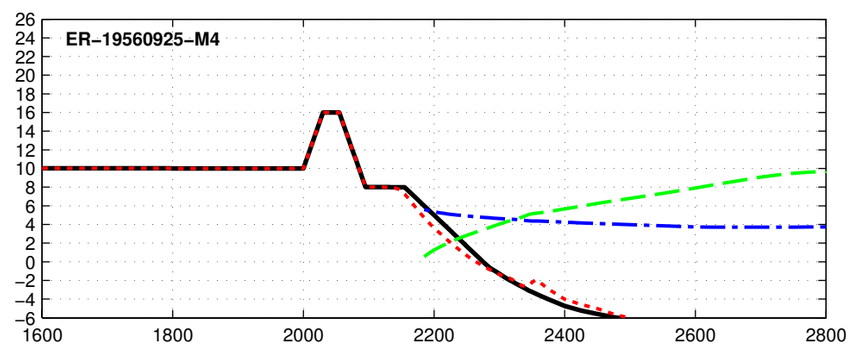










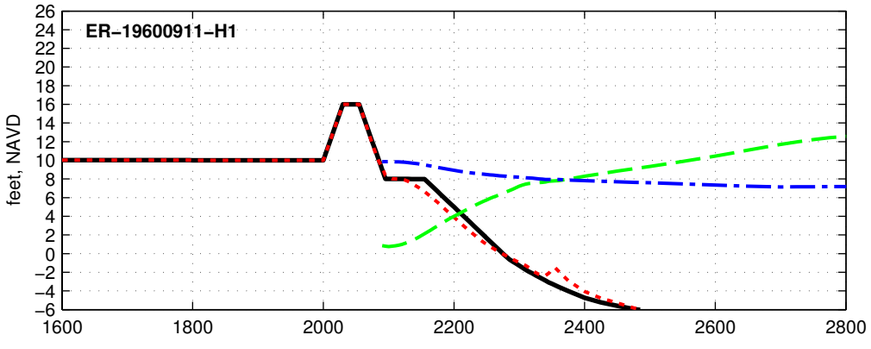


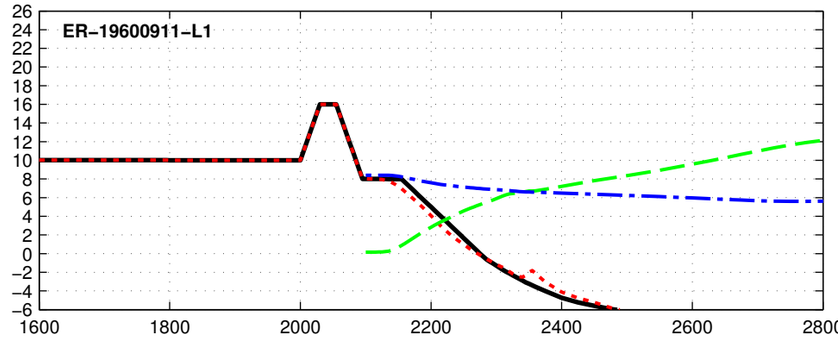
feet, NAVD

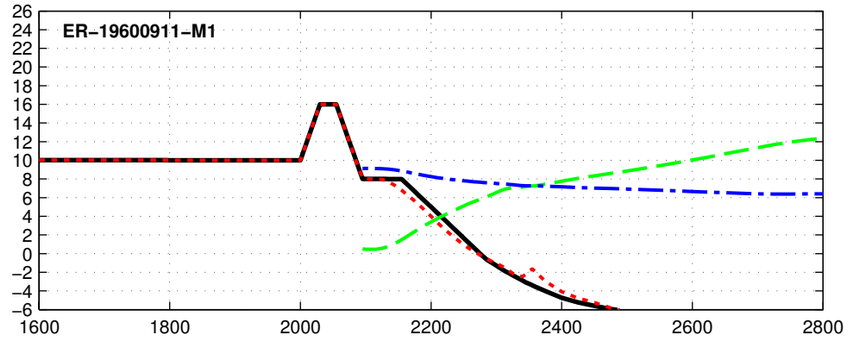
distance (feet)

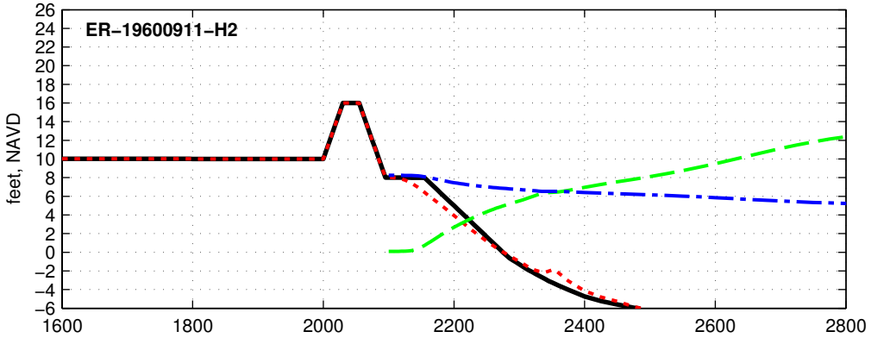
Initial Final Max Hs Max Water Level

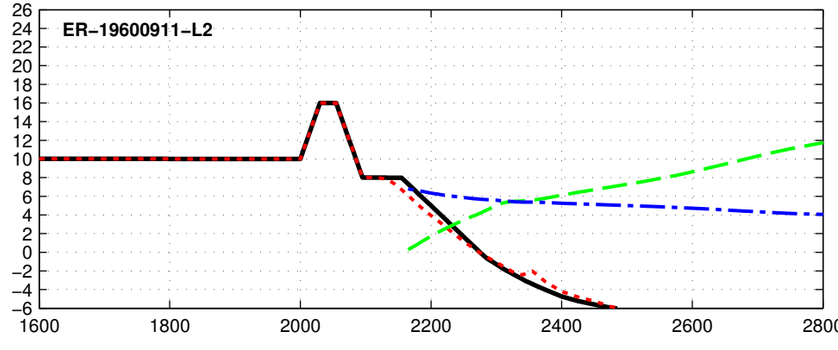
Dune R2T1-16.0-025-060 - ER-19600911

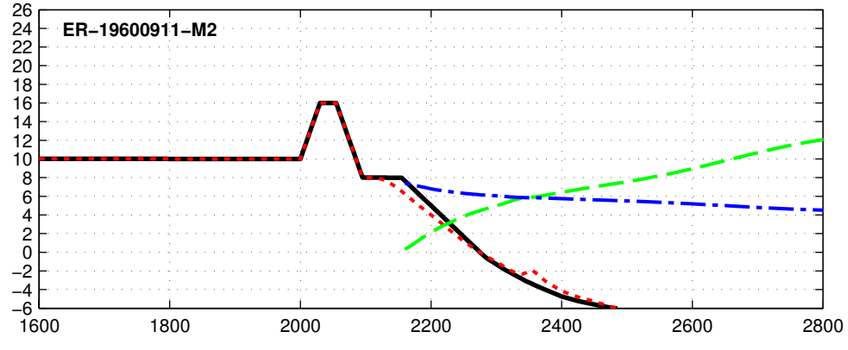


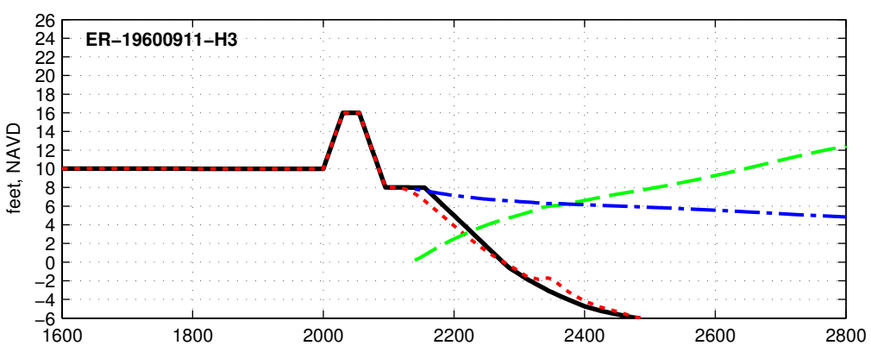


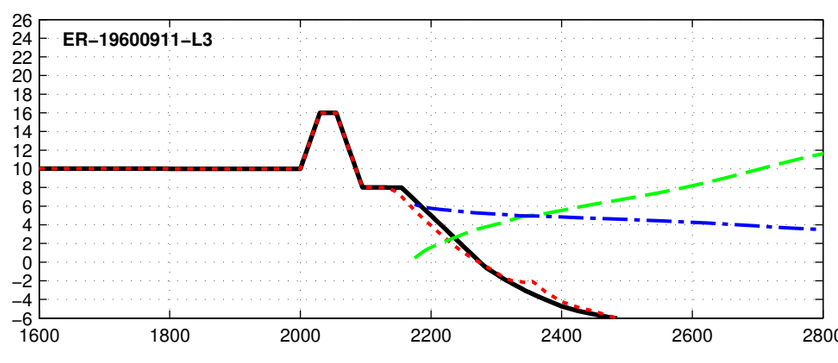


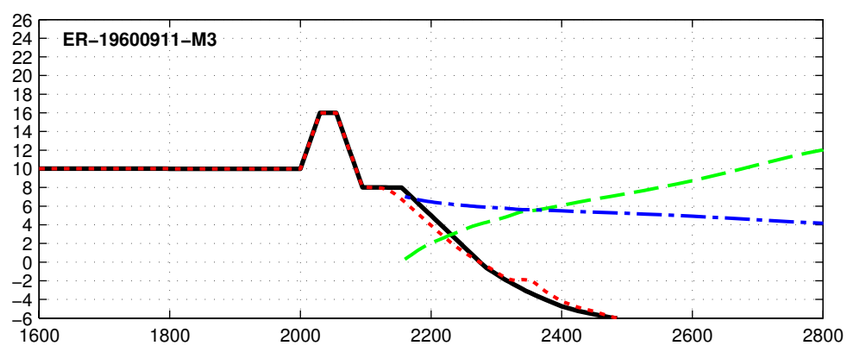


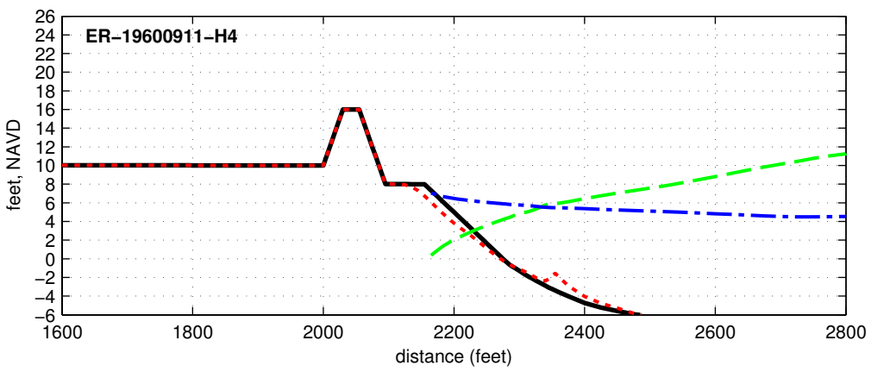


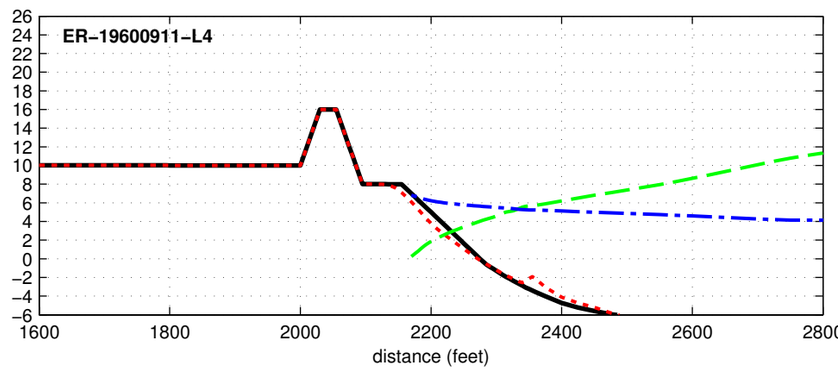


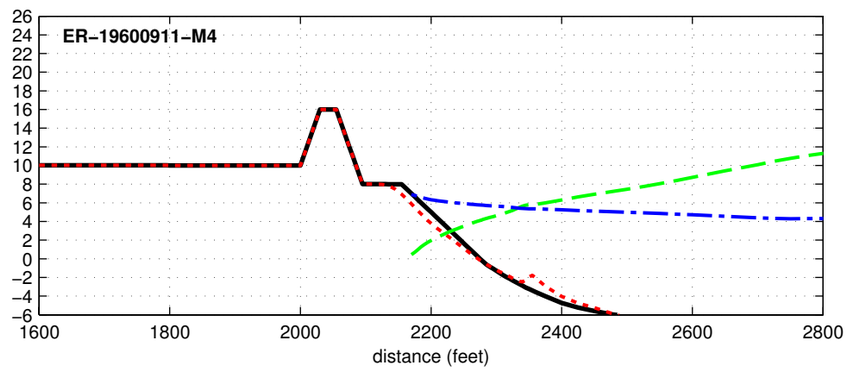






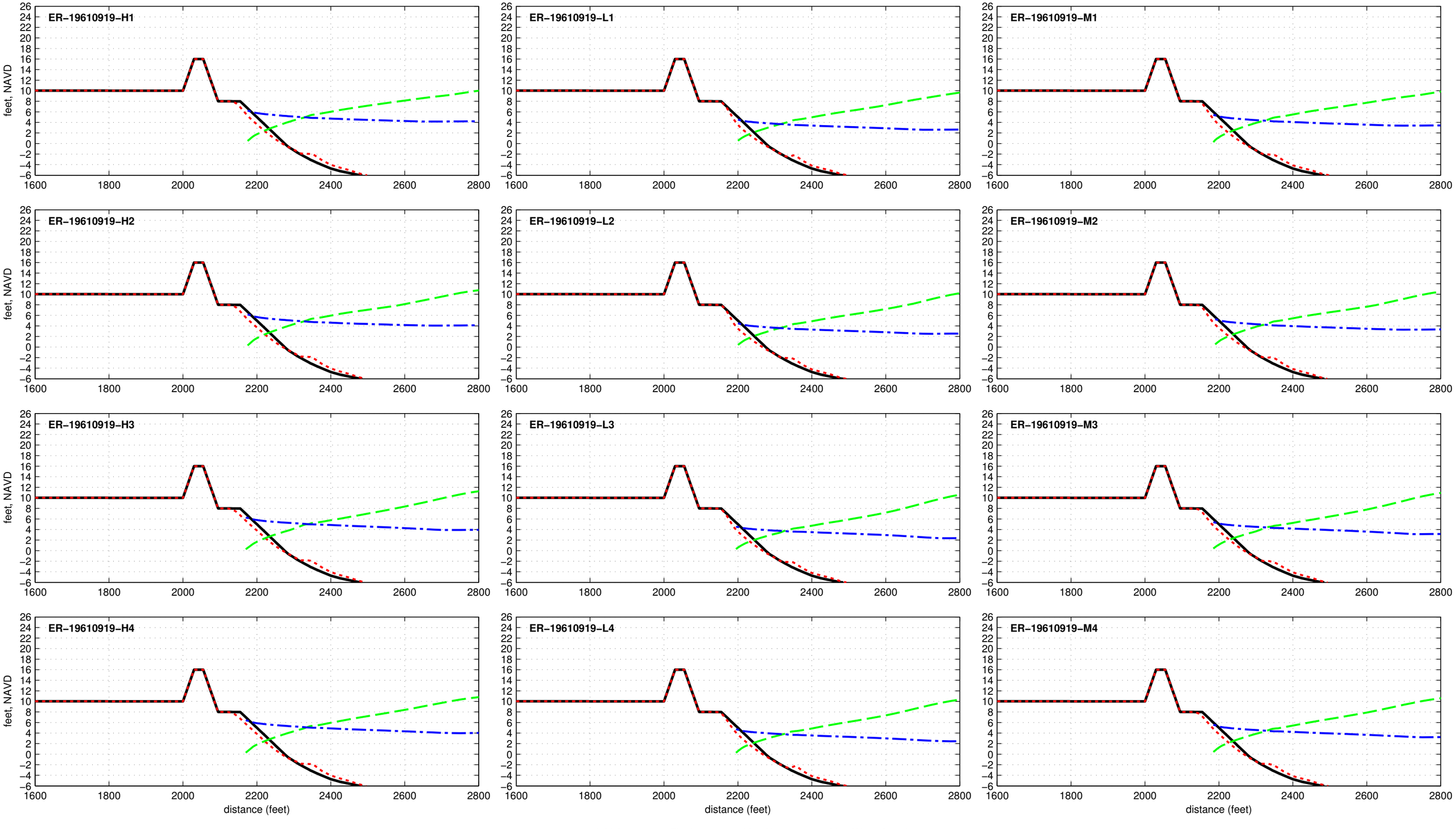




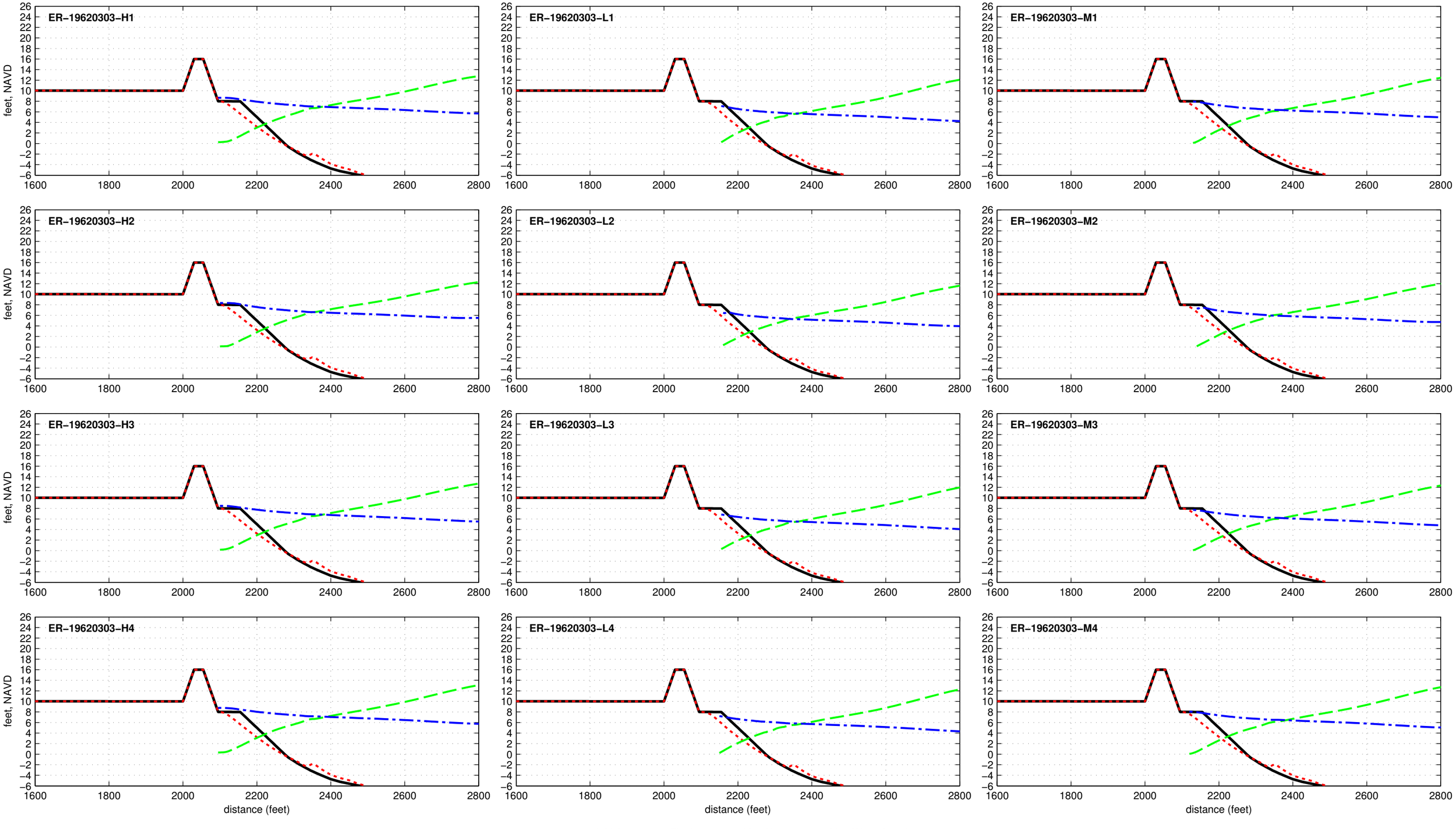


Initial Final Max Hs Max Water Level

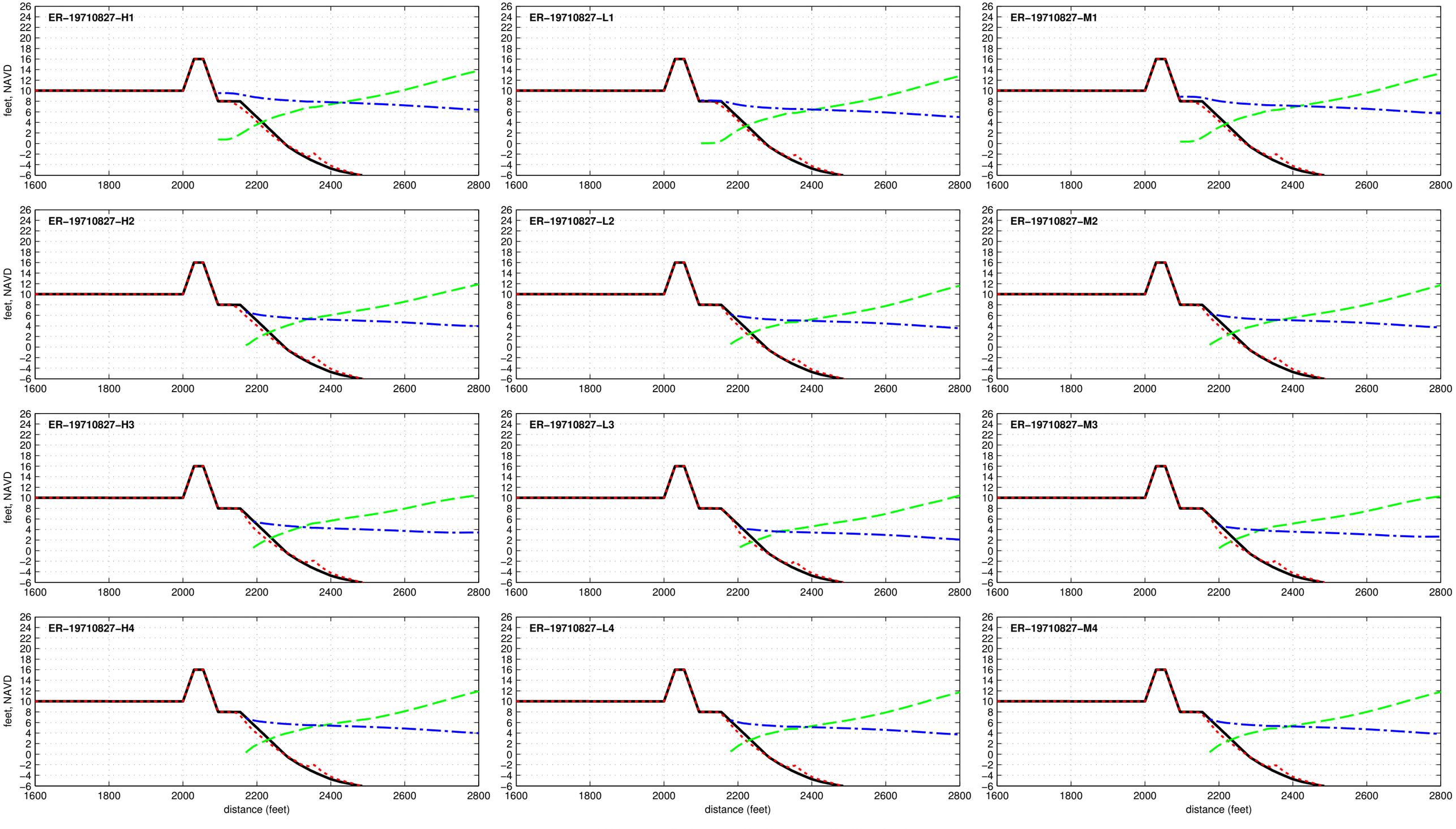
Dune R2T1-16.0-025-060 - ER-19610919



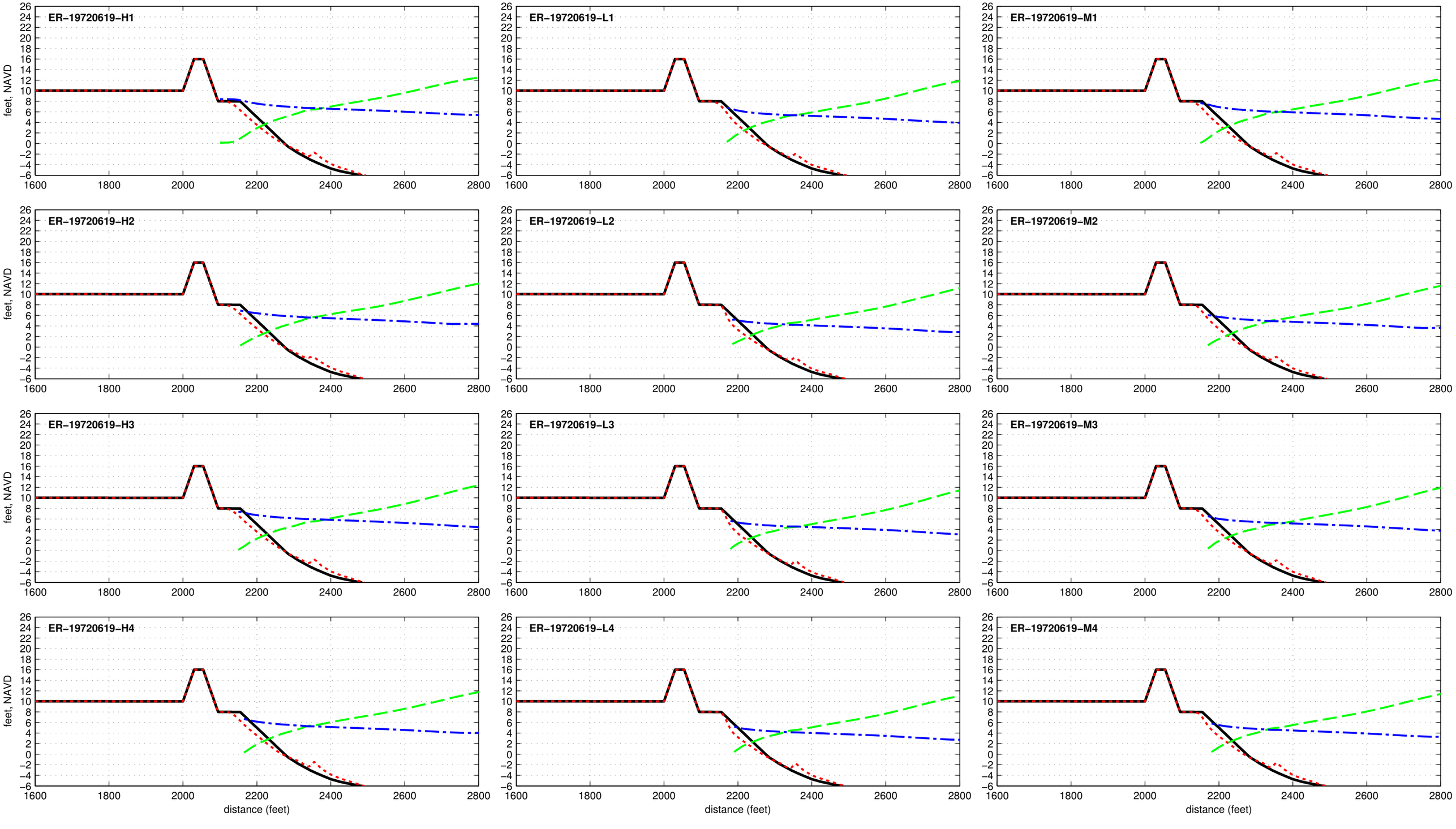
Dune R2T1-16.0-025-060 - ER-19620303



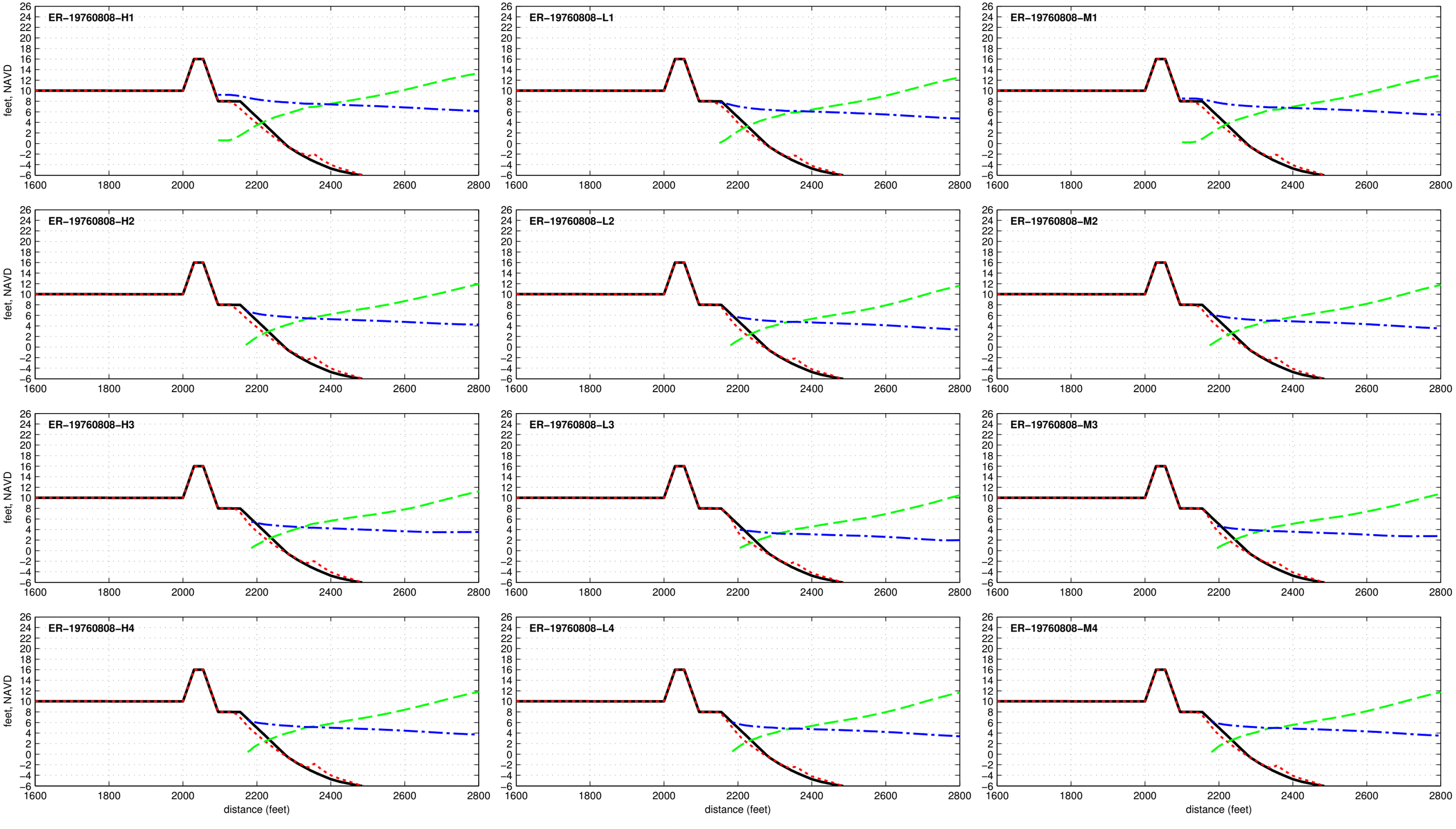
Dune R2T1-16.0-025-060 - ER-19710827



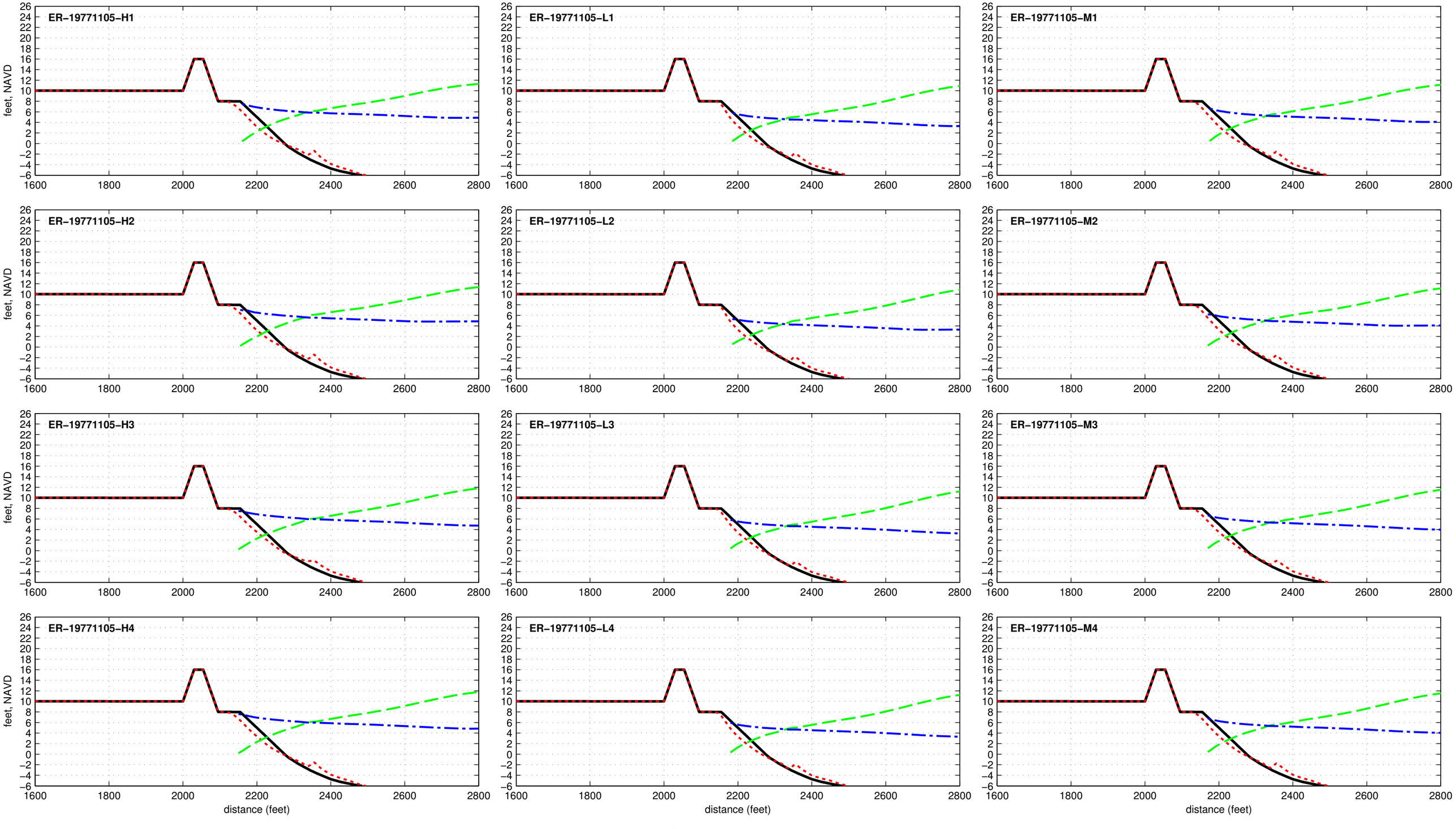
Dune R2T1-16.0-025-060 - ER-19720619



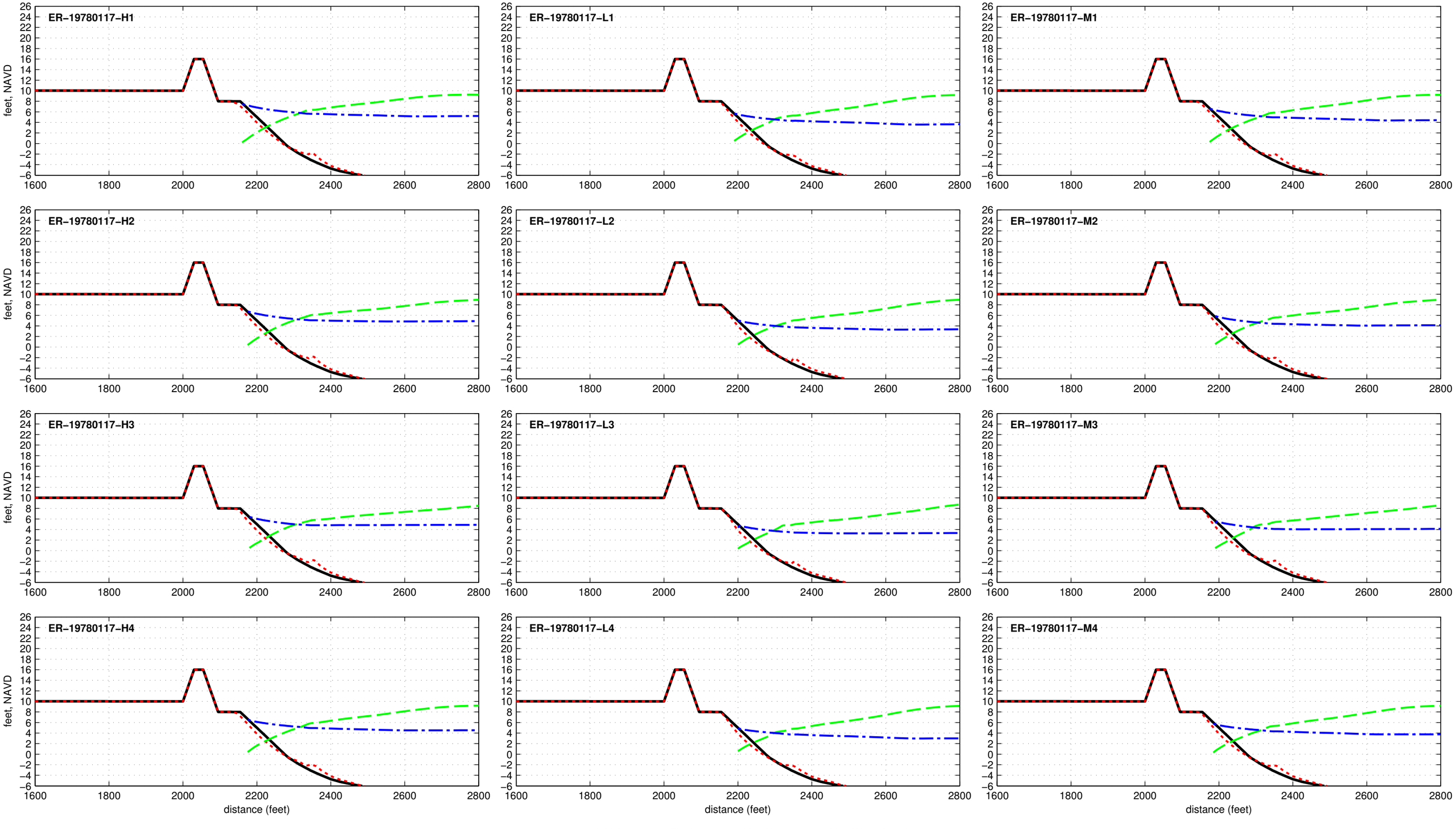
Dune R2T1-16.0-025-060 - ER-19760808



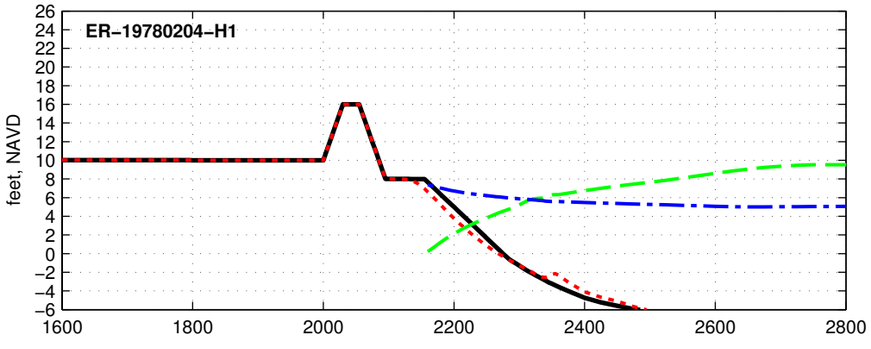
Dune R2T1-16.0-025-060 - ER-19771105

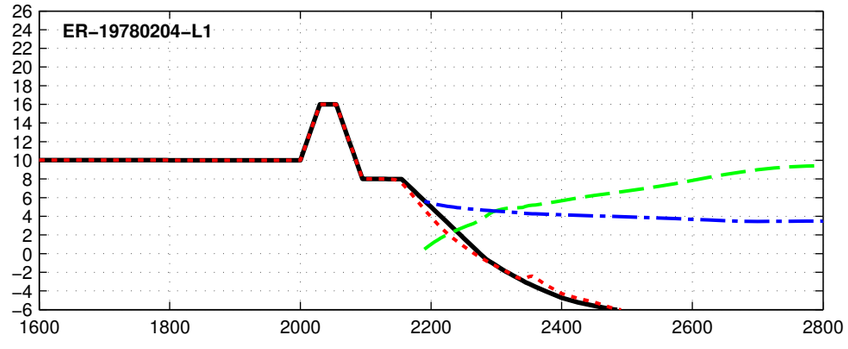


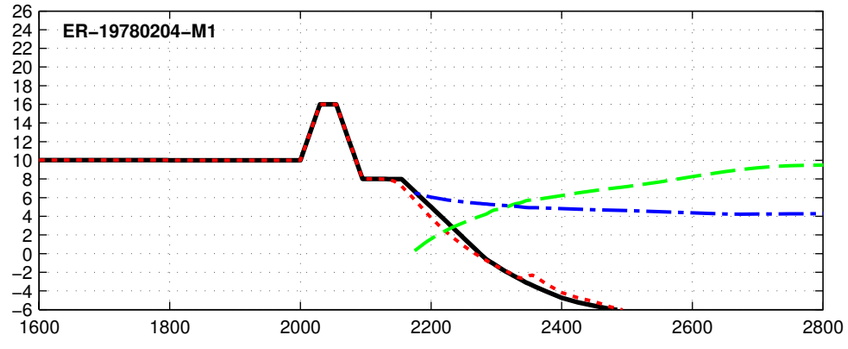
Dune R2T1-16.0-025-060 - ER-19780117

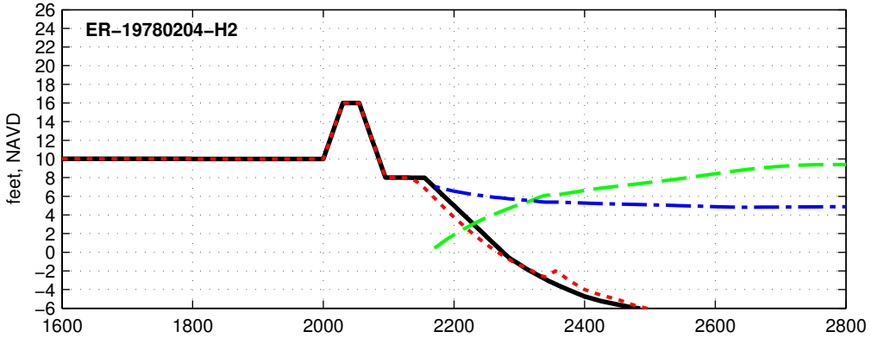


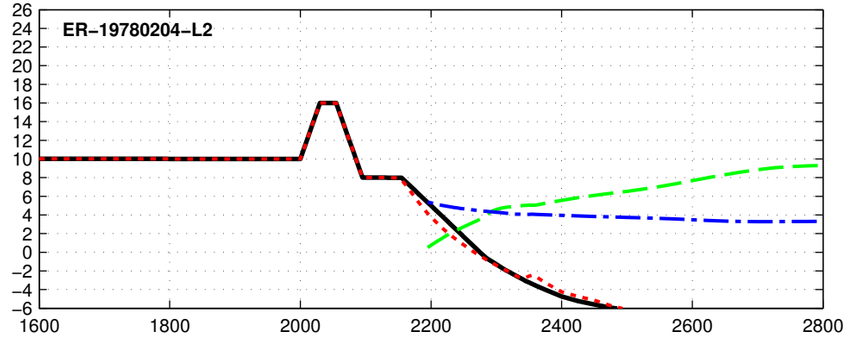
Dune R2T1-16.0-025-060 - ER-19780204

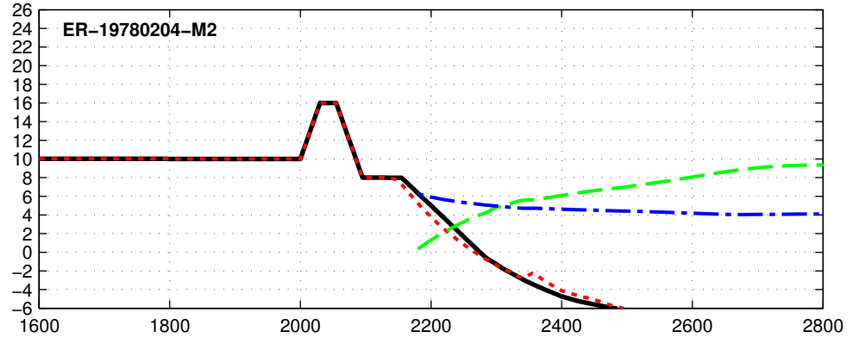


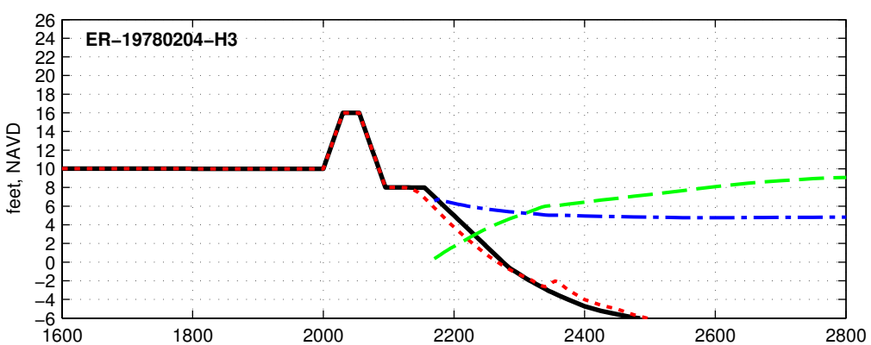


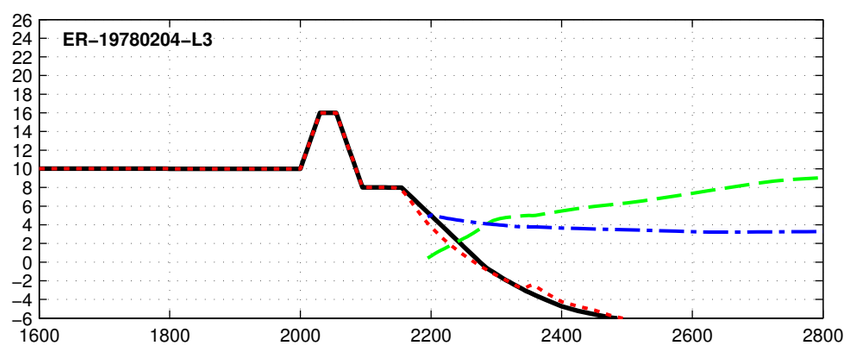


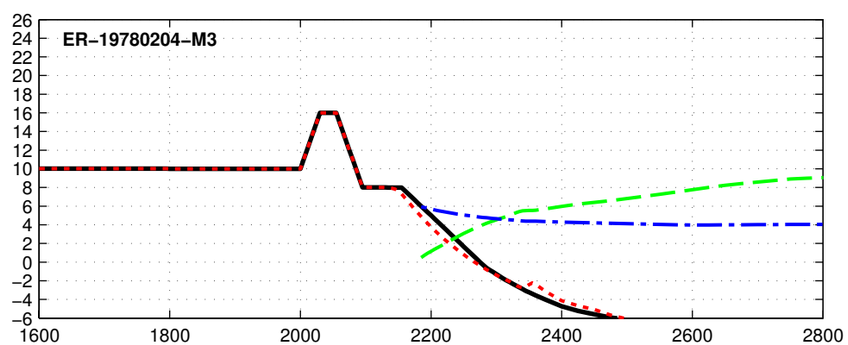


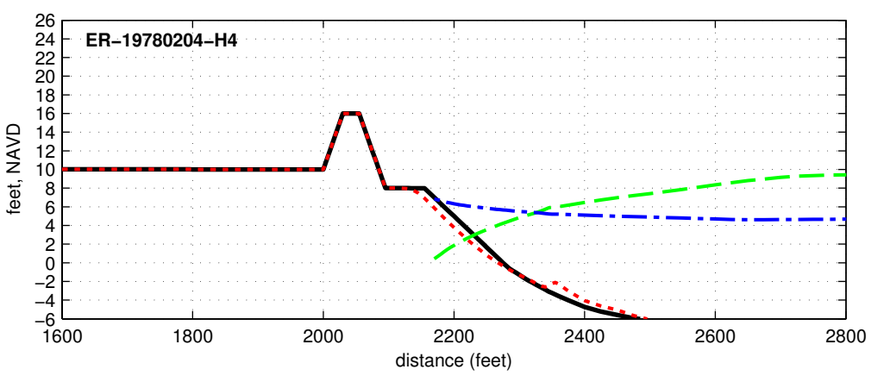


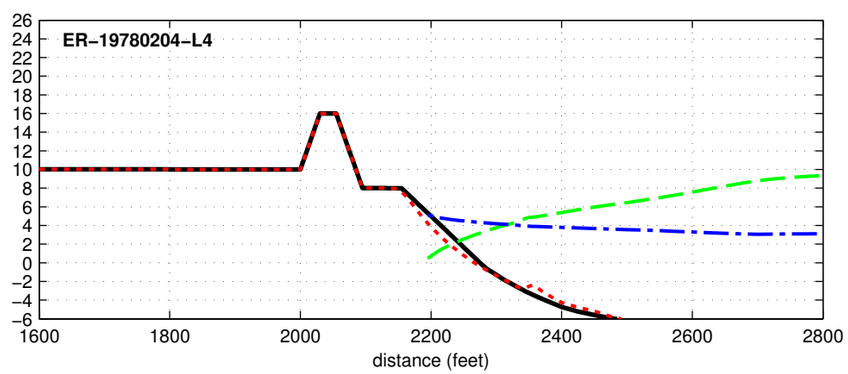


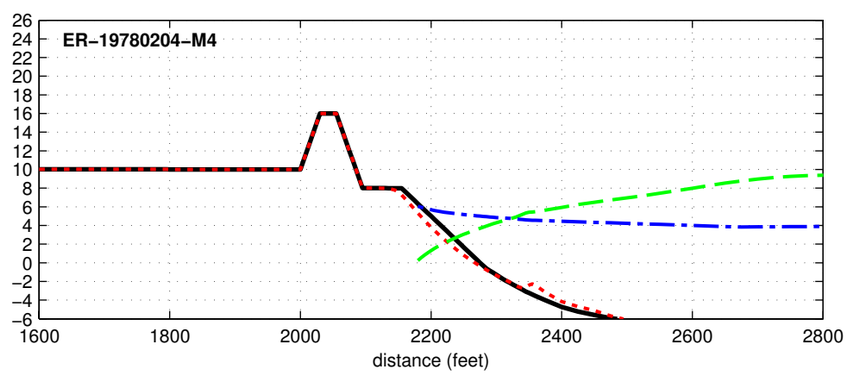






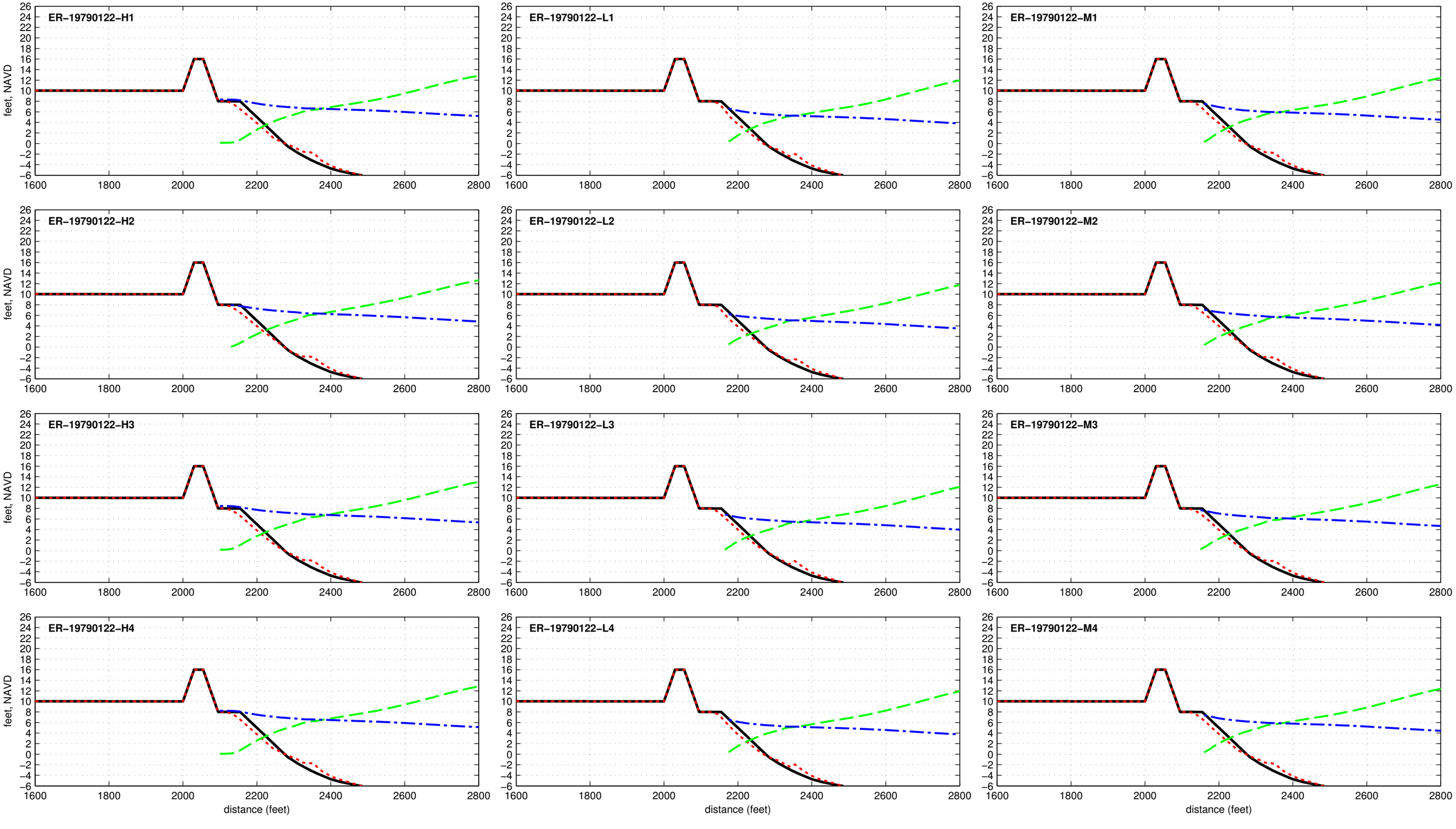




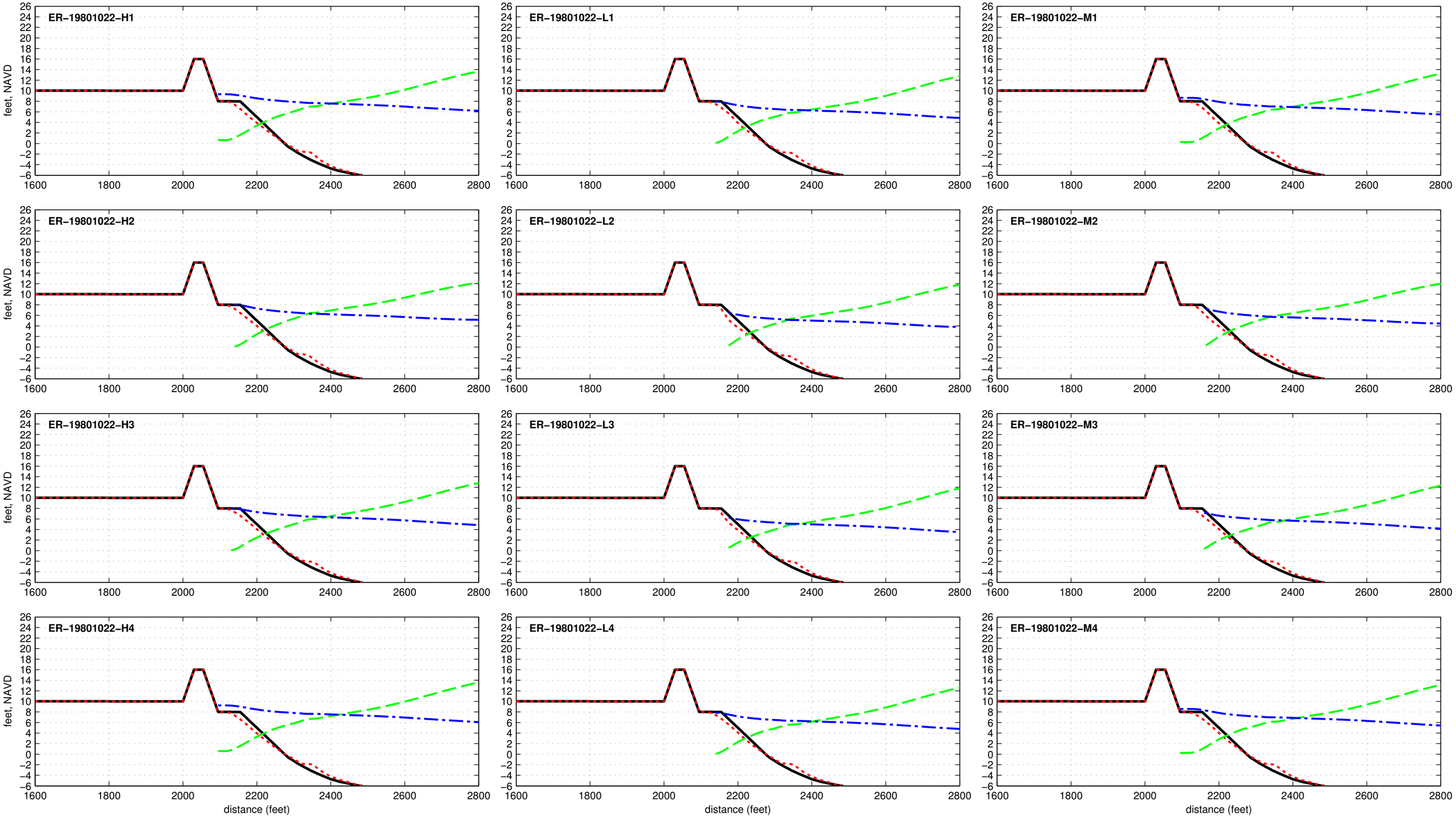


Initial Final Max Hs Max Water Level

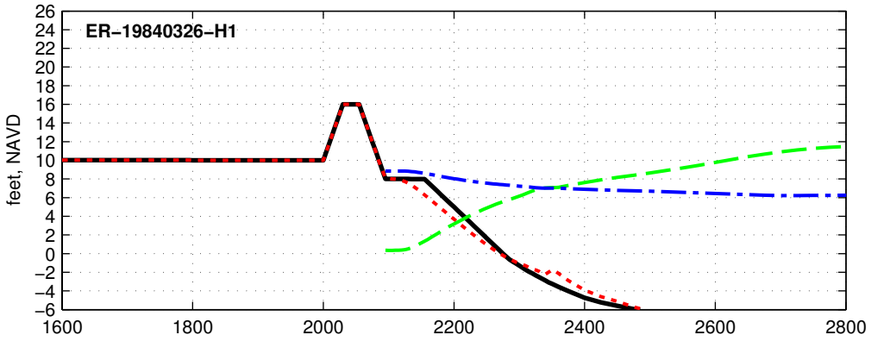
Dune R2T1-16.0-025-060 - ER-19790122

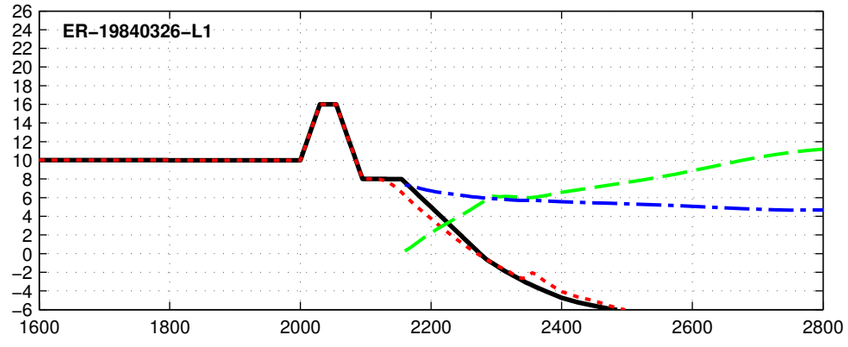


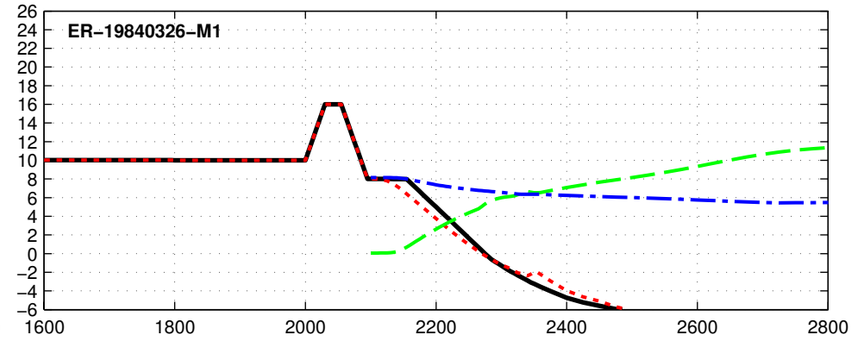
Dune R2T1-16.0-025-060 - ER-19801022

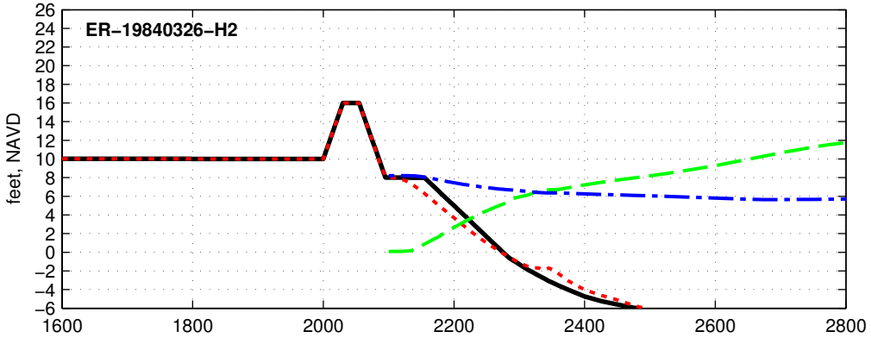


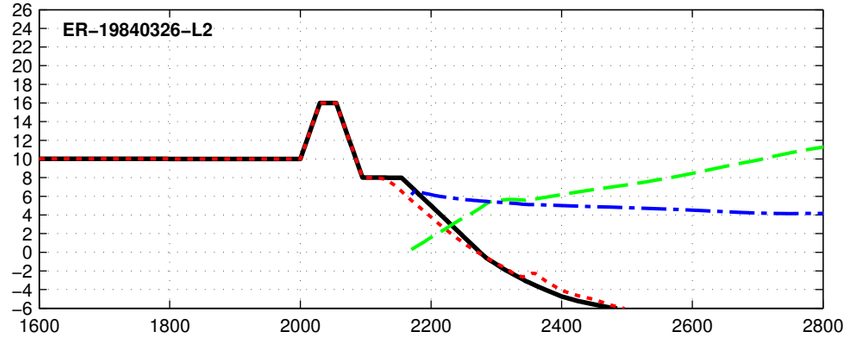
Dune R2T1-16.0-025-060 - ER-19840326

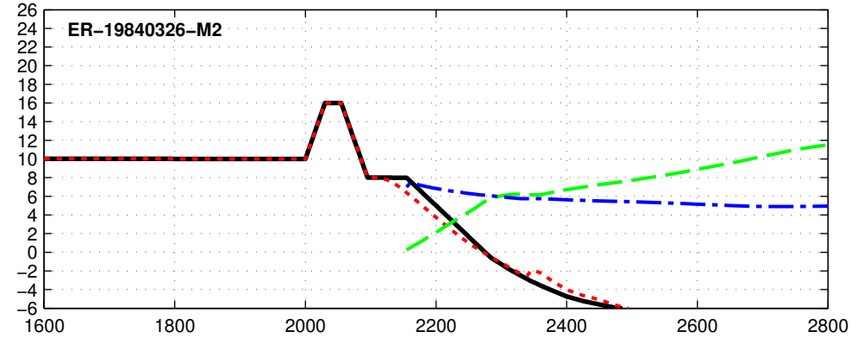


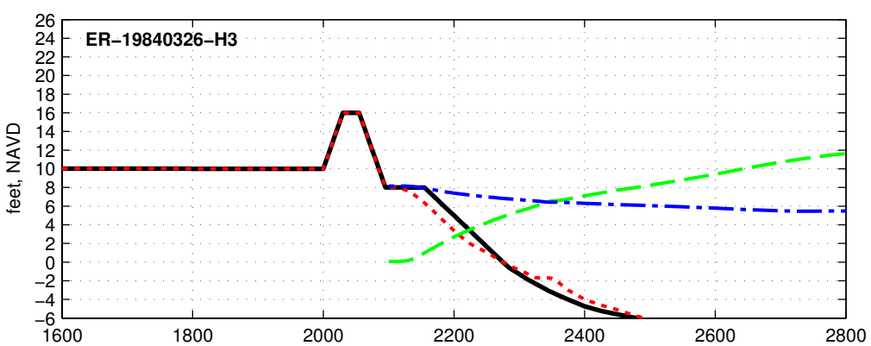


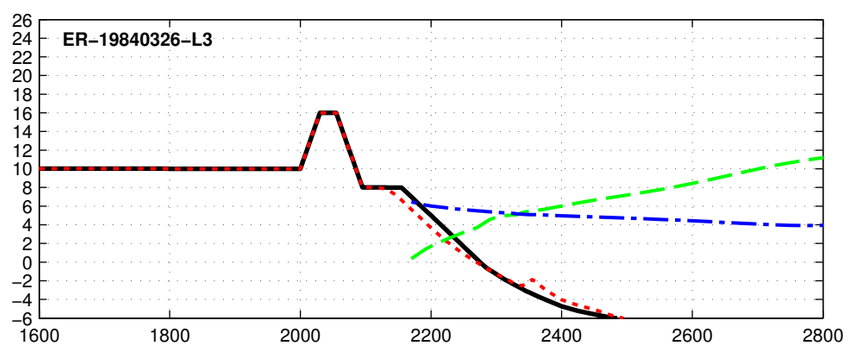


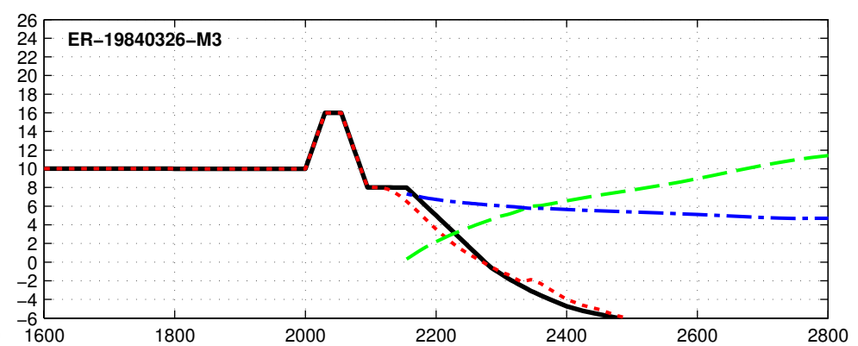


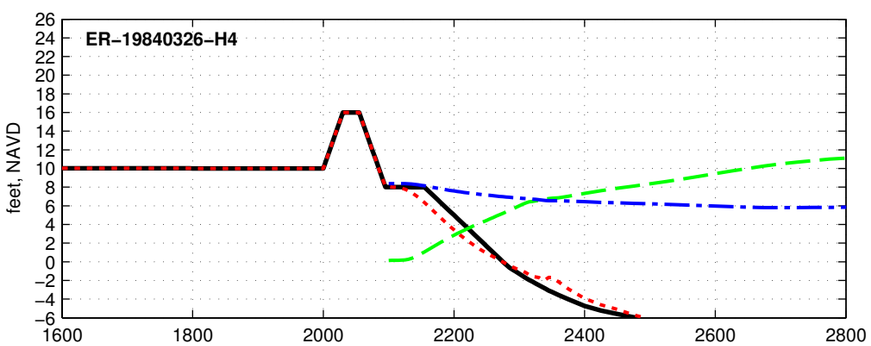


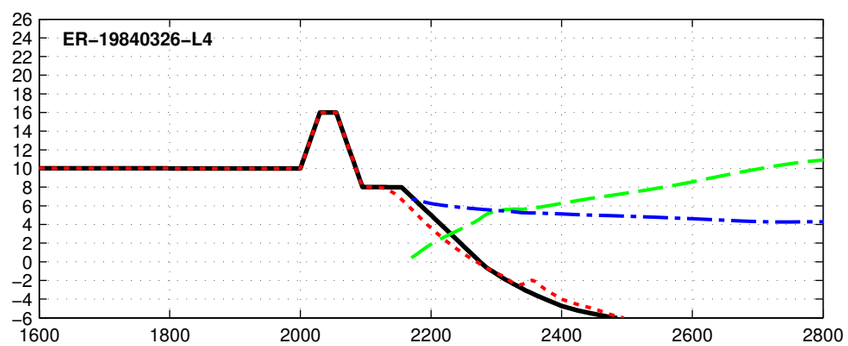


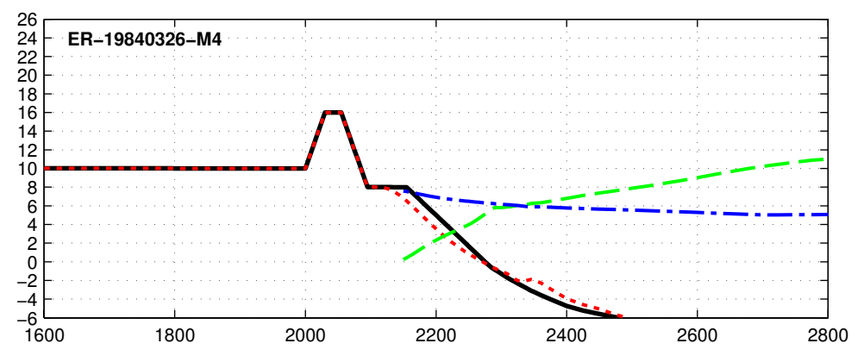






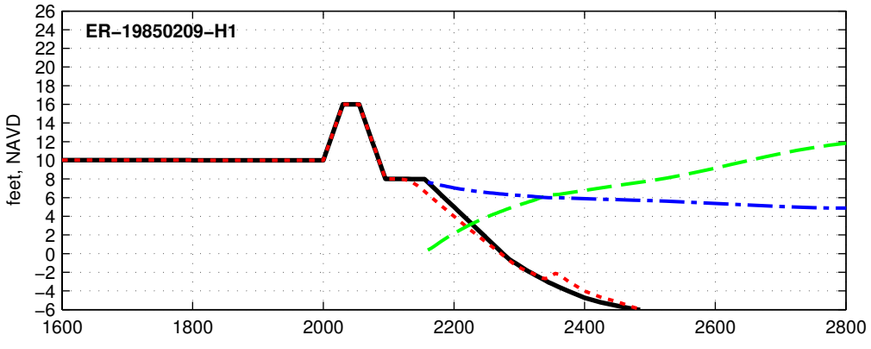


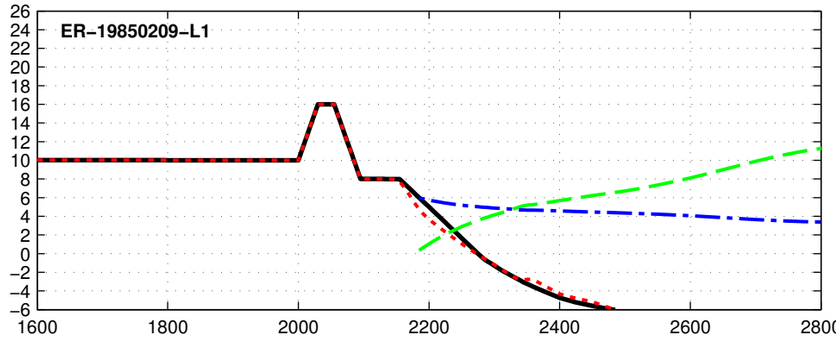


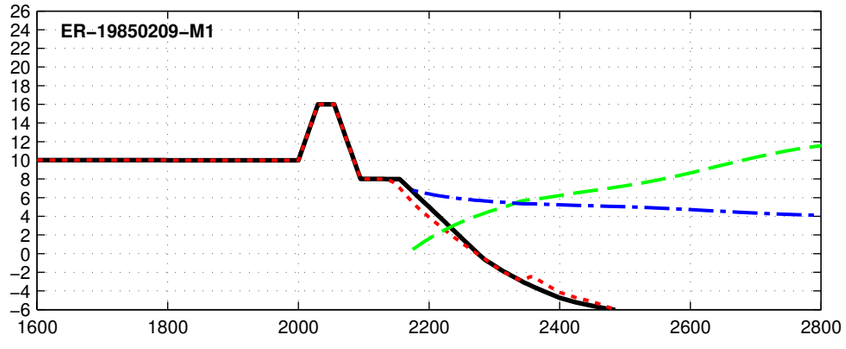


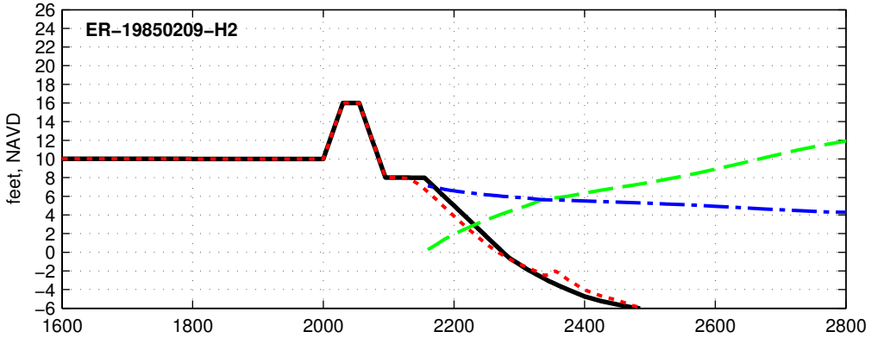
Initial Final Max Hs Max Water Level

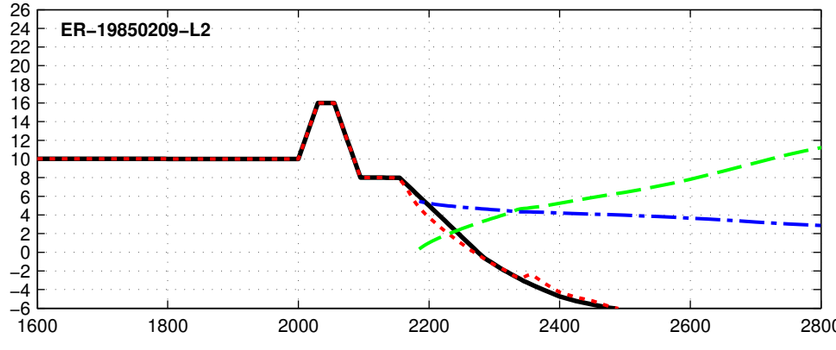
Dune R2T1-16.0-025-060 - ER-19850209

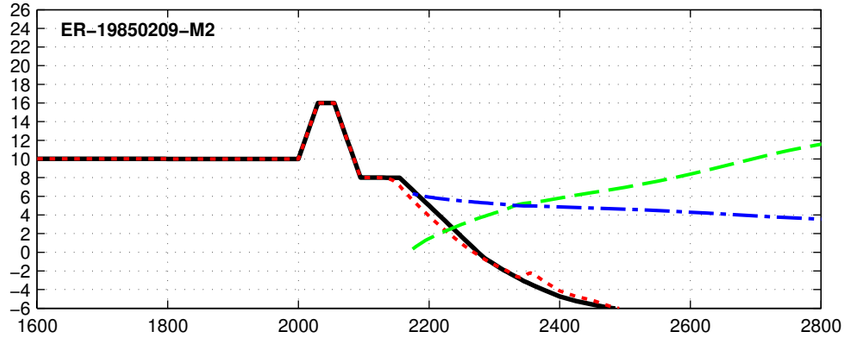


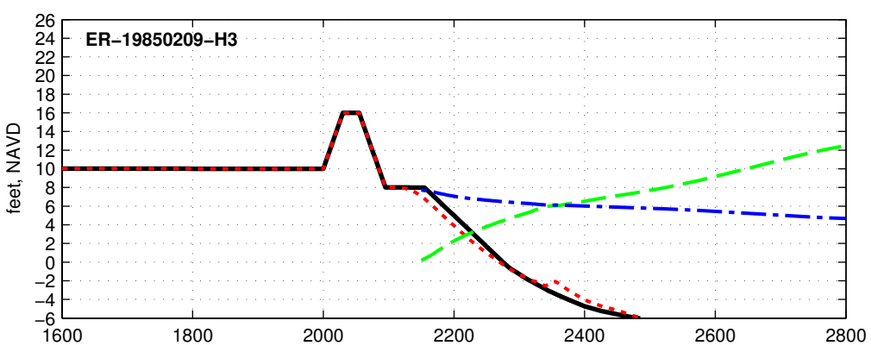


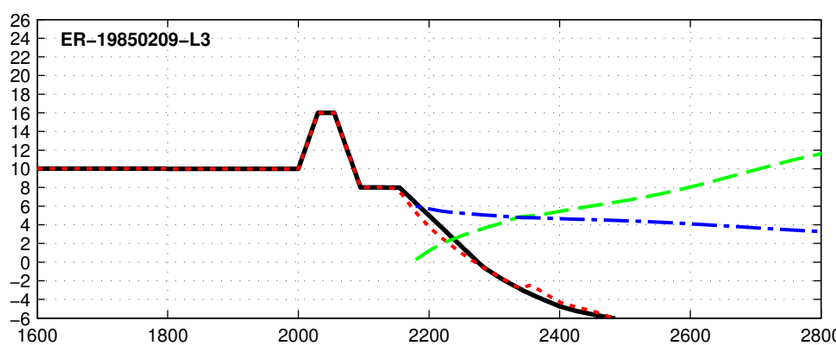


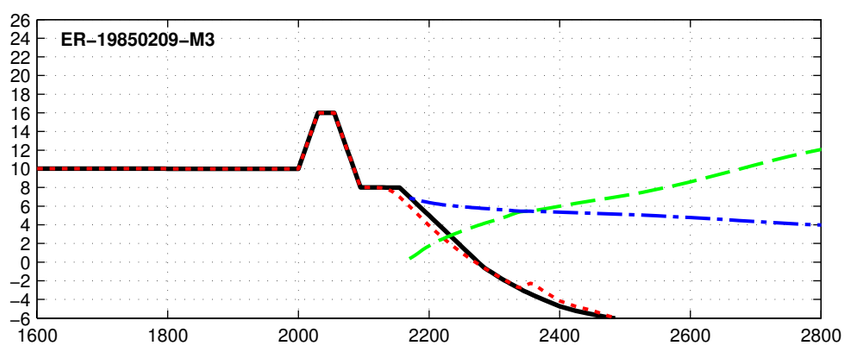


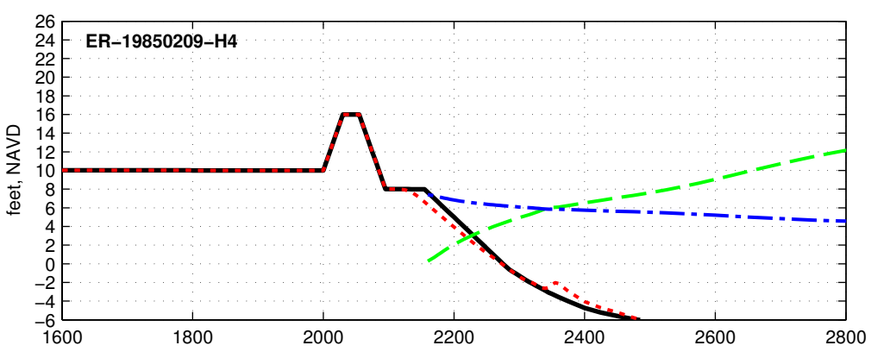


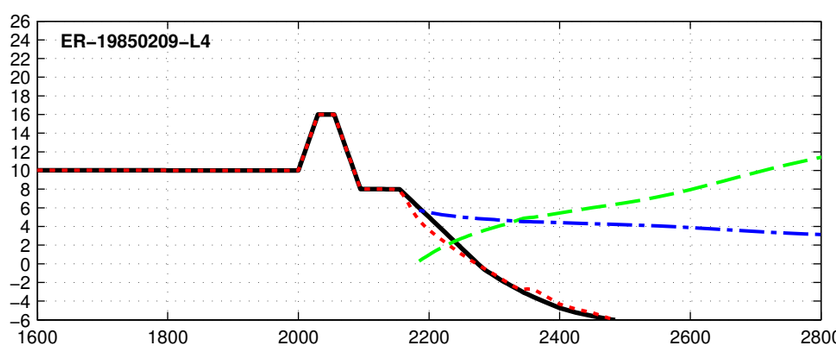


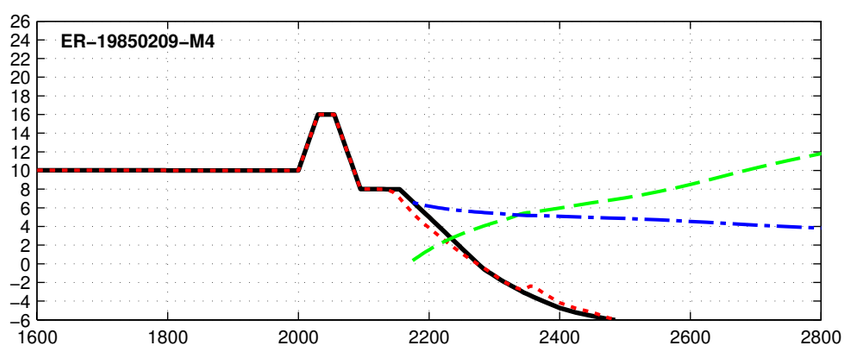










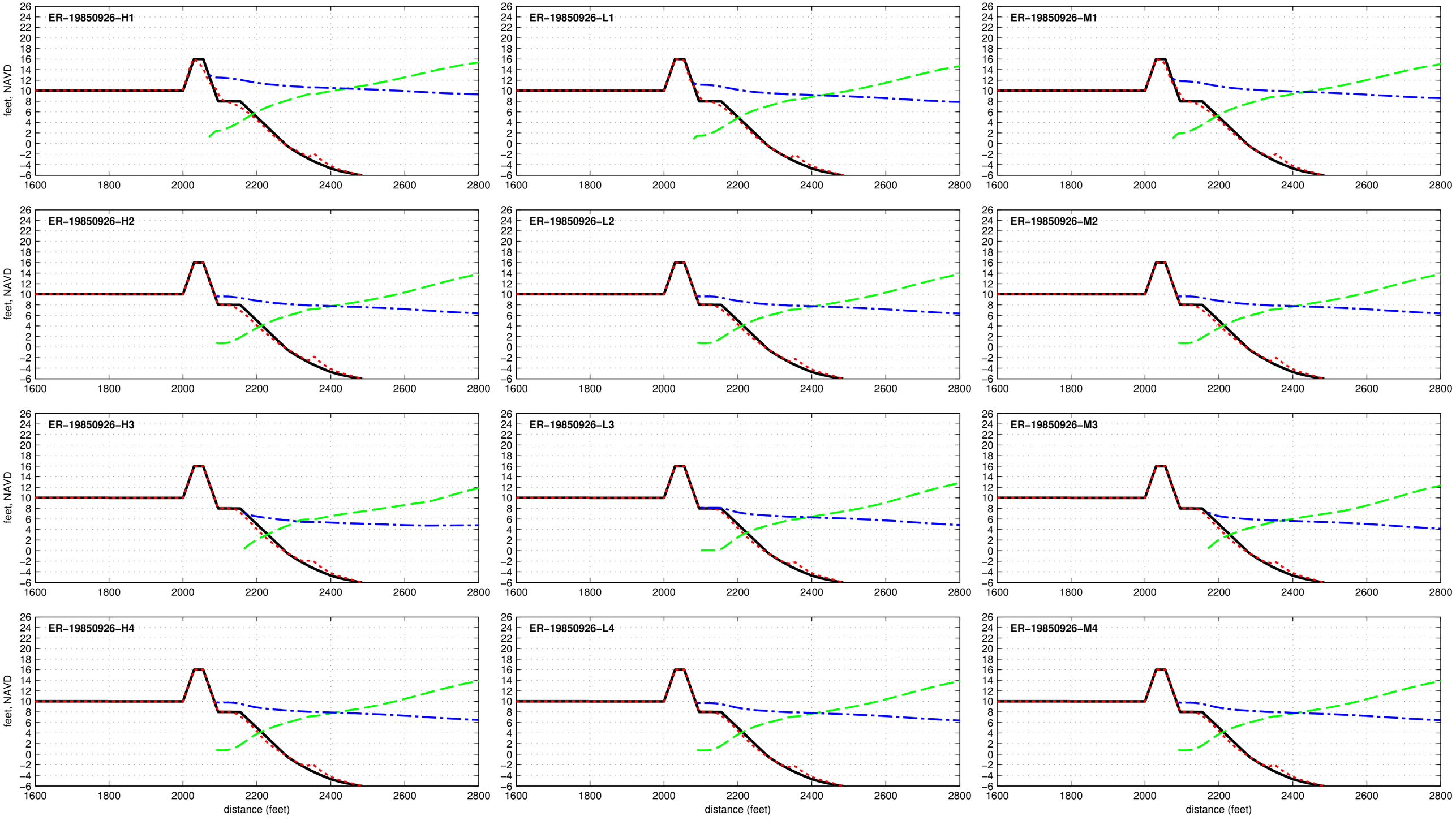


feet, NAVD

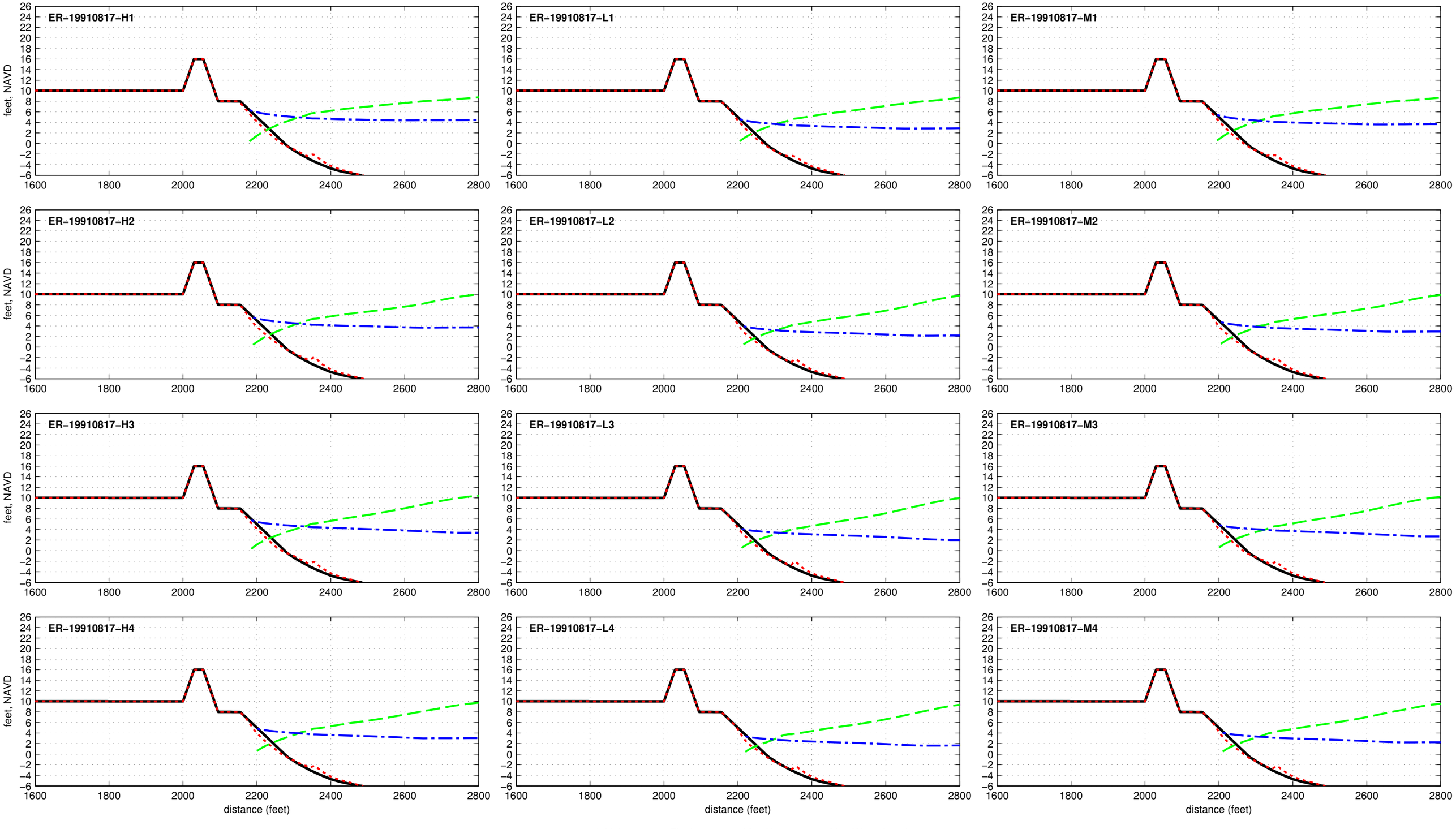
distance (feet)

Initial Final Max Hs Max Water Level

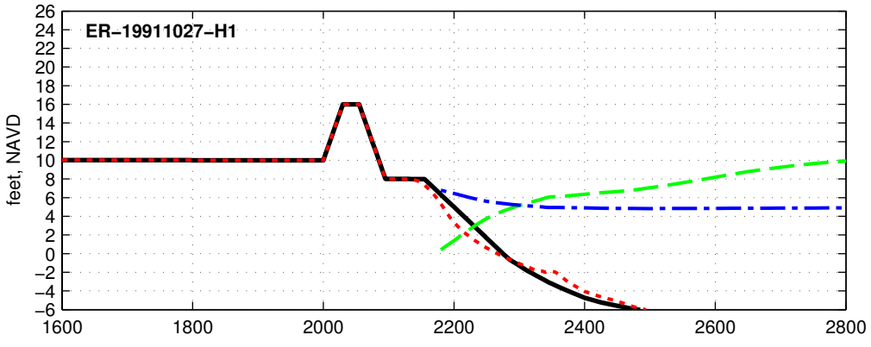
Dune R2T1-16.0-025-060 - ER-19850926

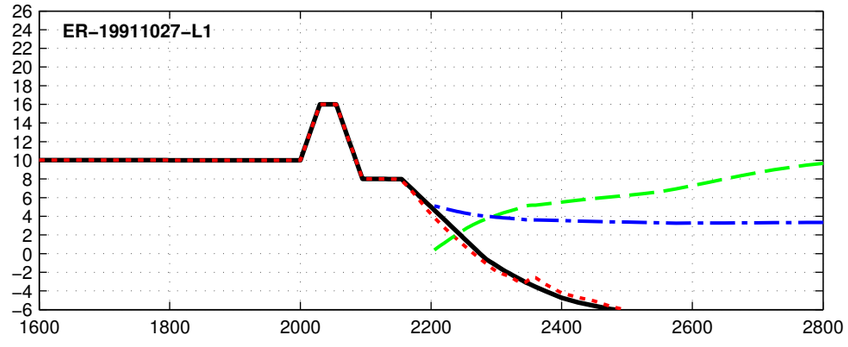


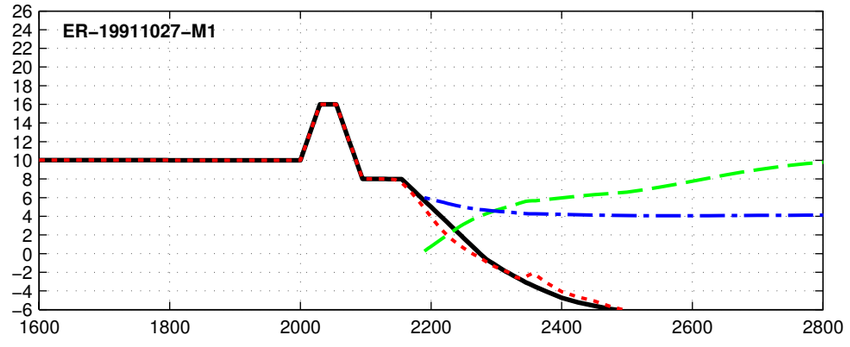
Dune R2T1-16.0-025-060 - ER-19910817

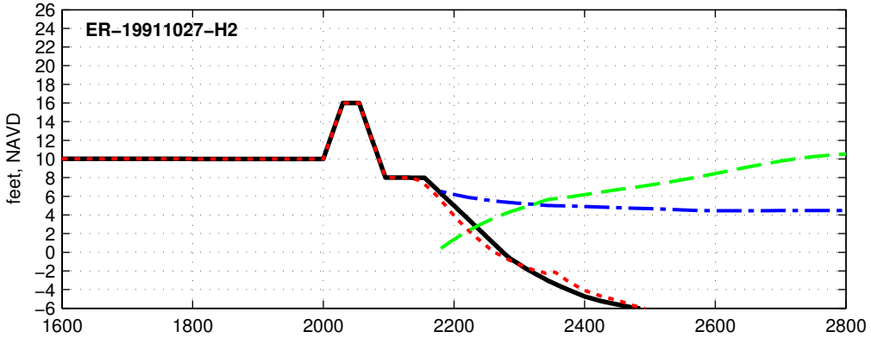


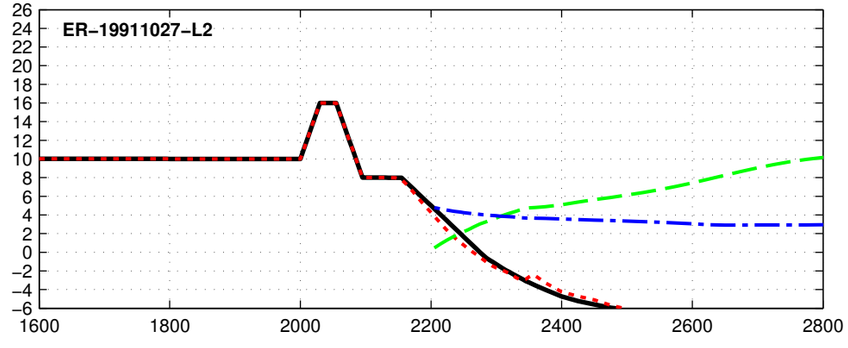
Dune R2T1-16.0-025-060 - ER-19911027

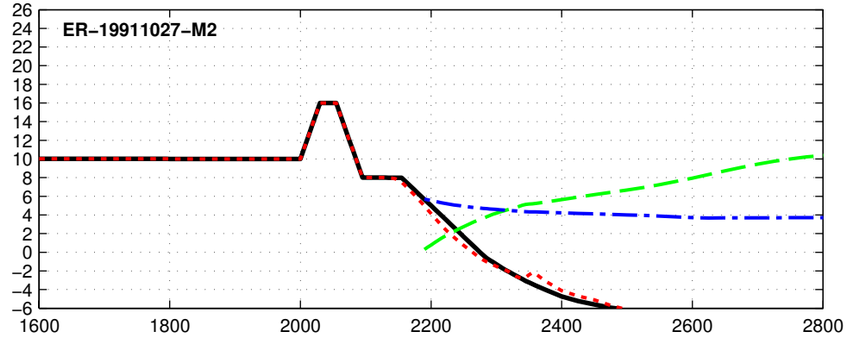


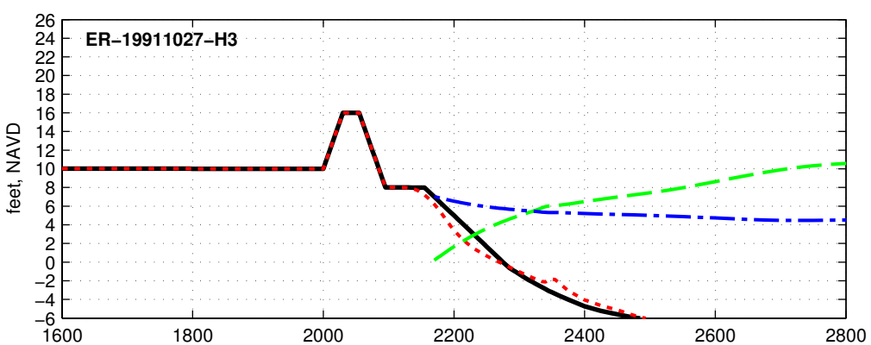


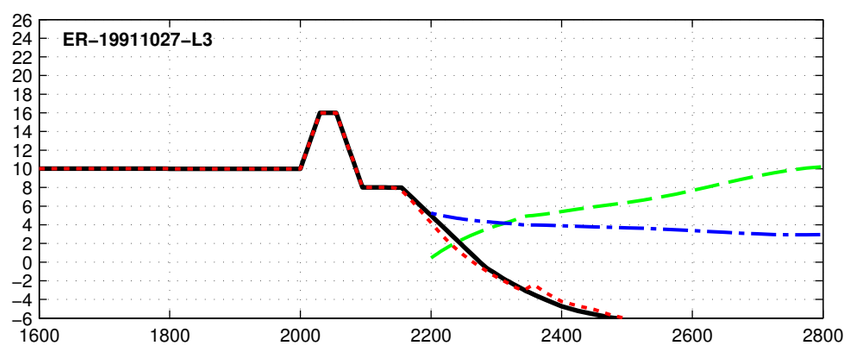


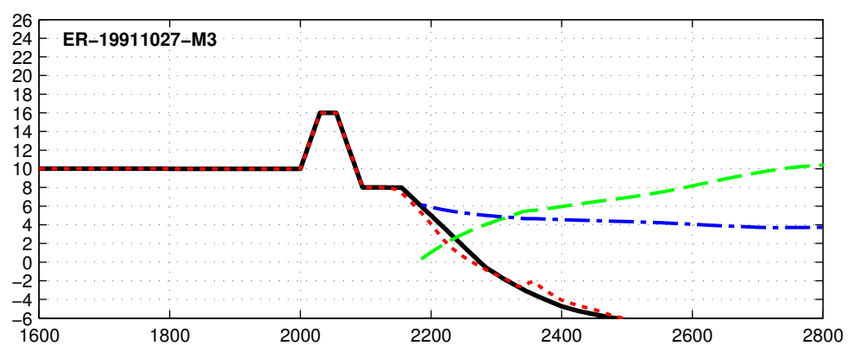


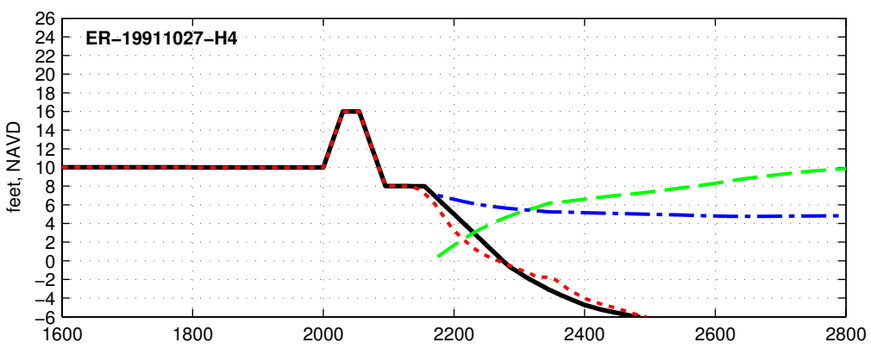


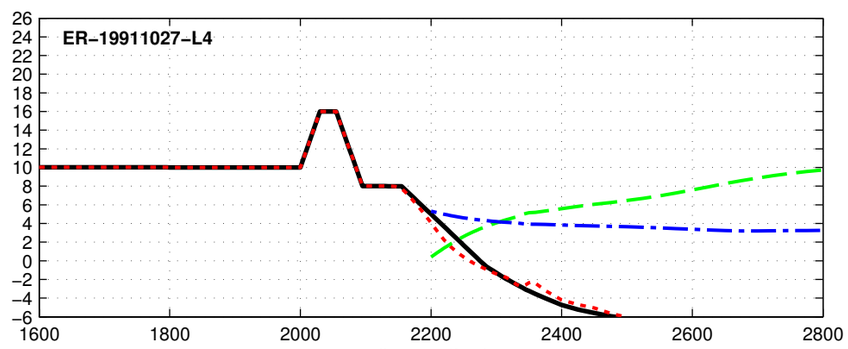


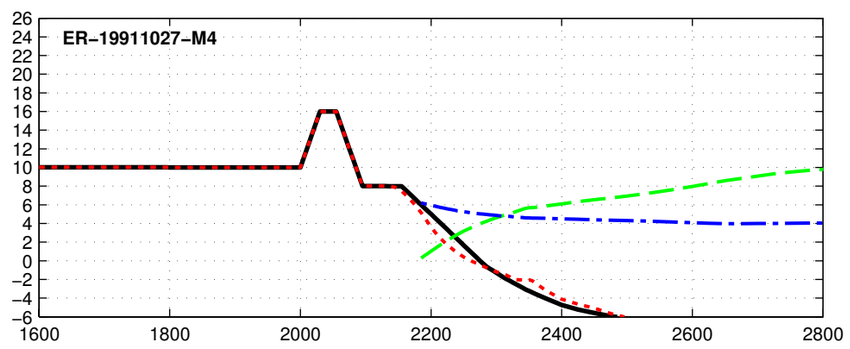






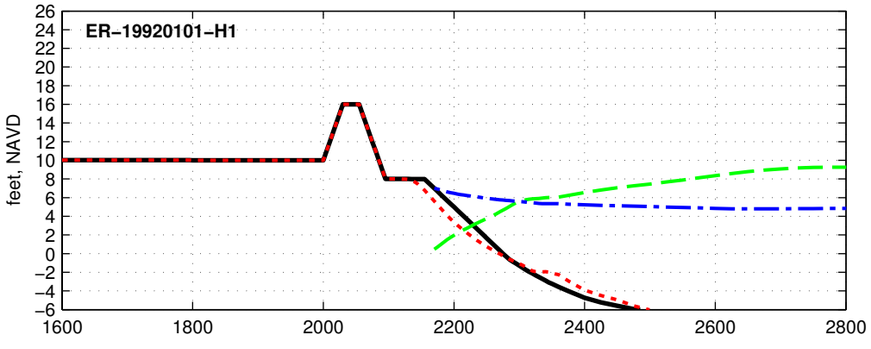


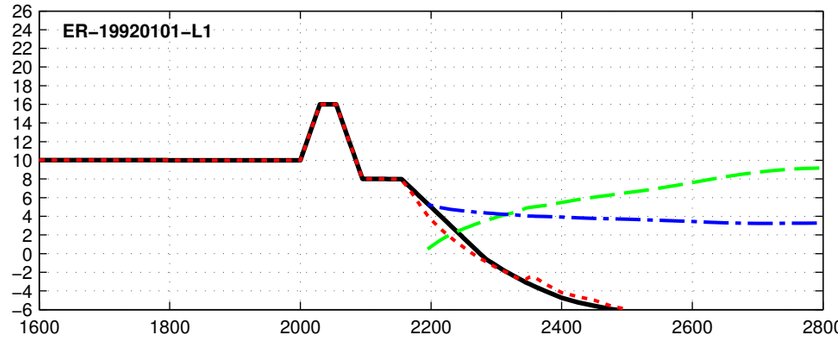


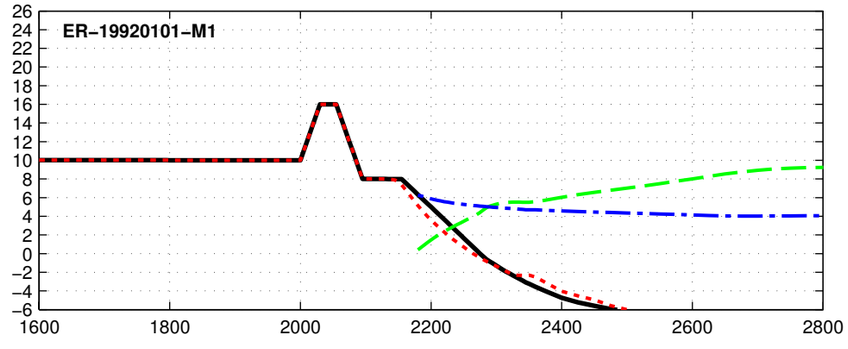


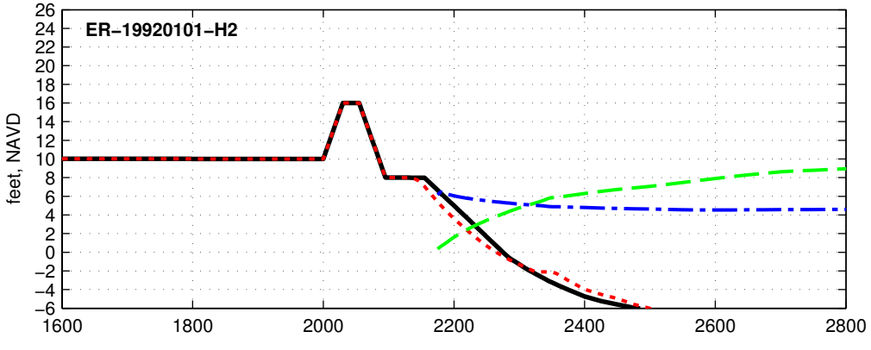
Initial Final Max Hs Max Water Level

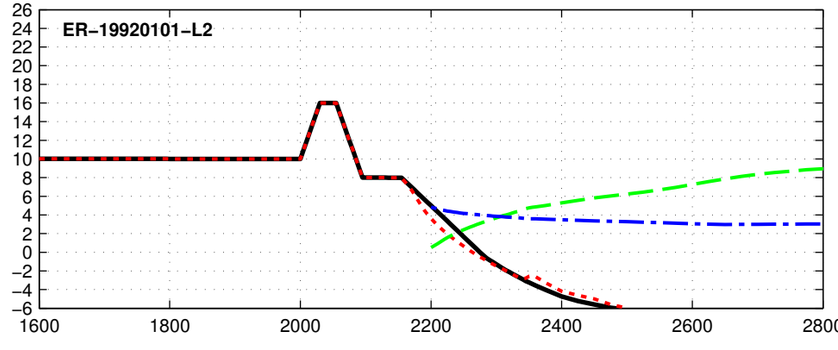
Dune R2T1-16.0-025-060 - ER-19920101

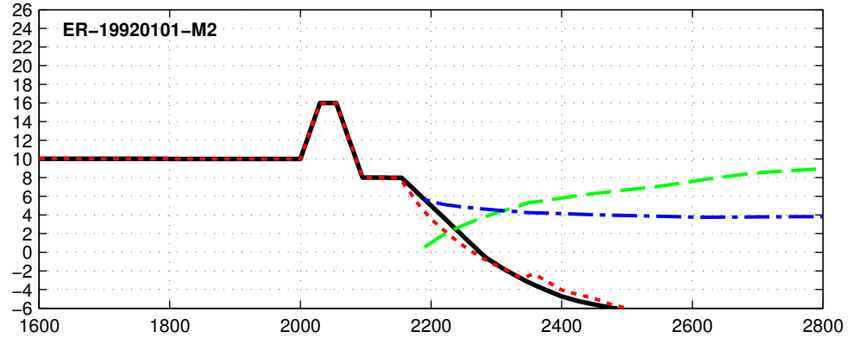


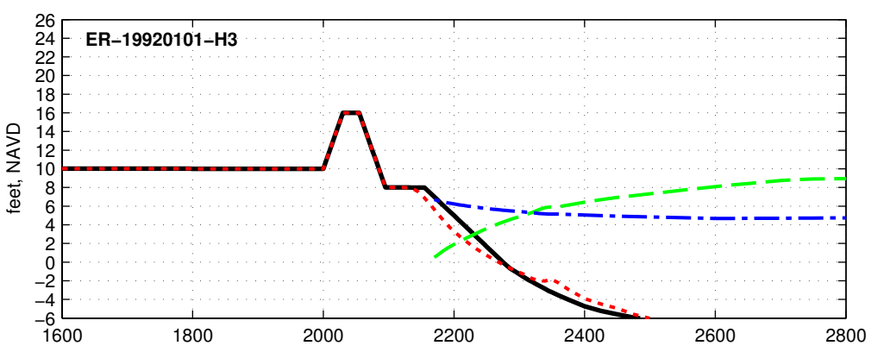


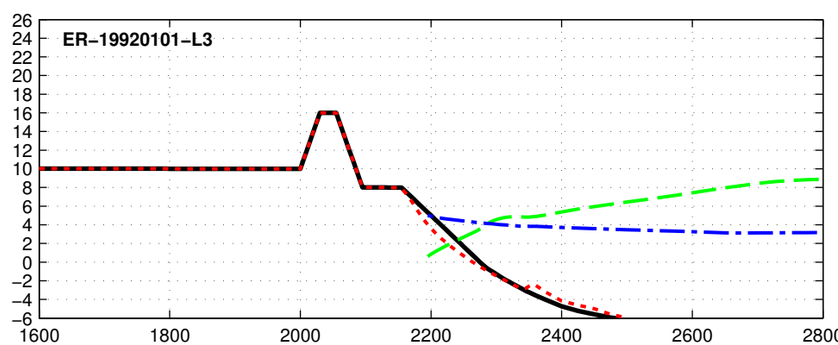


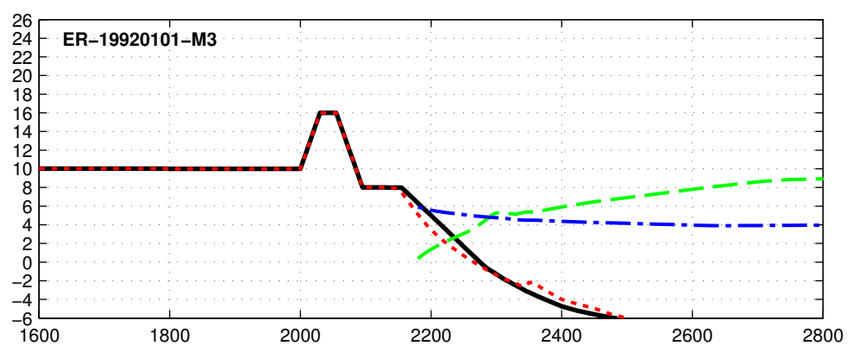


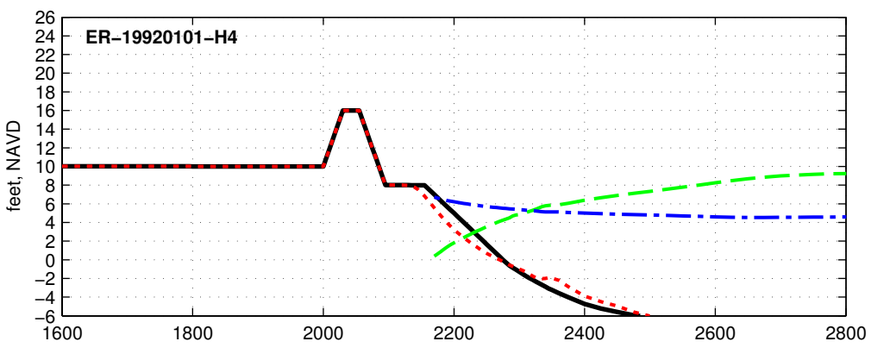


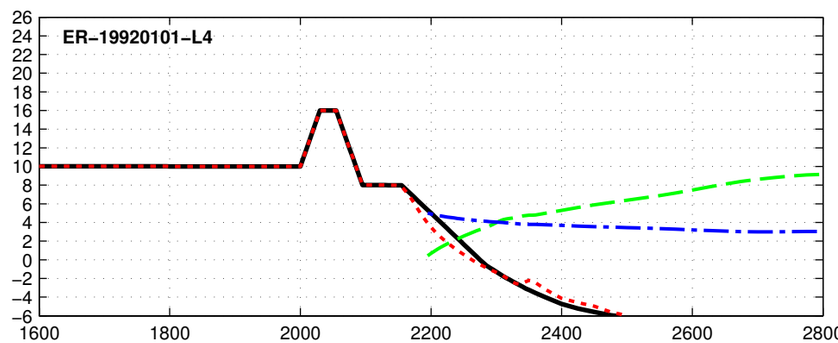


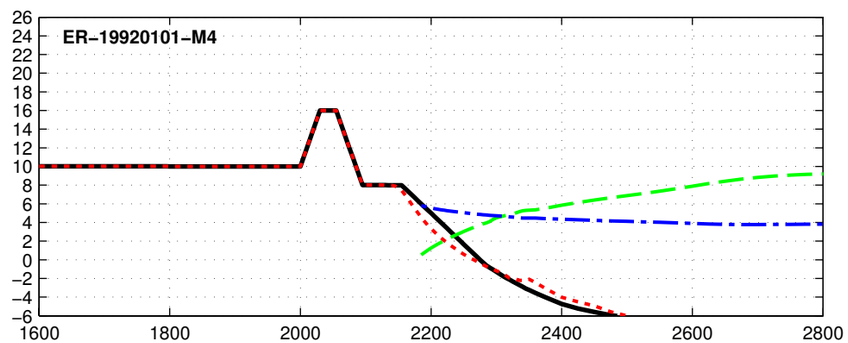






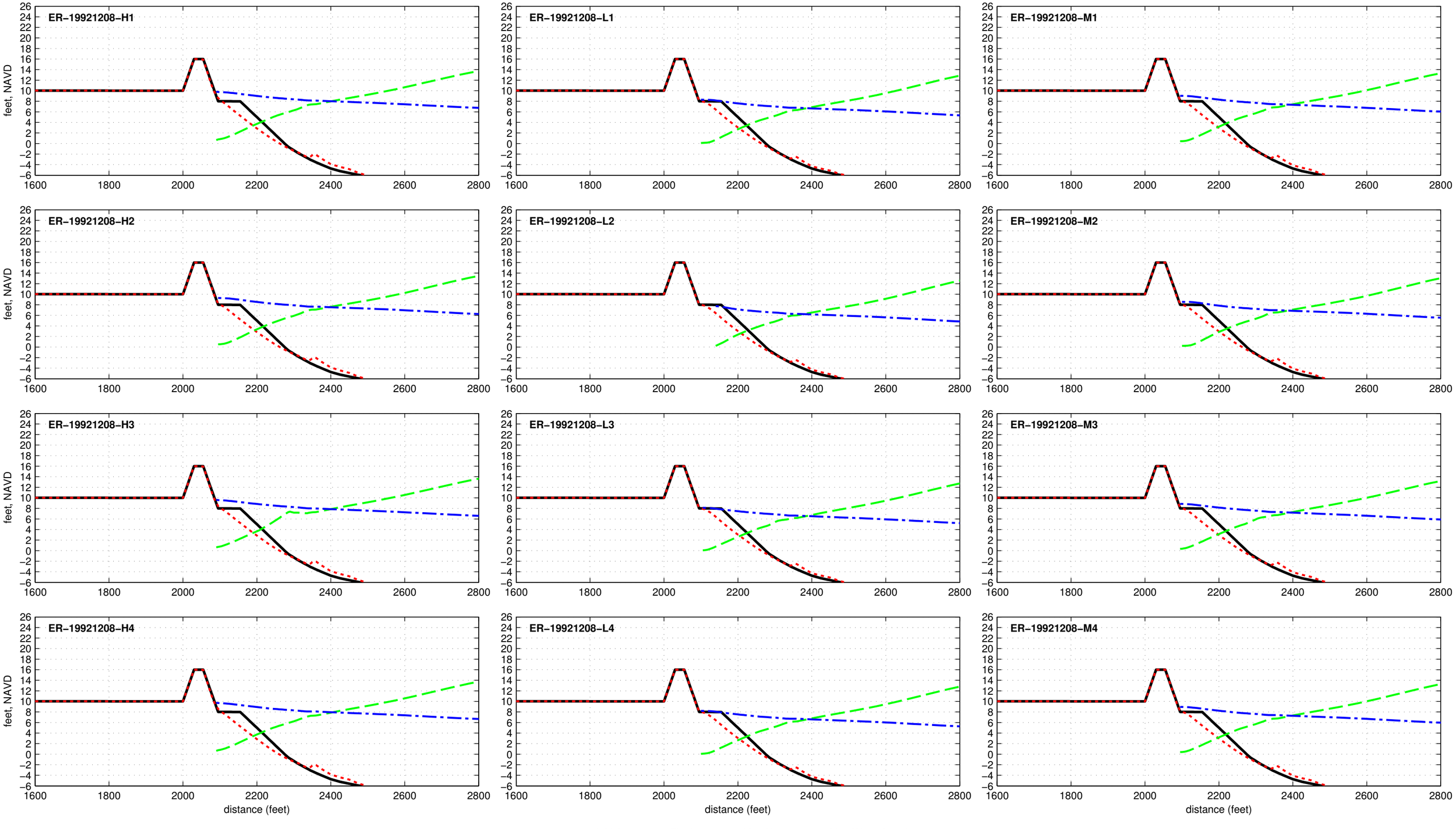




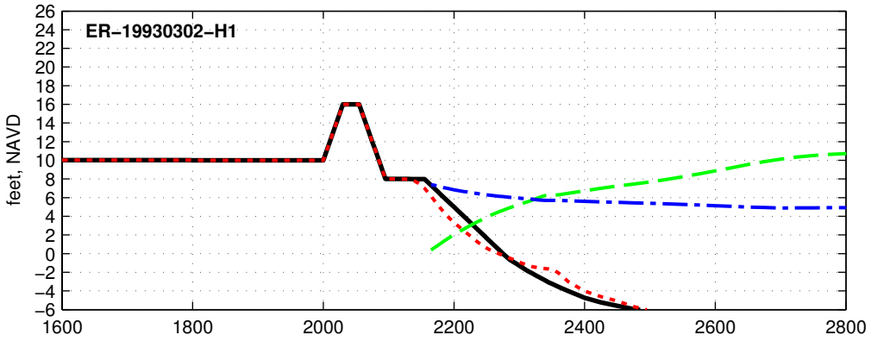


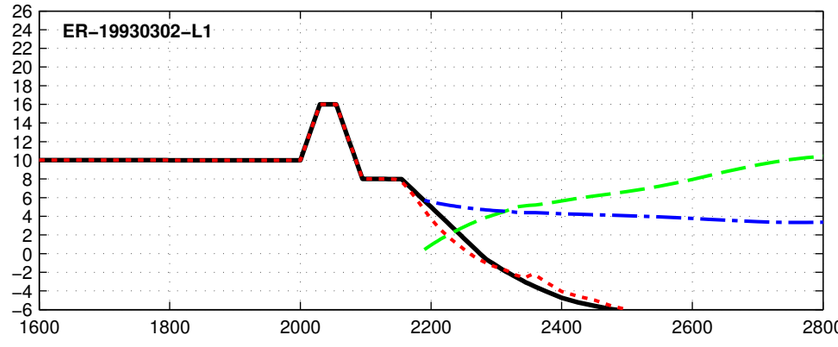
Initial Final Max Hs Max Water Level

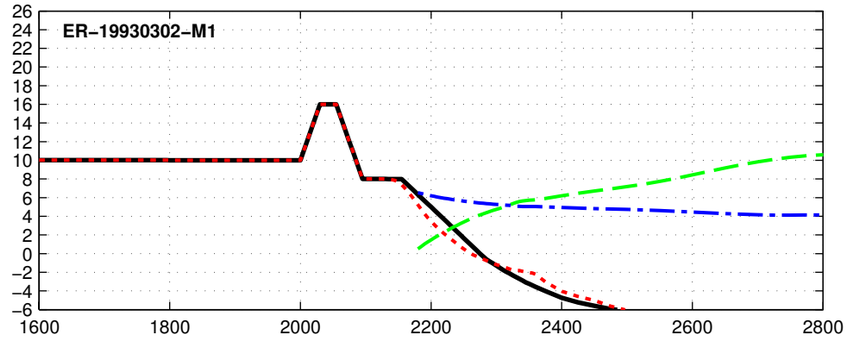
Dune R2T1-16.0-025-060 - ER-19921208

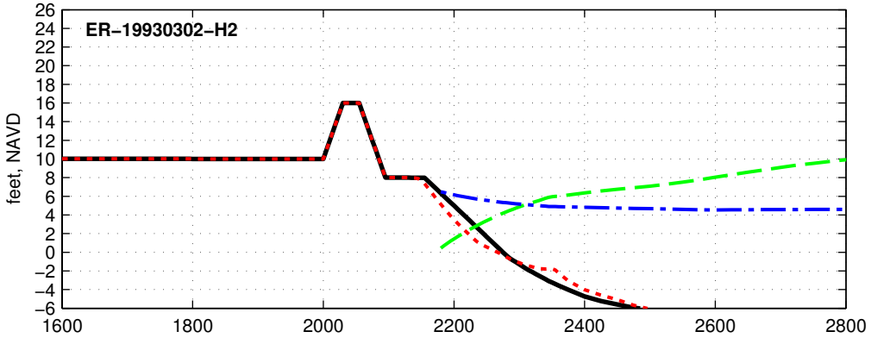


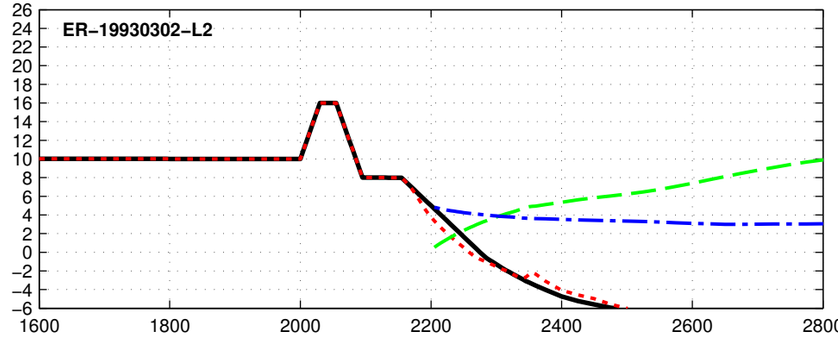
Dune R2T1-16.0-025-060 - ER-19930302

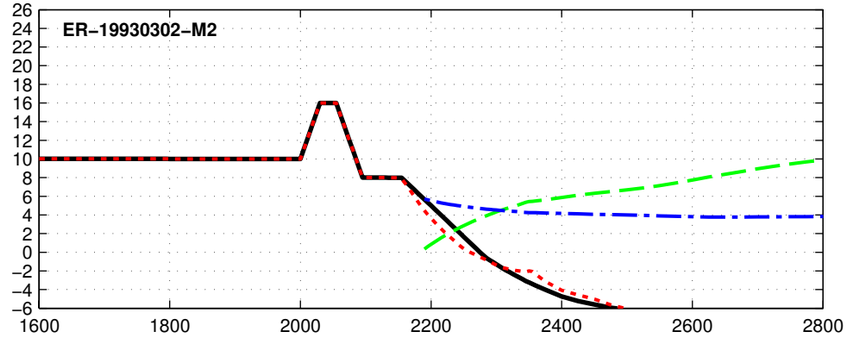


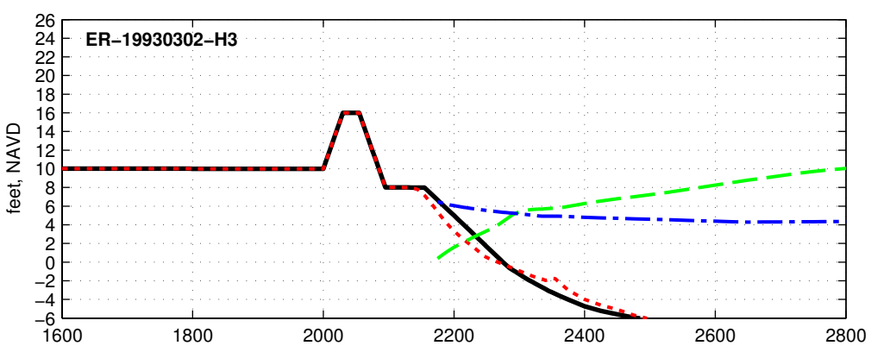


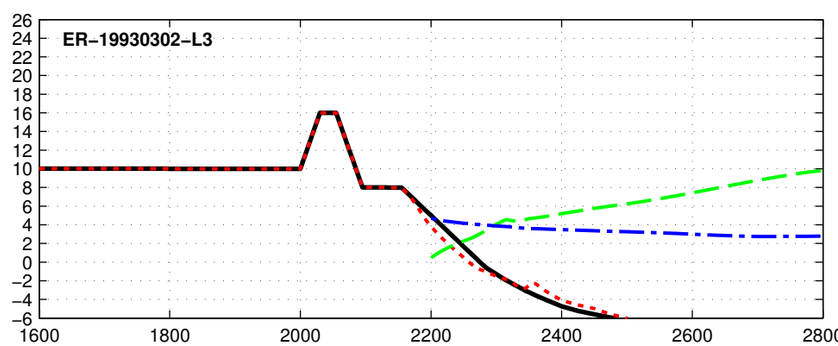


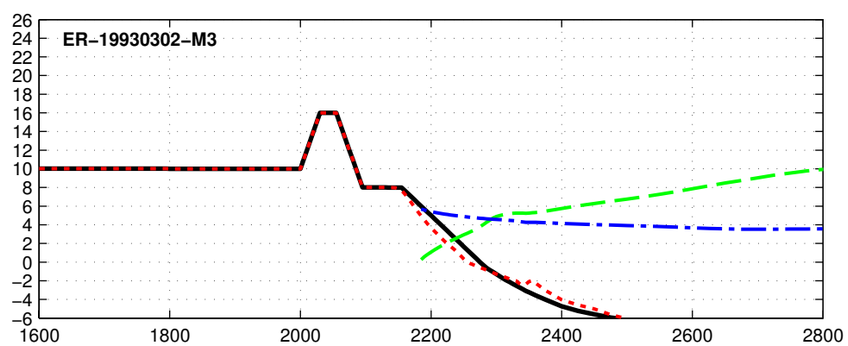


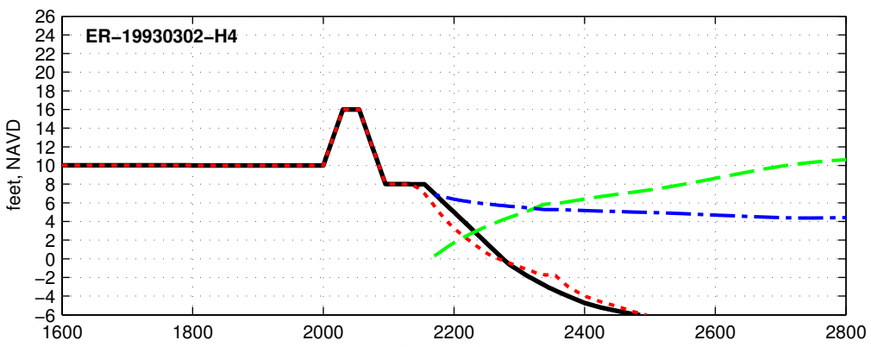


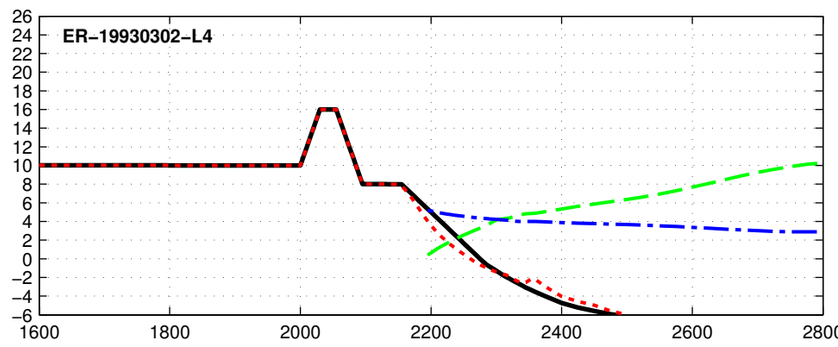


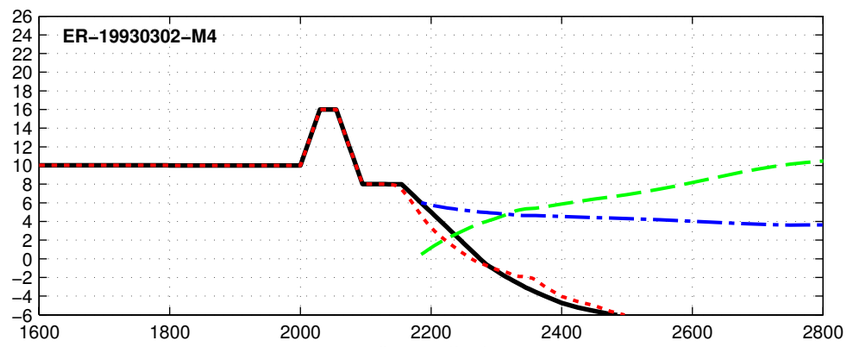






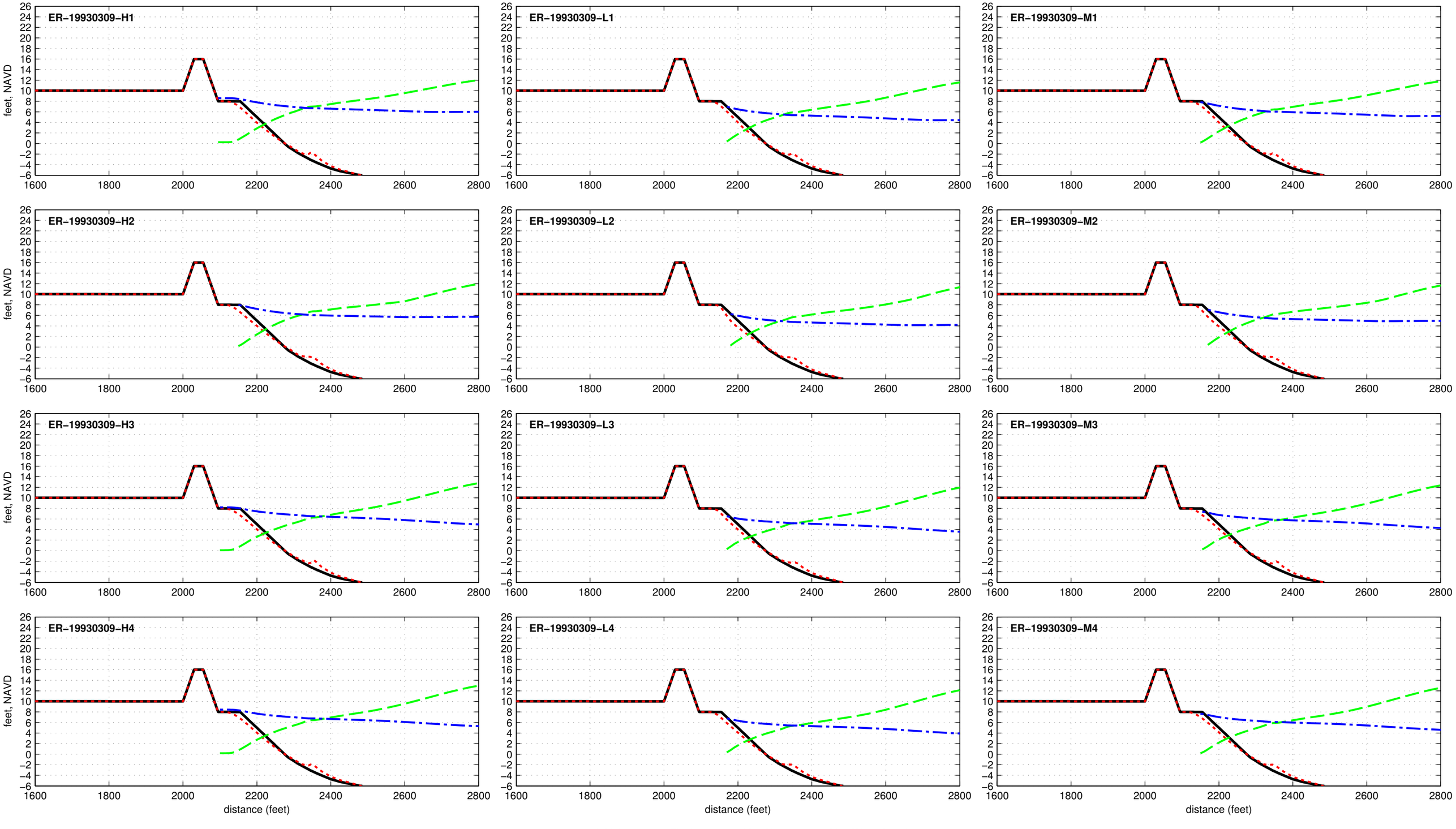




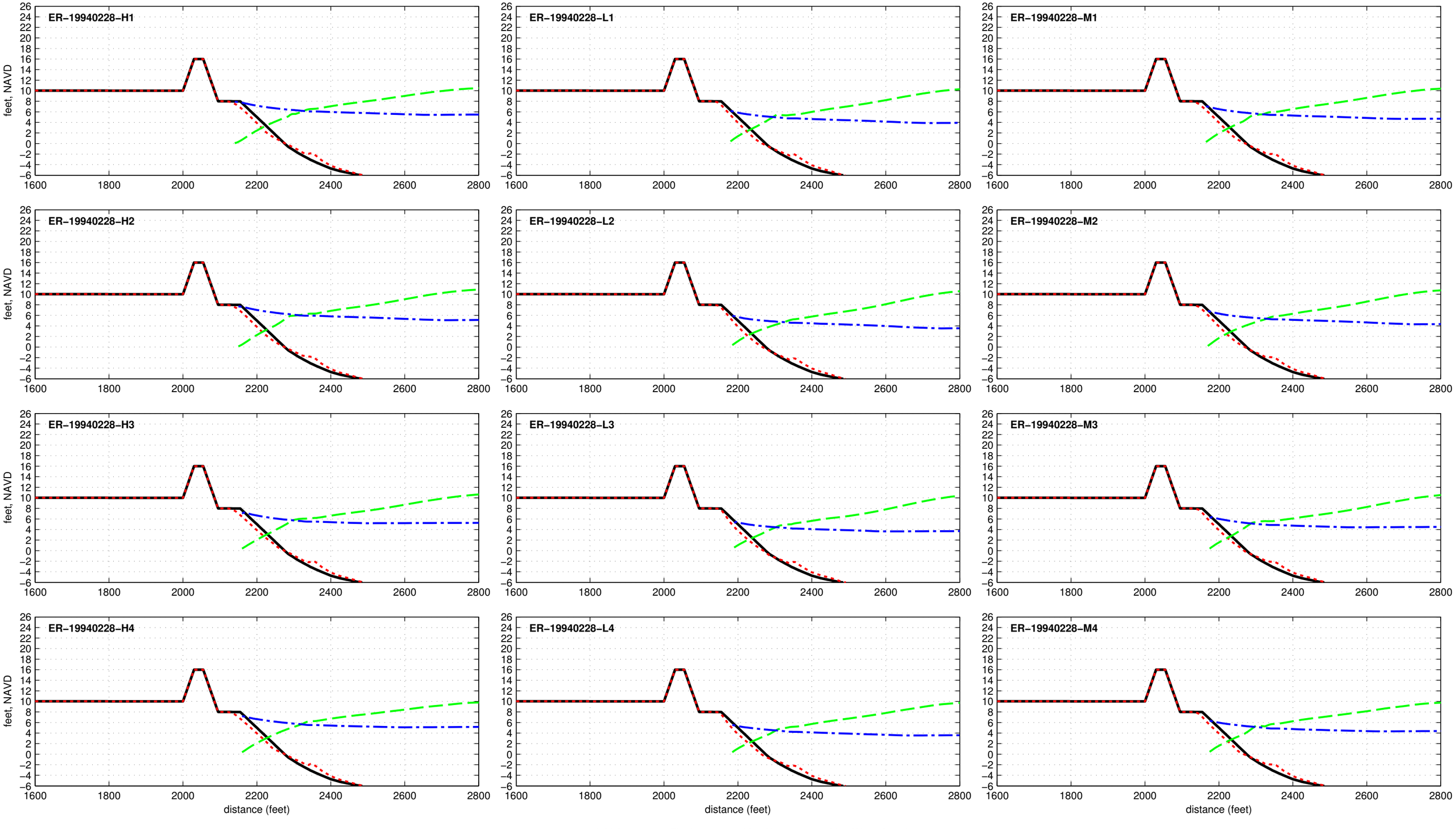


Initial Final Max Hs Max Water Level

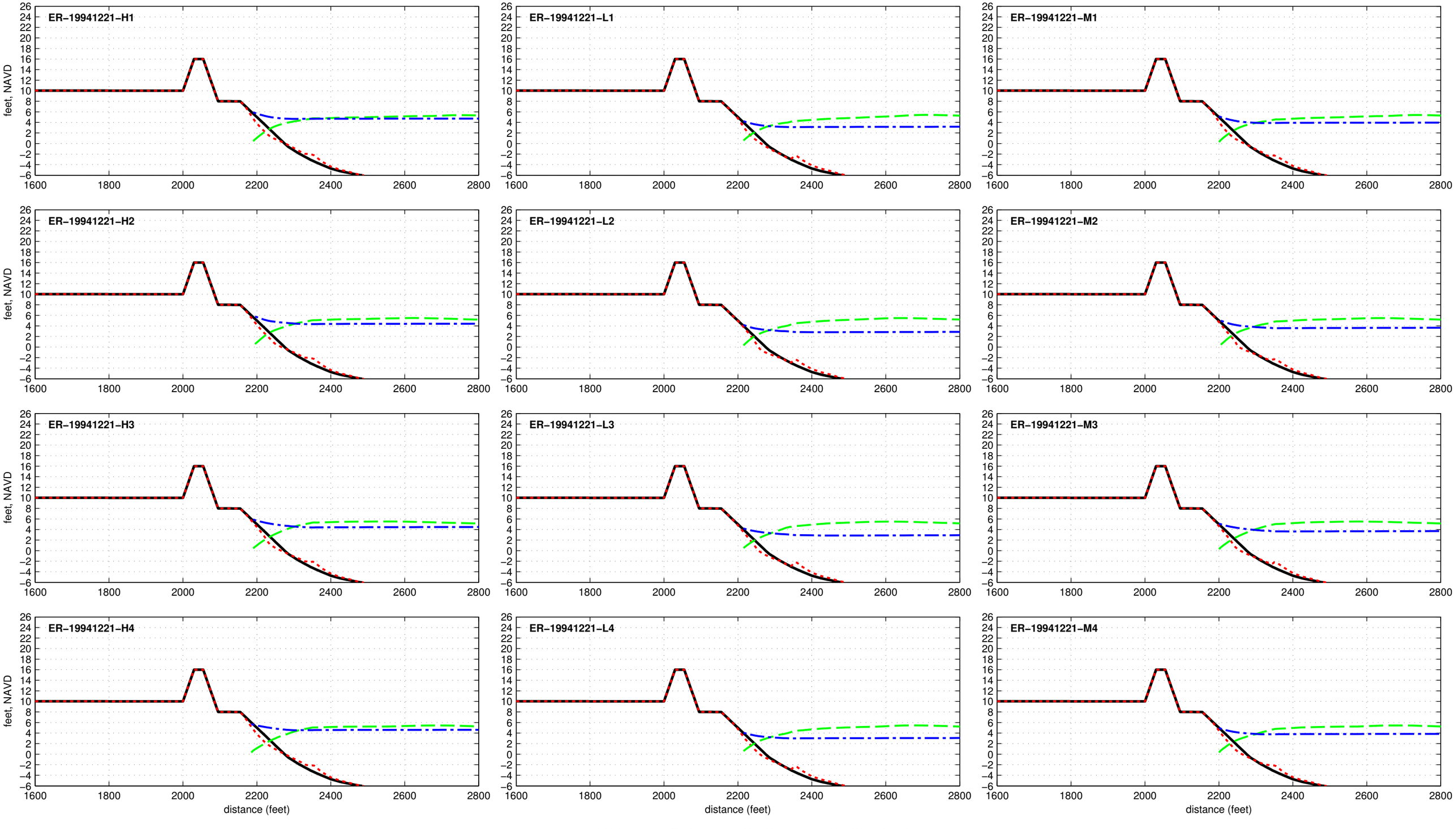
Dune R2T1-16.0-025-060 - ER-19930309



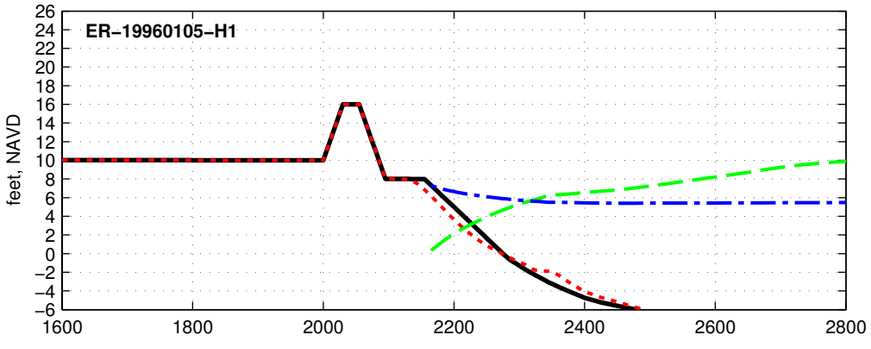
Dune R2T1-16.0-025-060 - ER-19940228

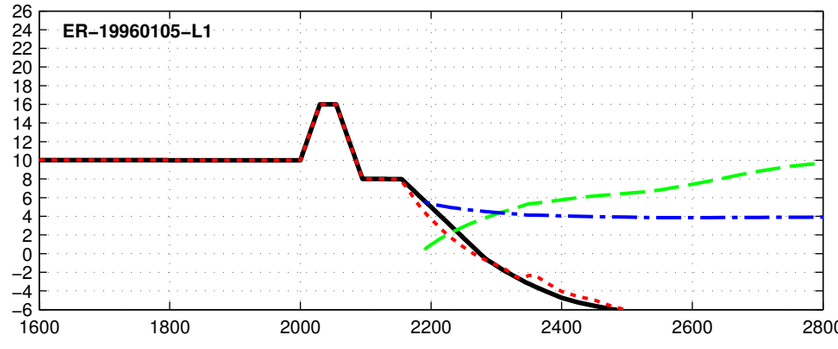


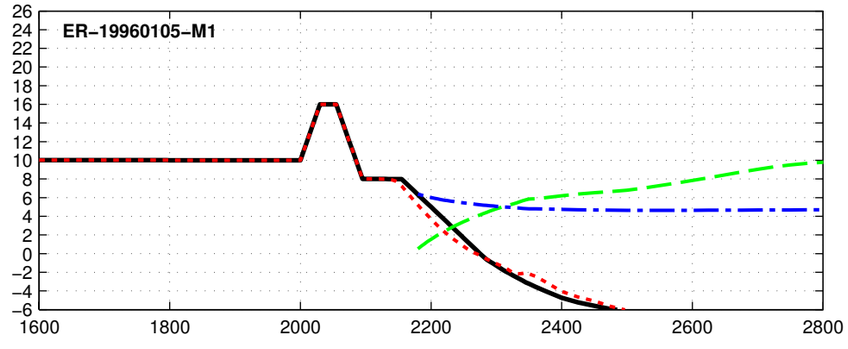
Dune R2T1-16.0-025-060 - ER-19941221

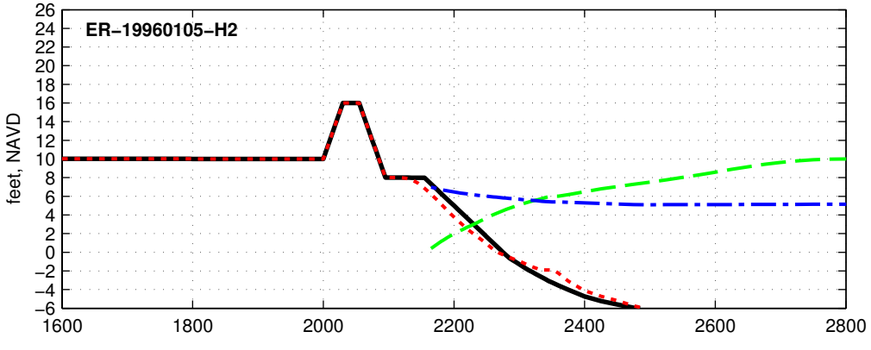


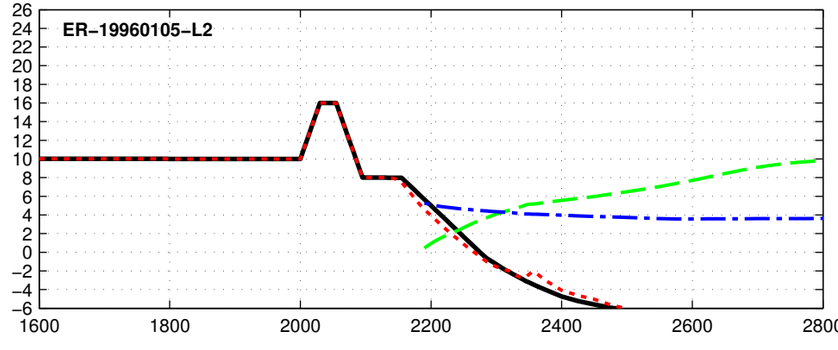
Dune R2T1-16.0-025-060 - ER-19960105

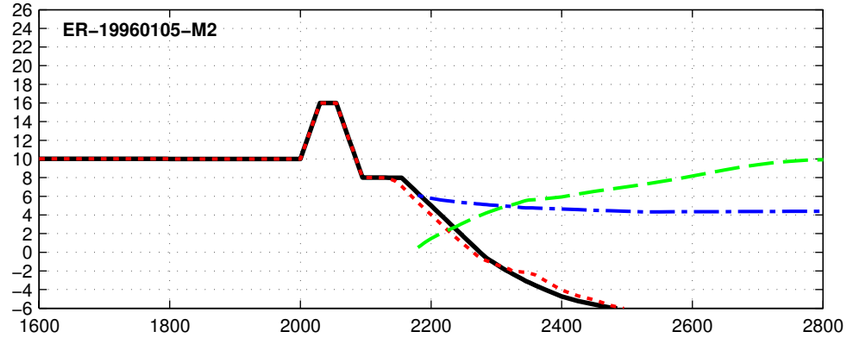


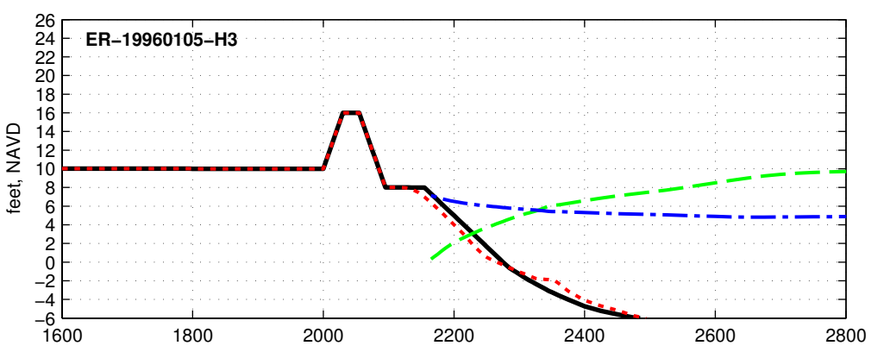


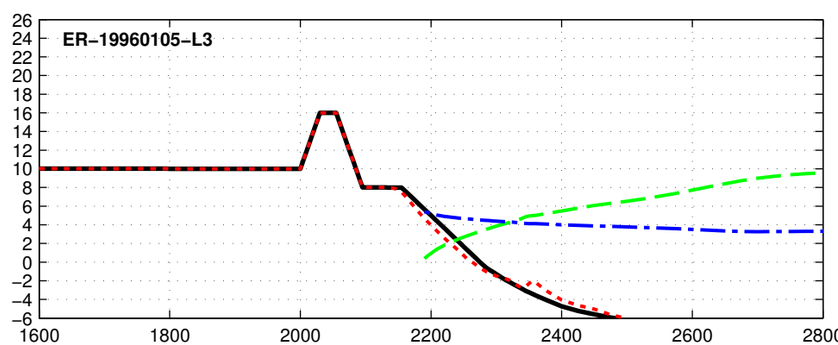


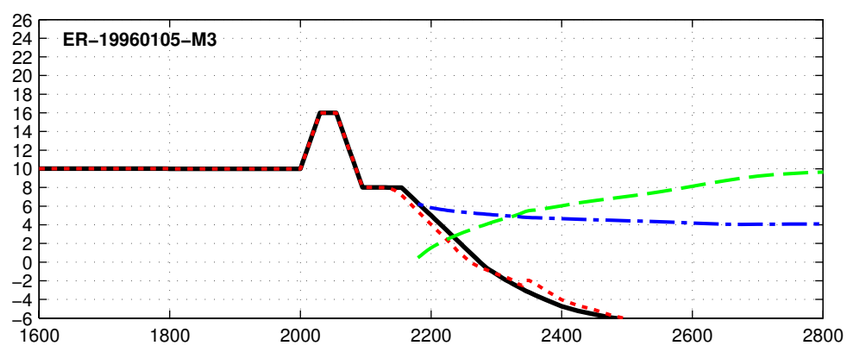


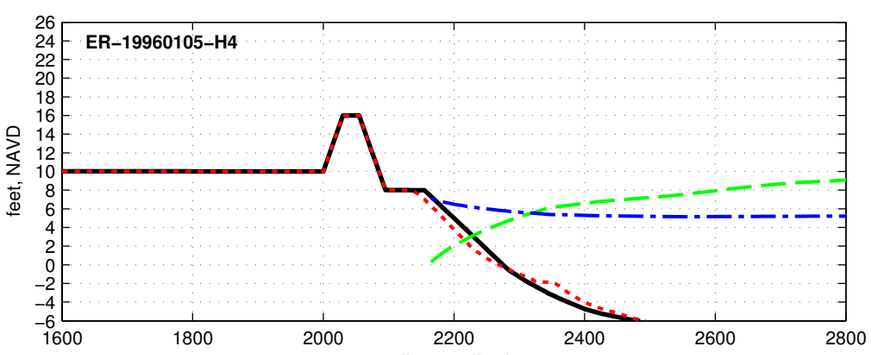


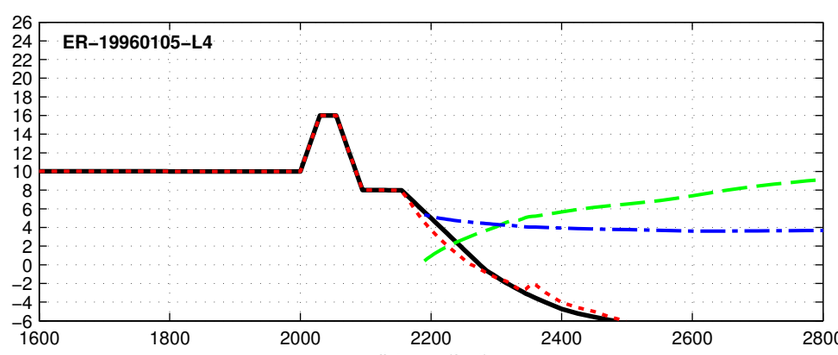


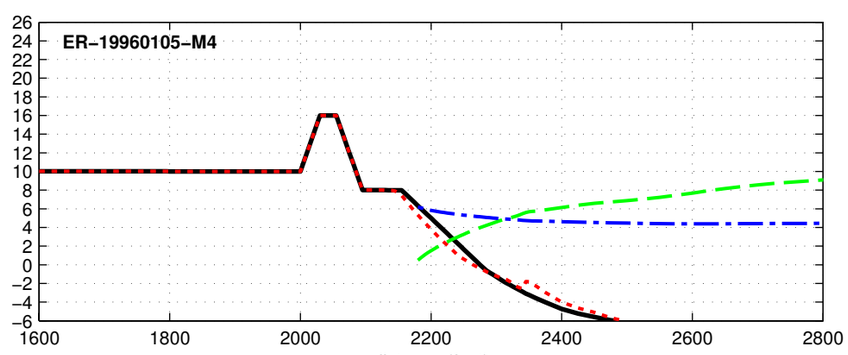






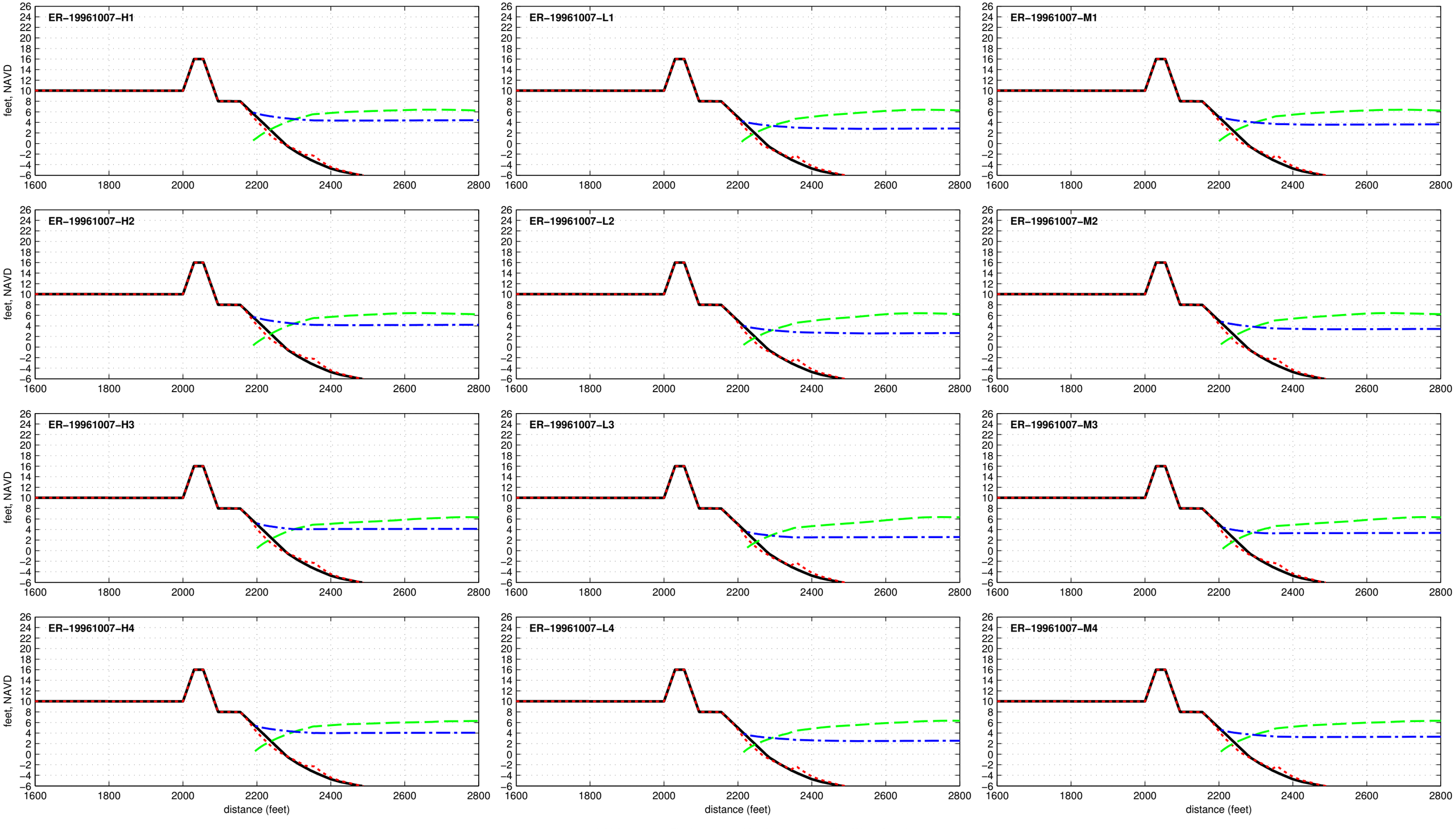




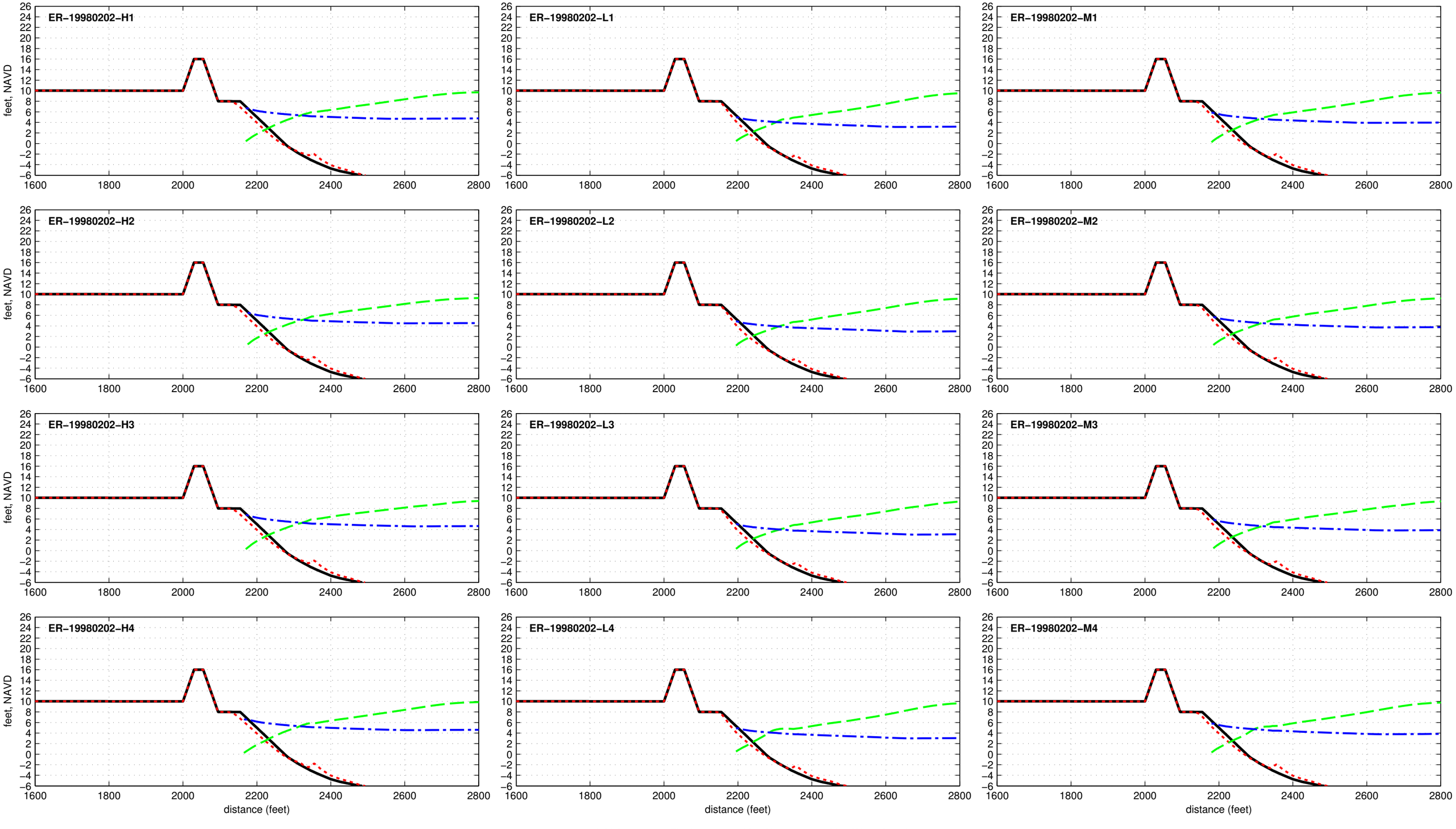


Initial Final Max Hs Max Water Level

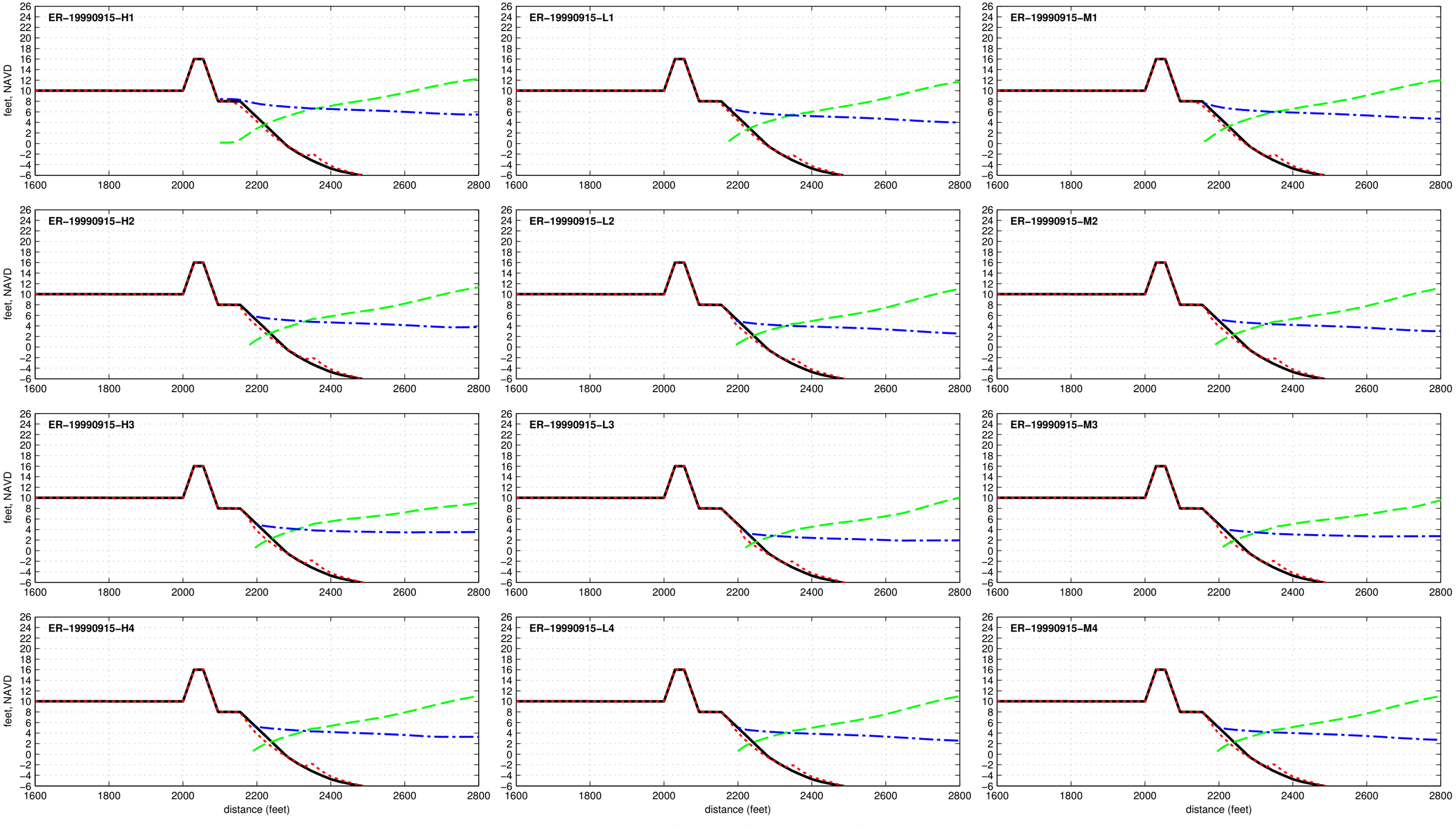
Dune R2T1-16.0-025-060 - ER-19961007



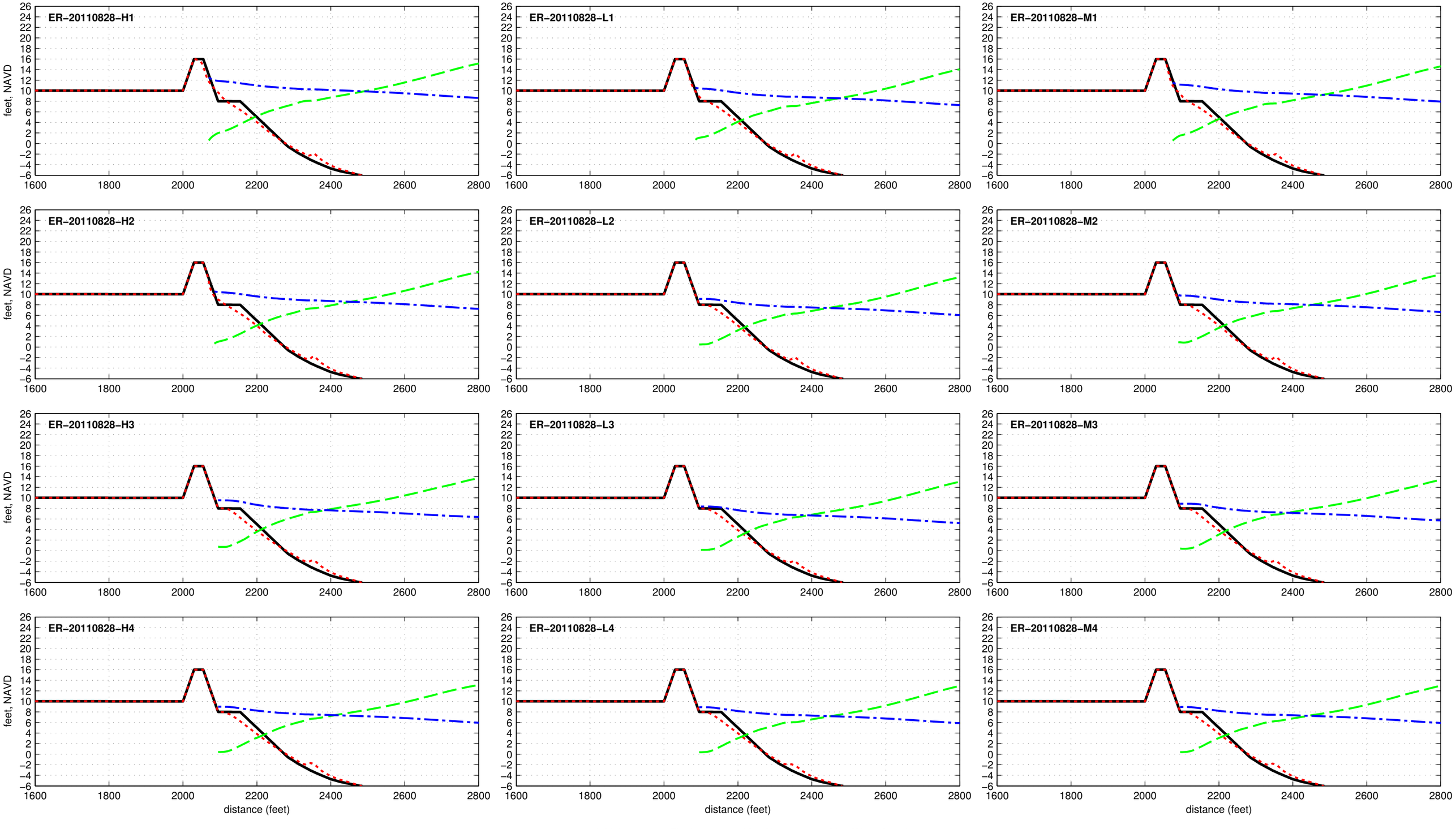
Dune R2T1-16.0-025-060 - ER-19980202



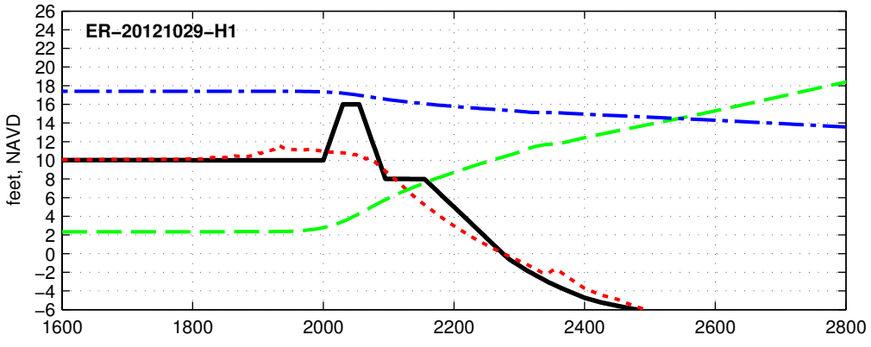
Dune R2T1-16.0-025-060 - ER-19990915

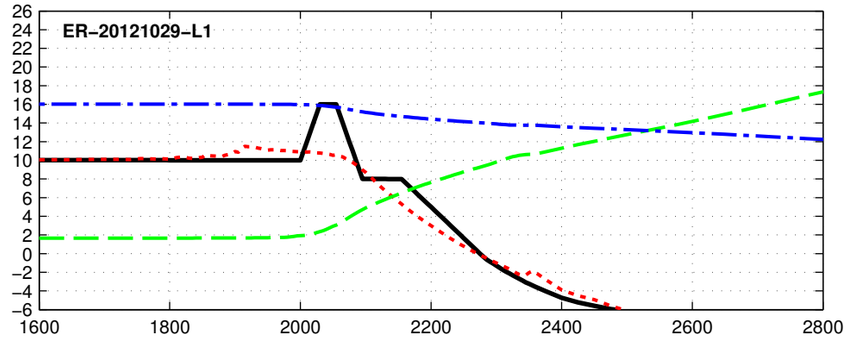


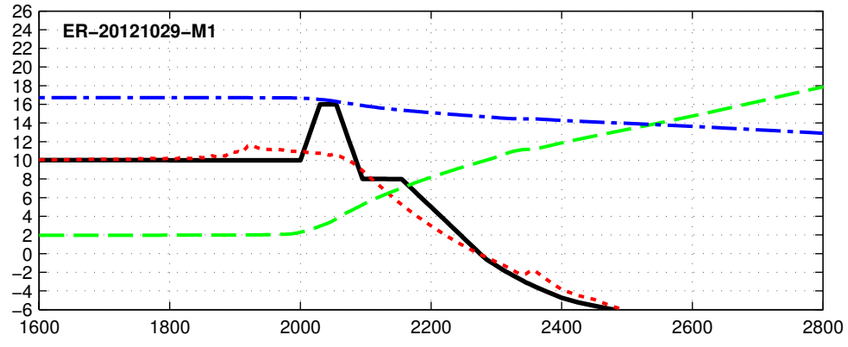
Dune R2T1-16.0-025-060 - ER-20110828

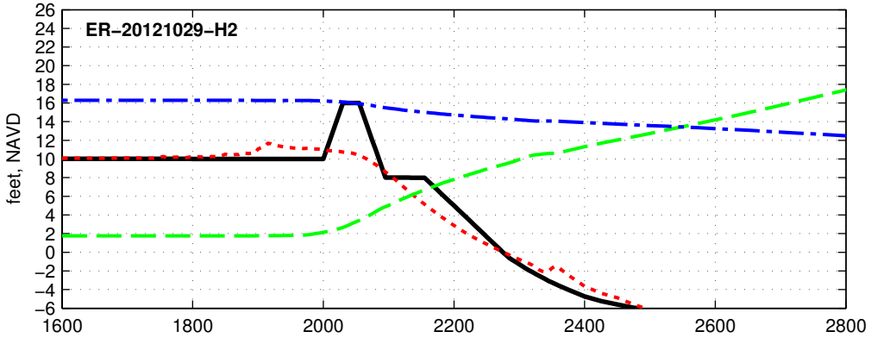


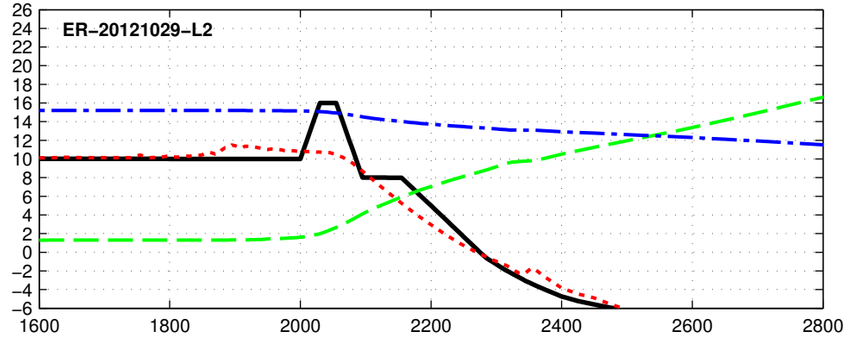
Dune R2T1-16.0-025-060 - ER-20121029

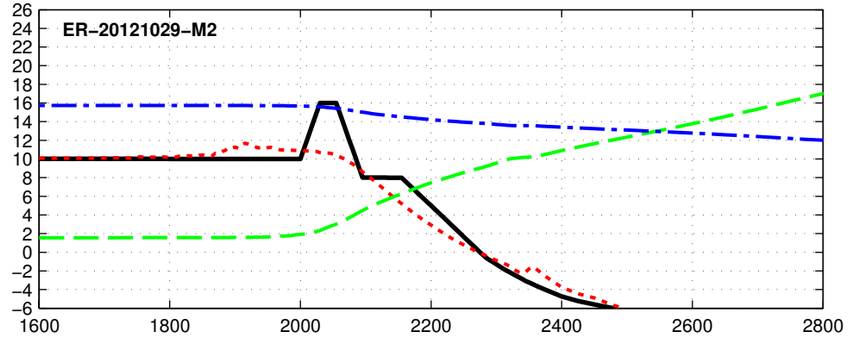


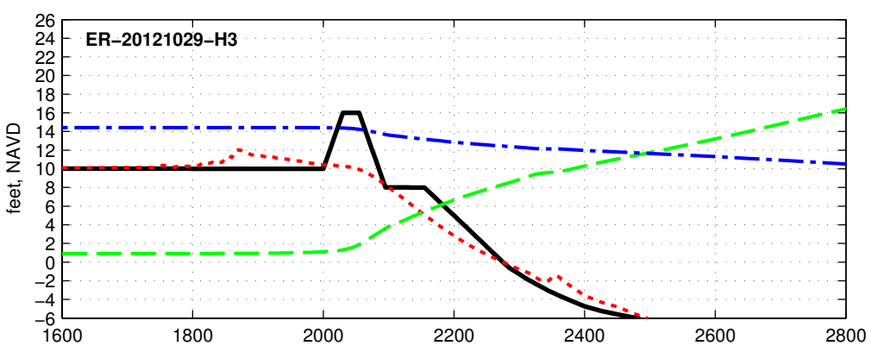


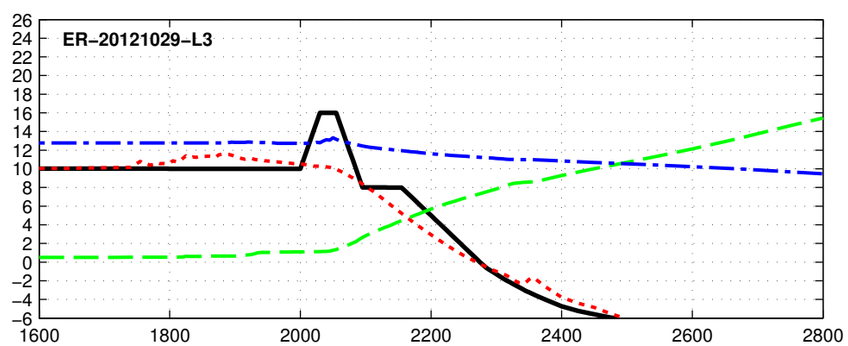


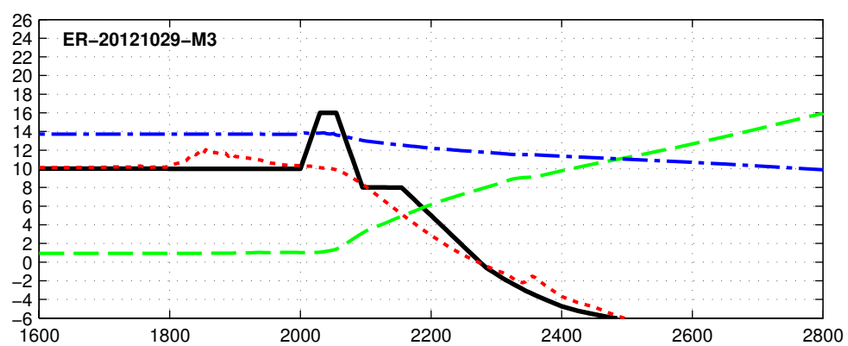


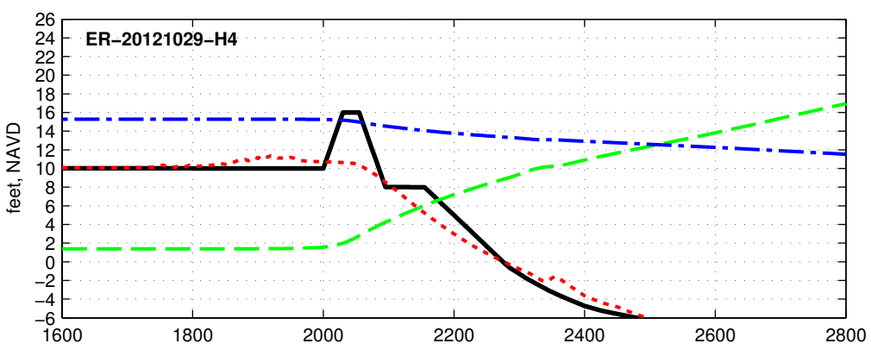


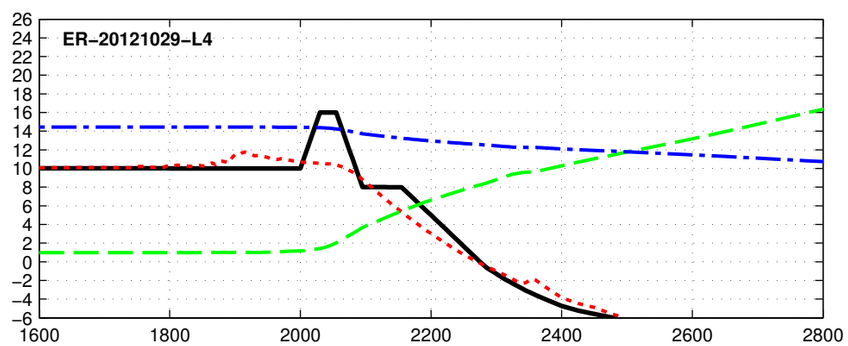


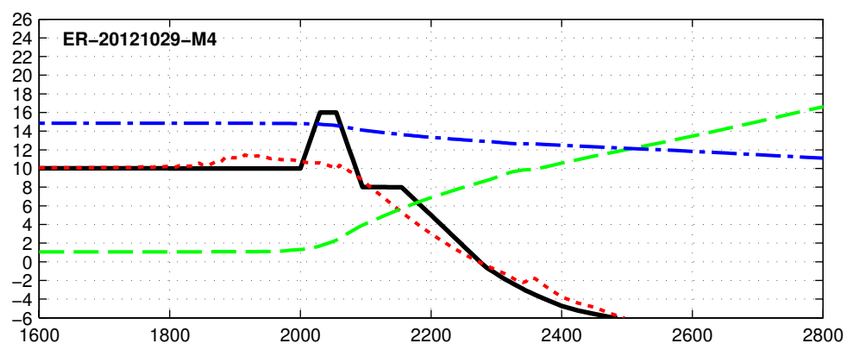








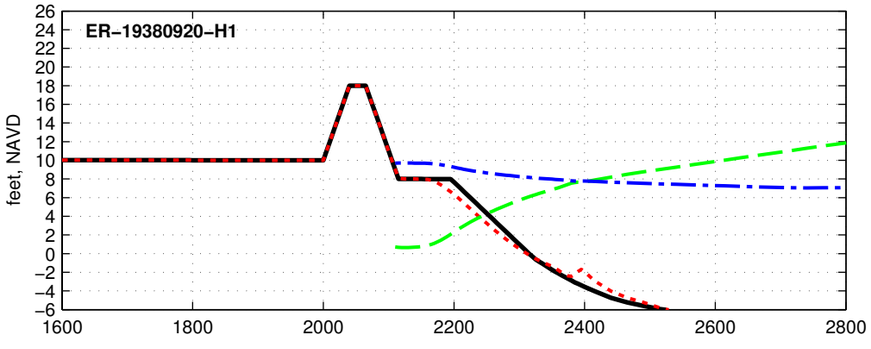


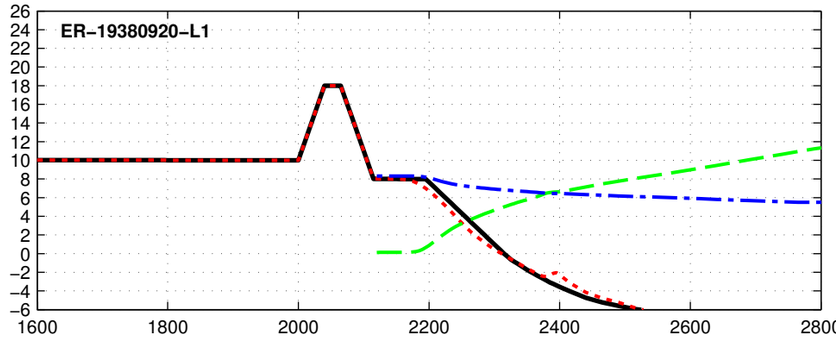


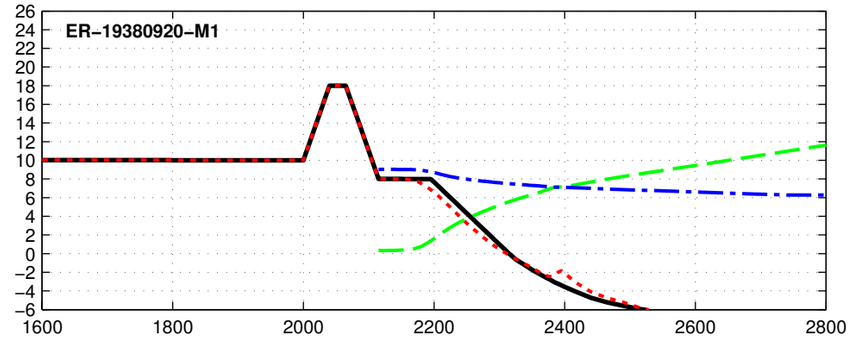
Initial Final Max Hs Max Water Level

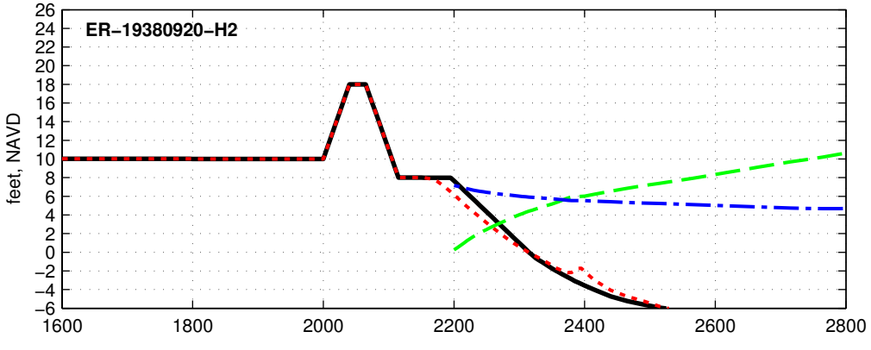
R2T1_18.0_025_080 - DUNE

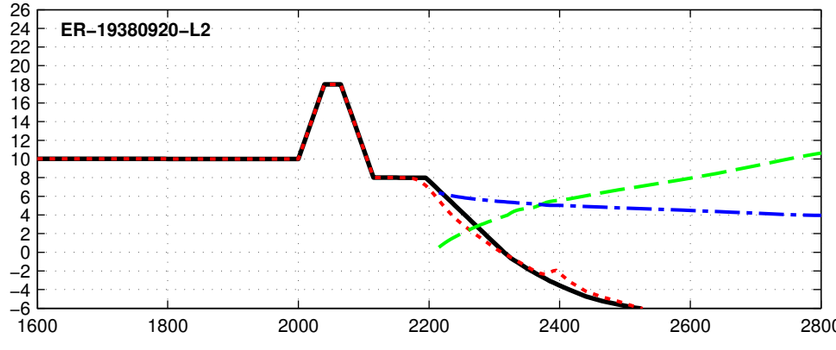
Dune R2T1-18.0-025-080 - ER-19380920

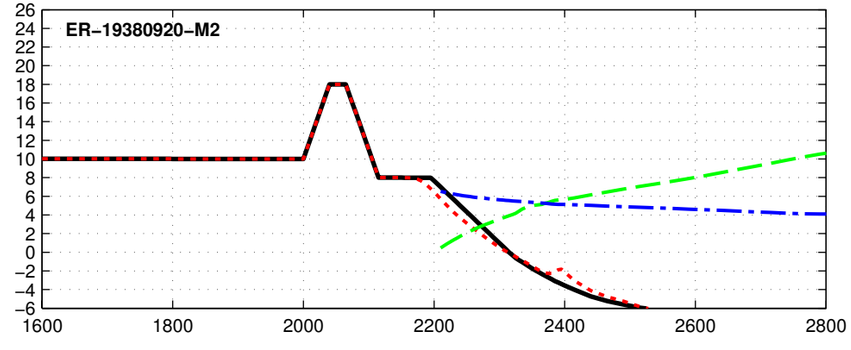


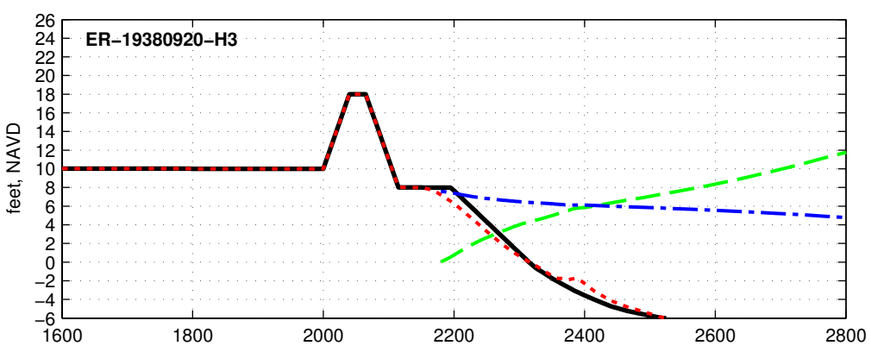


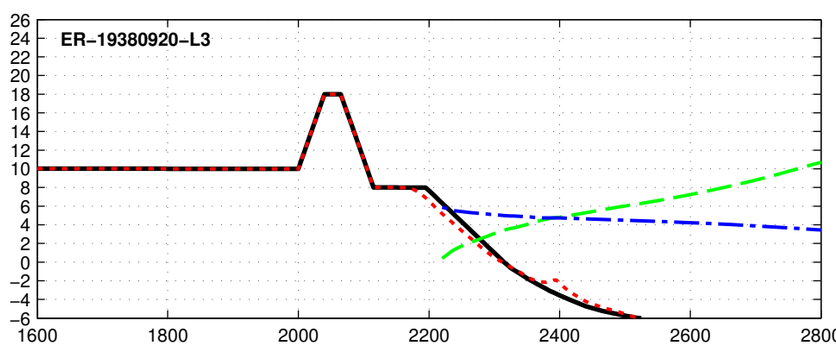


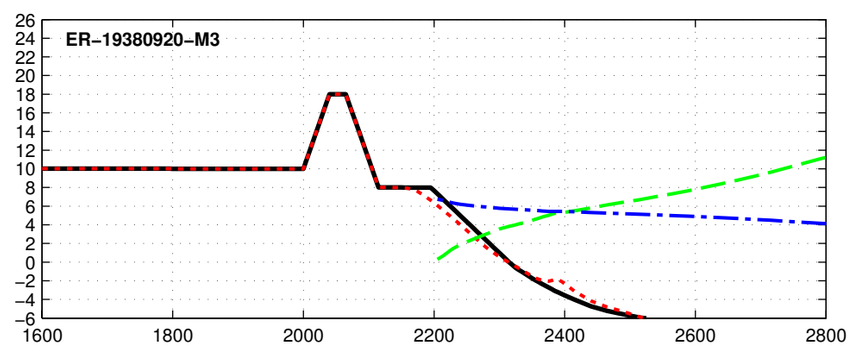


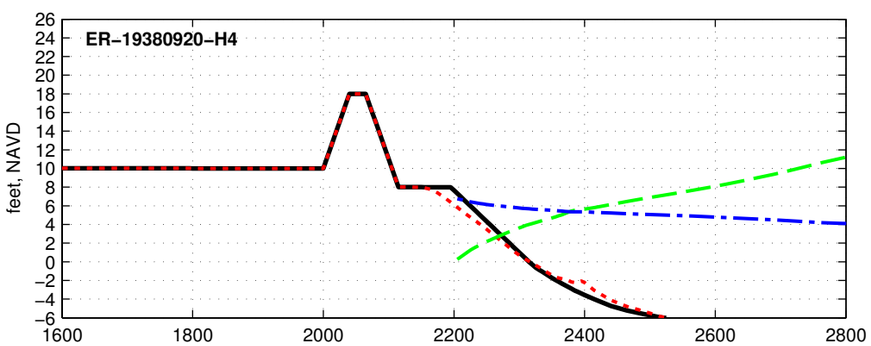


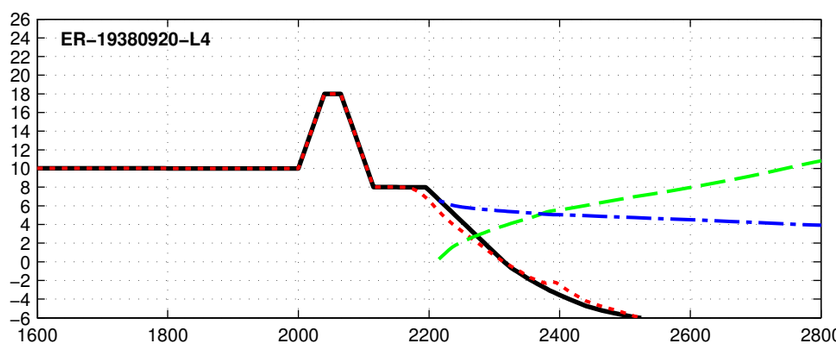


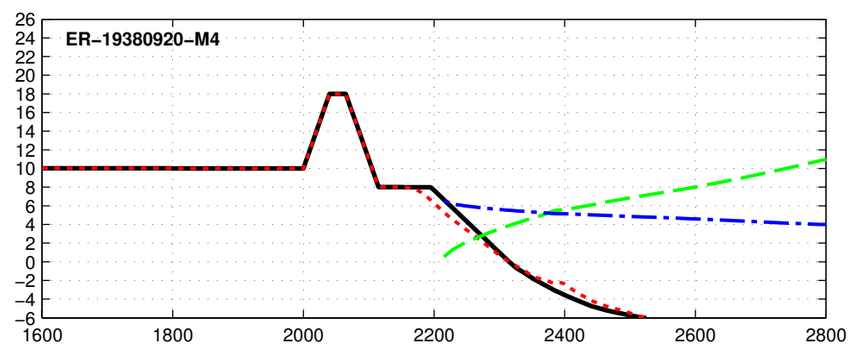










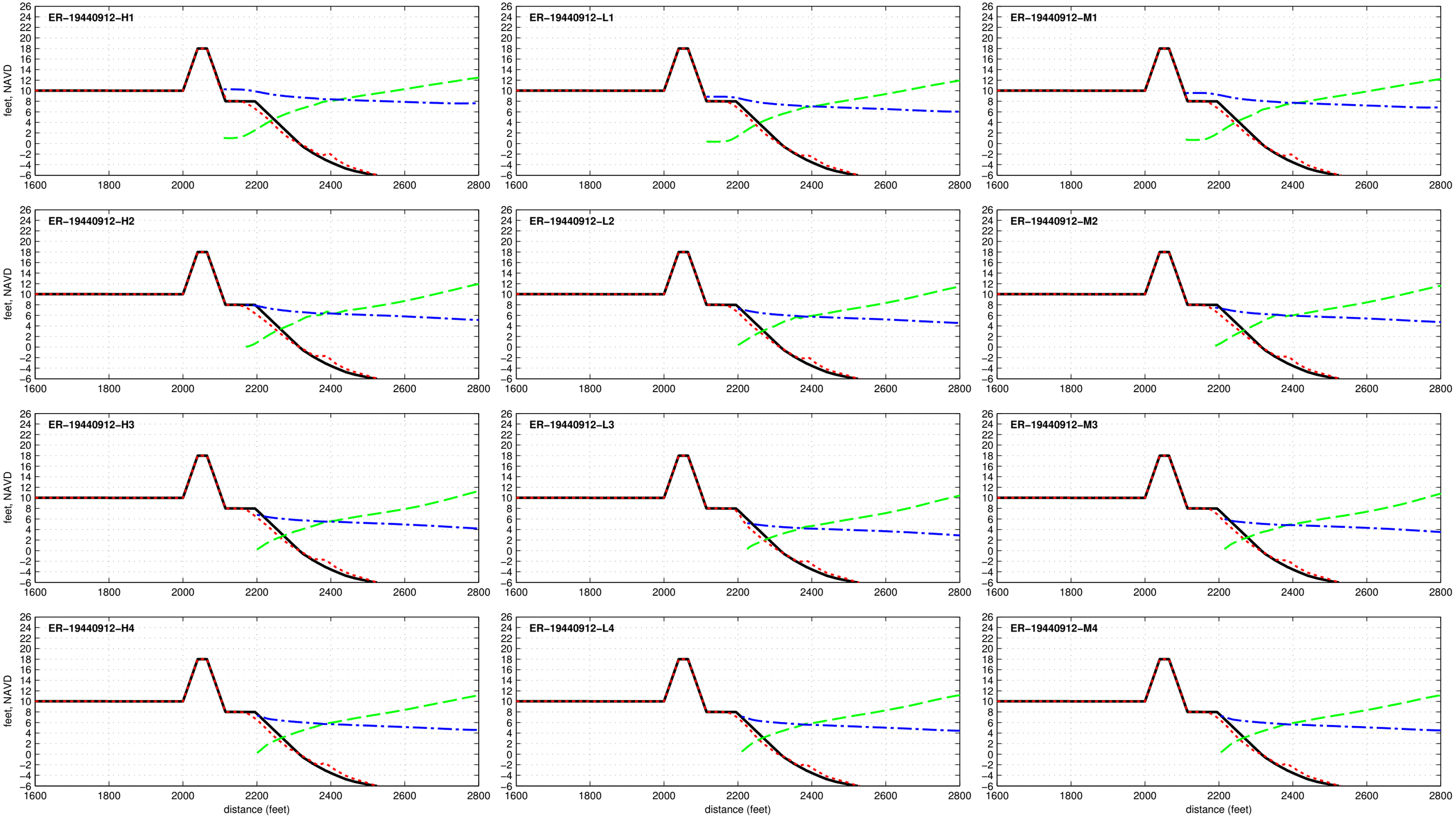


feet, NAVD

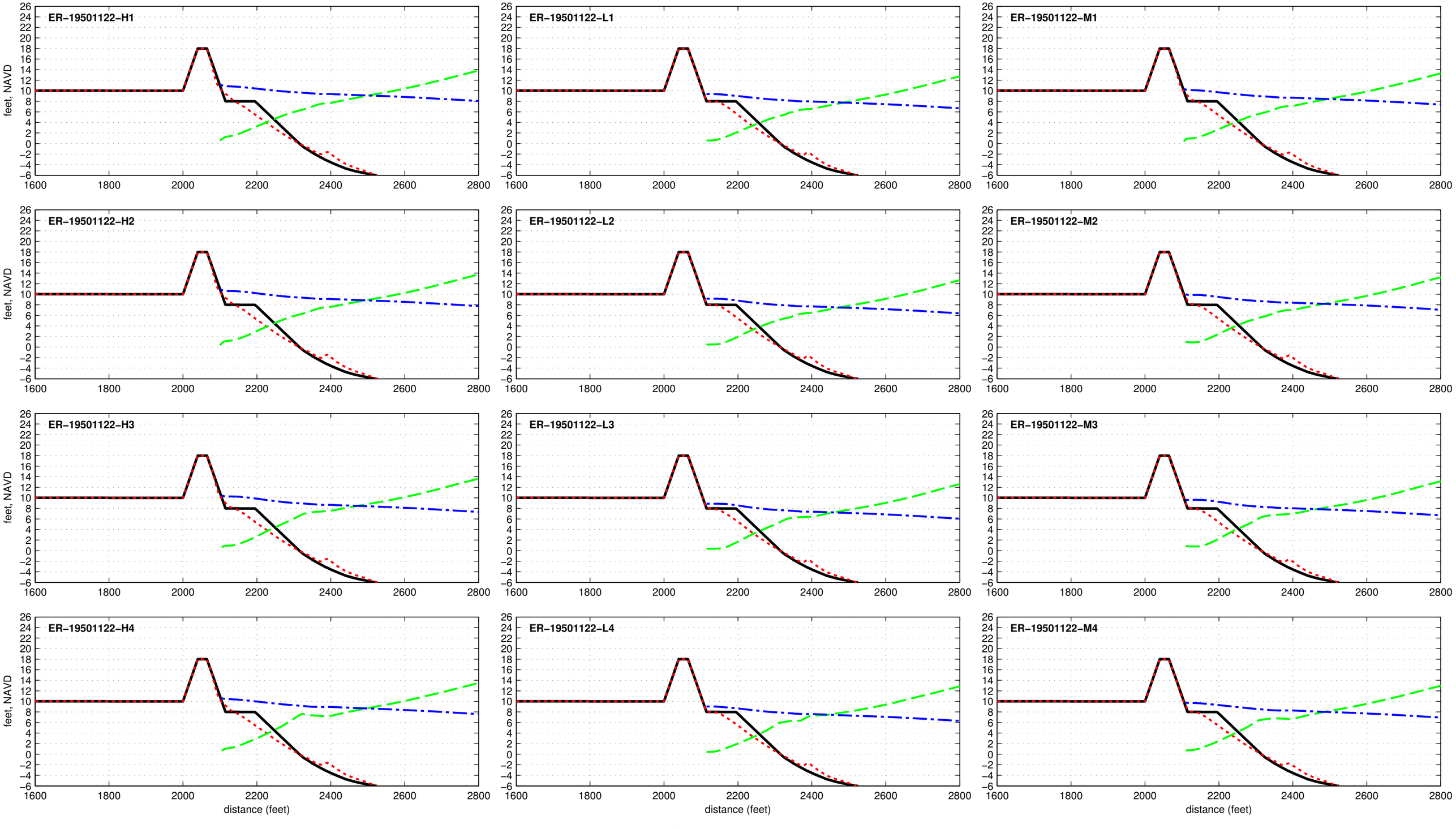
distance (feet)

Initial Final Max Hs Max Water Level

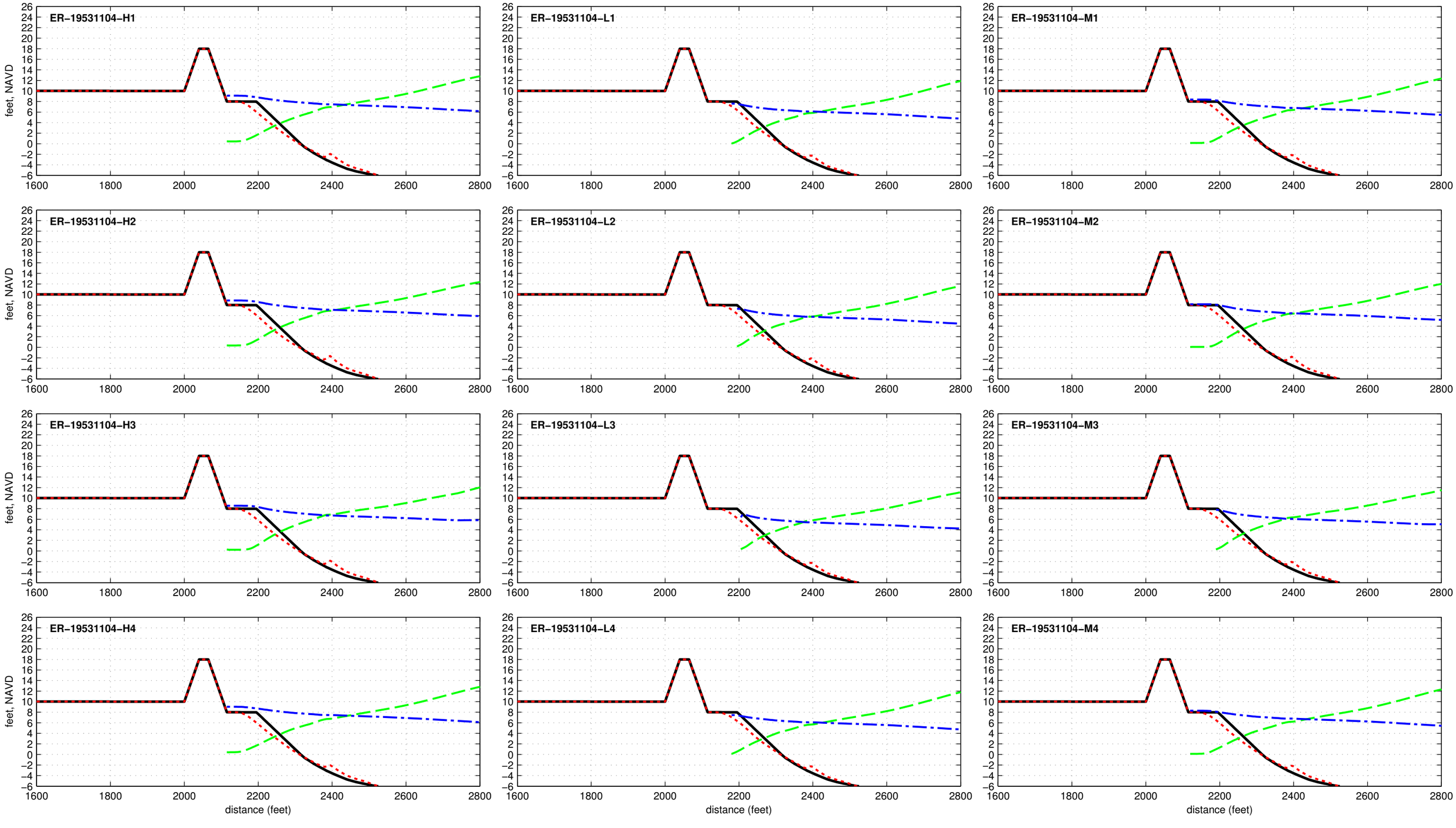
Dune R2T1–18.0–025–080 – ER–19440912



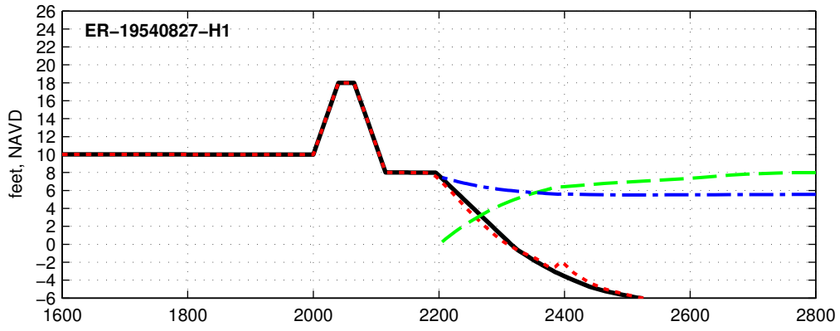
Dune R2T1-18.0-025-080 - ER-19501122

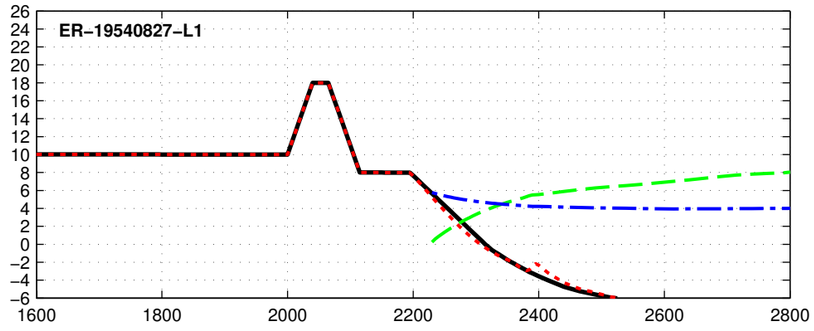


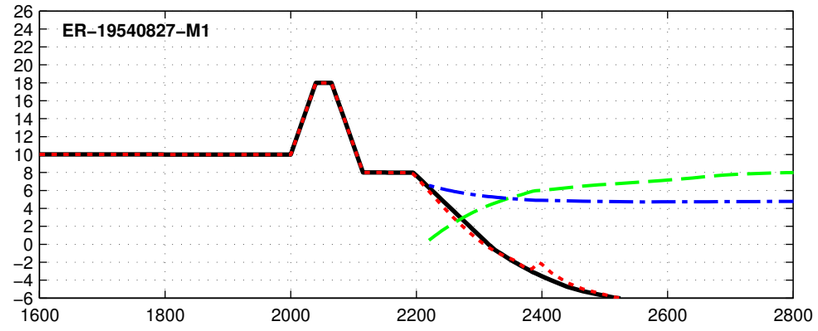
Dune R2T1–18.0–025–080 – ER–19531104

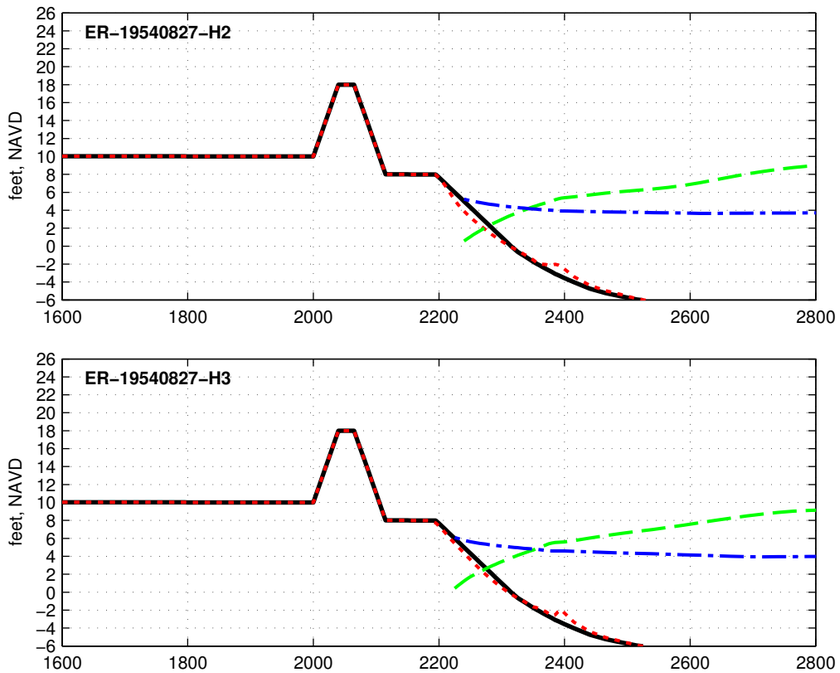


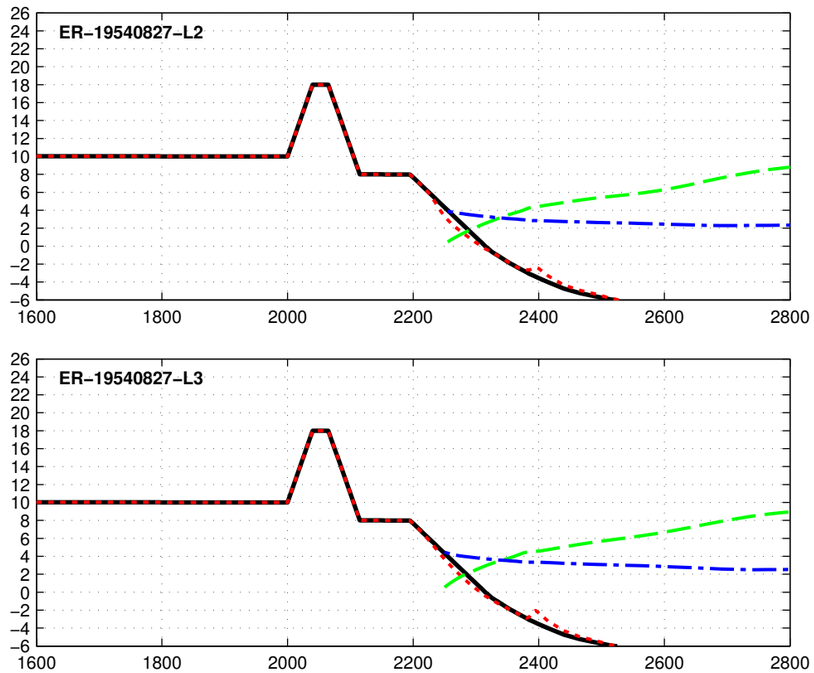
Dune R2T1-18.0-025-080 - ER-19540827

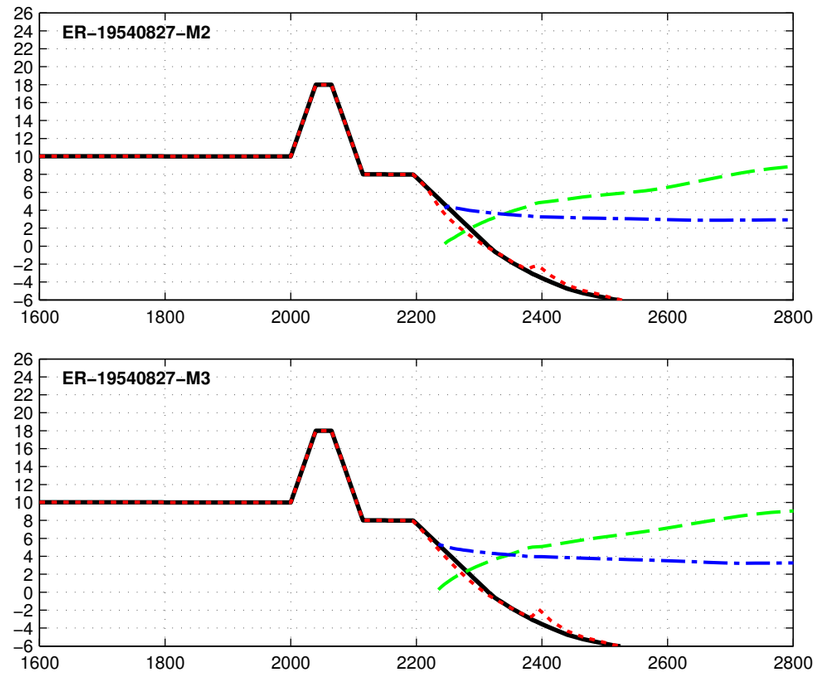


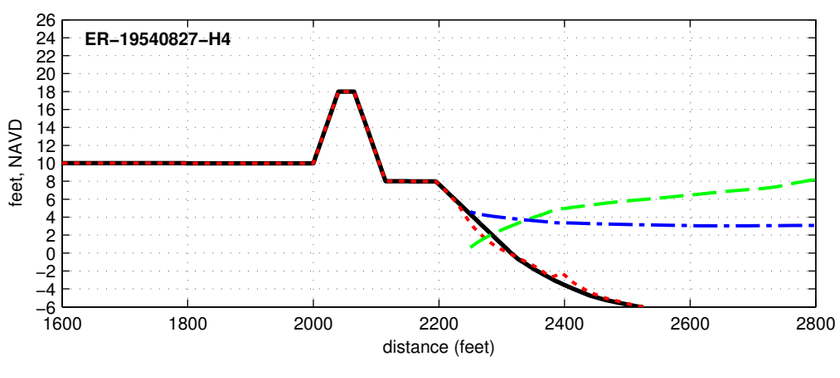


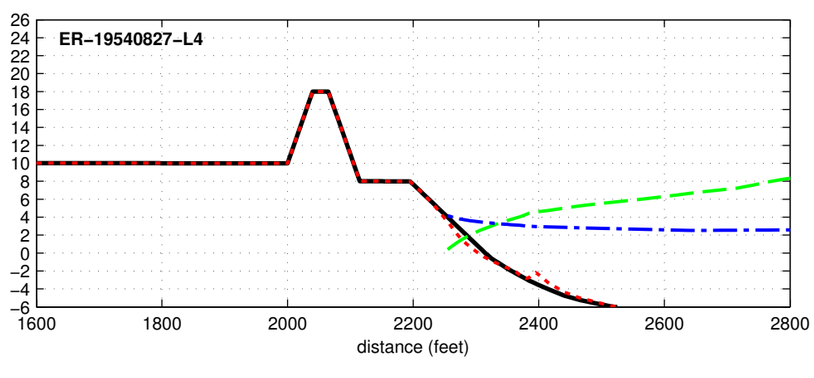


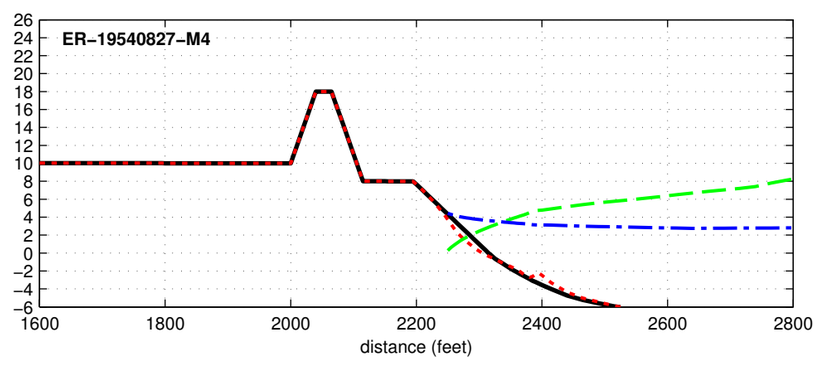






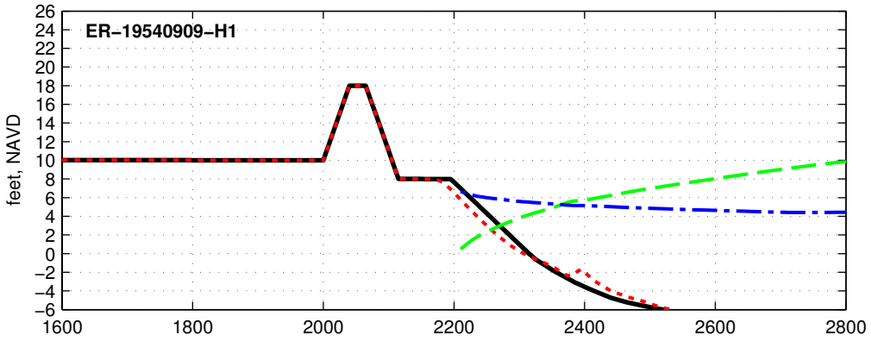


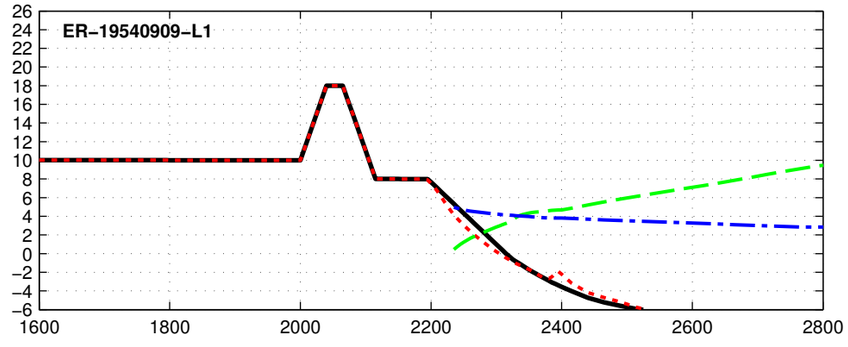


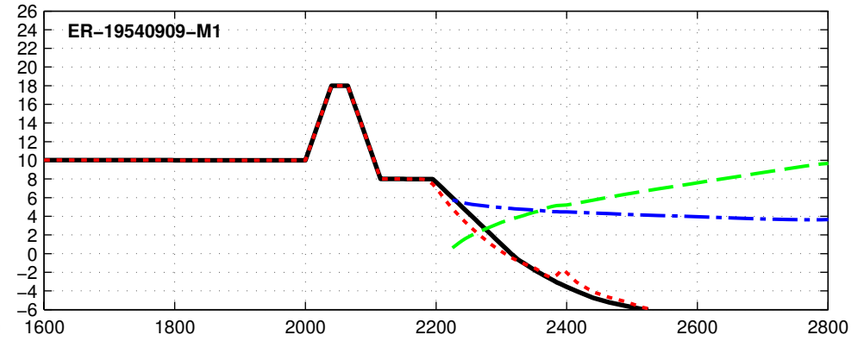


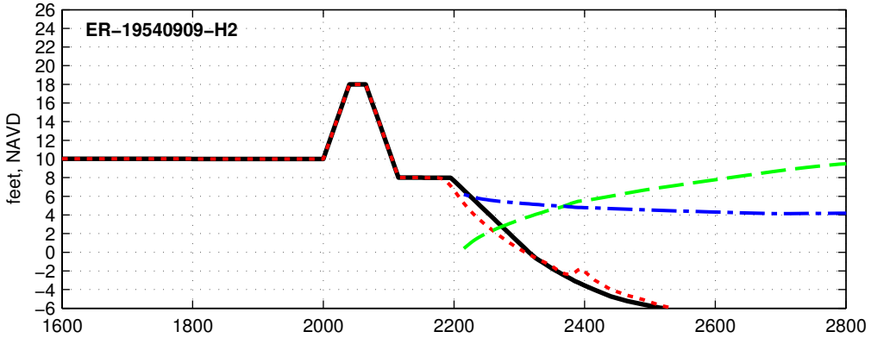
Initial Final Max Hs Max Water Level

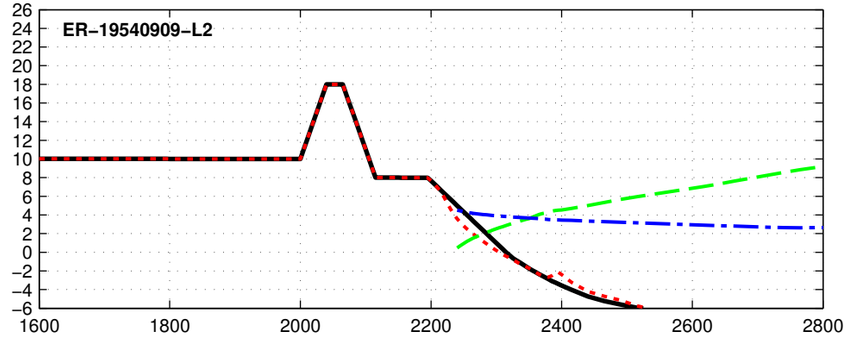
Dune R2T1-18.0-025-080 - ER-19540909

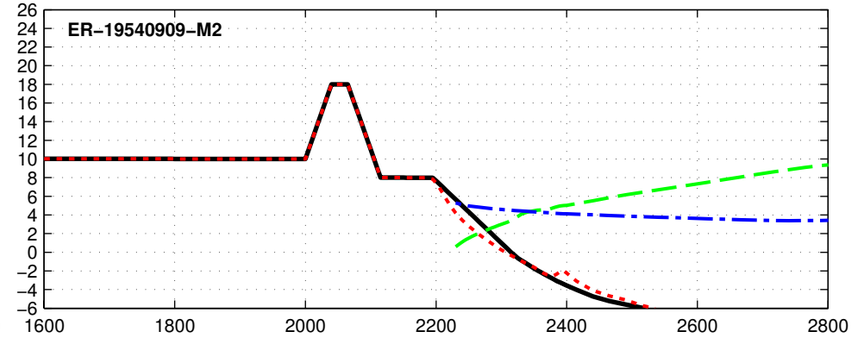


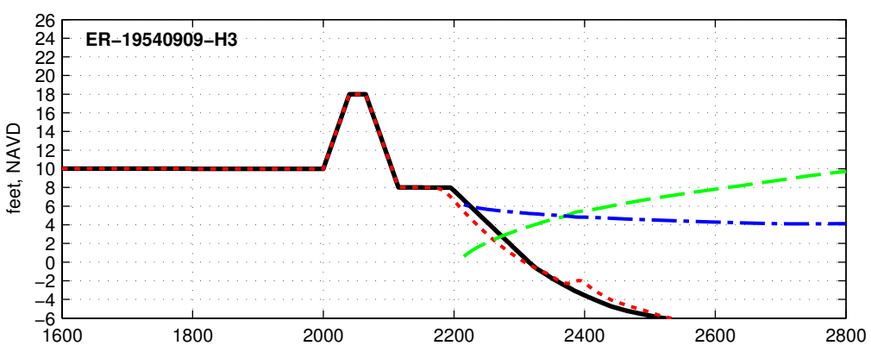


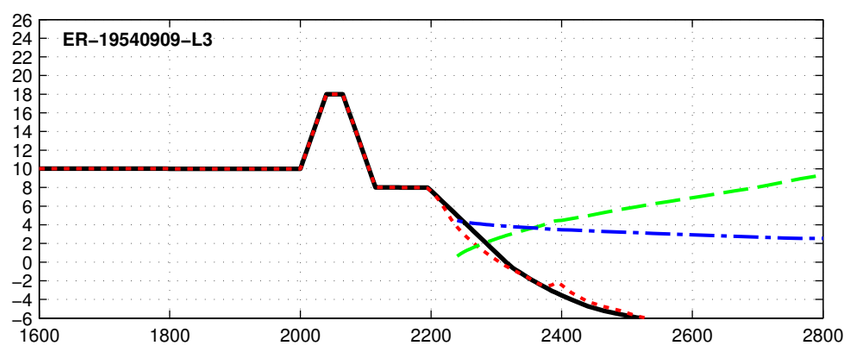


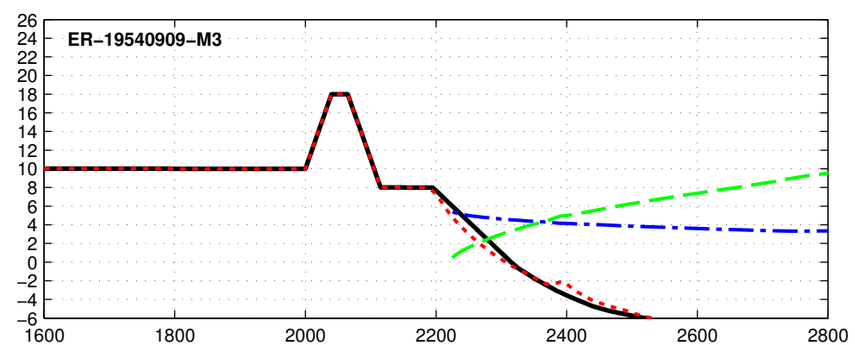


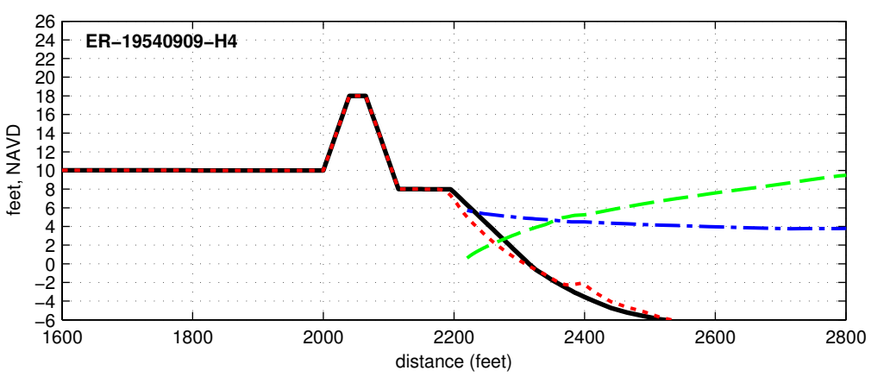


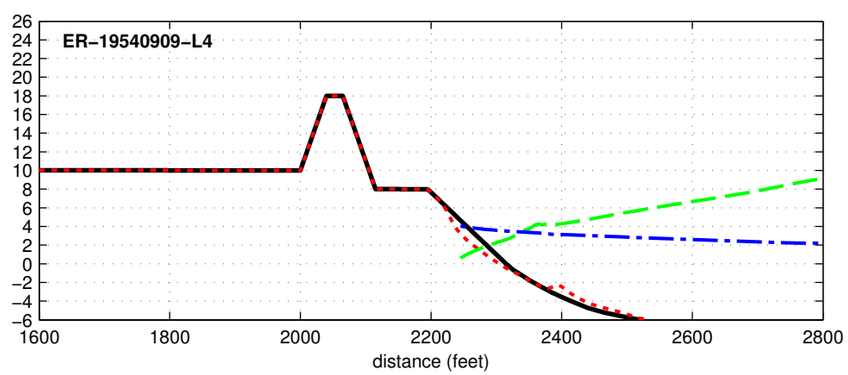


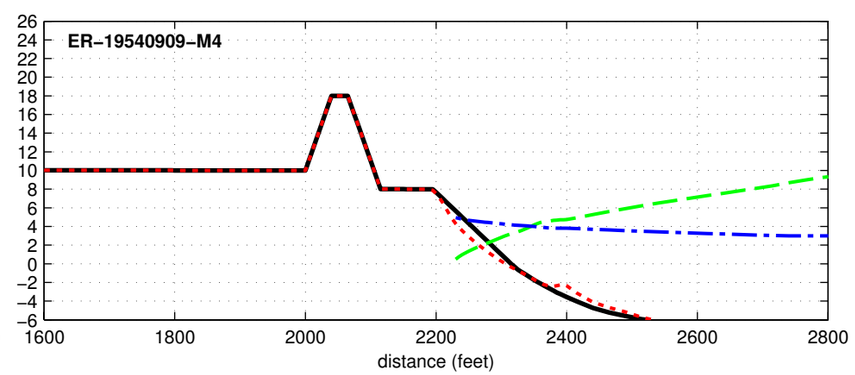






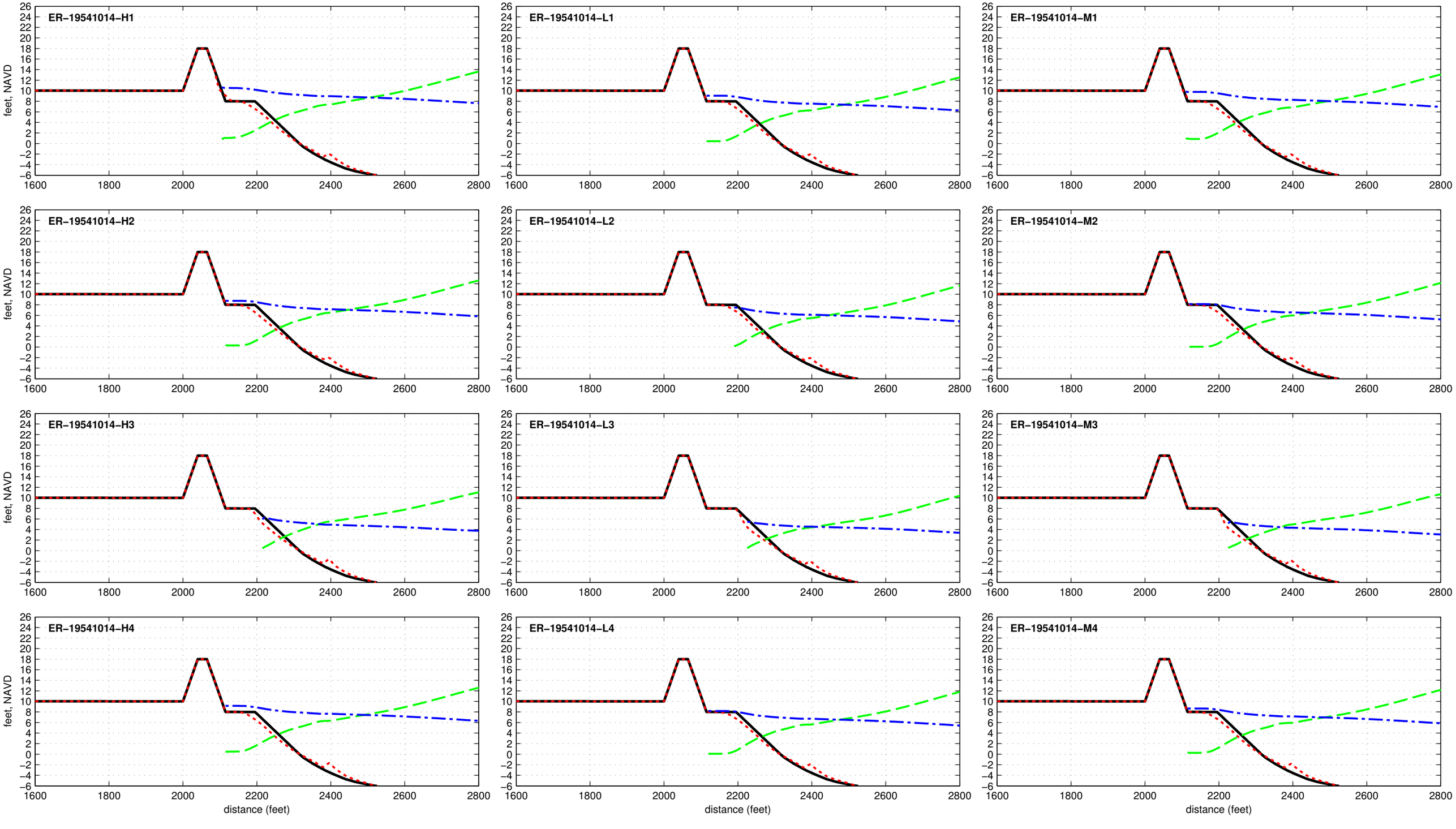




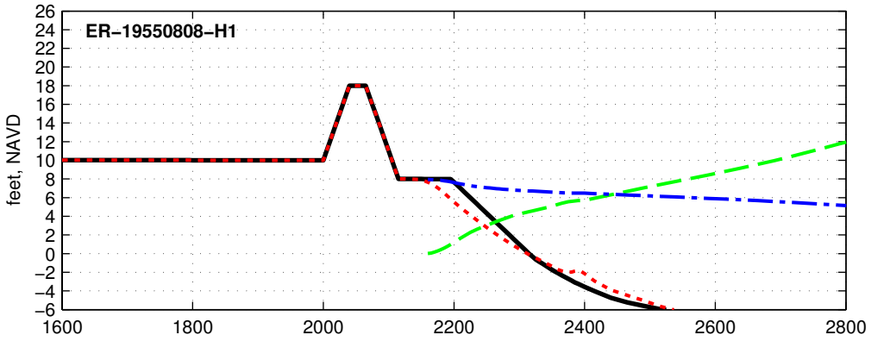


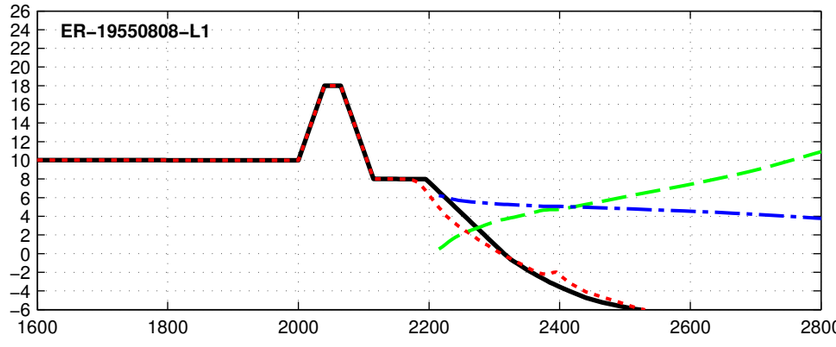
Initial Final Max Hs Max Water Level

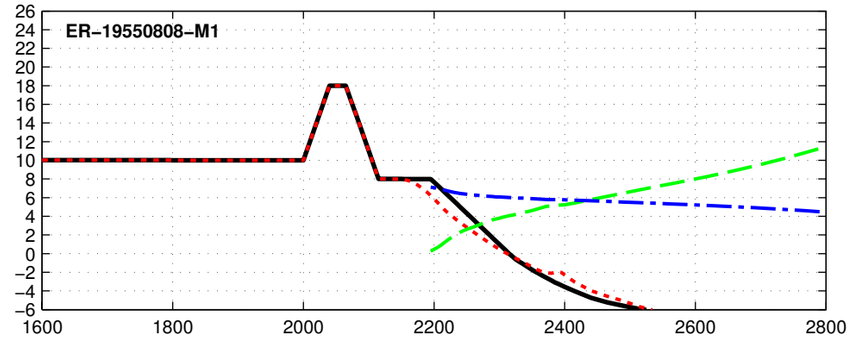
Dune R2T1-18.0-025-080 - ER-19541014

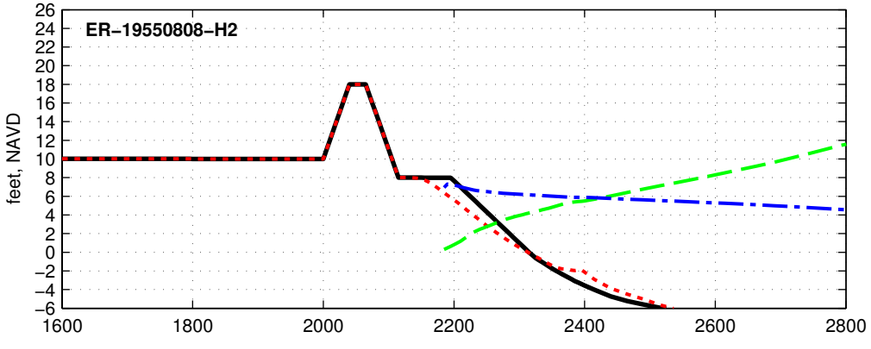


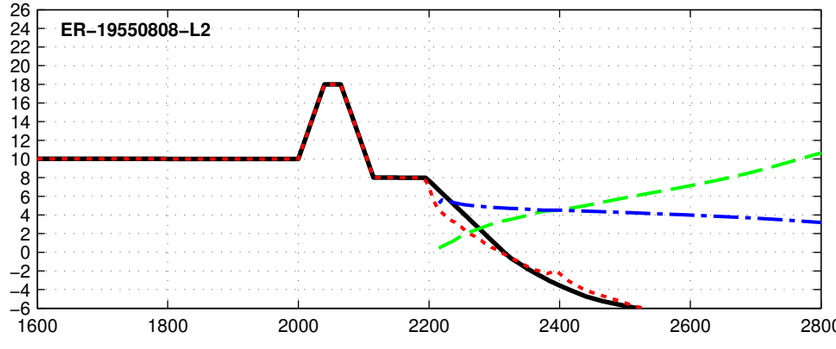
Dune R2T1-18.0-025-080 - ER-19550808

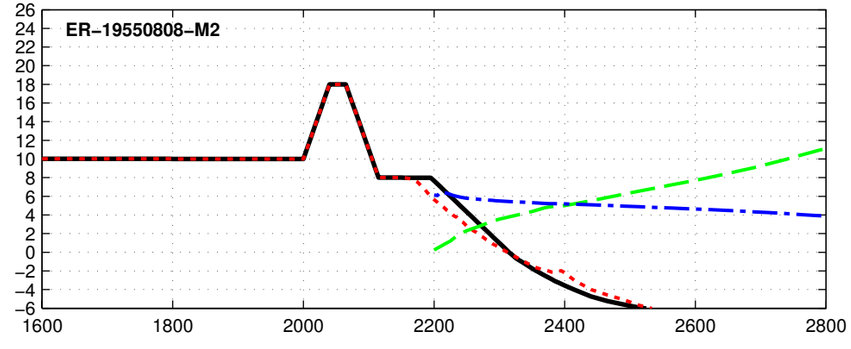


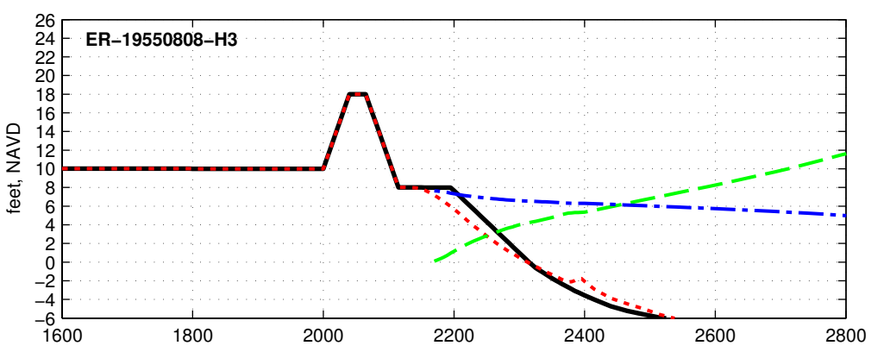


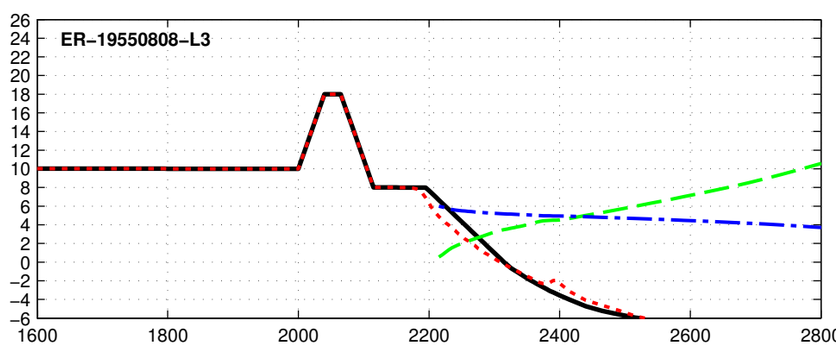


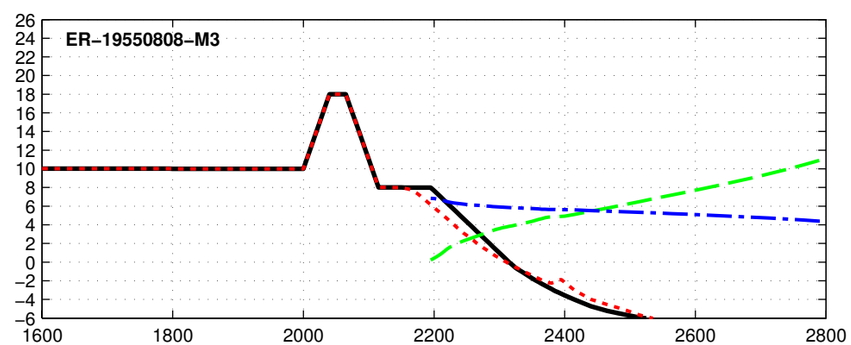


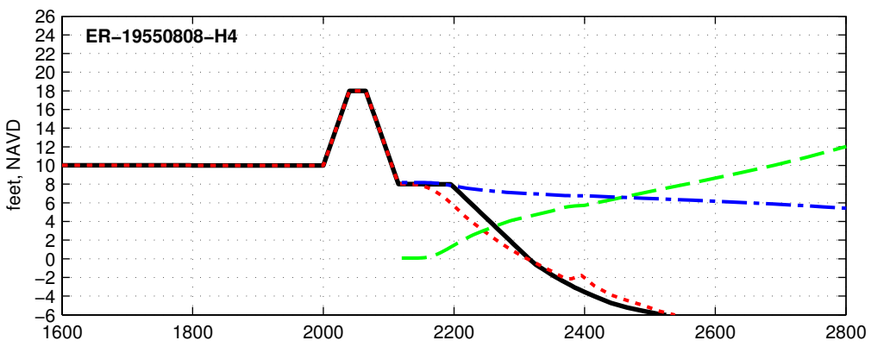


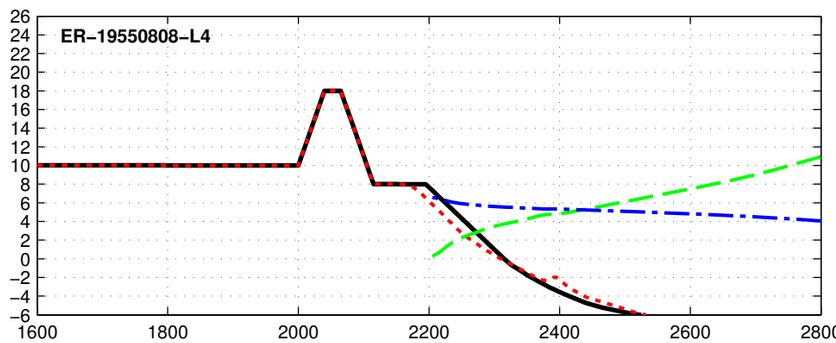


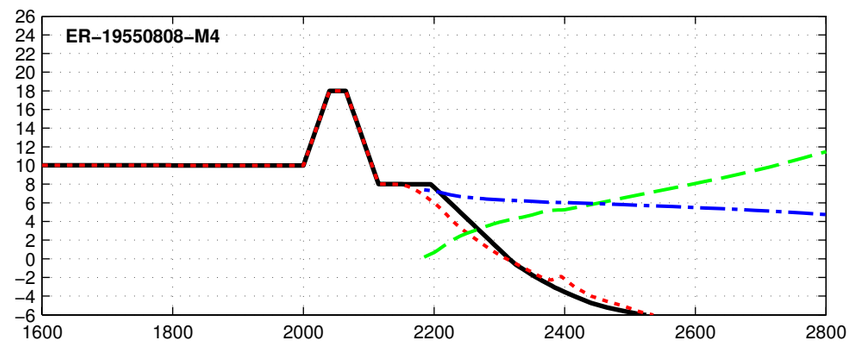






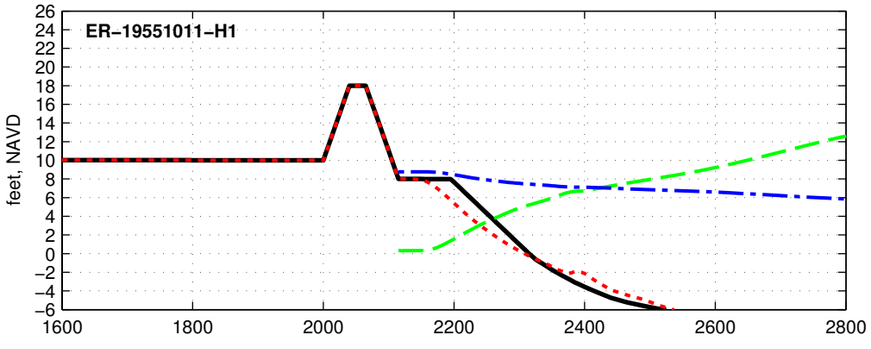


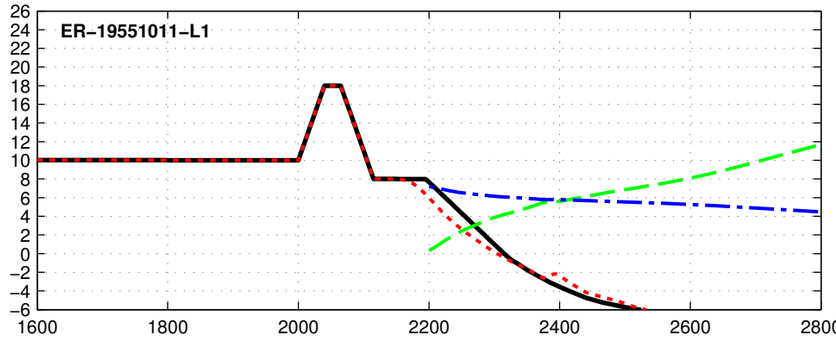


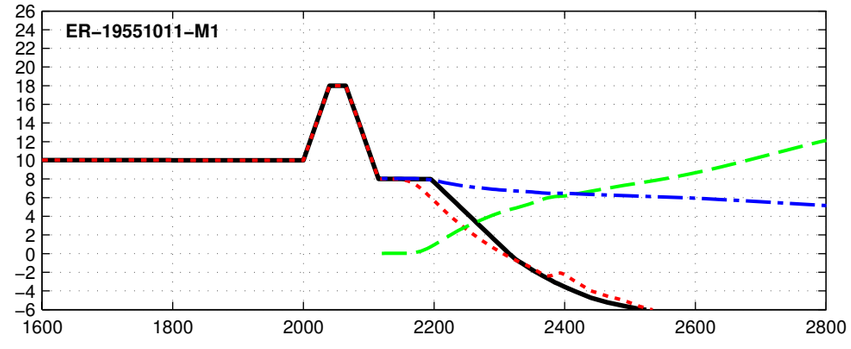


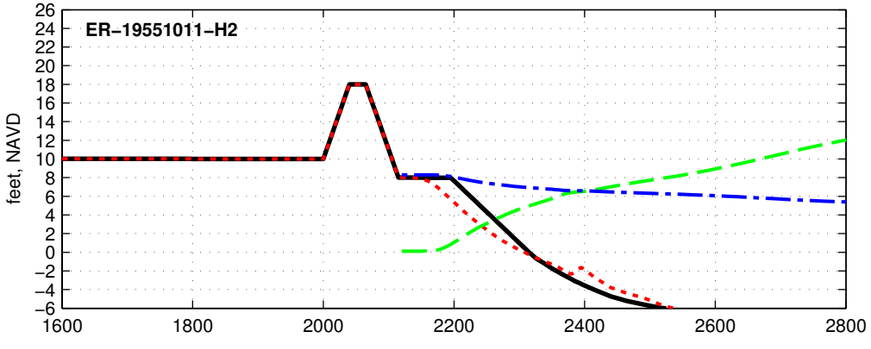
Initial Final Max Hs Max Water Level

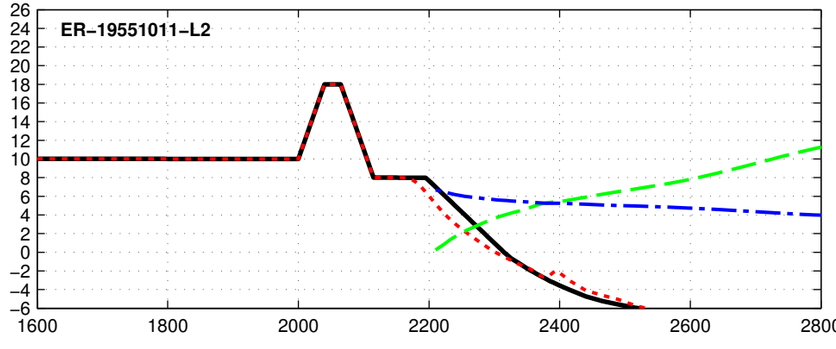
Dune R2T1-18.0-025-080 - ER-19551011

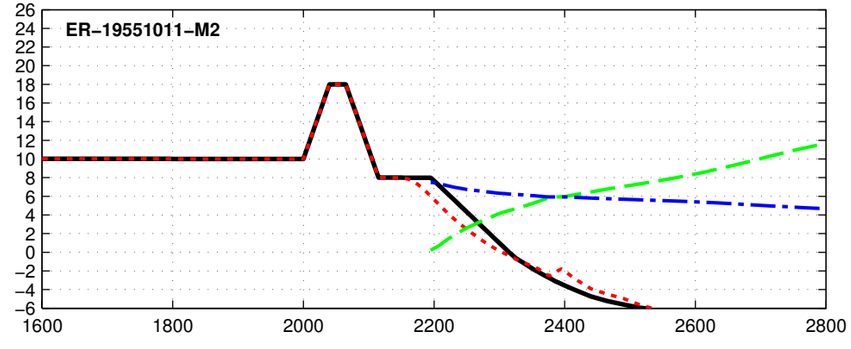


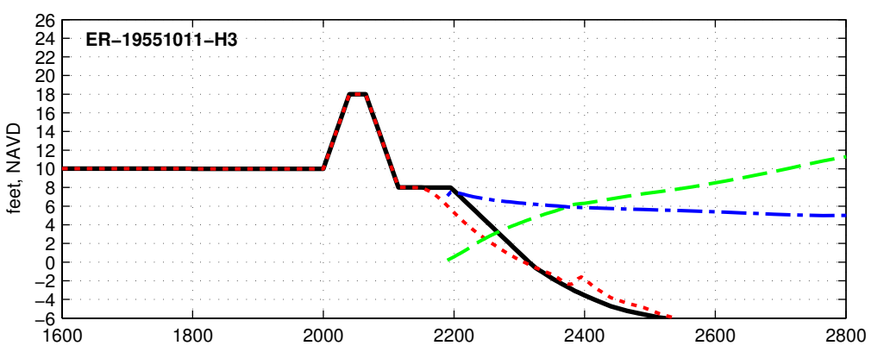


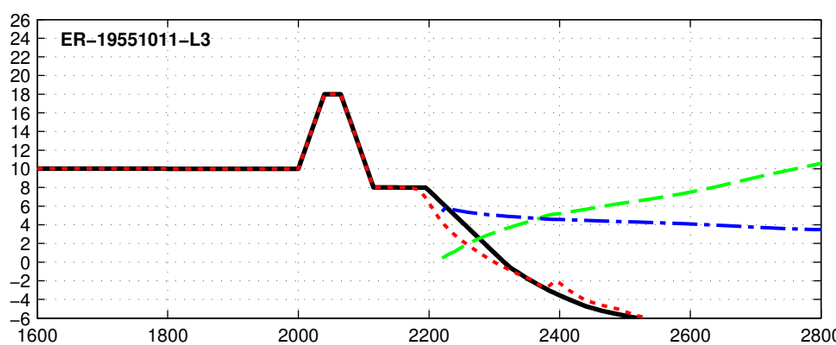


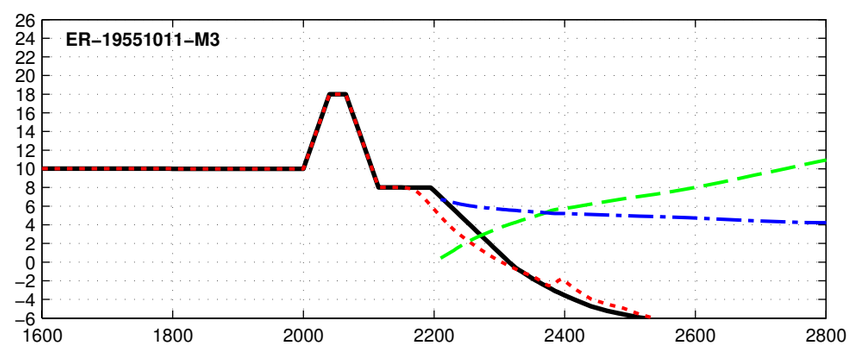


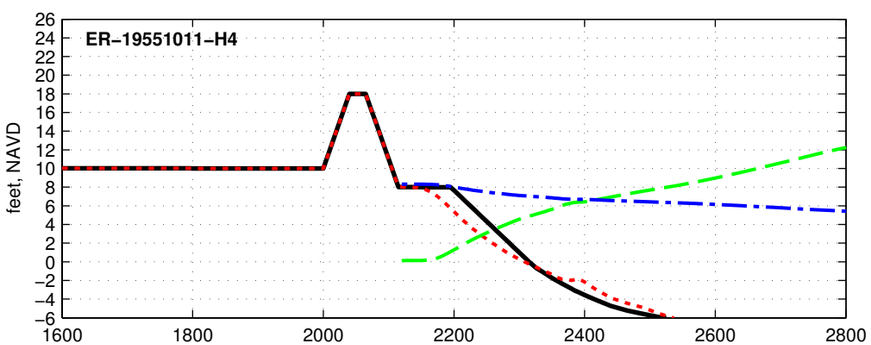


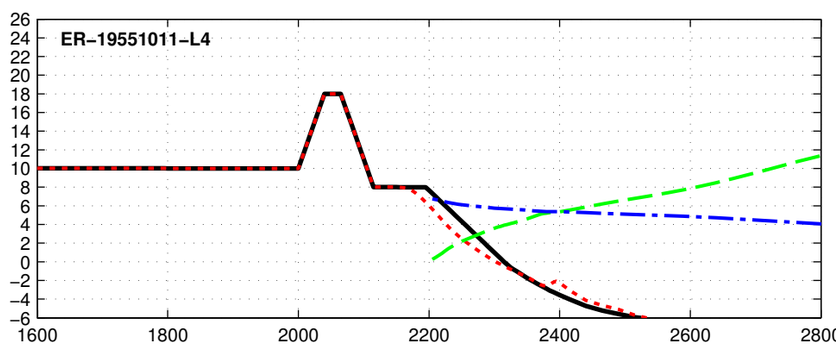


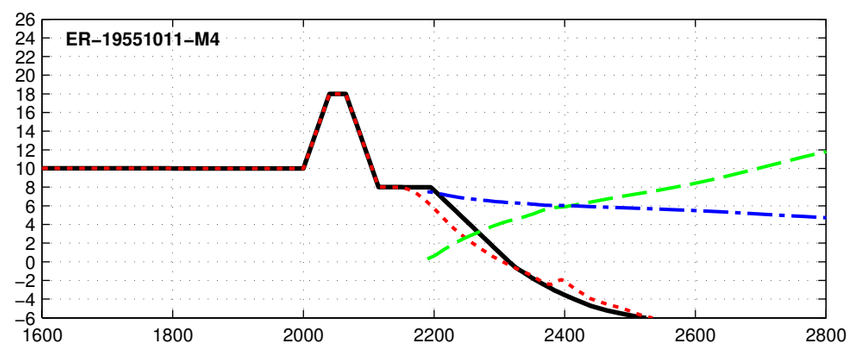






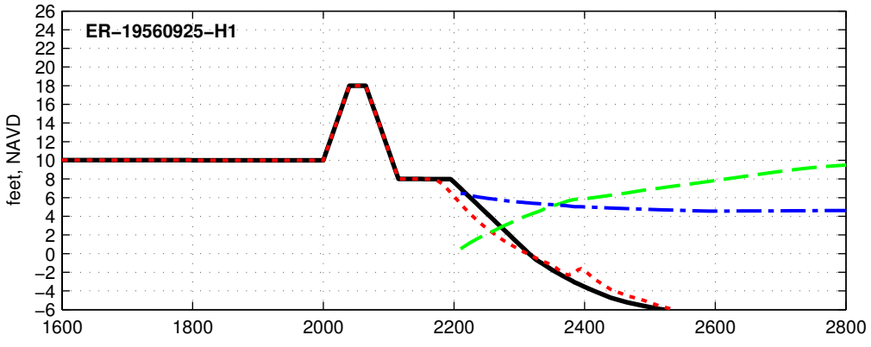


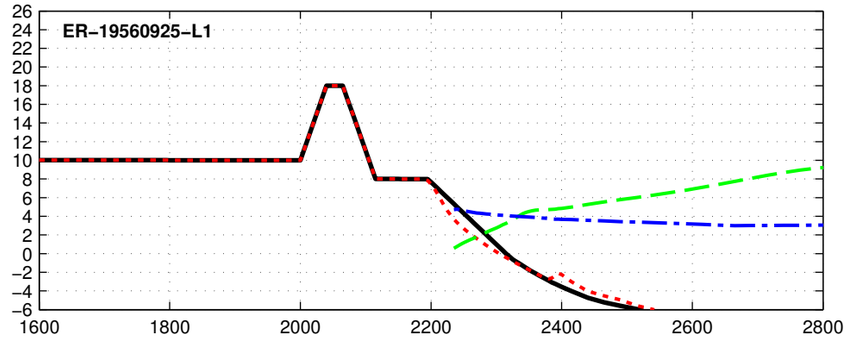


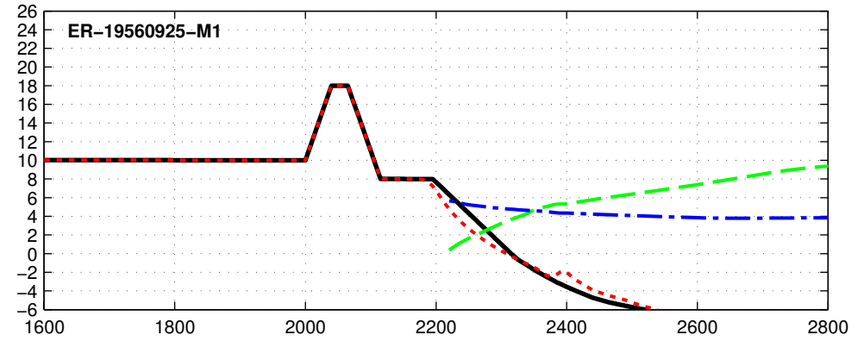


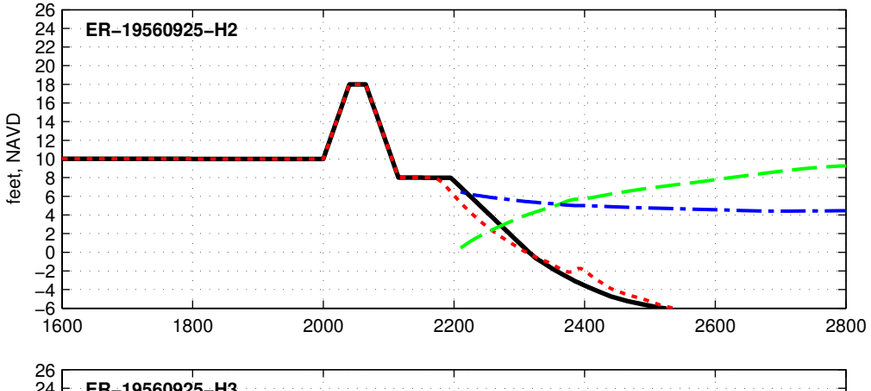
Initial Final Max Hs Max Water Level

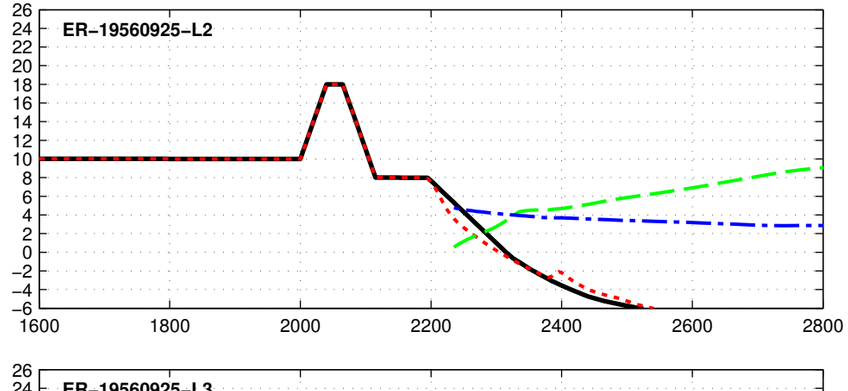
Dune R2T1-18.0-025-080 - ER-19560925

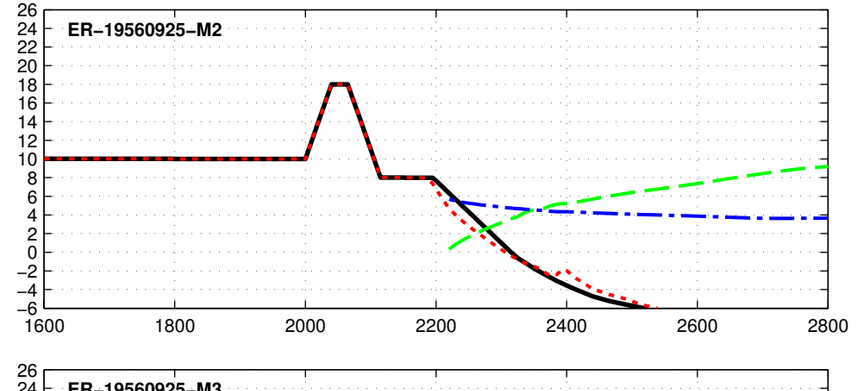


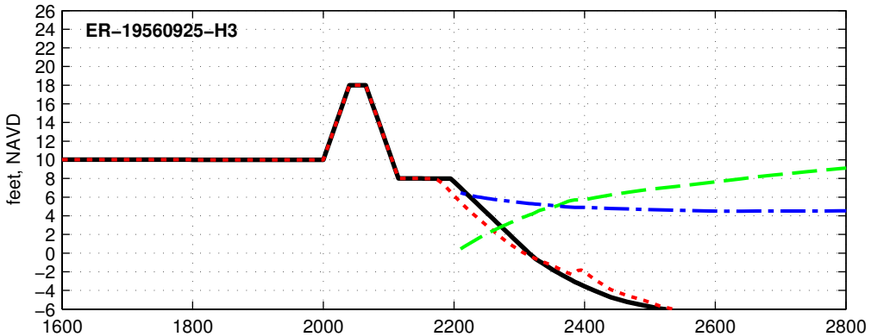


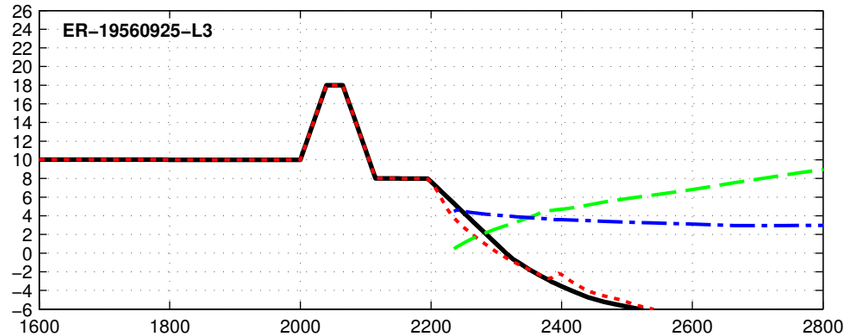


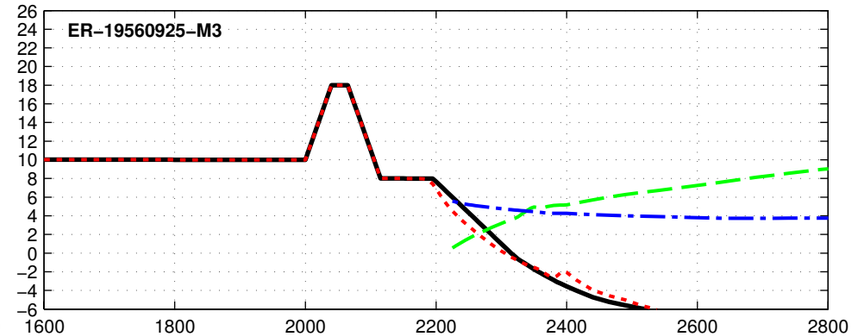


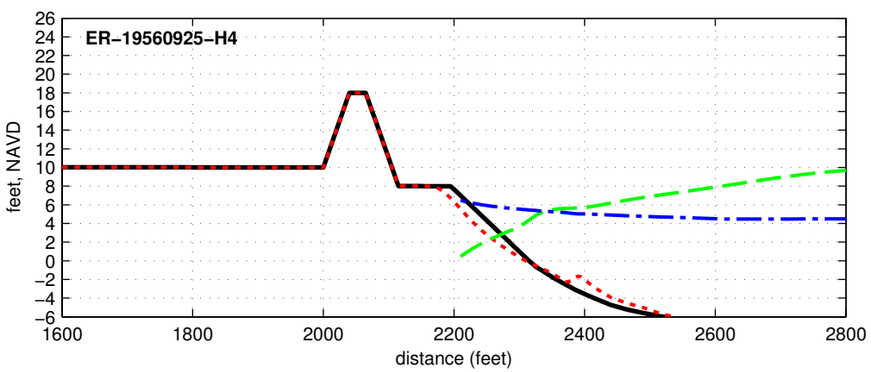


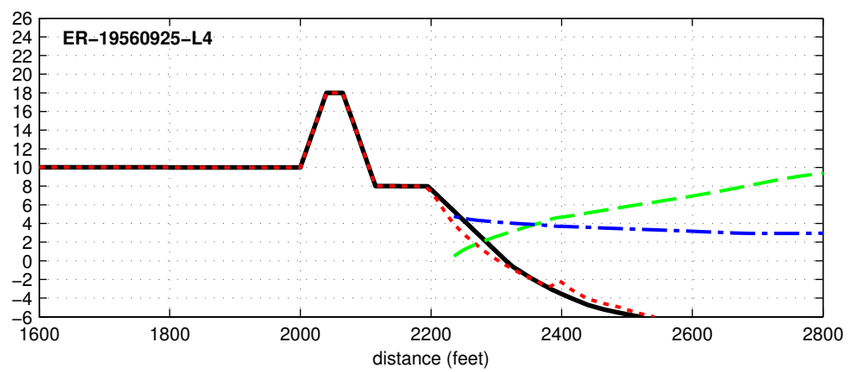


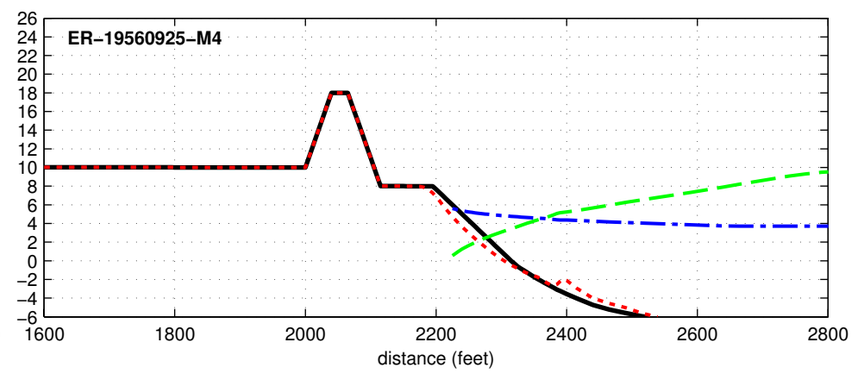






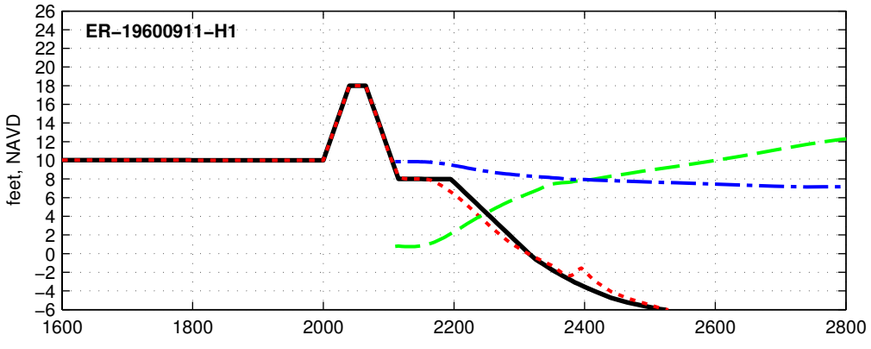


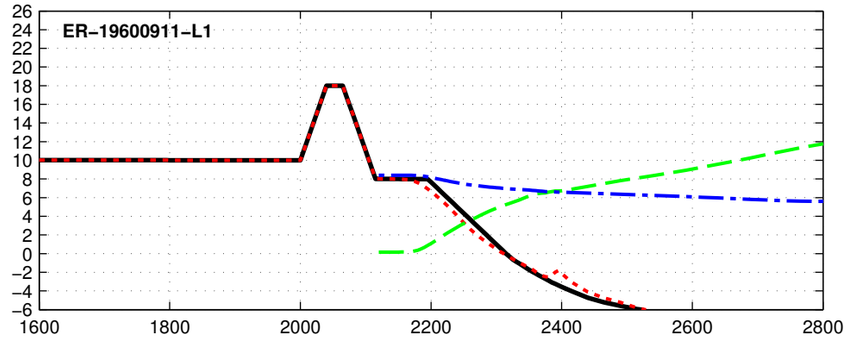


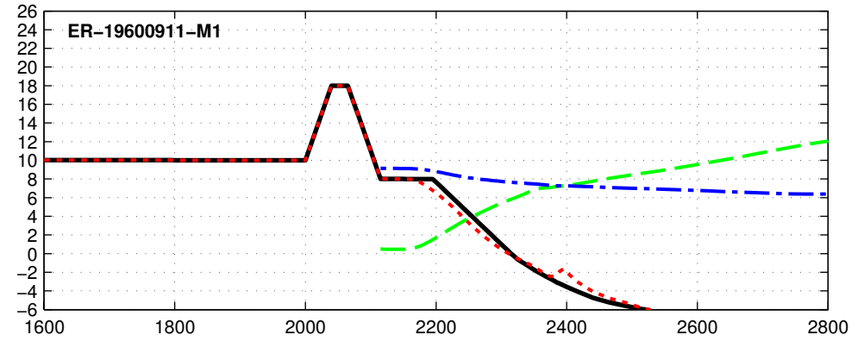


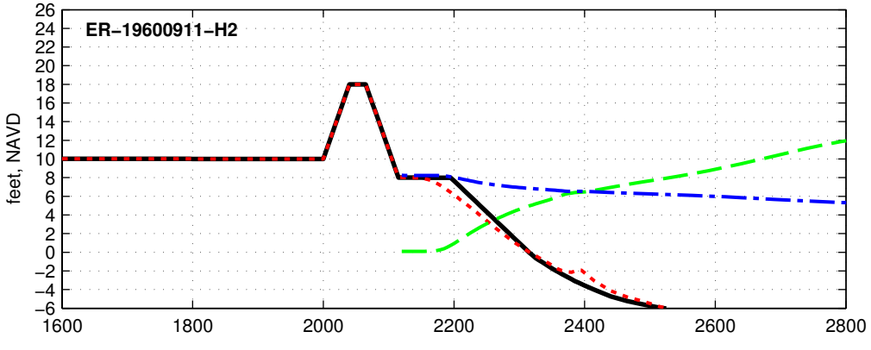
Initial Final Max Hs Max Water Level

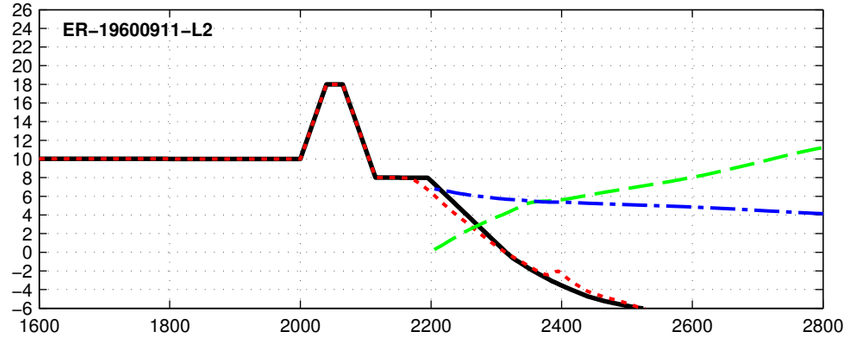
Dune R2T1-18.0-025-080 - ER-19600911

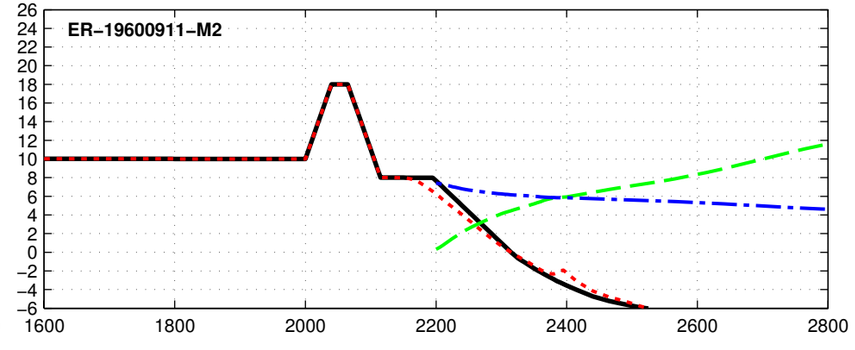


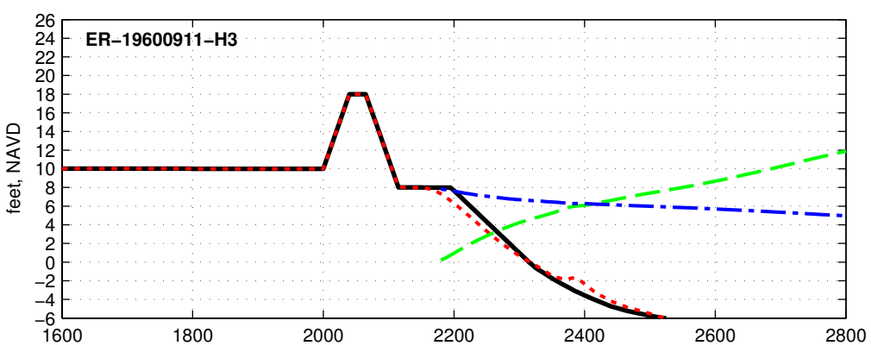


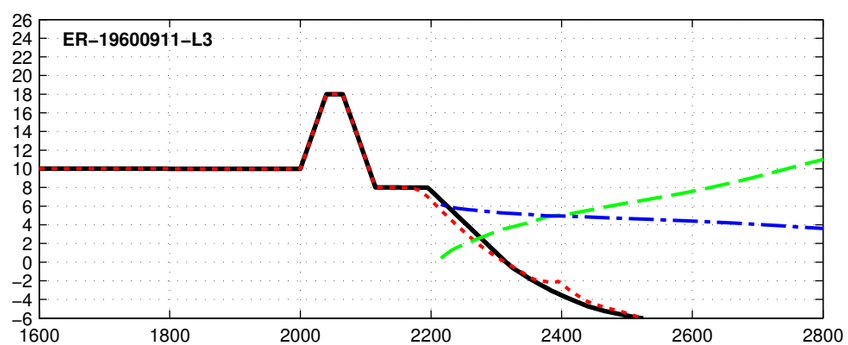


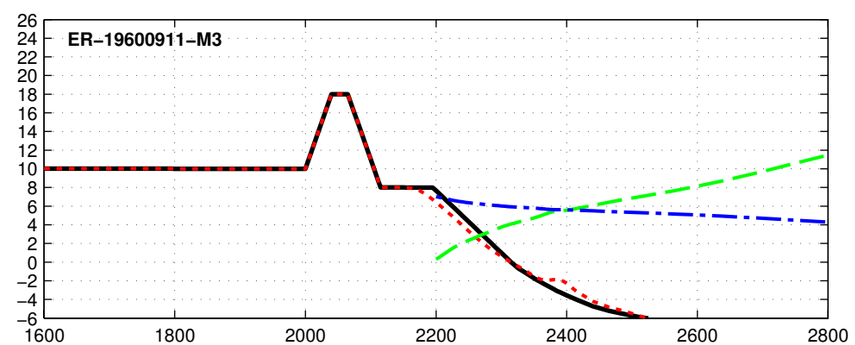


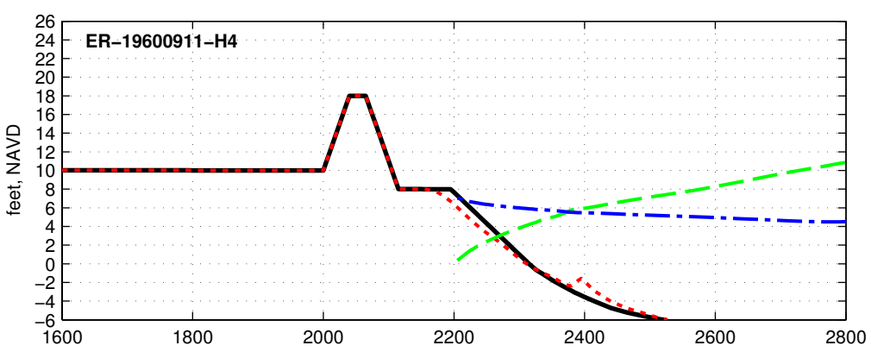


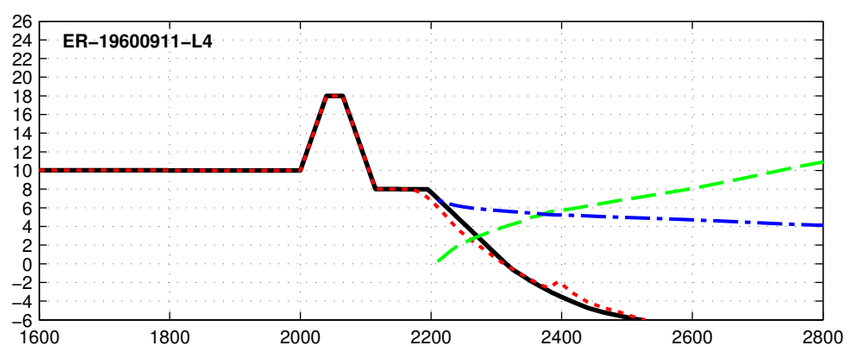


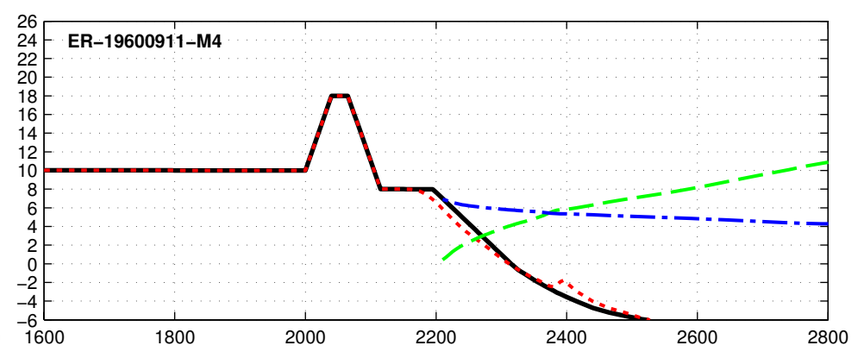






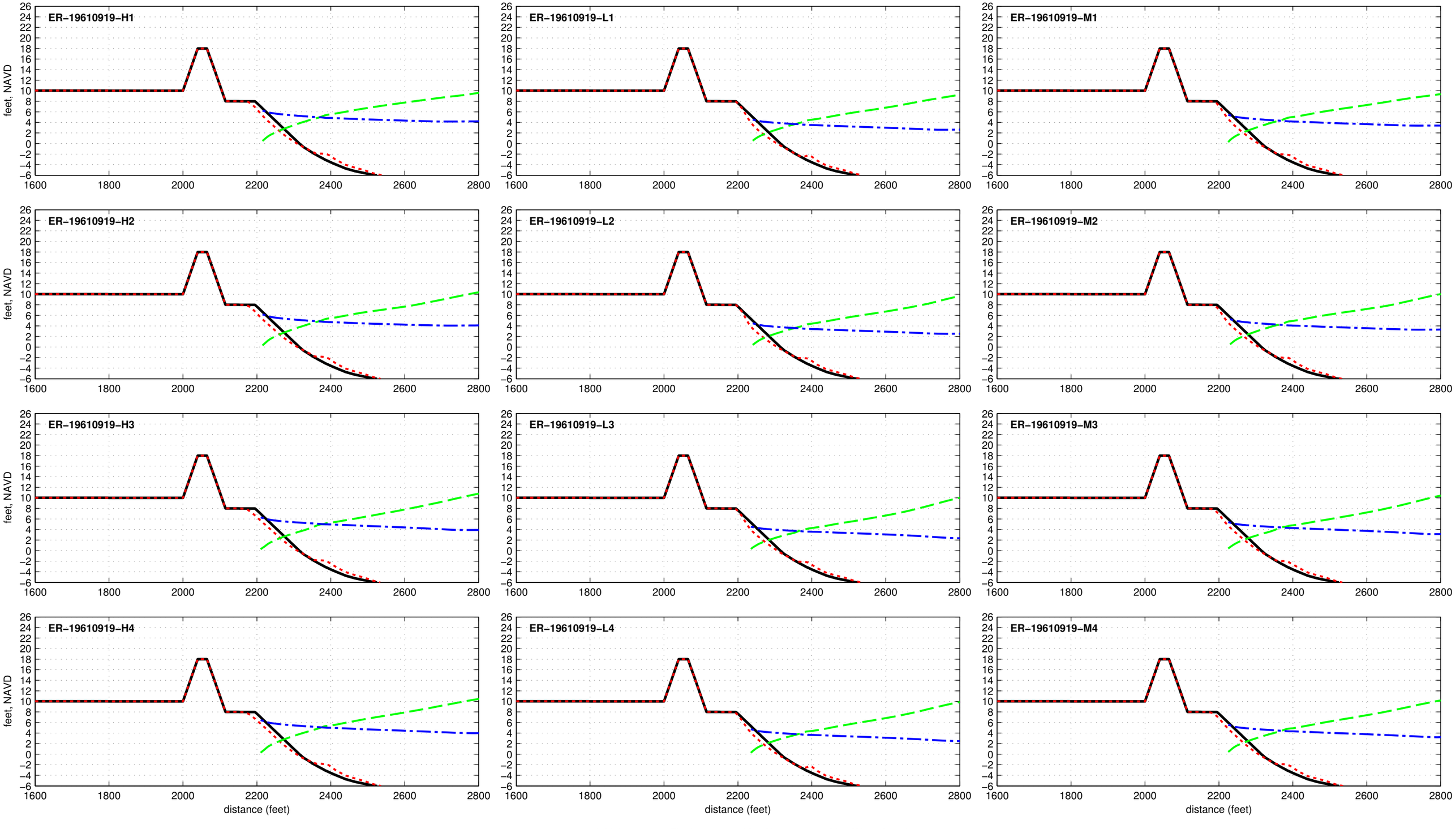




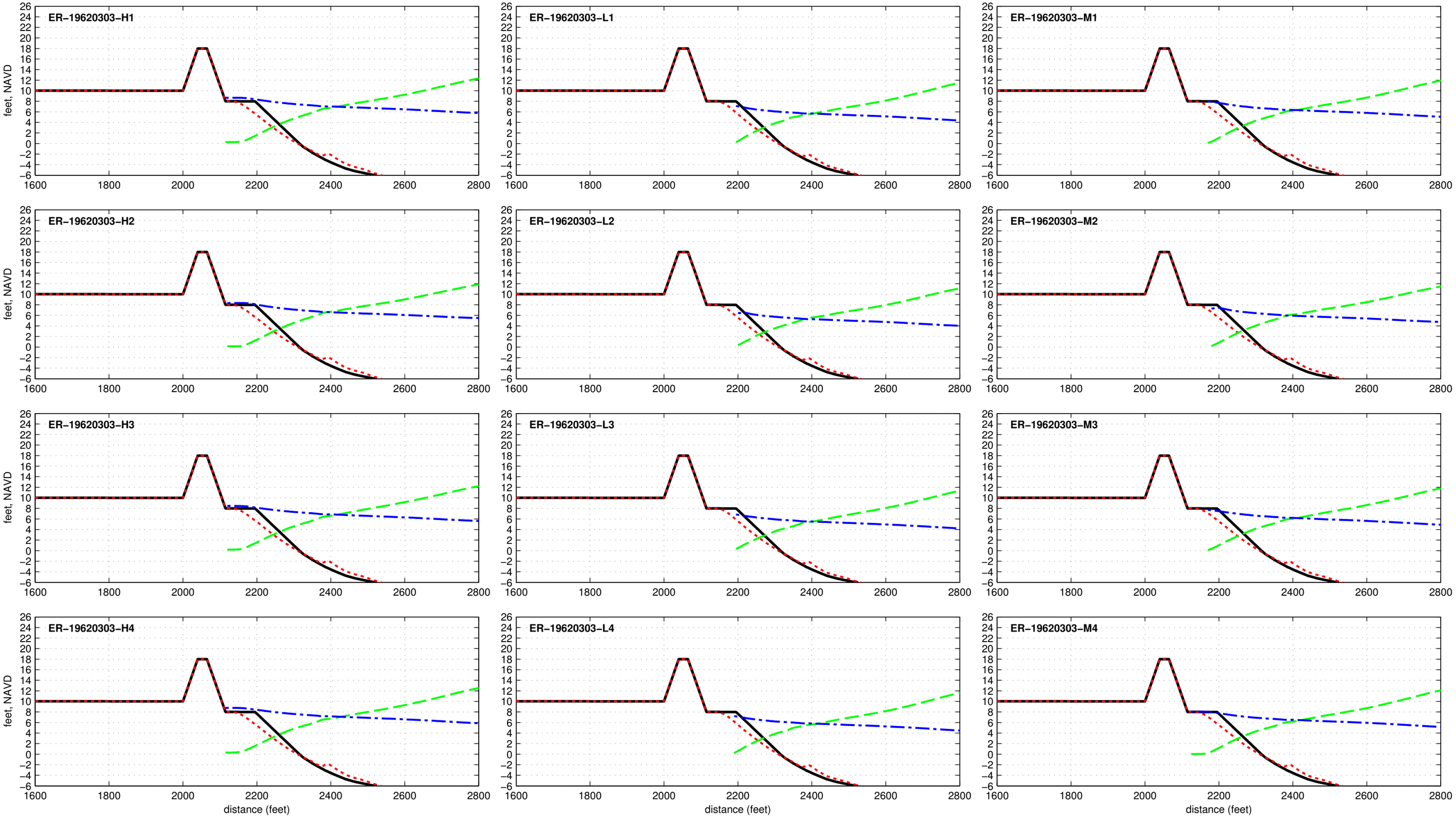


Initial Final Max Hs Max Water Level

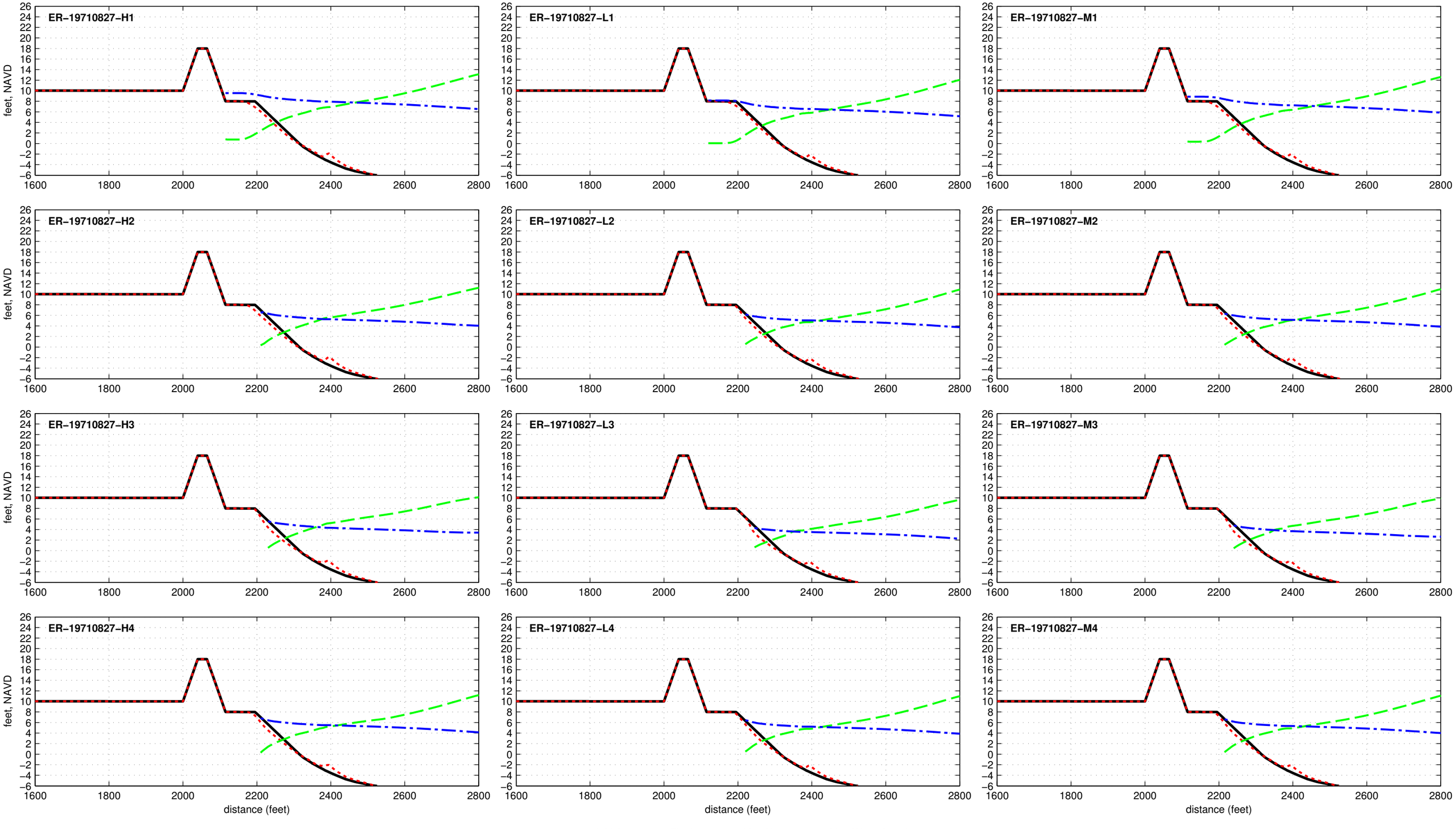
Dune R2T1-18.0-025-080 - ER-19610919



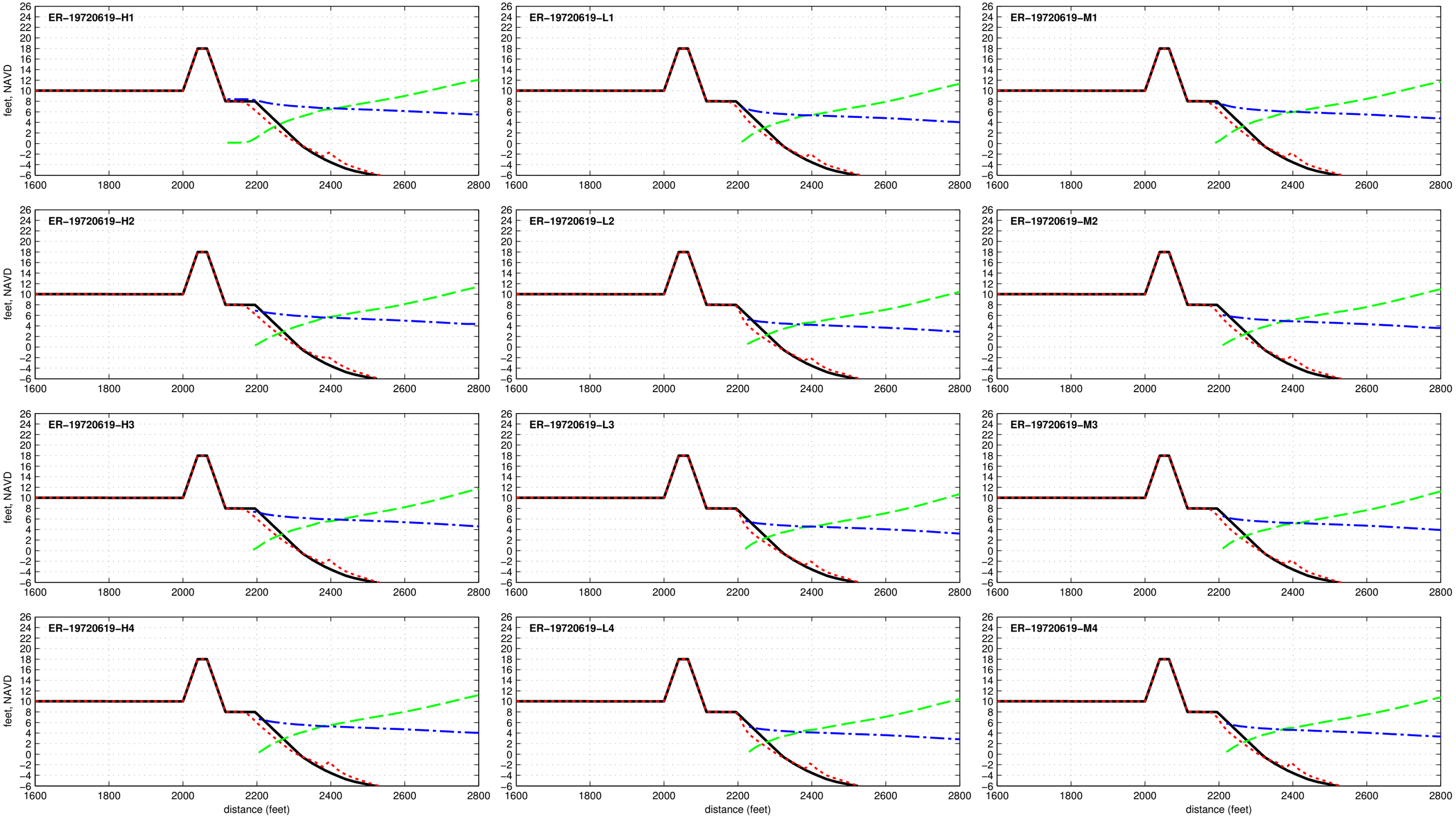
Dune R2T1-18.0-025-080 - ER-19620303



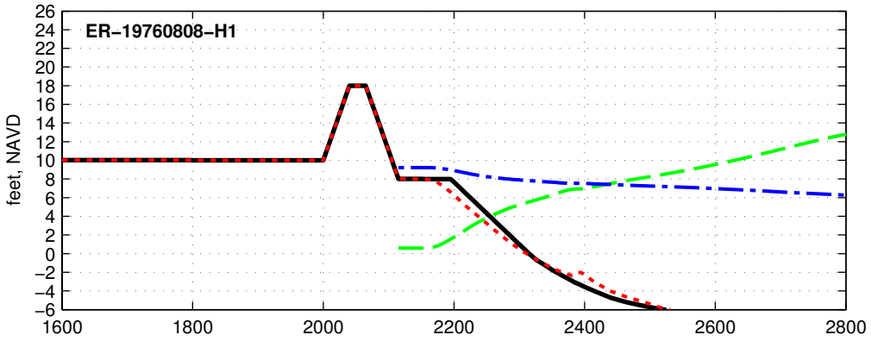
Dune R2T1-18.0-025-080 - ER-19710827

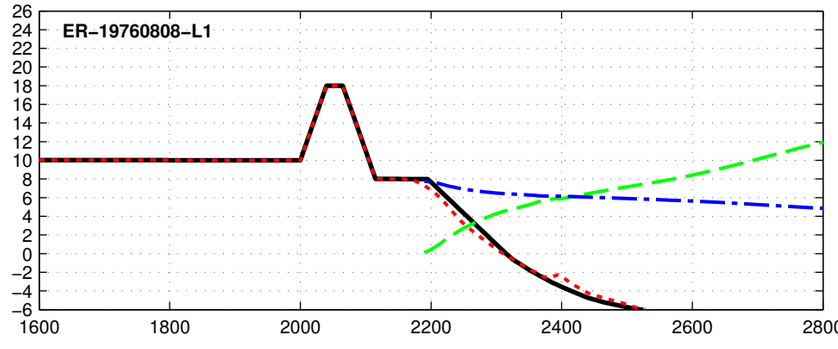


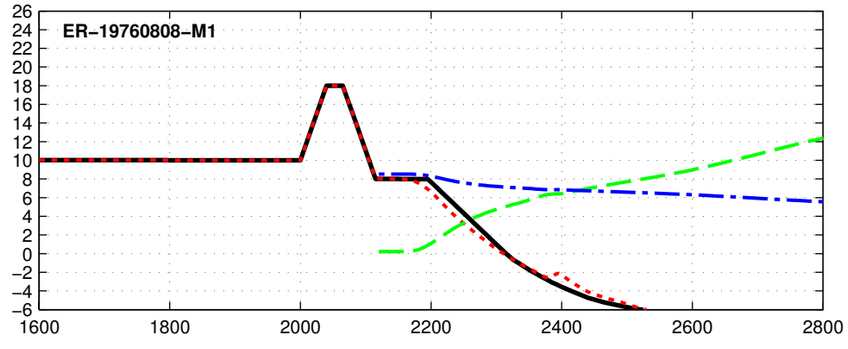
Dune R2T1-18.0-025-080 - ER-19720619

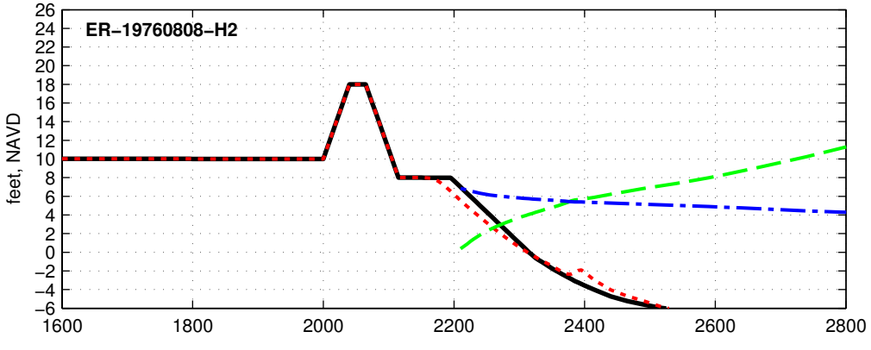


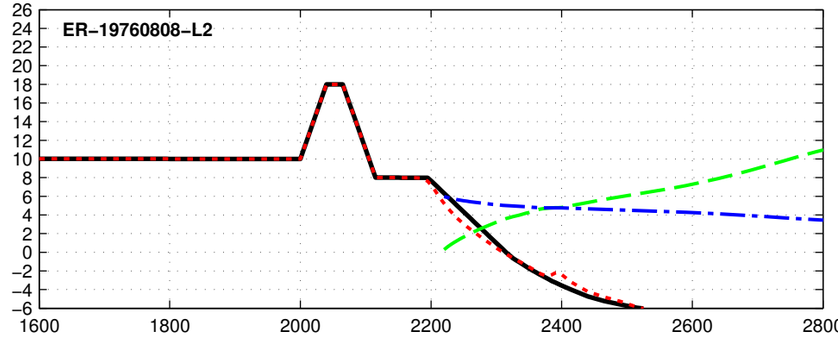
Dune R2T1-18.0-025-080 - ER-19760808

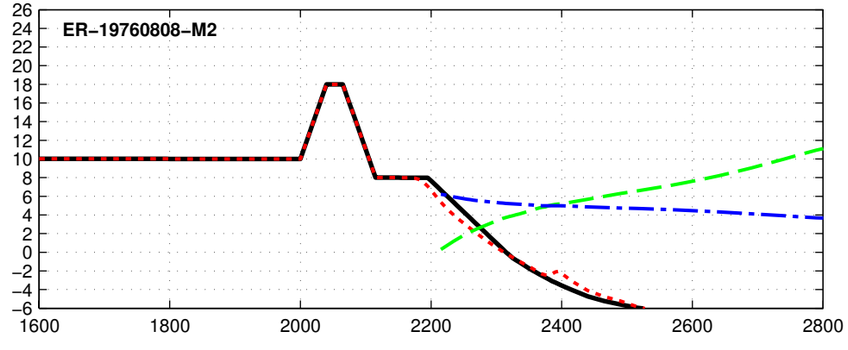


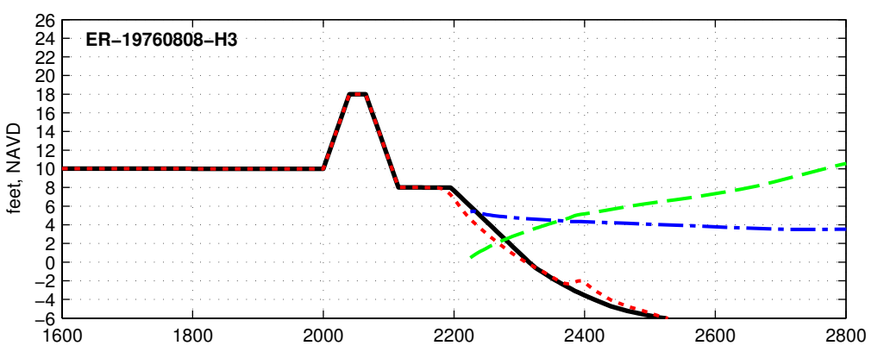


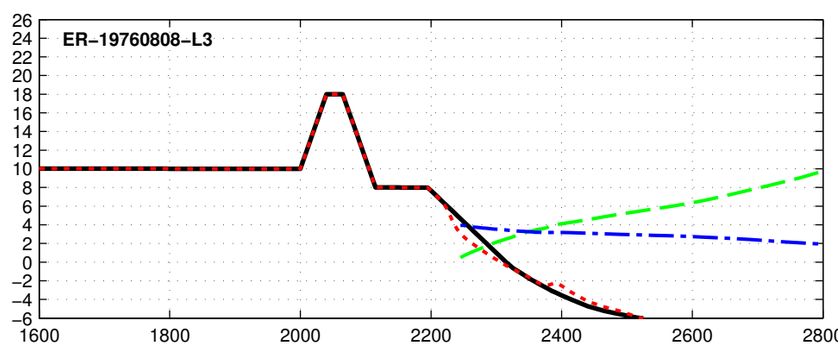


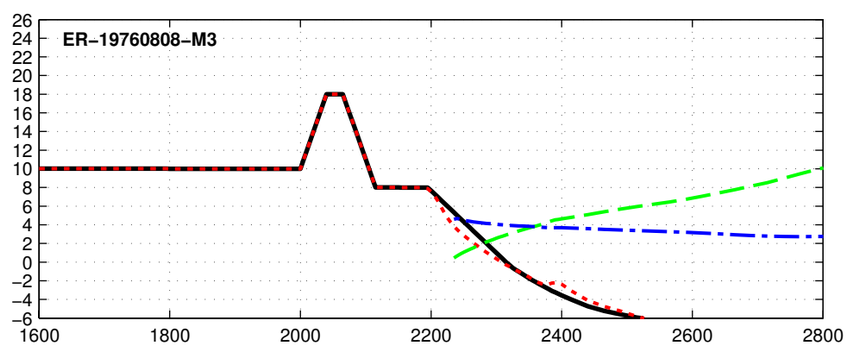


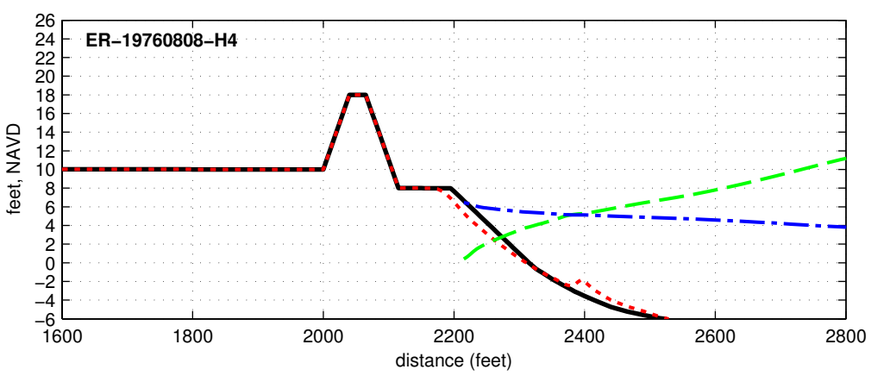


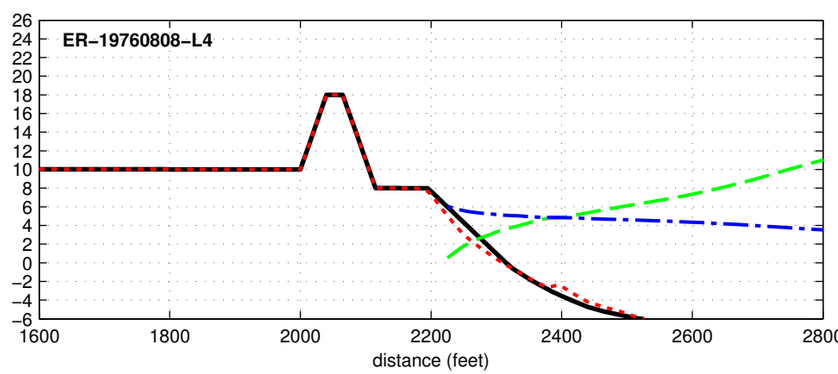


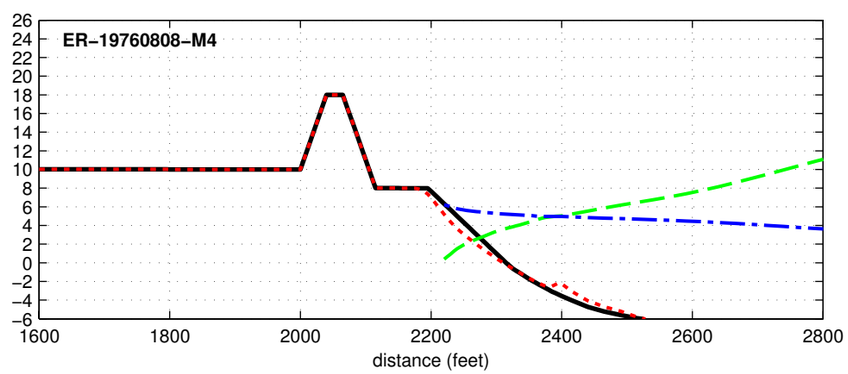






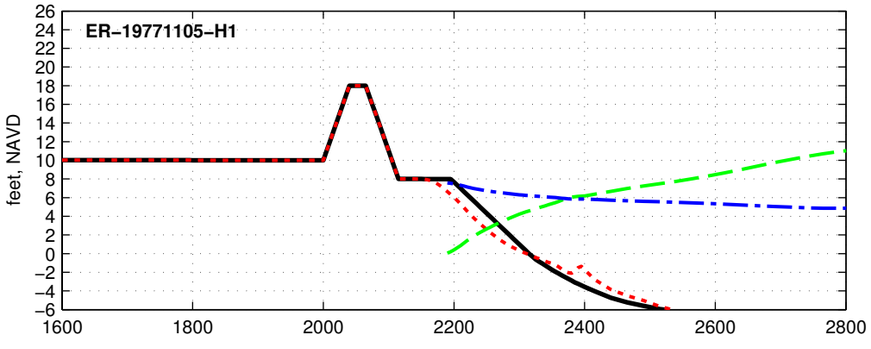


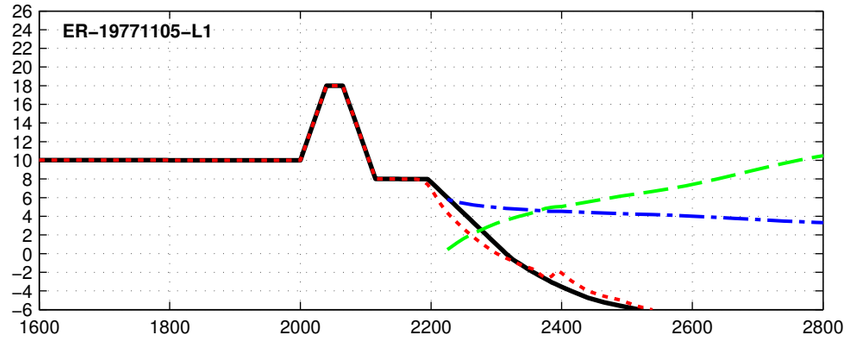


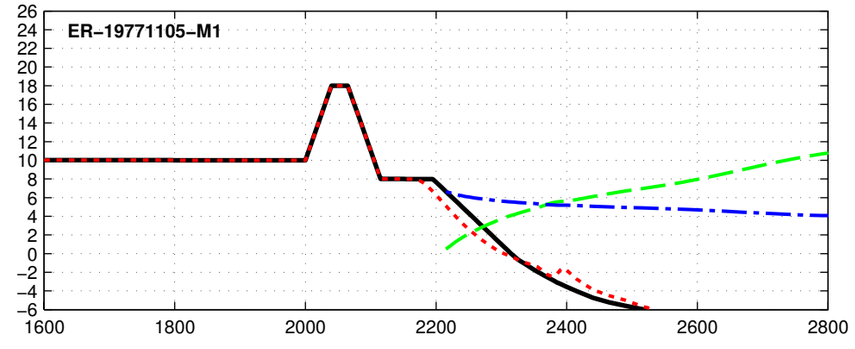


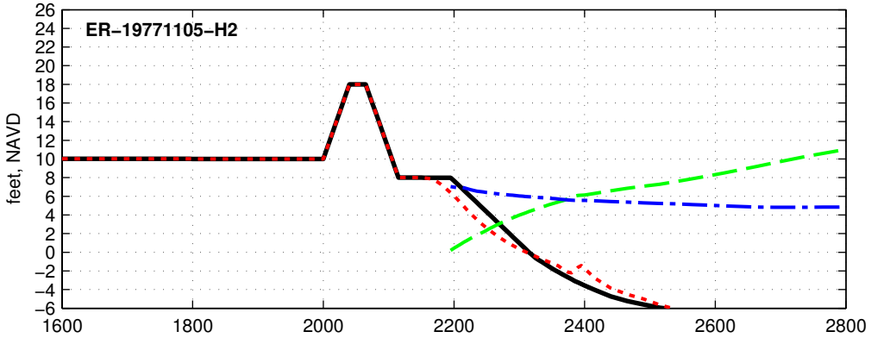
Initial Final Max Hs Max Water Level

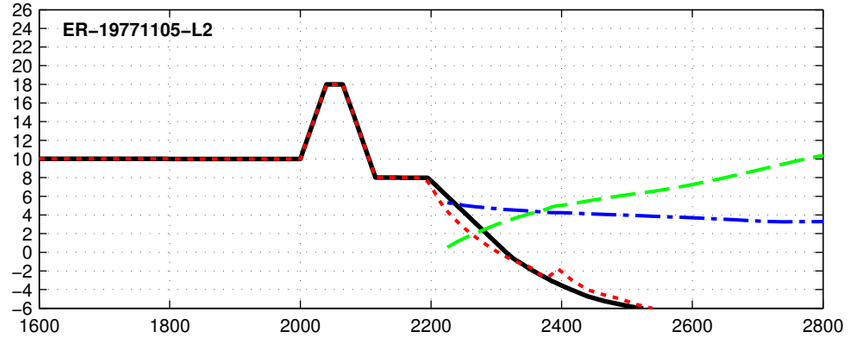
Dune R2T1-18.0-025-080 - ER-19771105

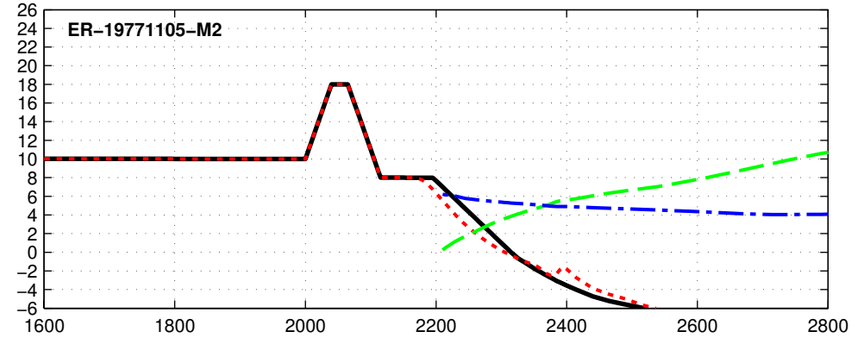


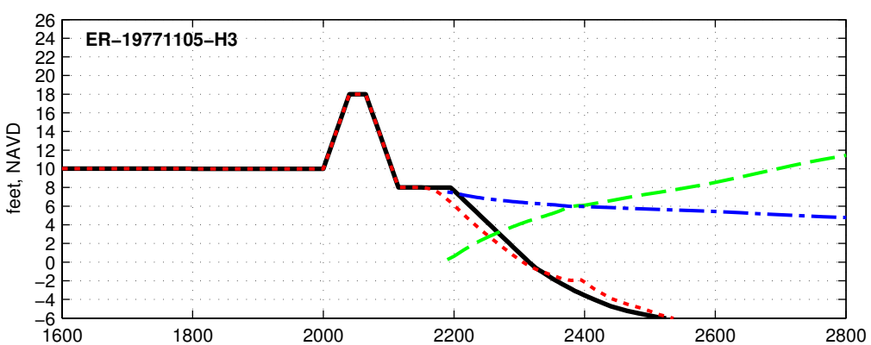


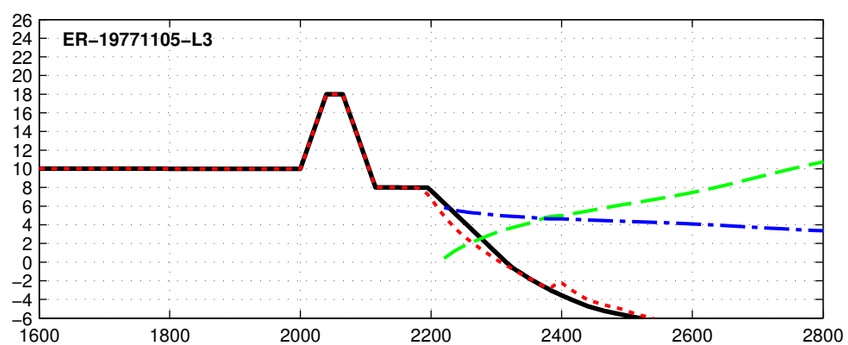


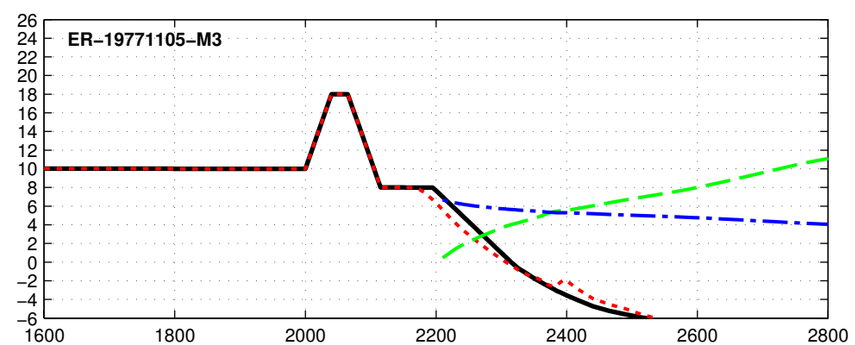


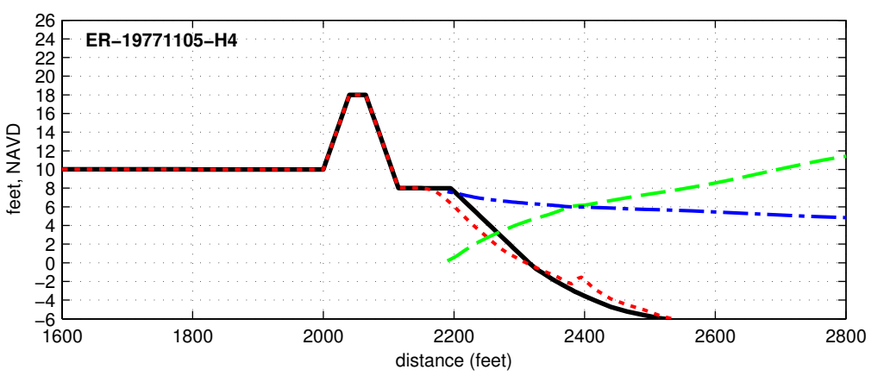


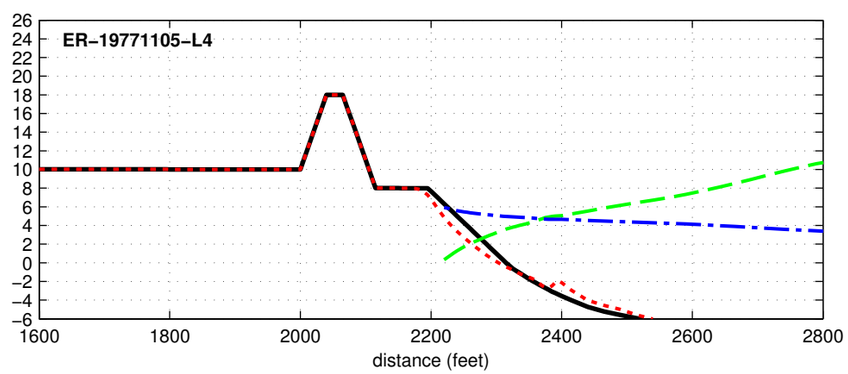


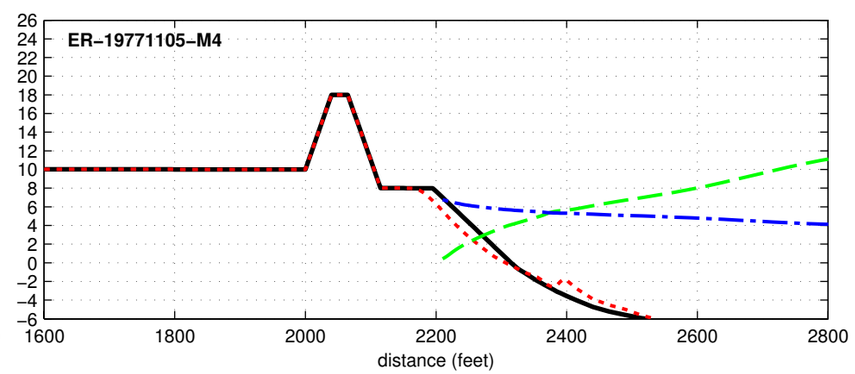






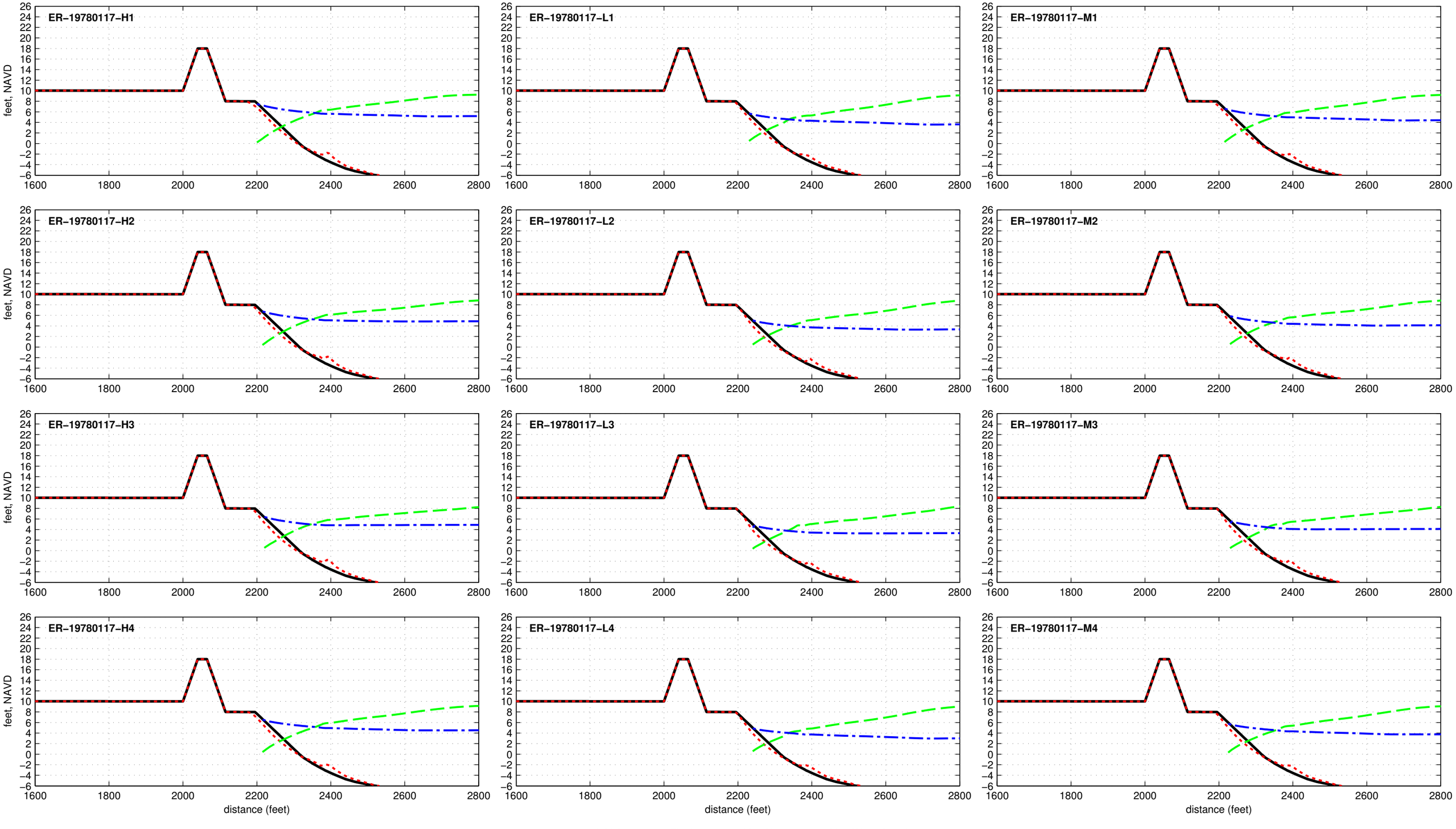




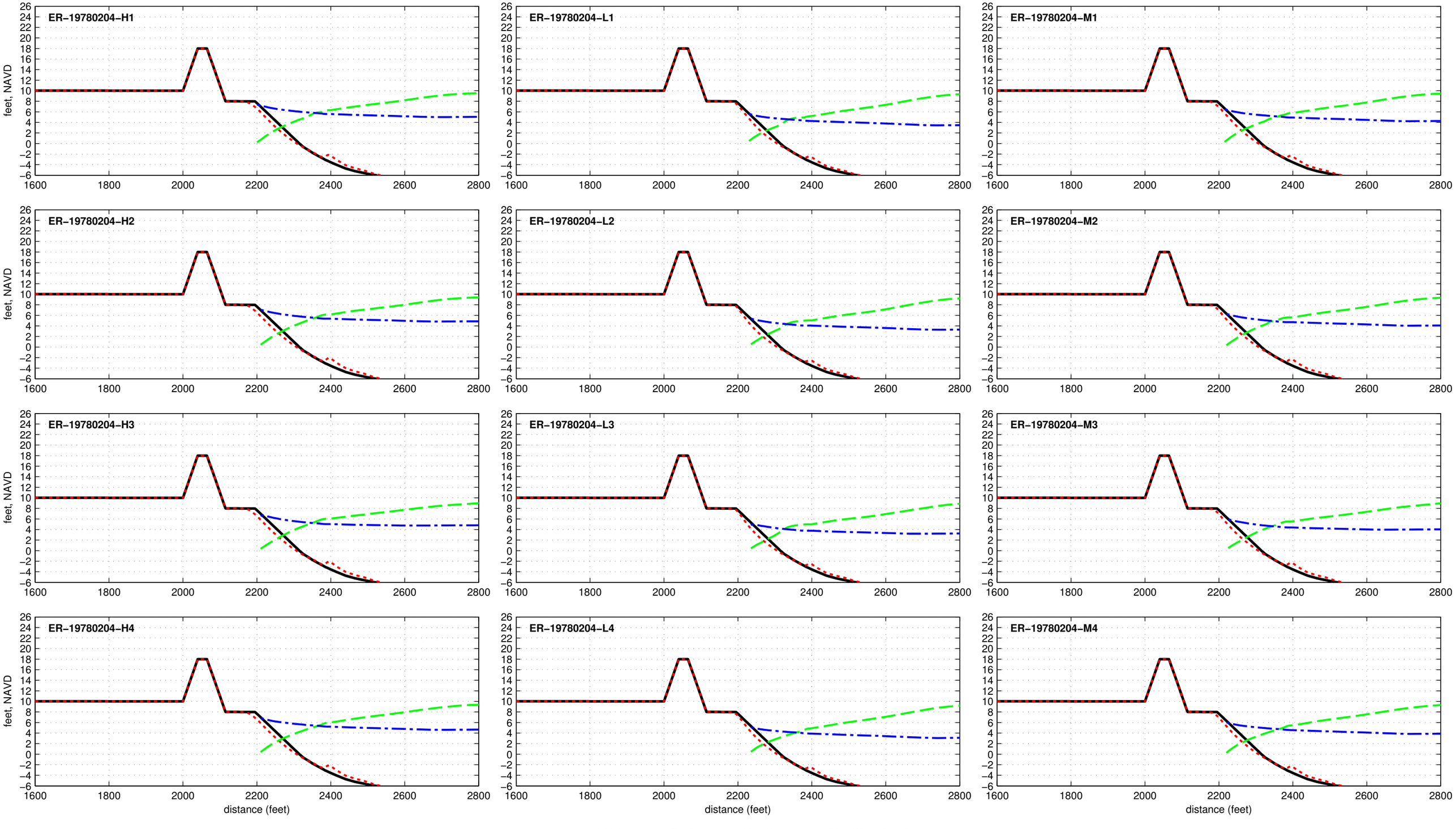


Initial Final Max Hs Max Water Level

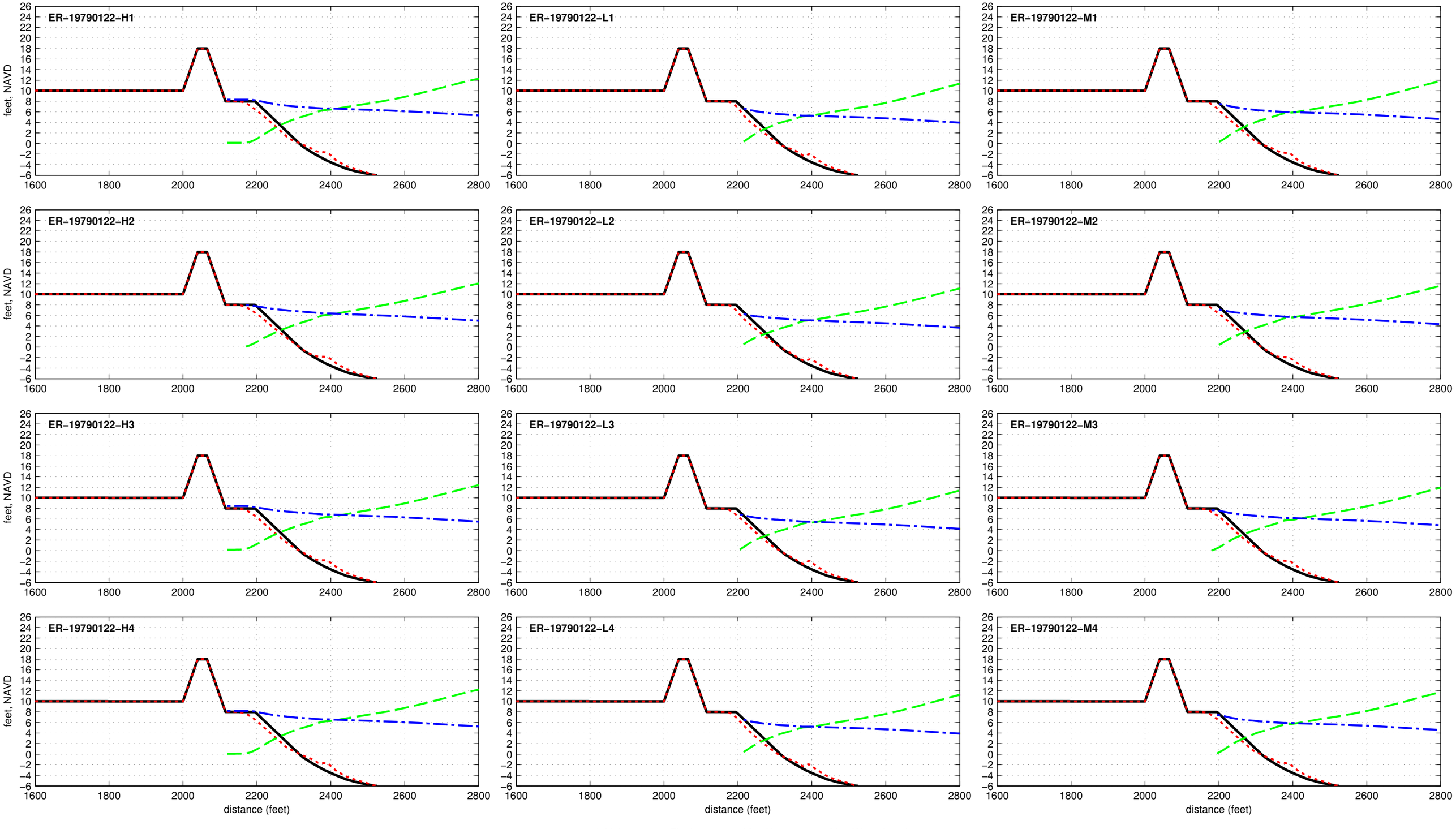
Dune R2T1–18.0–025–080 – ER–19780117



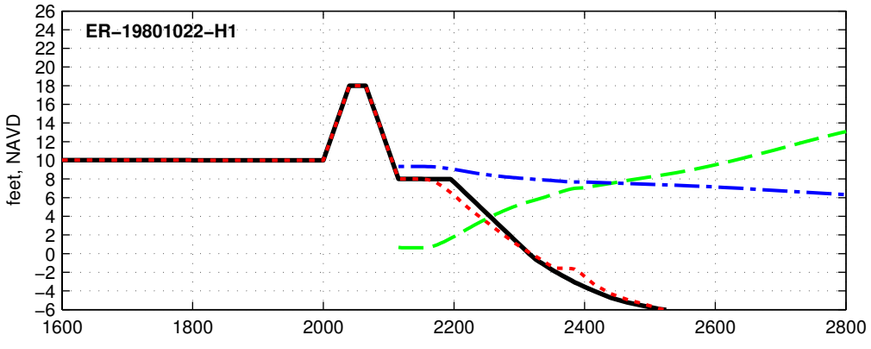
Dune R2T1-18.0-025-080 - ER-19780204

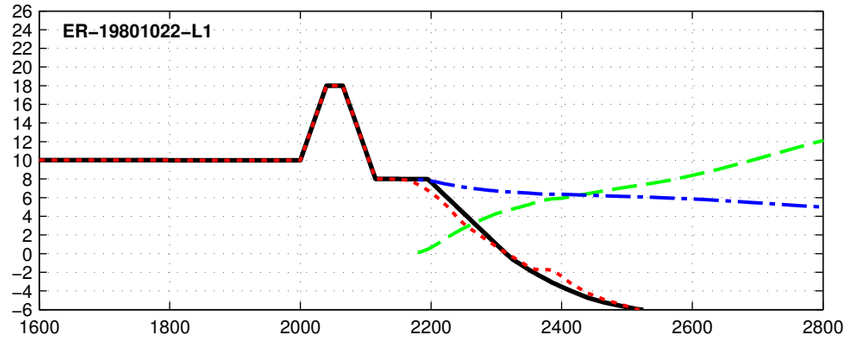


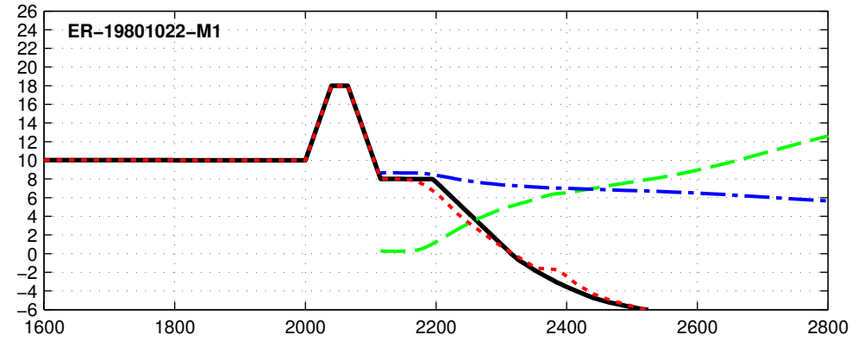
Dune R2T1-18.0-025-080 - ER-19790122

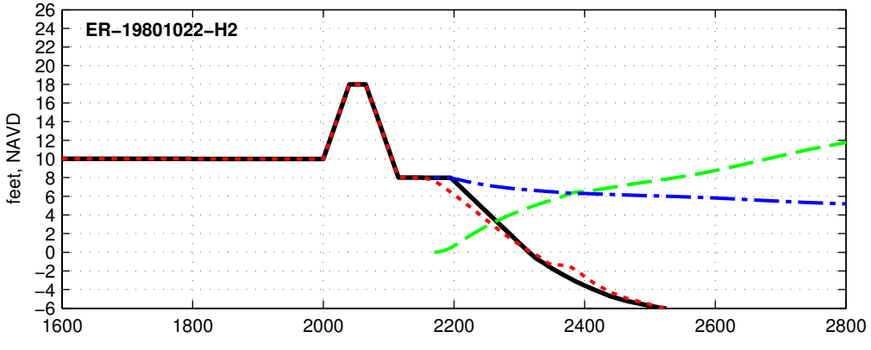


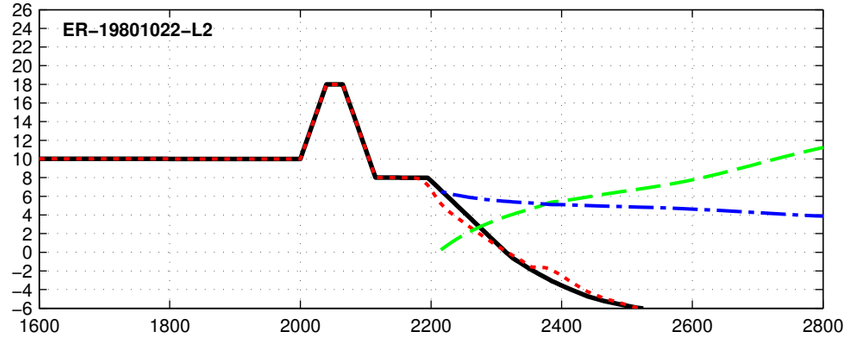
Dune R2T1-18.0-025-080 - ER-19801022

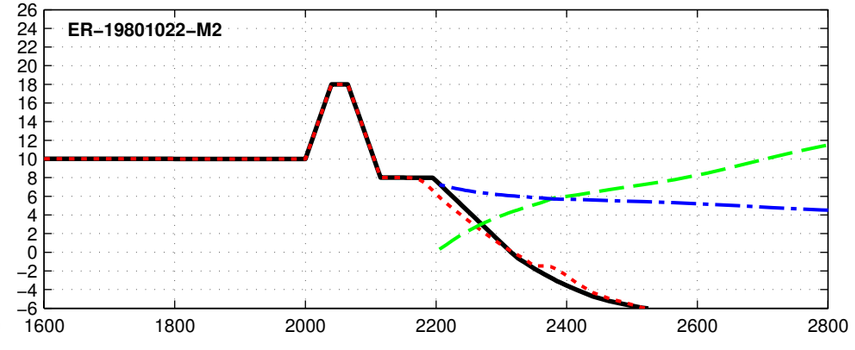


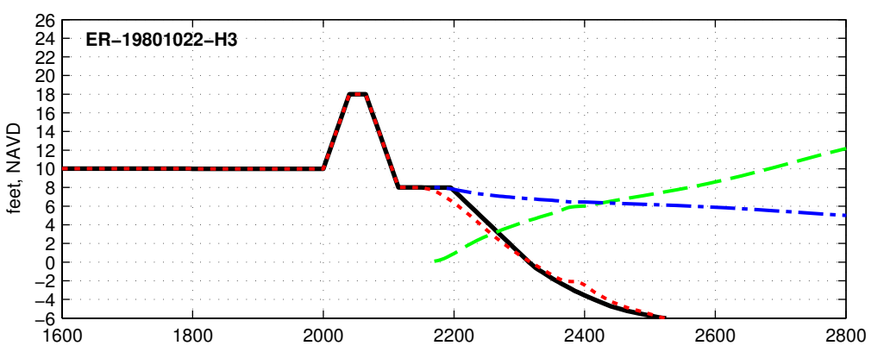


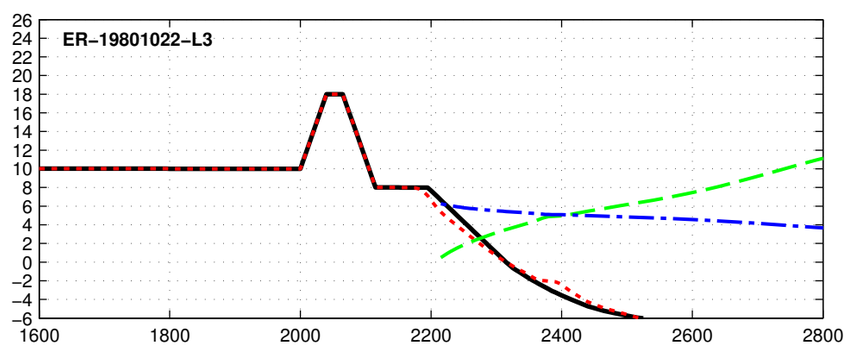


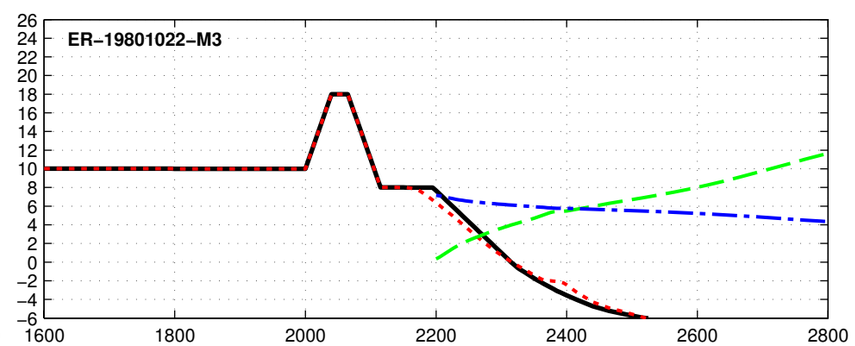


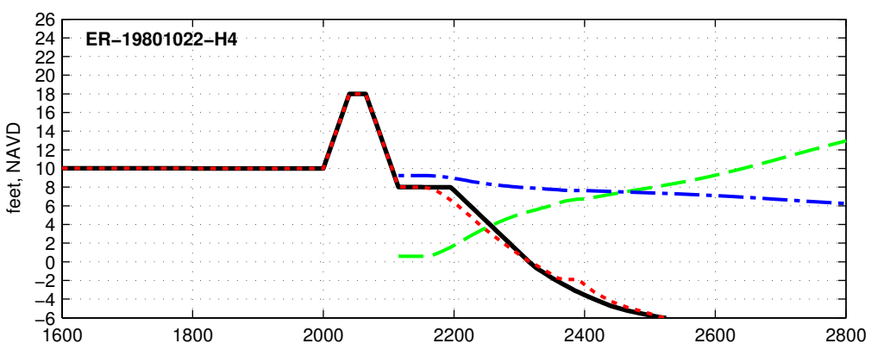


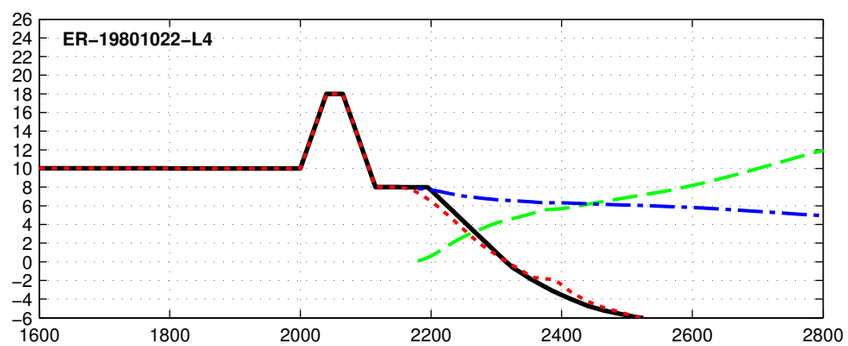


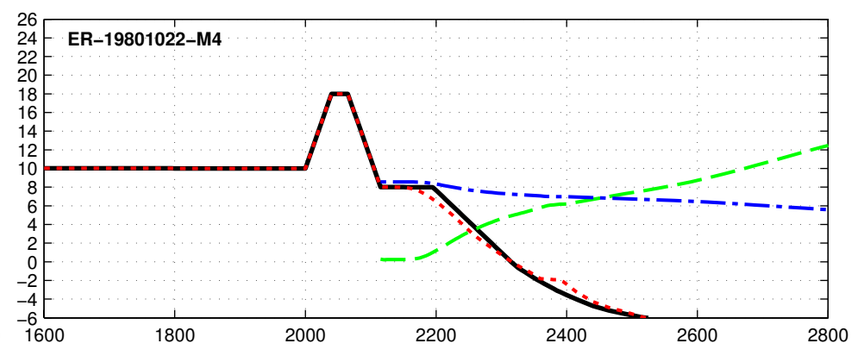






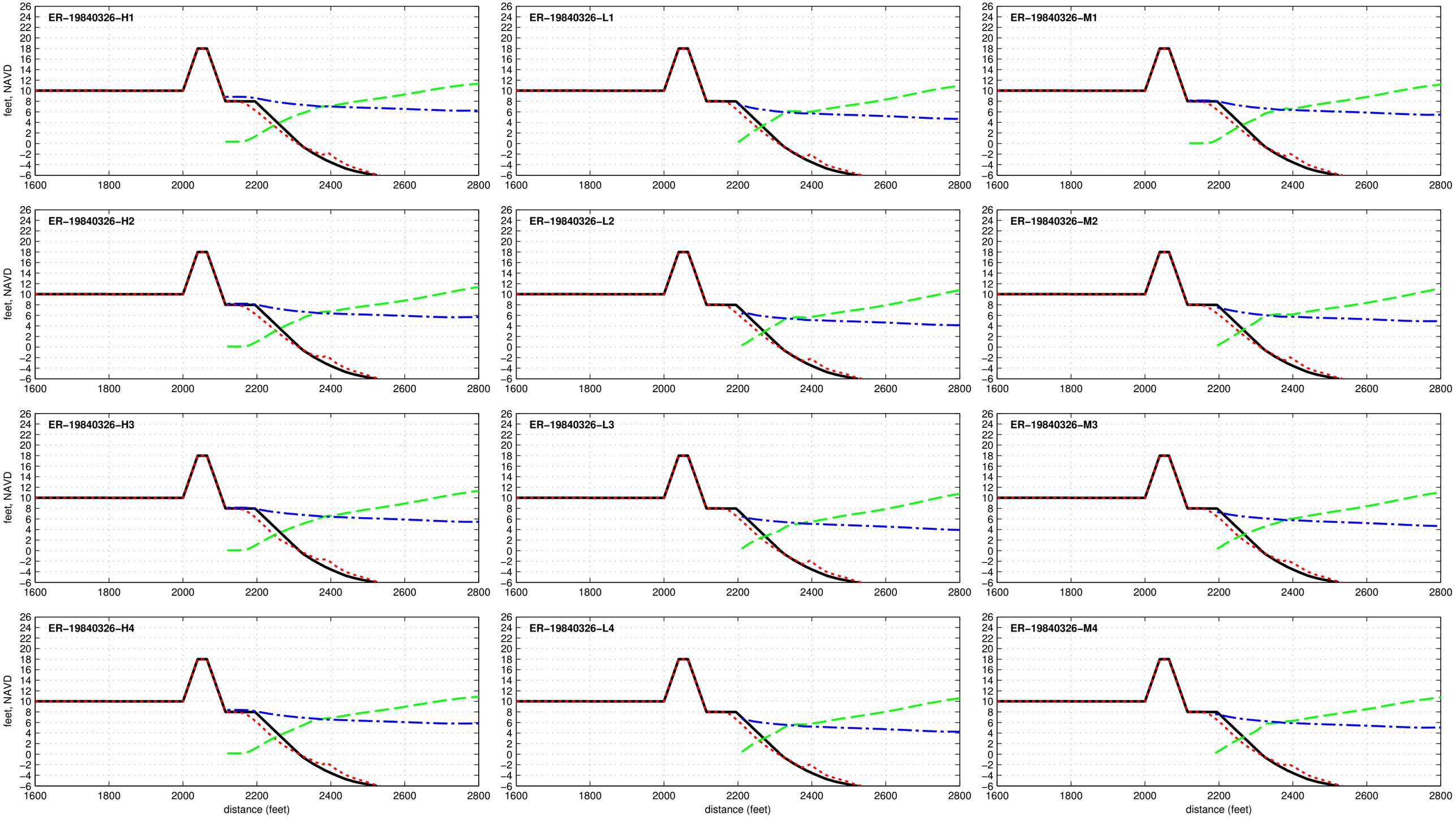




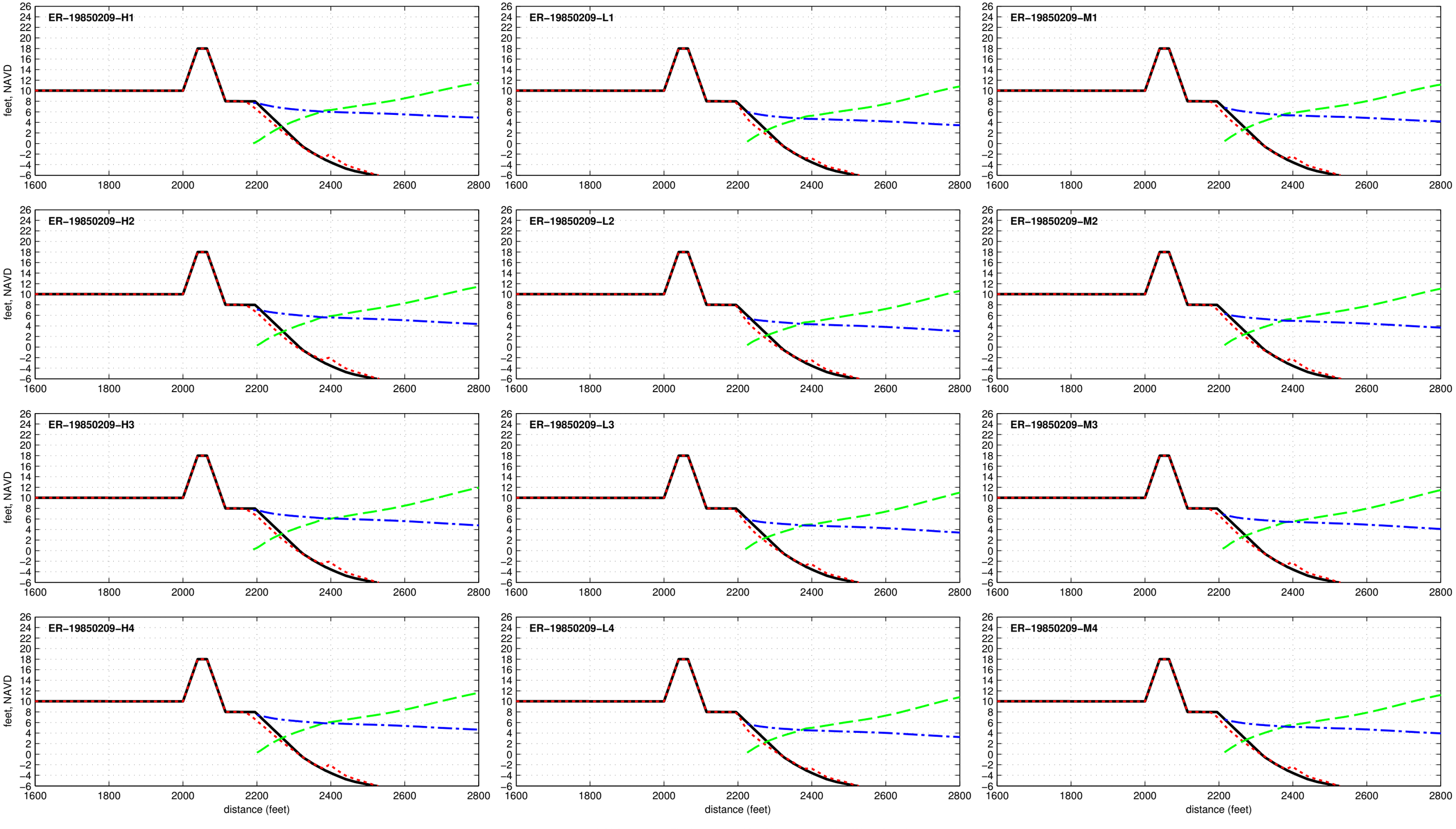


Initial Final Max Hs Max Water Level

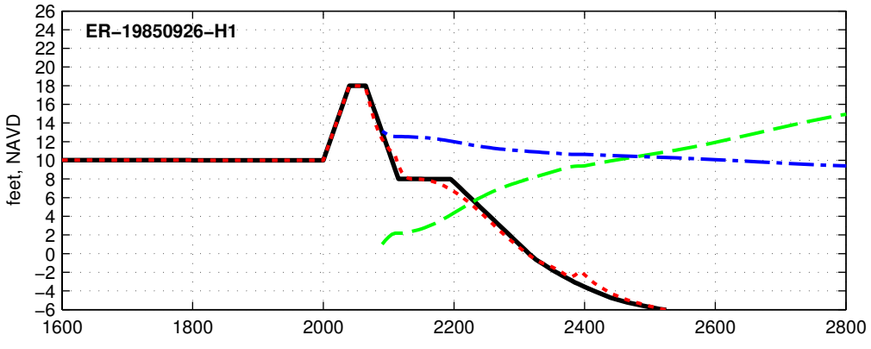
Dune R2T1-18.0-025-080 - ER-19840326

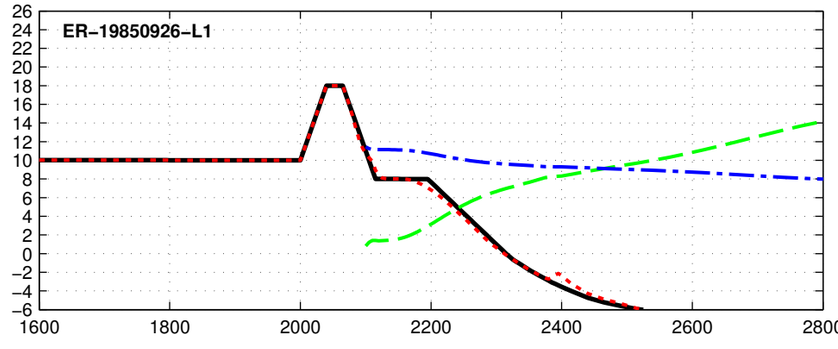


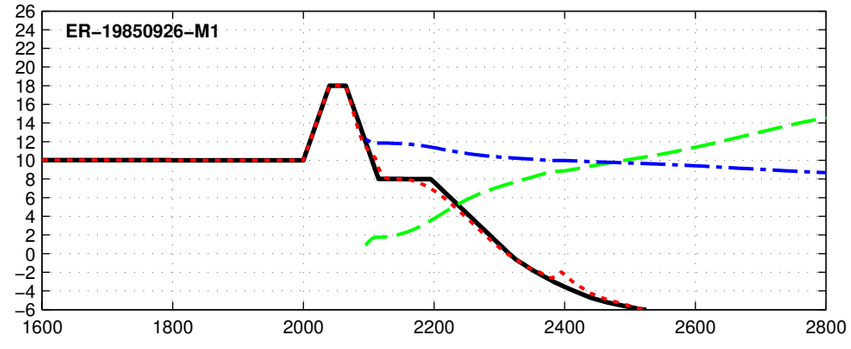
Dune R2T1-18.0-025-080 - ER-19850209

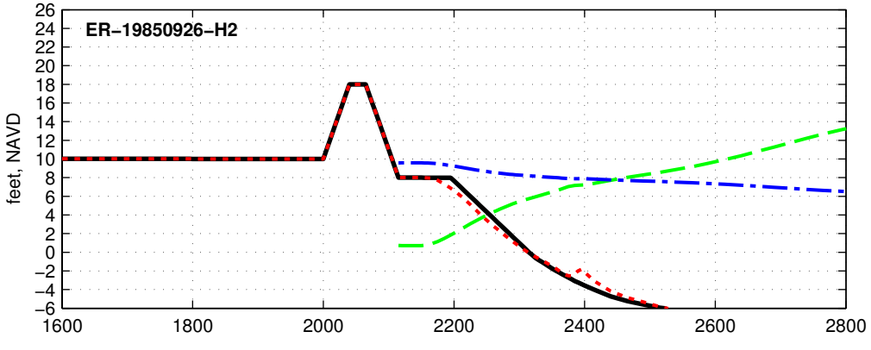


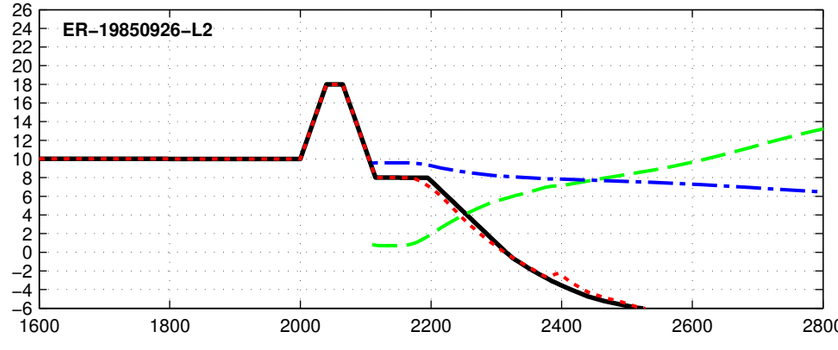
Dune R2T1-18.0-025-080 - ER-19850926

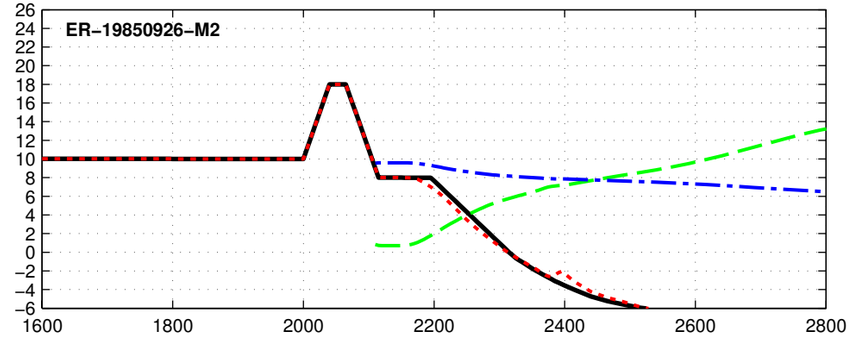


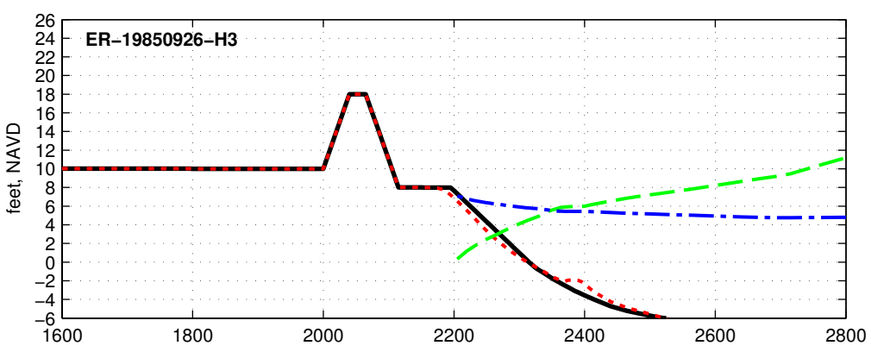


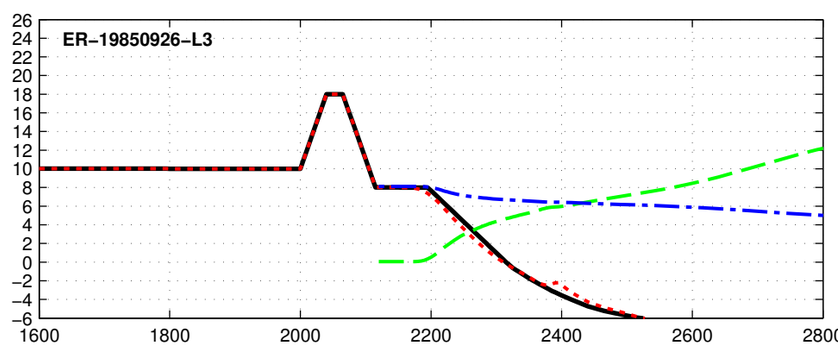


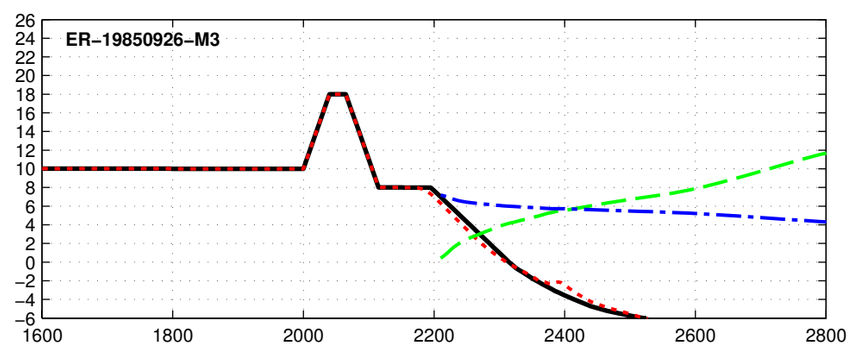


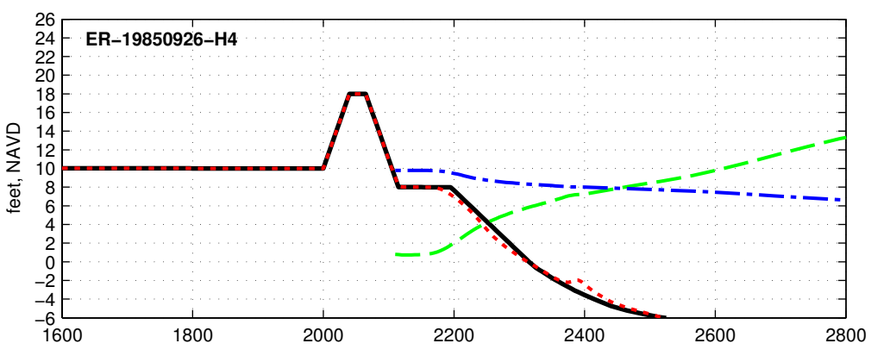


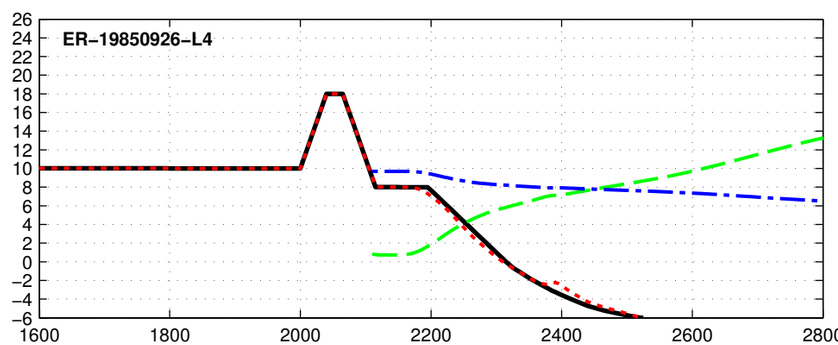


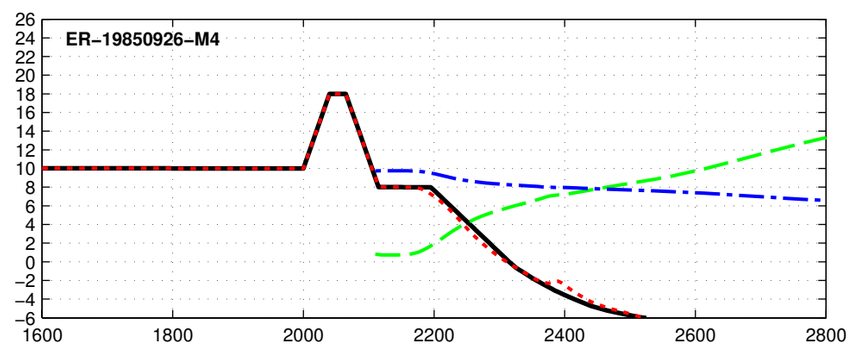










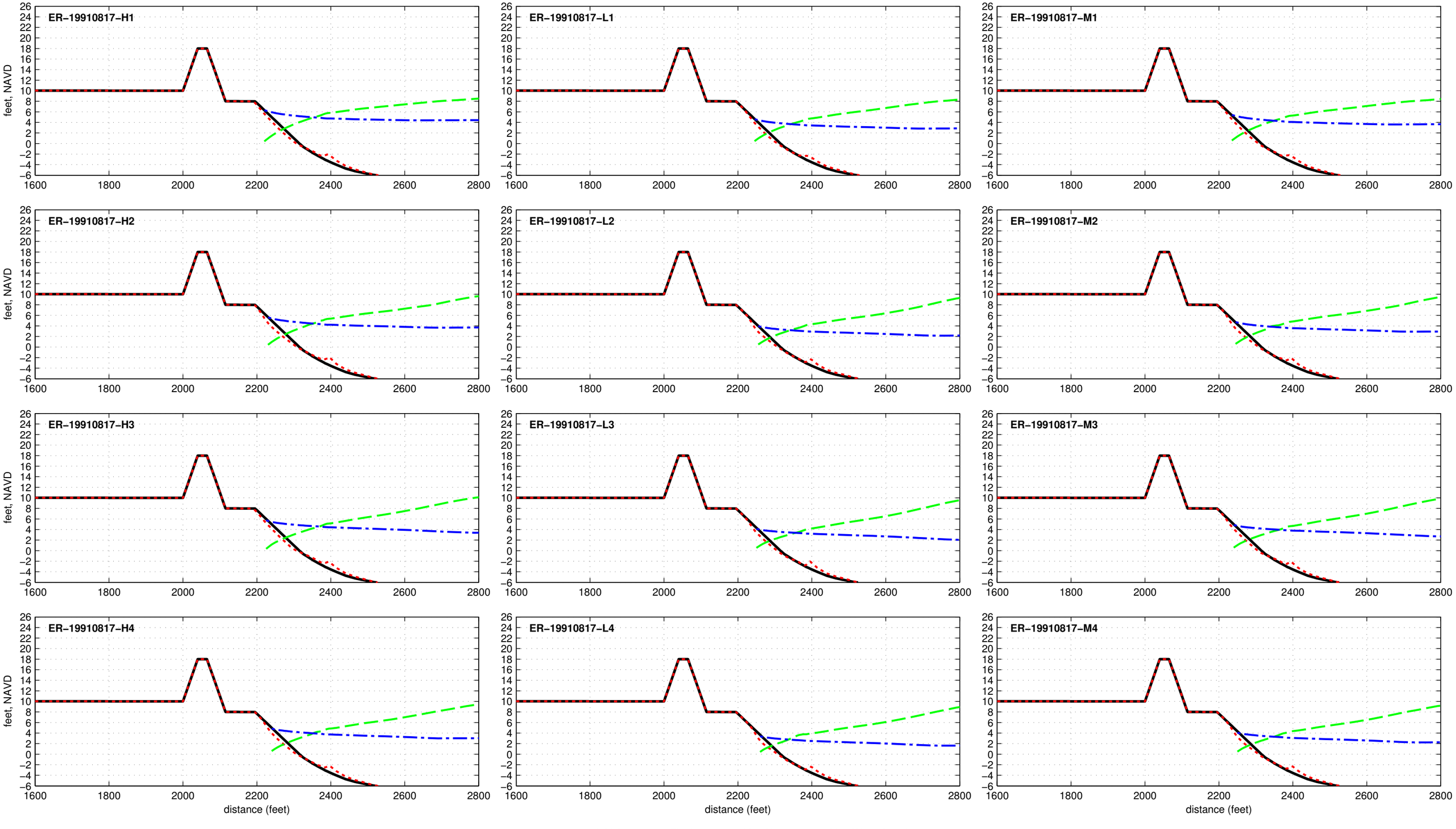


feet, NAVD

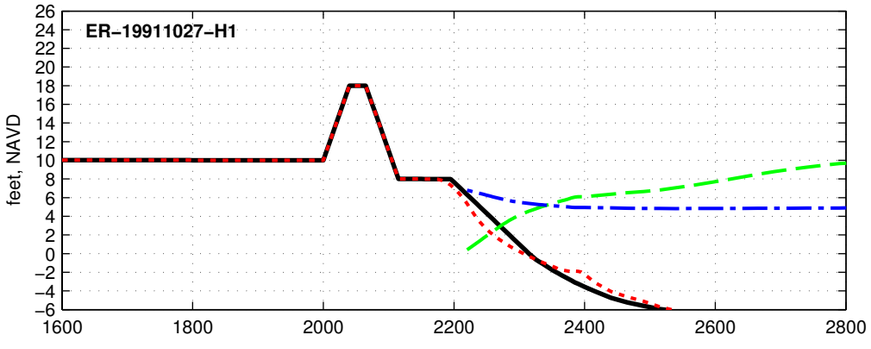
distance (feet)

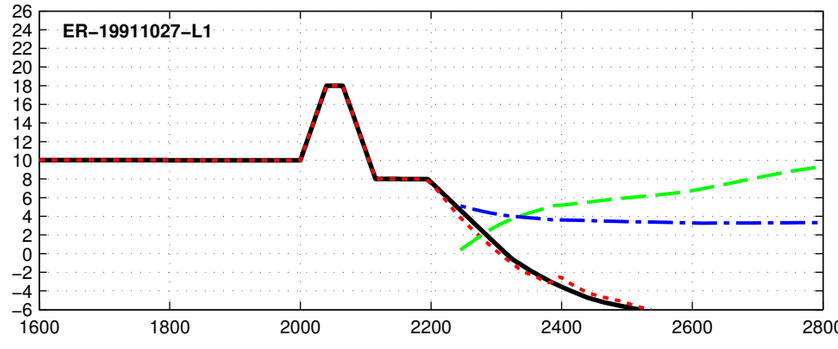
Initial Final Max Hs Max Water Level

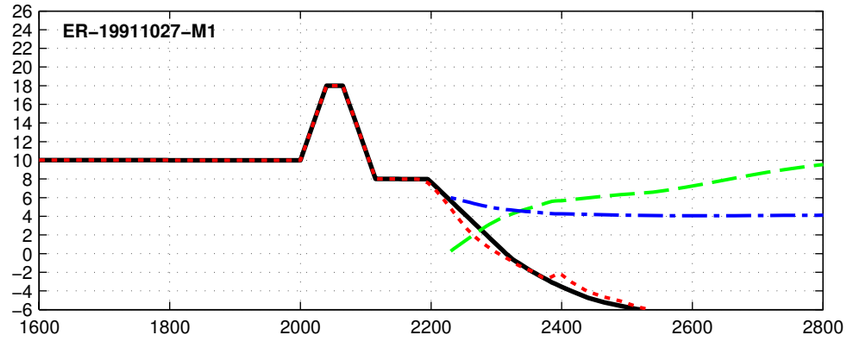
Dune R2T1-18.0-025-080 - ER-19910817

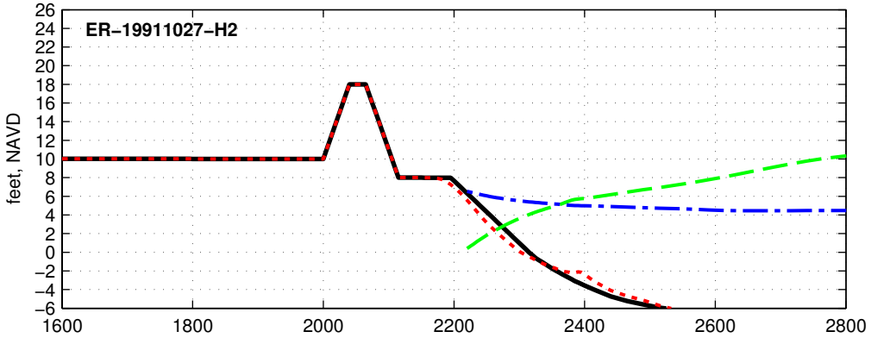


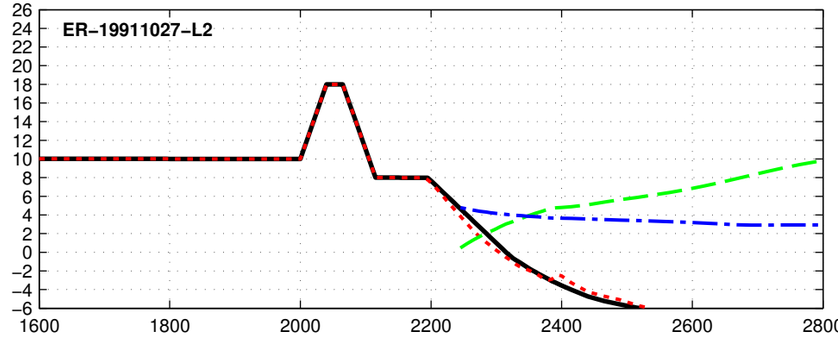
Dune R2T1-18.0-025-080 - ER-19911027

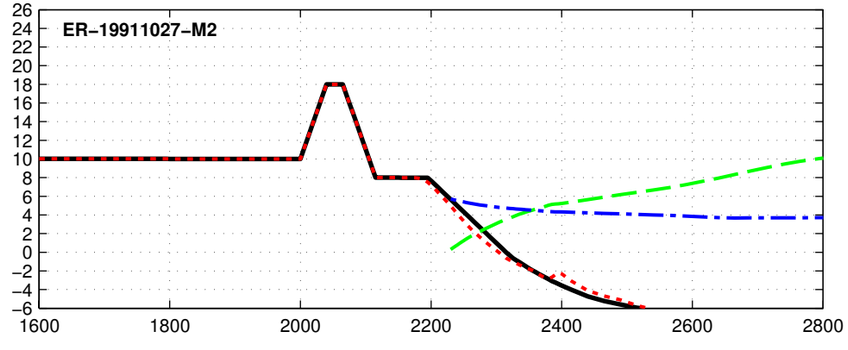


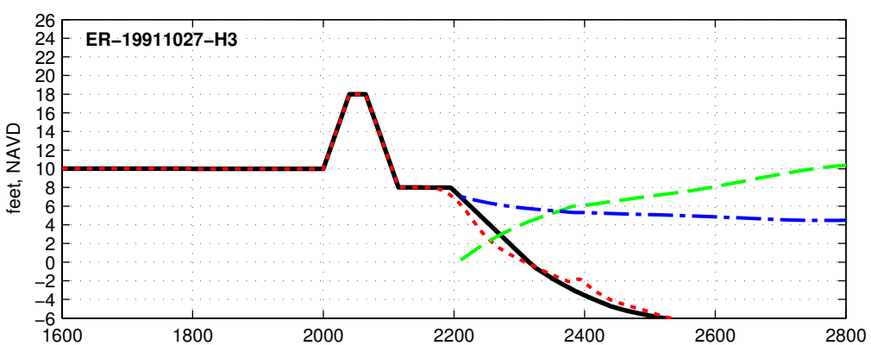


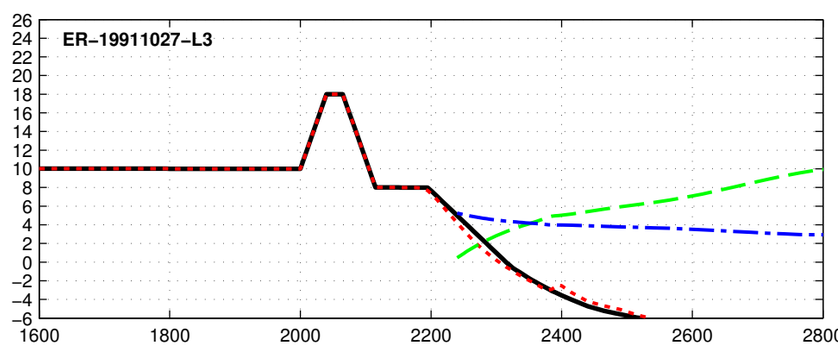


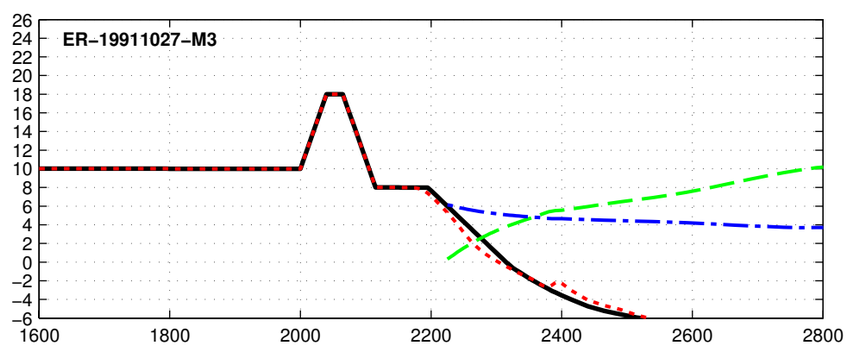


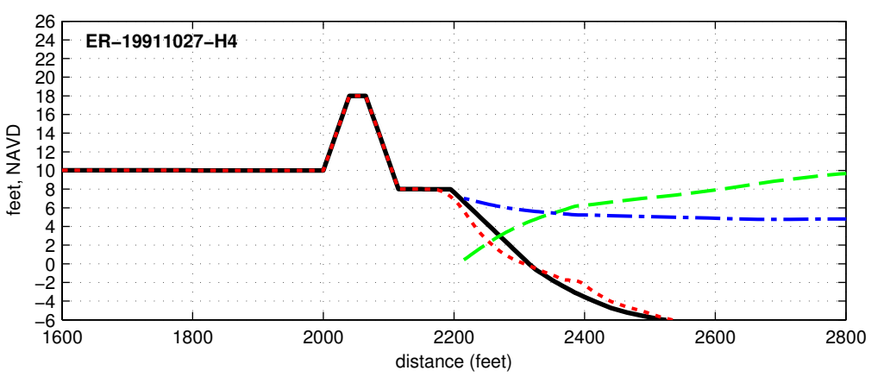


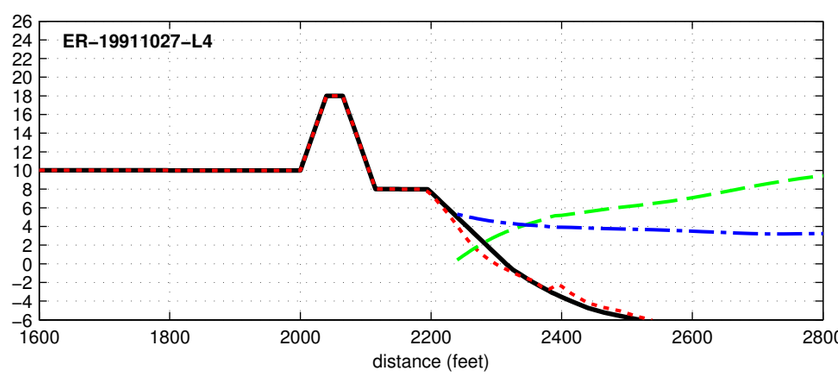


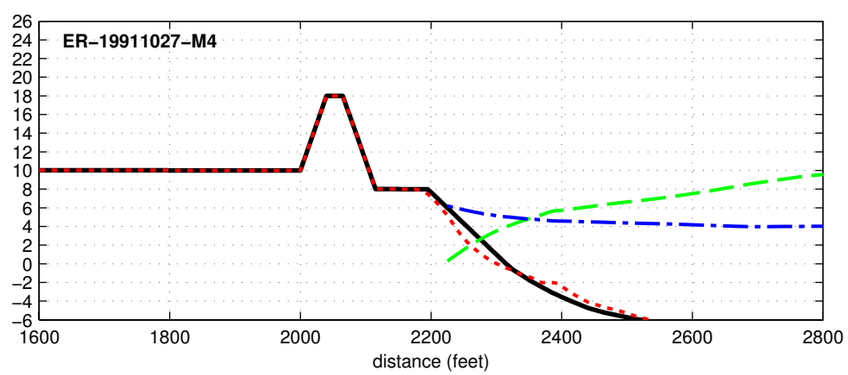






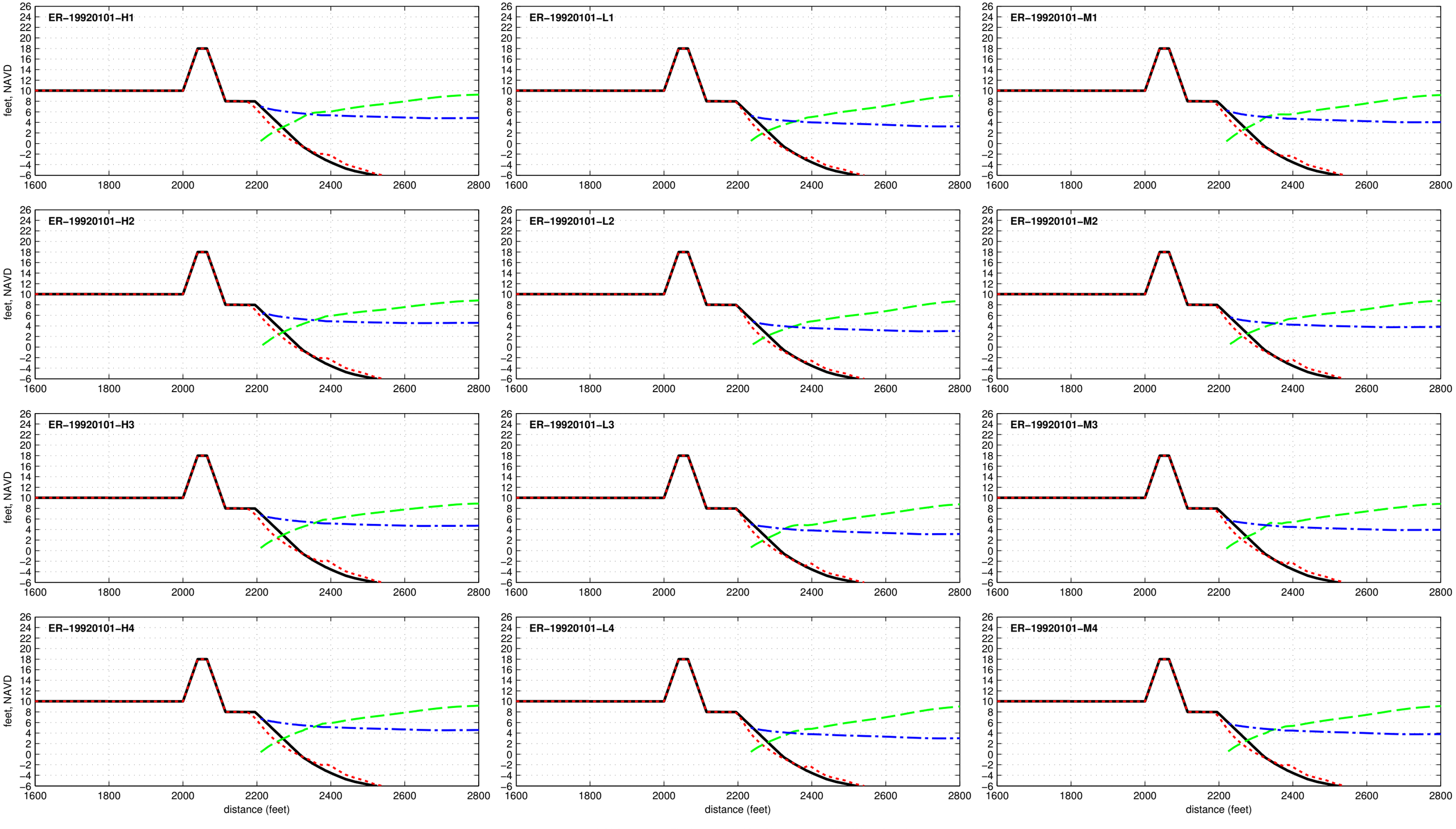




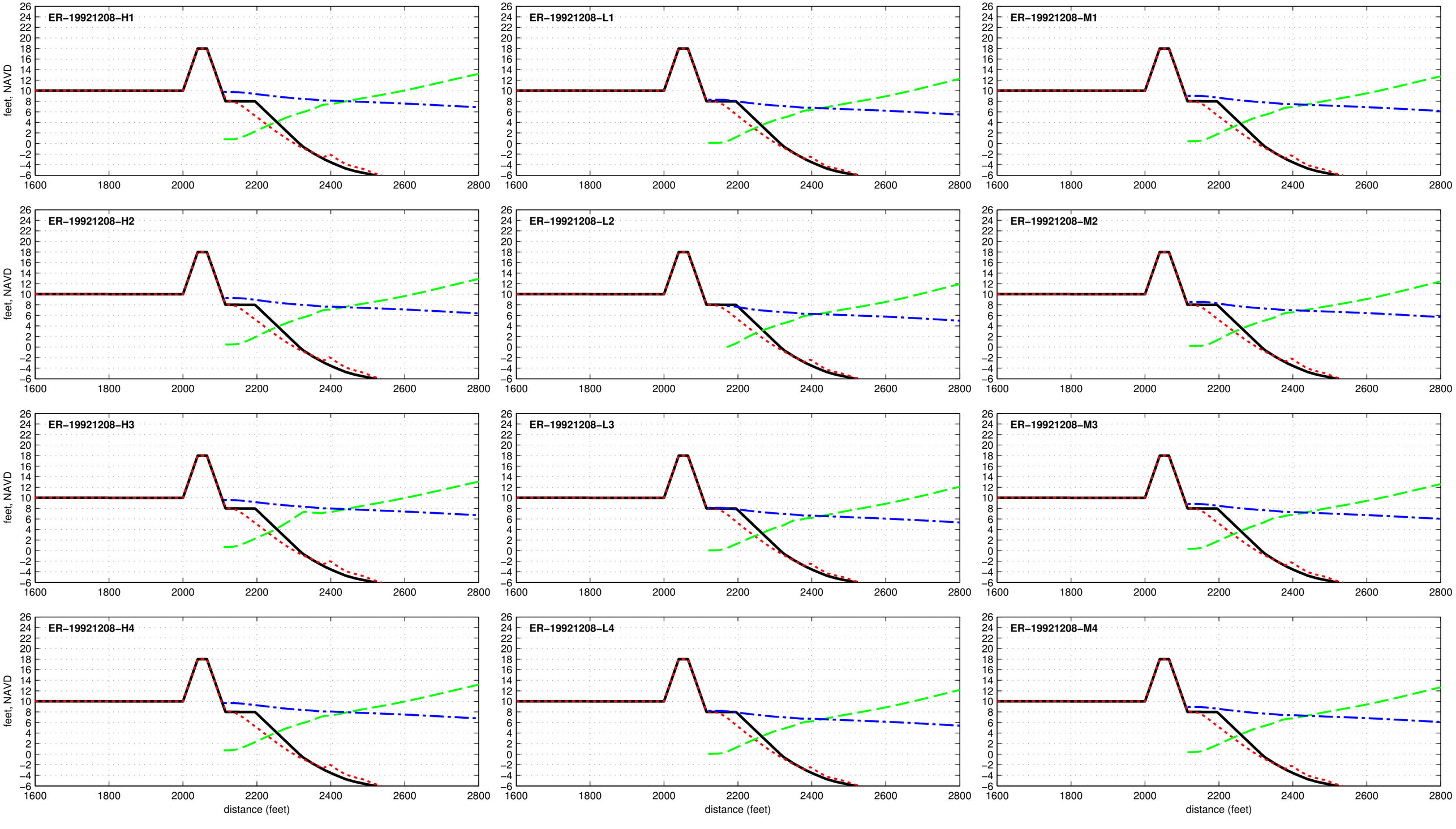


Initial Final Max Hs Max Water Level

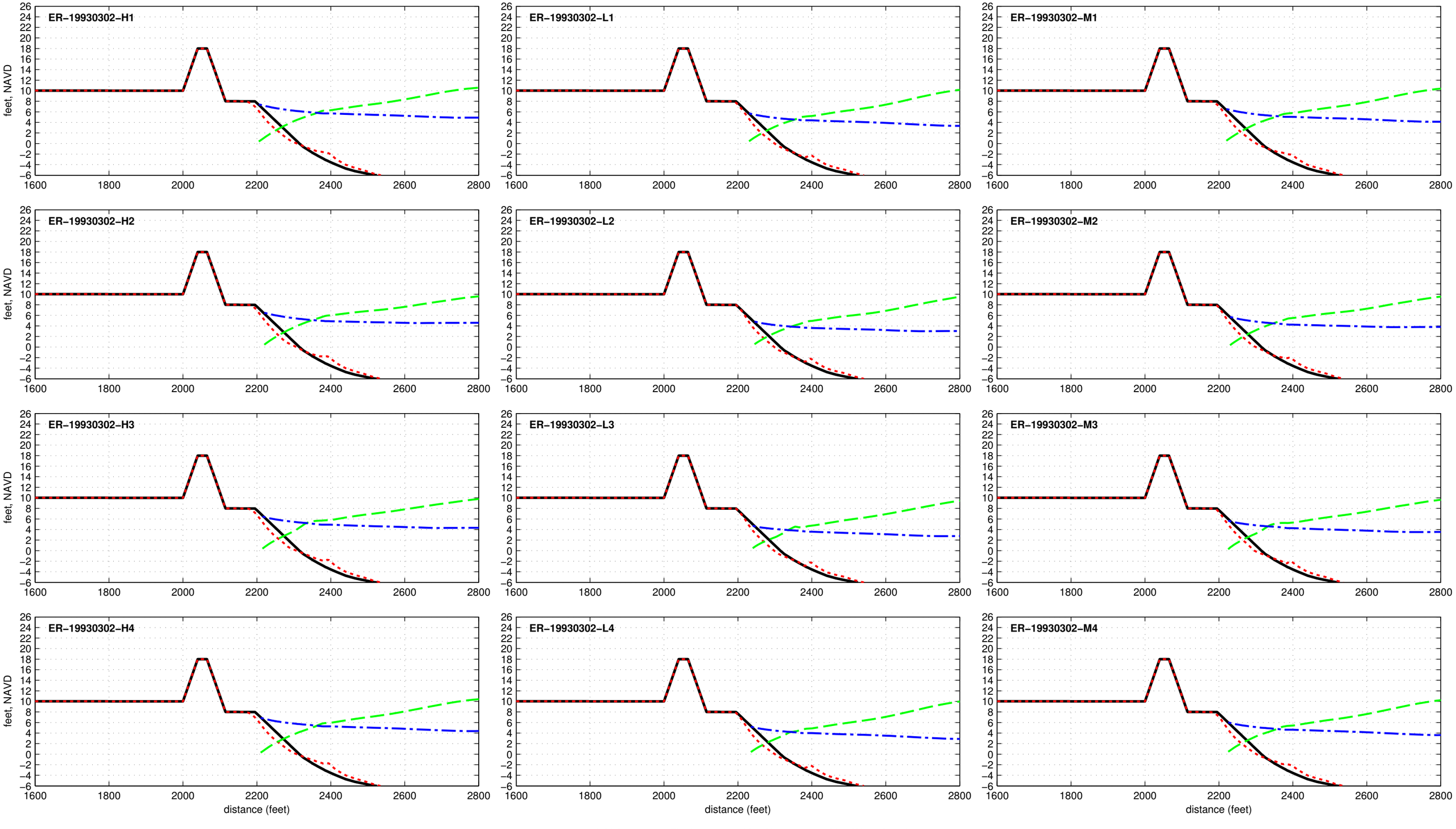
Dune R2T1-18.0-025-080 - ER-19920101



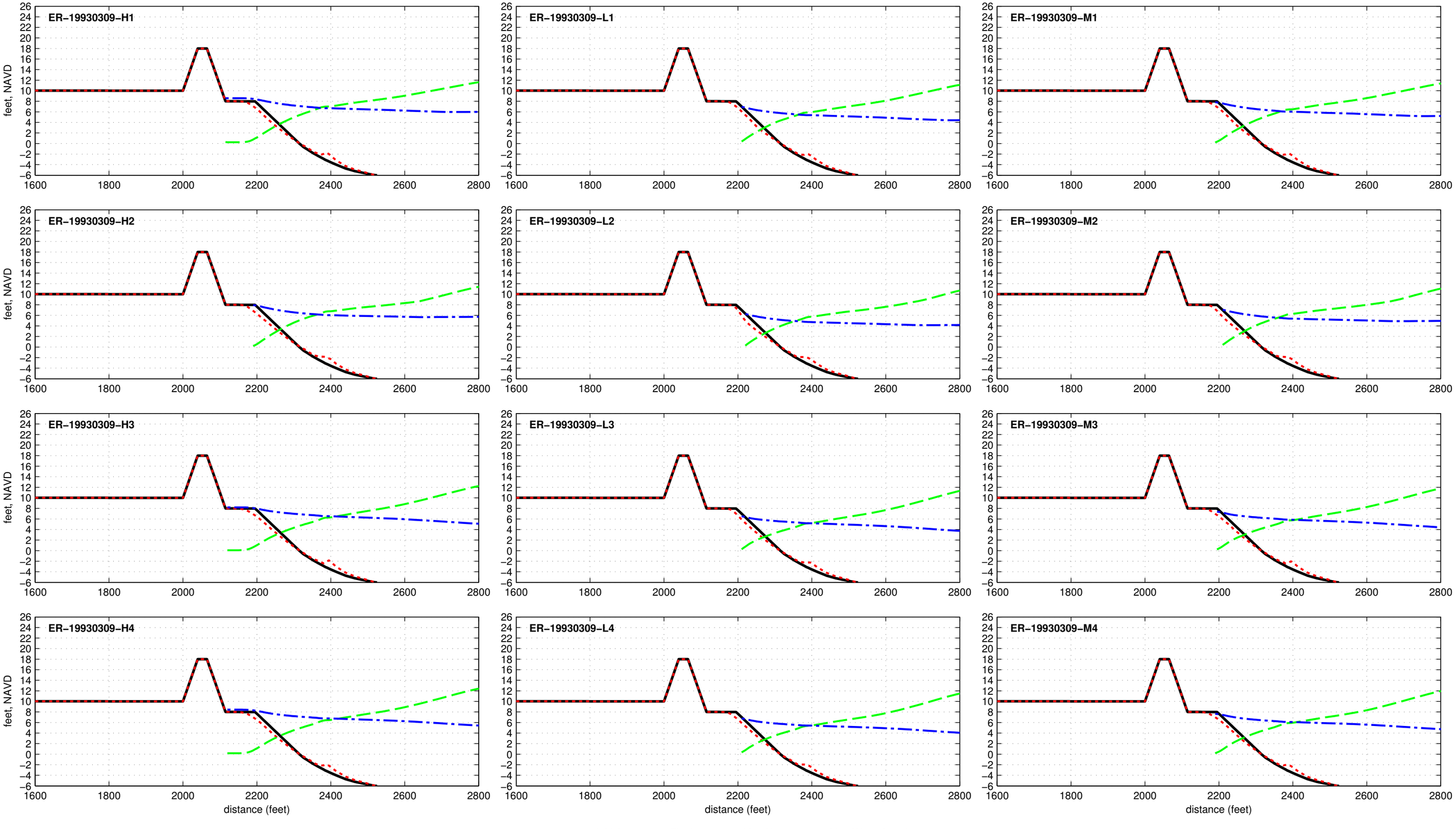
Dune R2T1-18.0-025-080 - ER-19921208



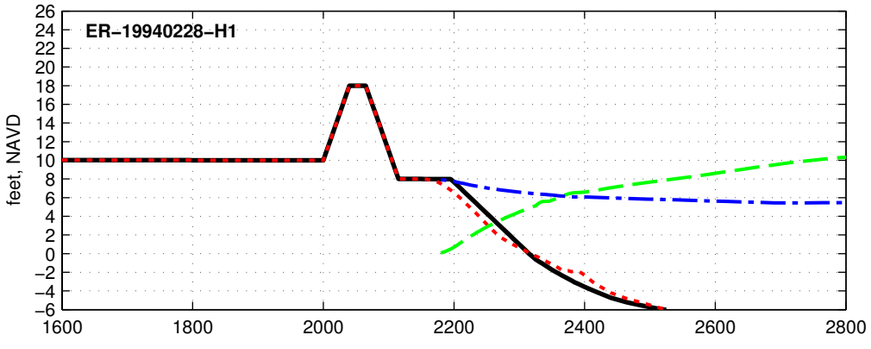
Dune R2T1-18.0-025-080 - ER-19930302

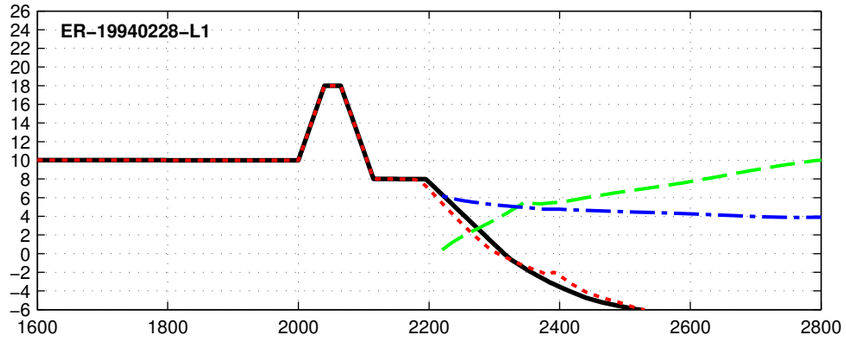


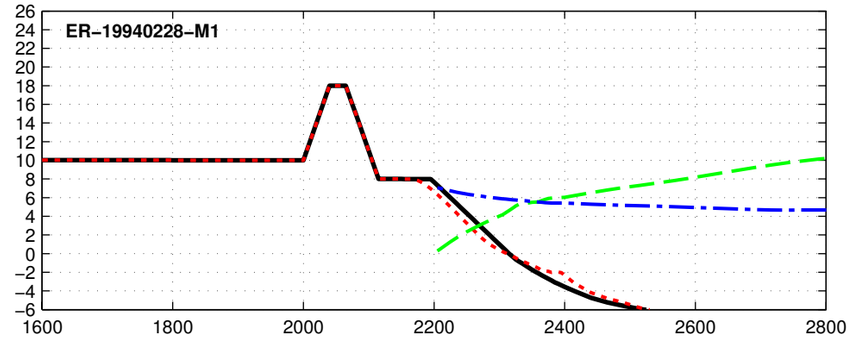
Dune R2T1-18.0-025-080 - ER-19930309

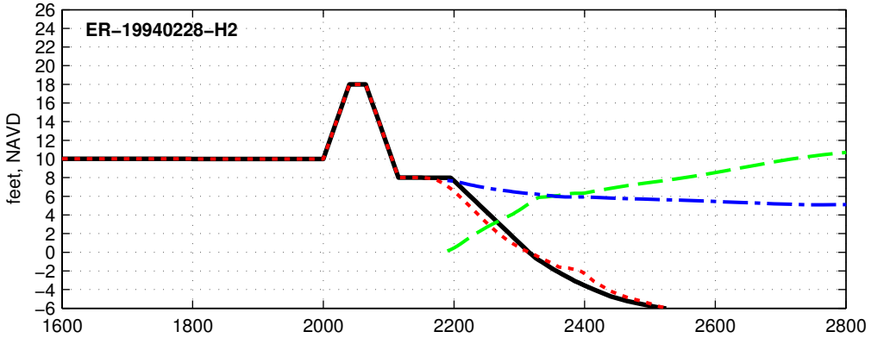


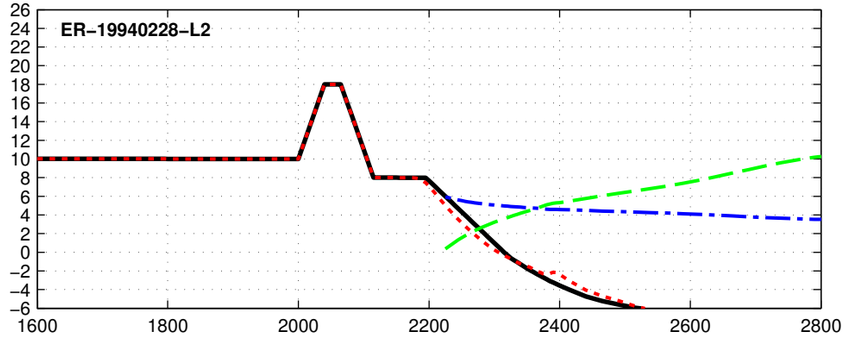
Dune R2T1-18.0-025-080 - ER-19940228

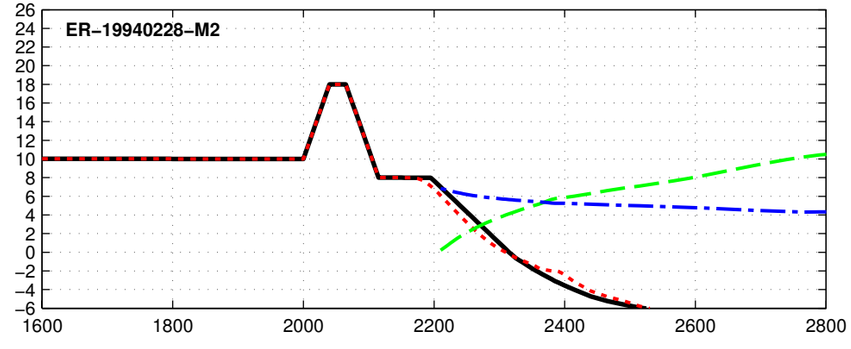


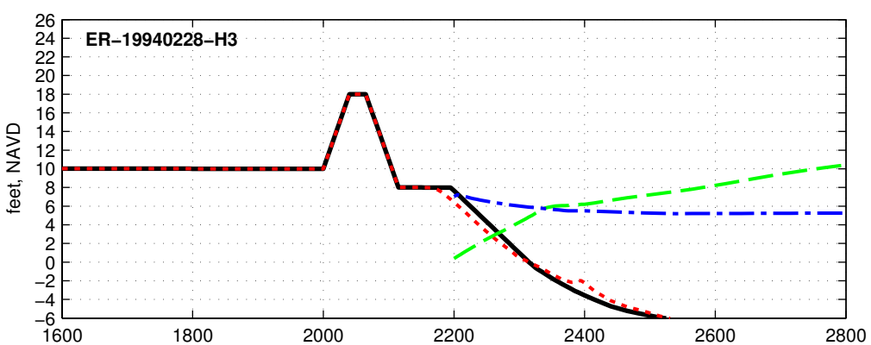


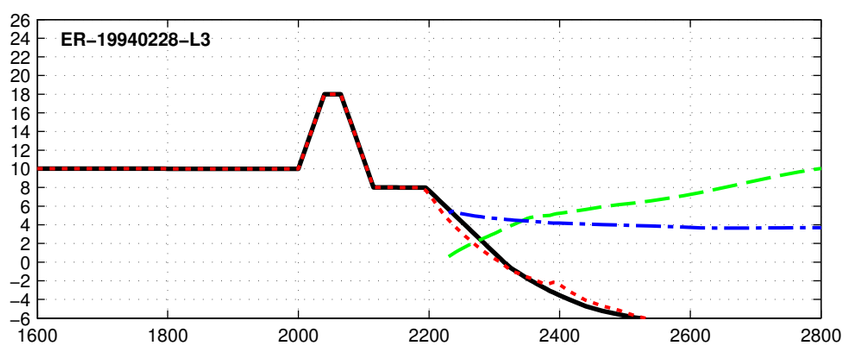


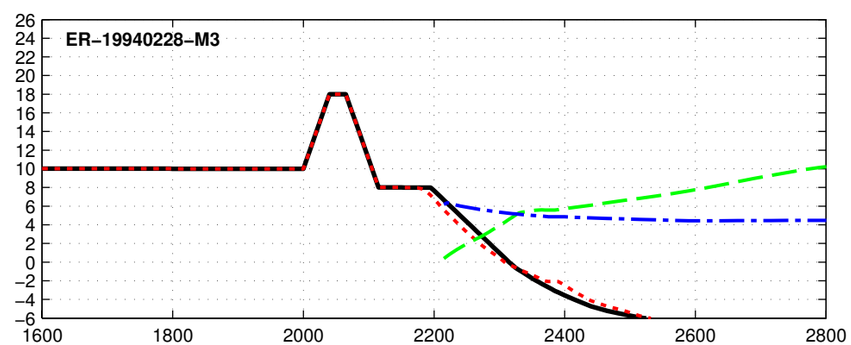


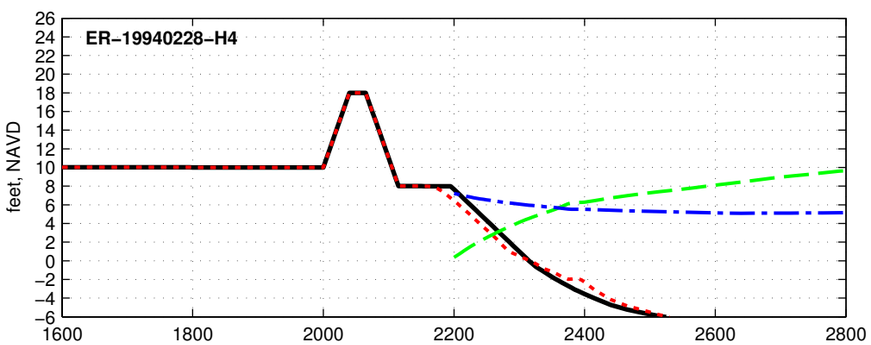


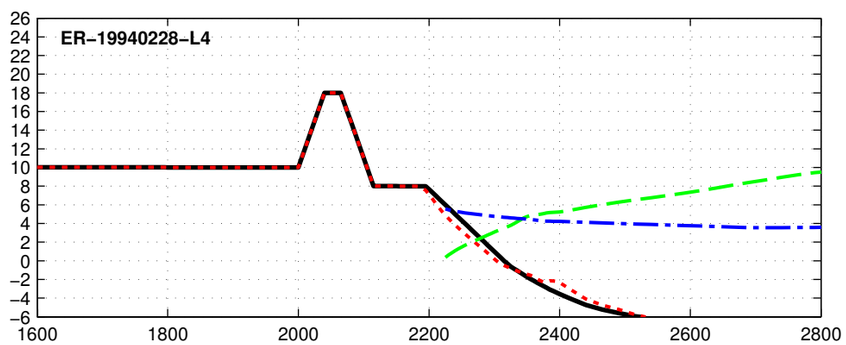


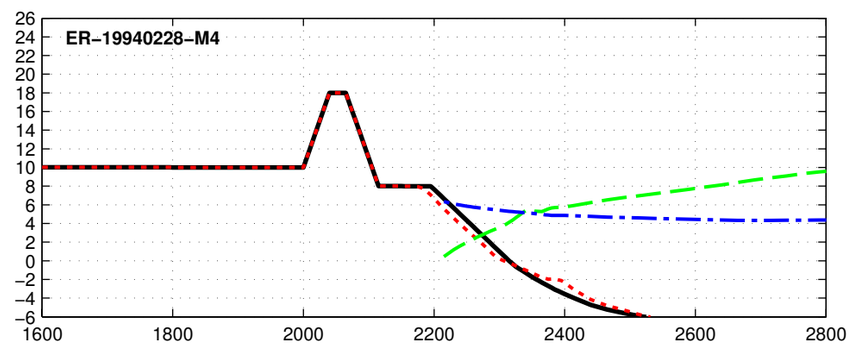






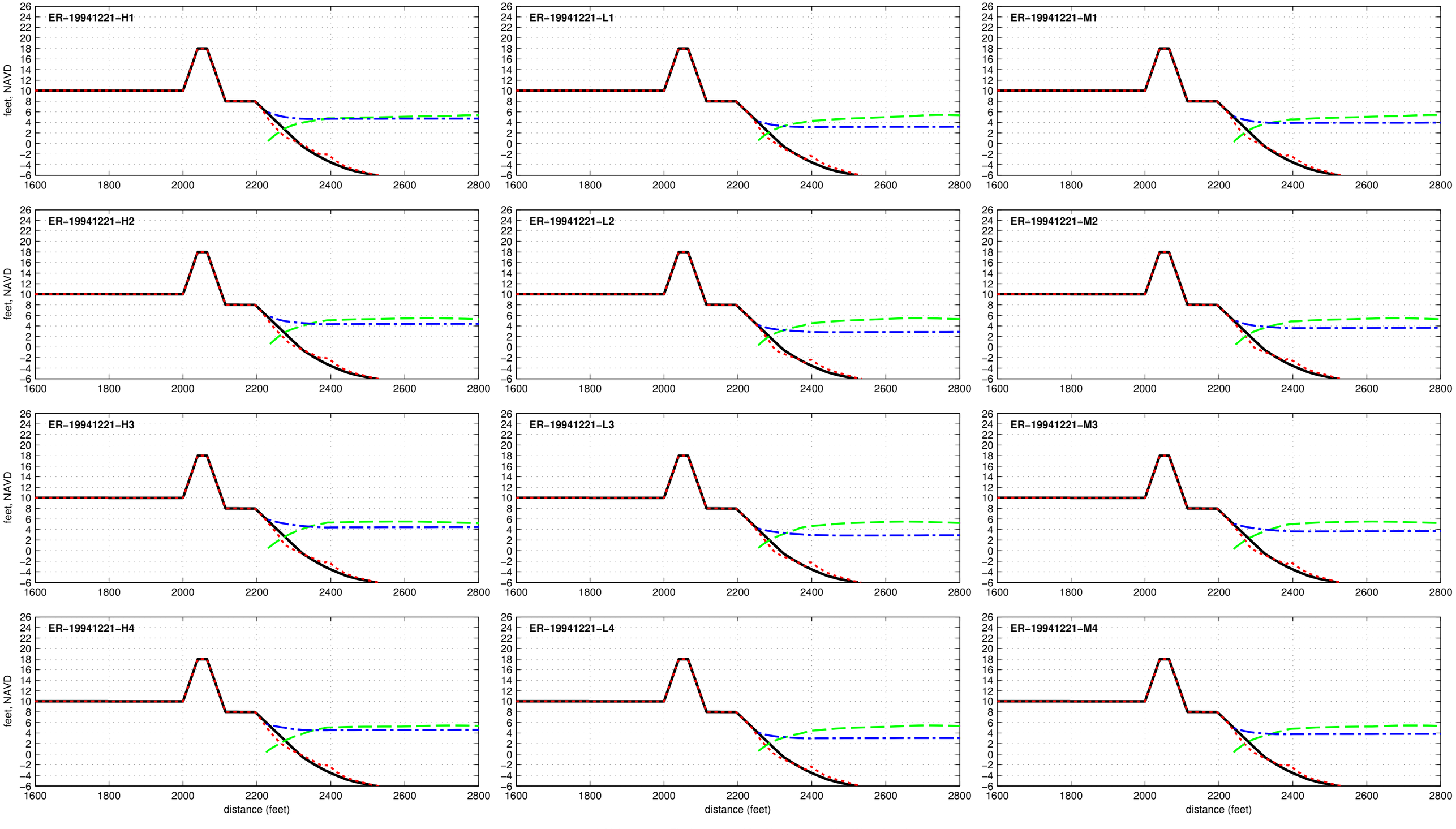




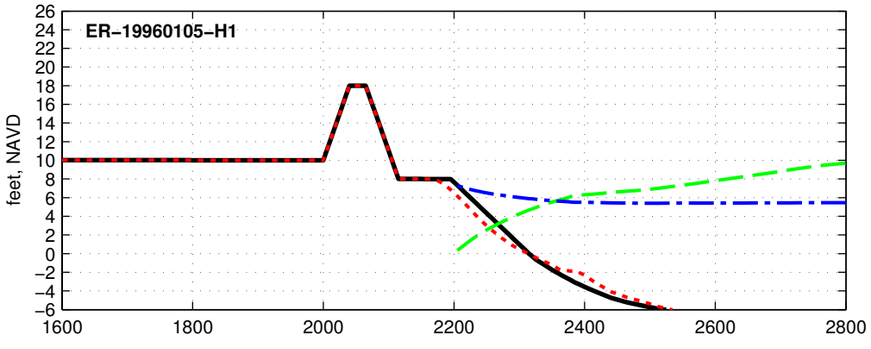


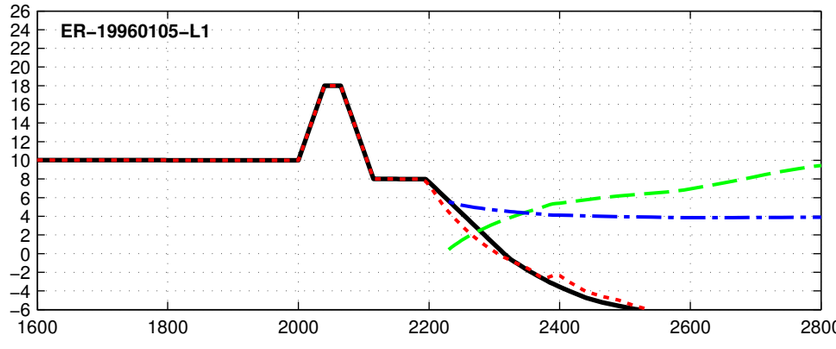
Initial Final Max Hs Max Water Level

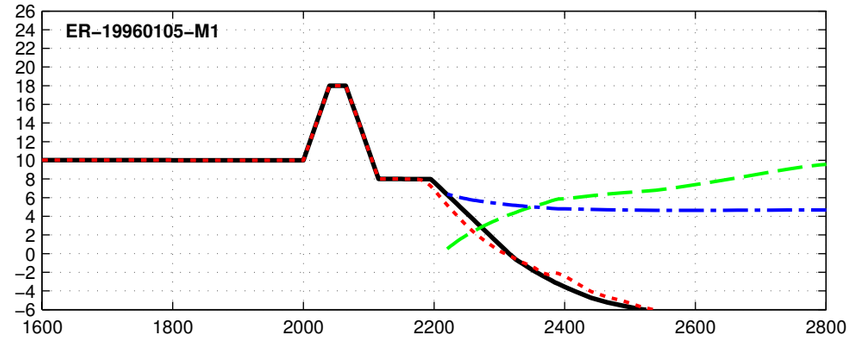
Dune R2T1-18.0-025-080 - ER-19941221

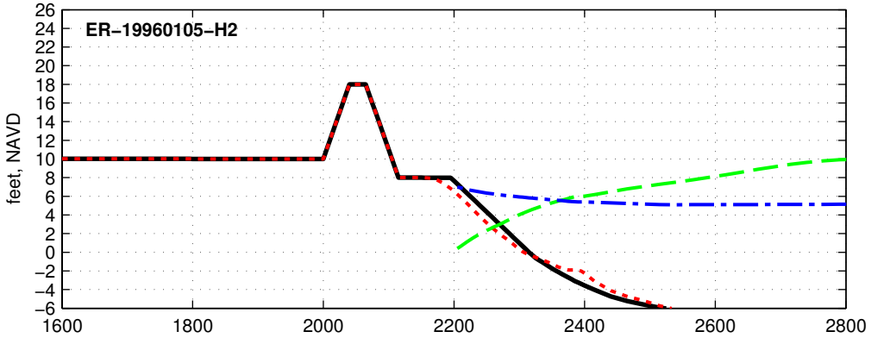


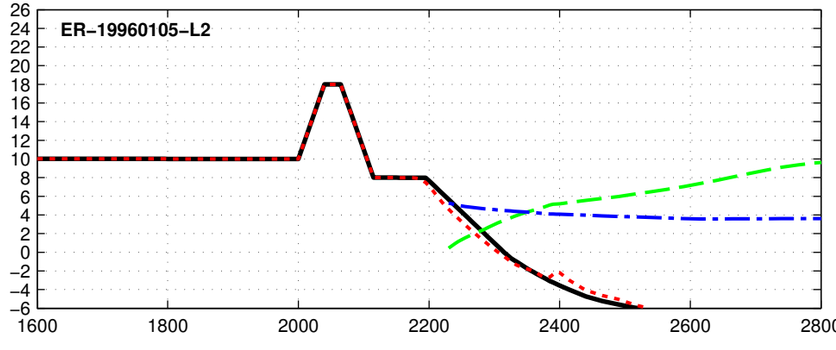
Dune R2T1-18.0-025-080 - ER-19960105

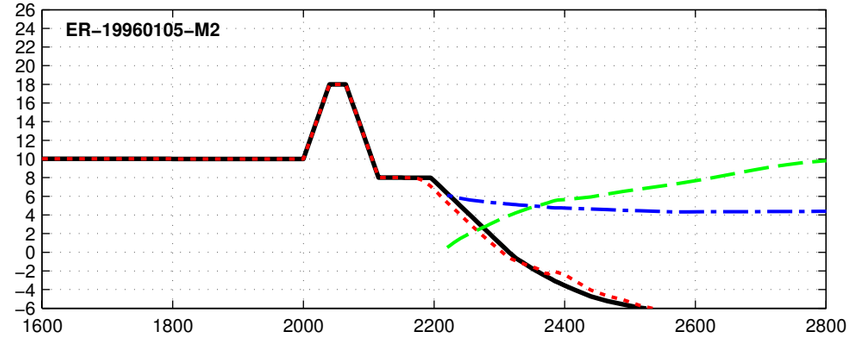


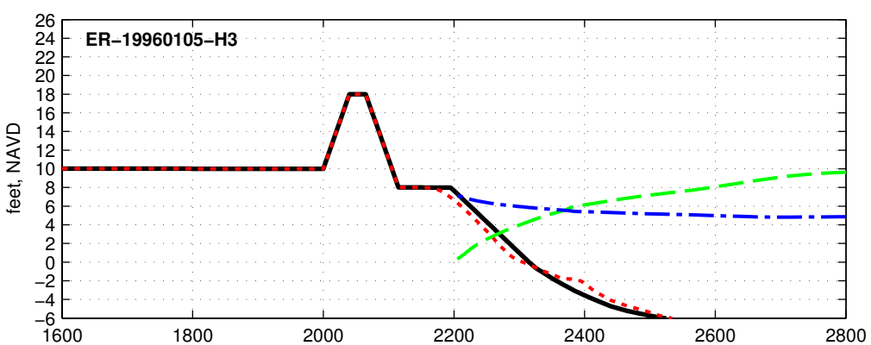


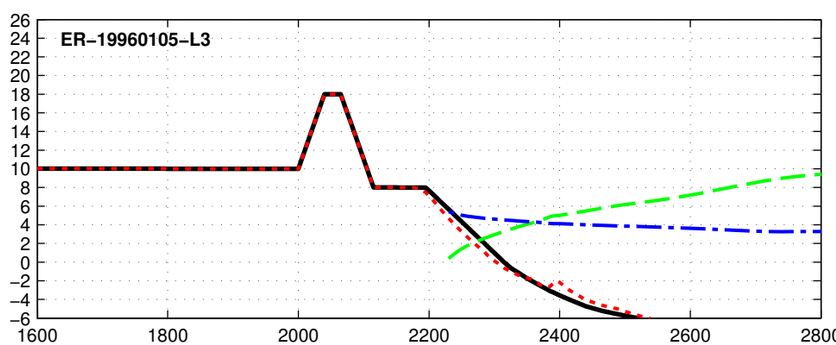


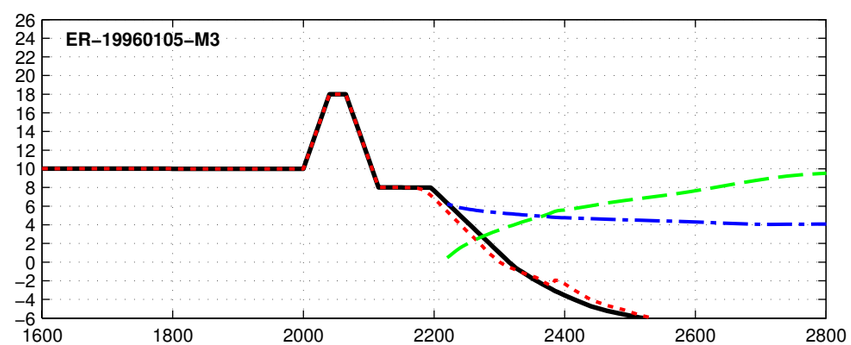


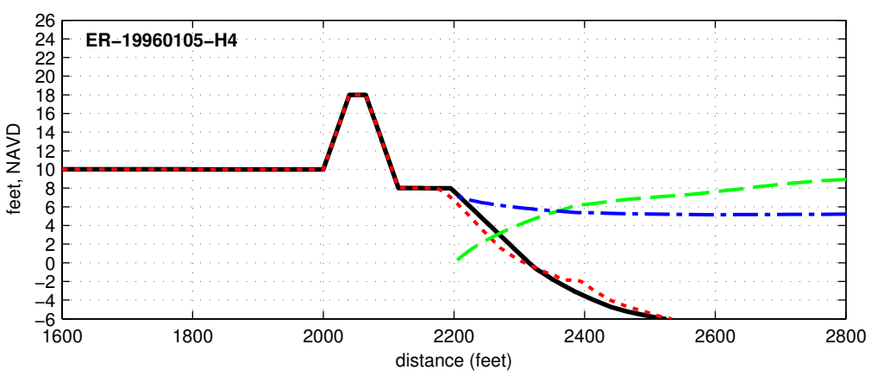


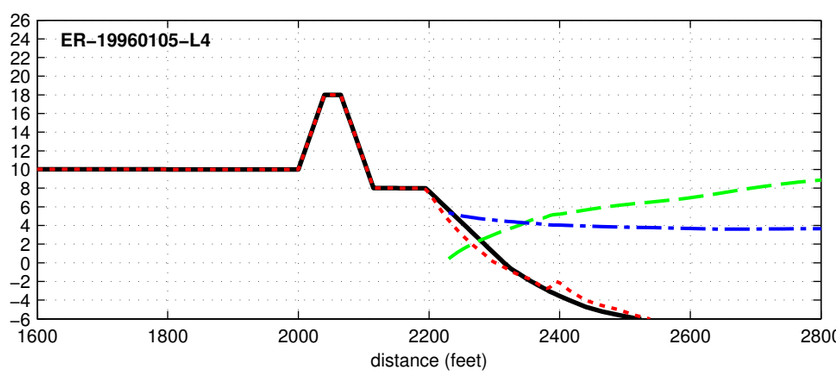


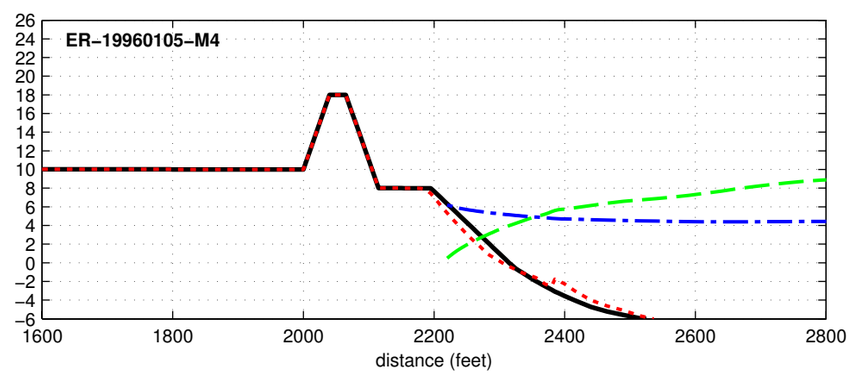






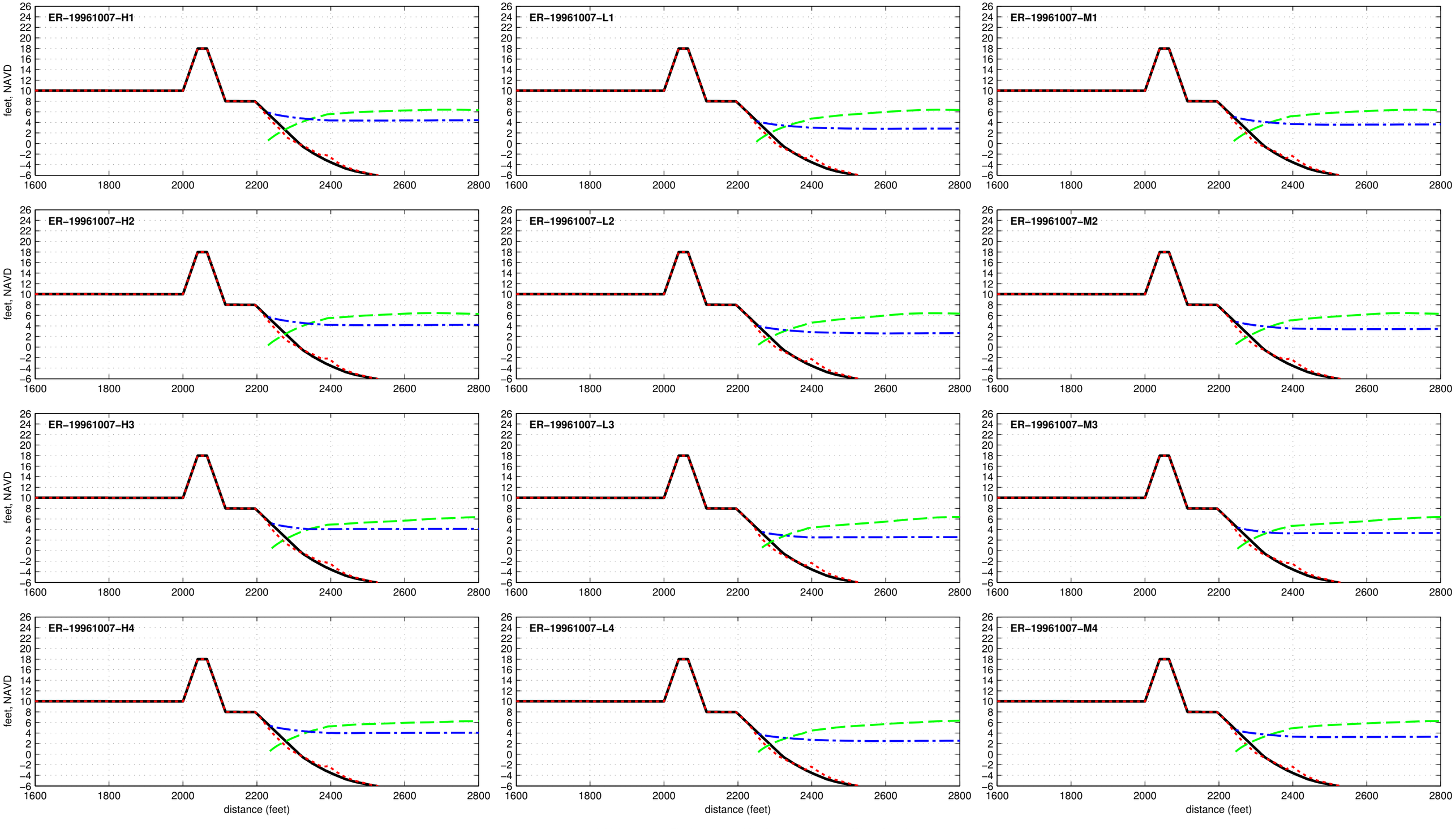




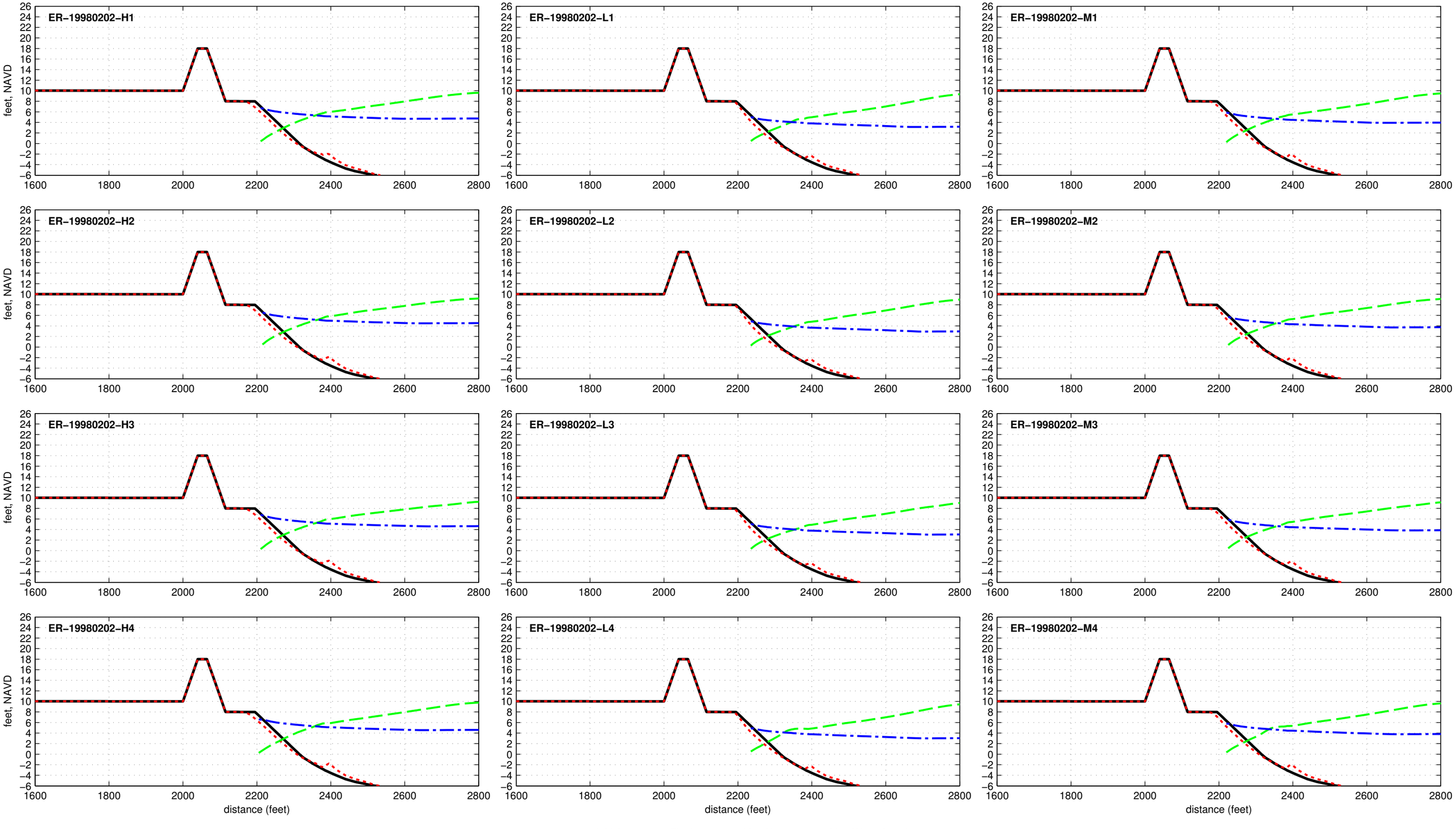


Initial Final Max Hs Max Water Level

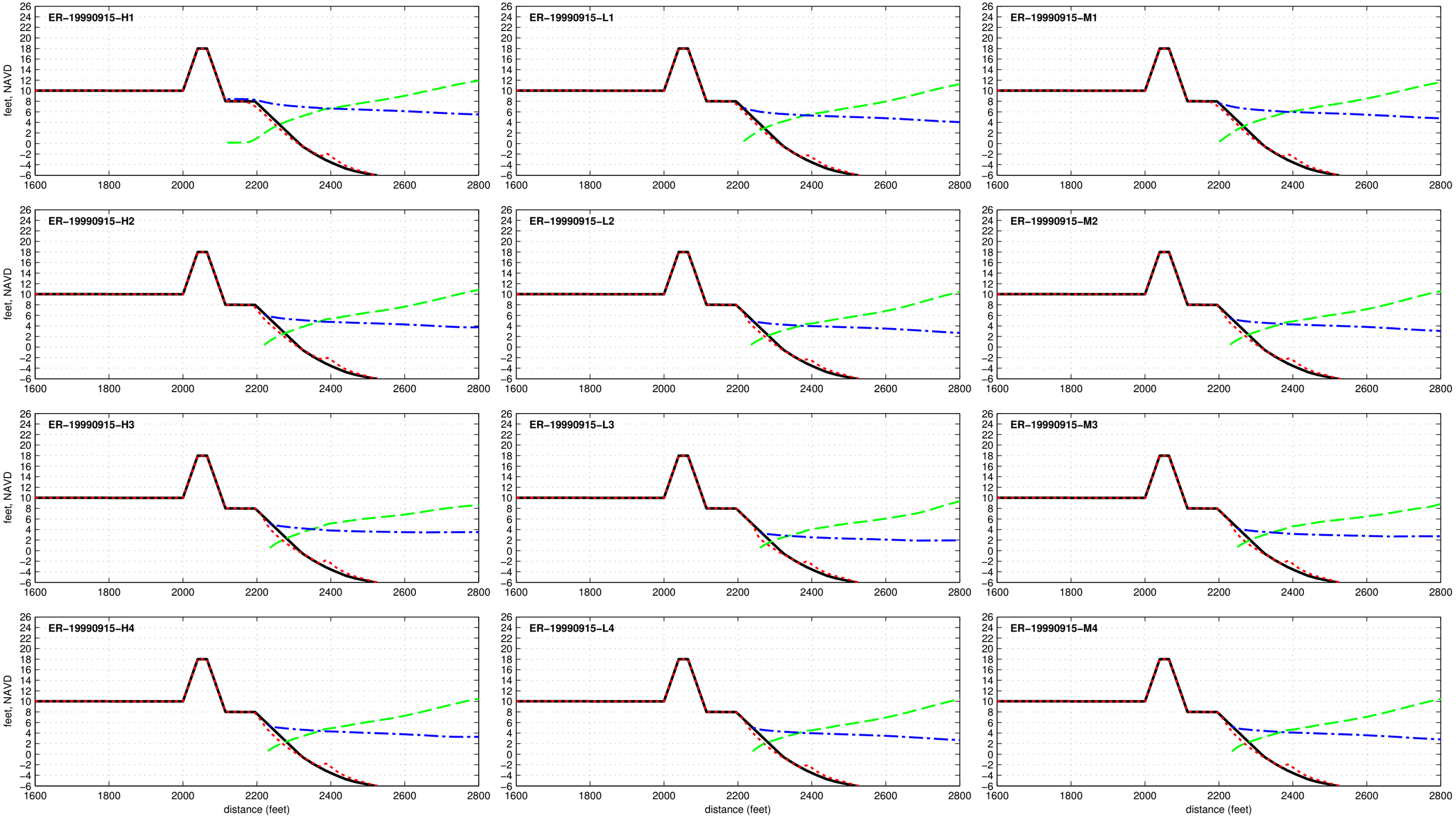
Dune R2T1-18.0-025-080 - ER-19961007



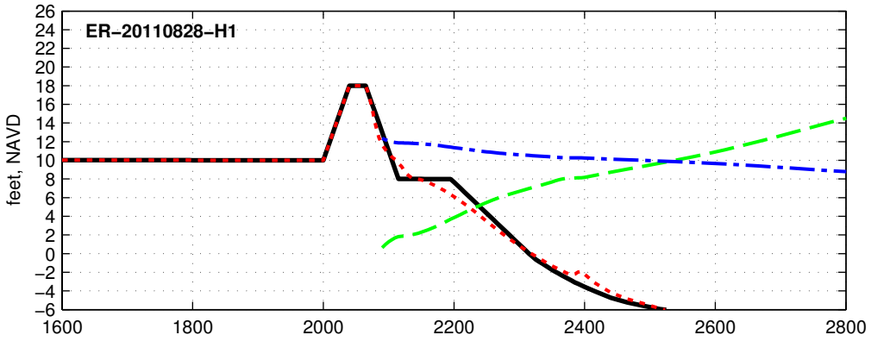
Dune R2T1-18.0-025-080 - ER-19980202

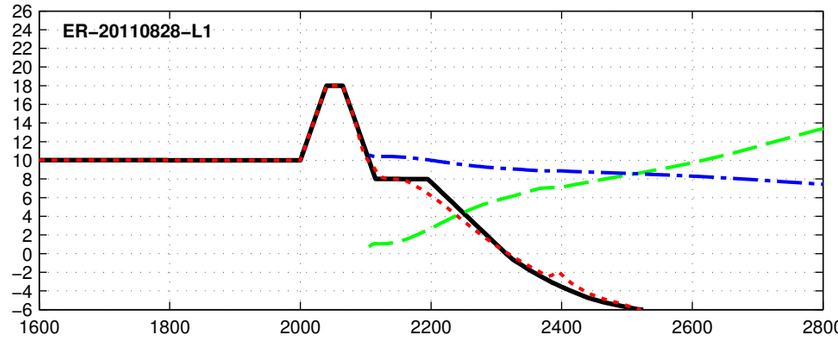


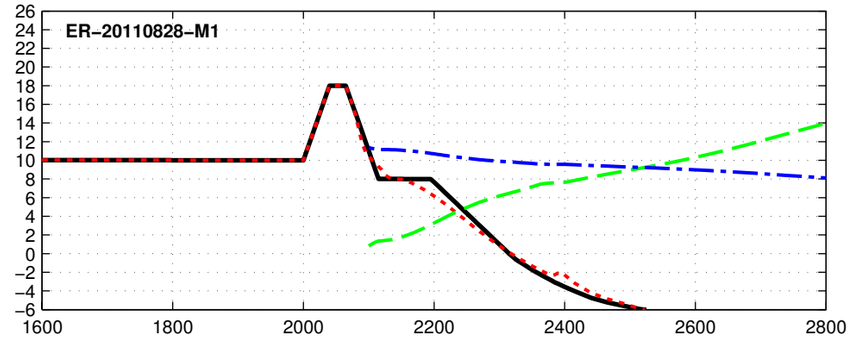
Dune R2T1-18.0-025-080 - ER-19990915

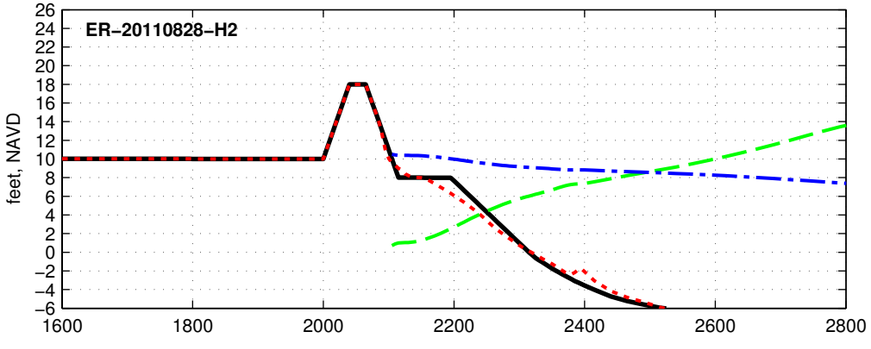


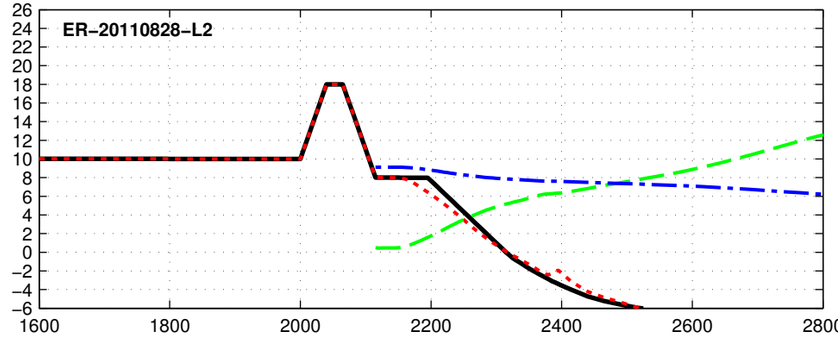
Dune R2T1-18.0-025-080 - ER-20110828

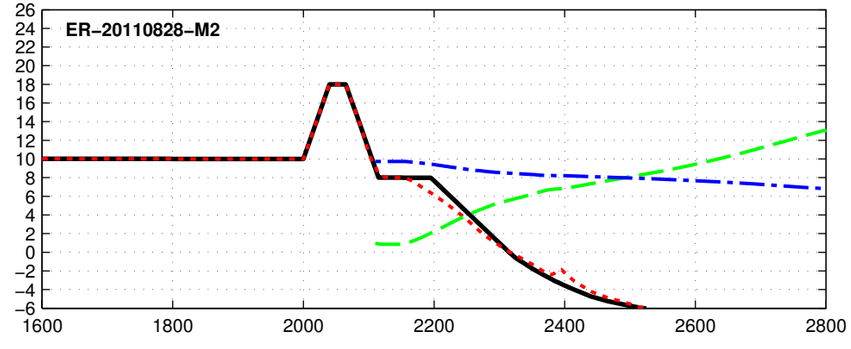


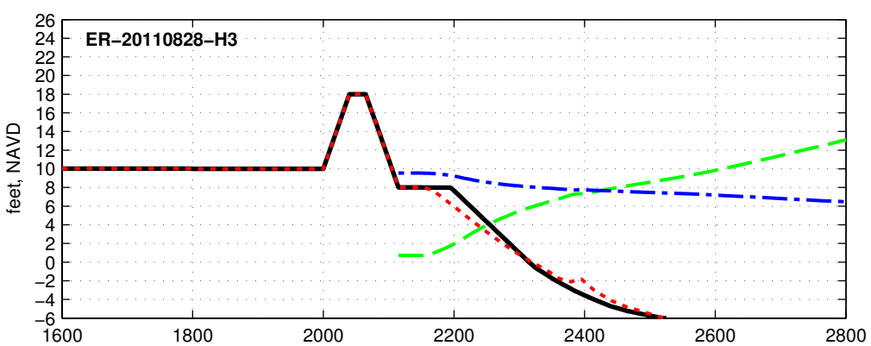


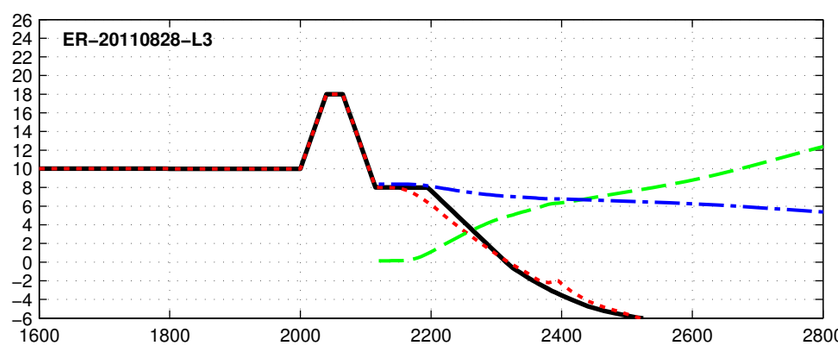


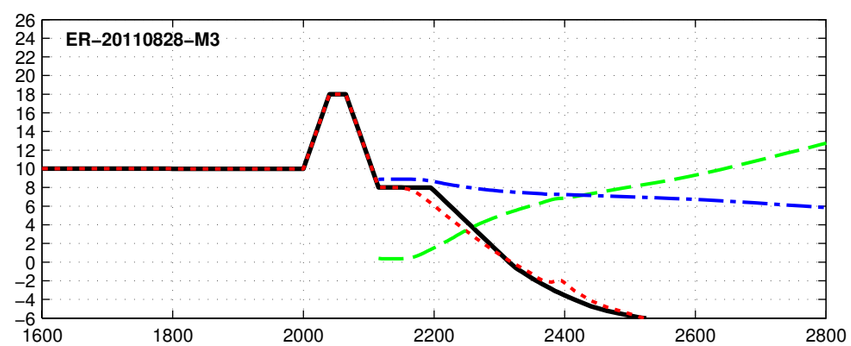


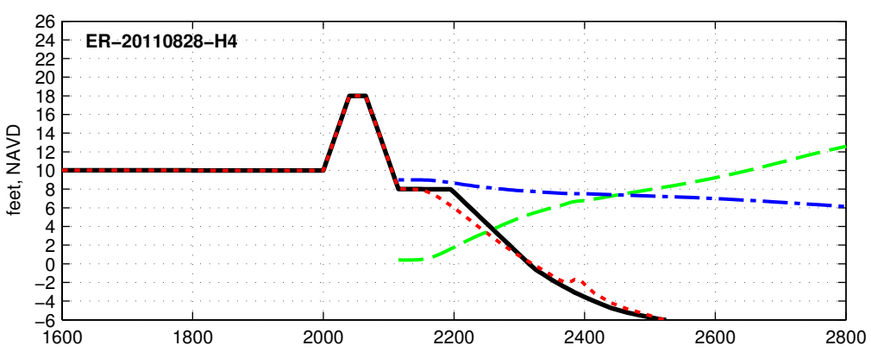


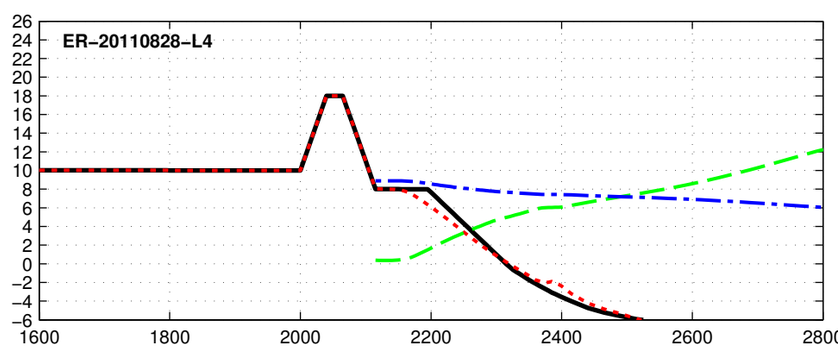


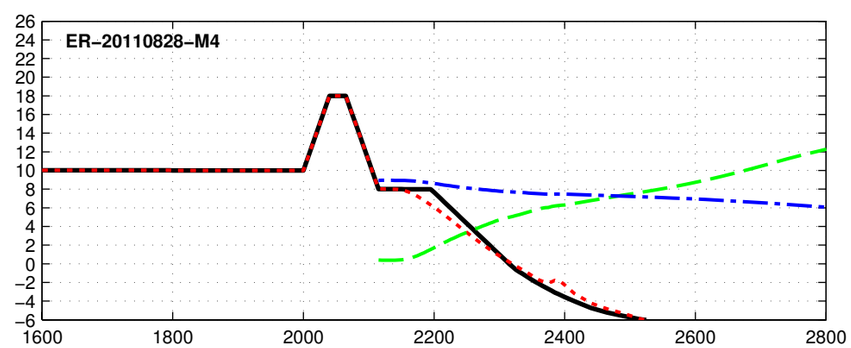






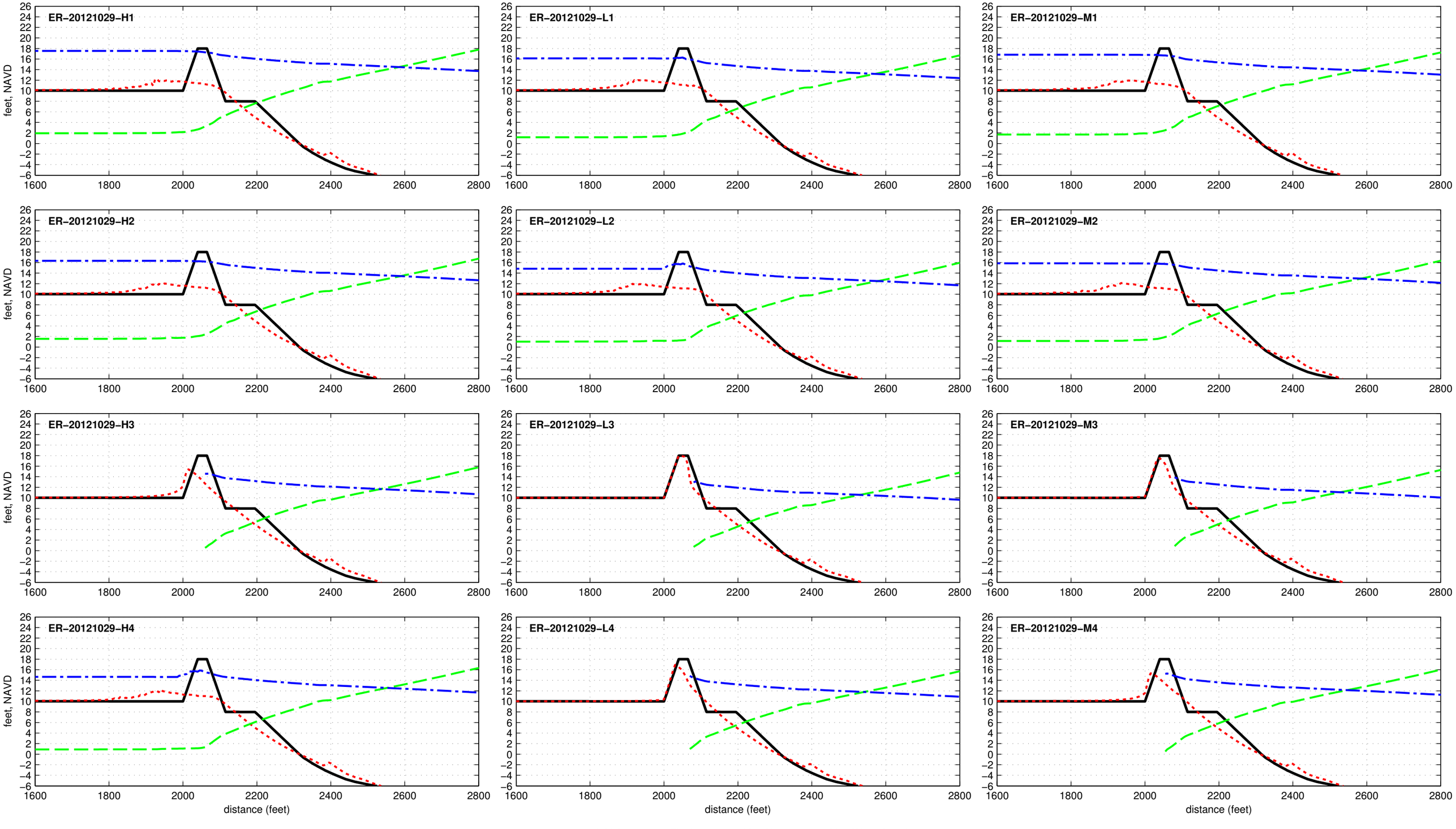






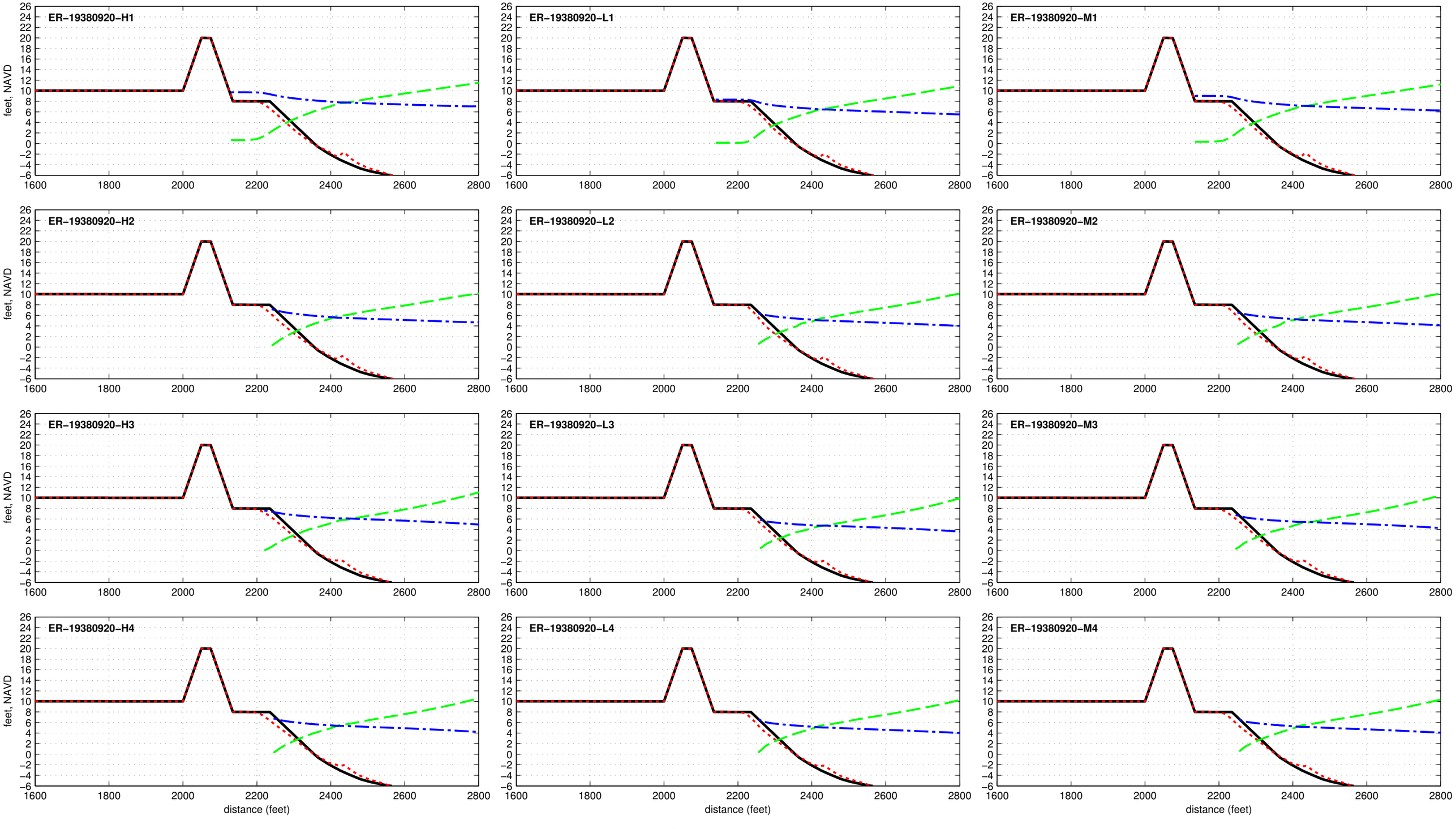
Initial Final Max Hs Max Water Level

Dune R2T1-18.0-025-080 - ER-20121029

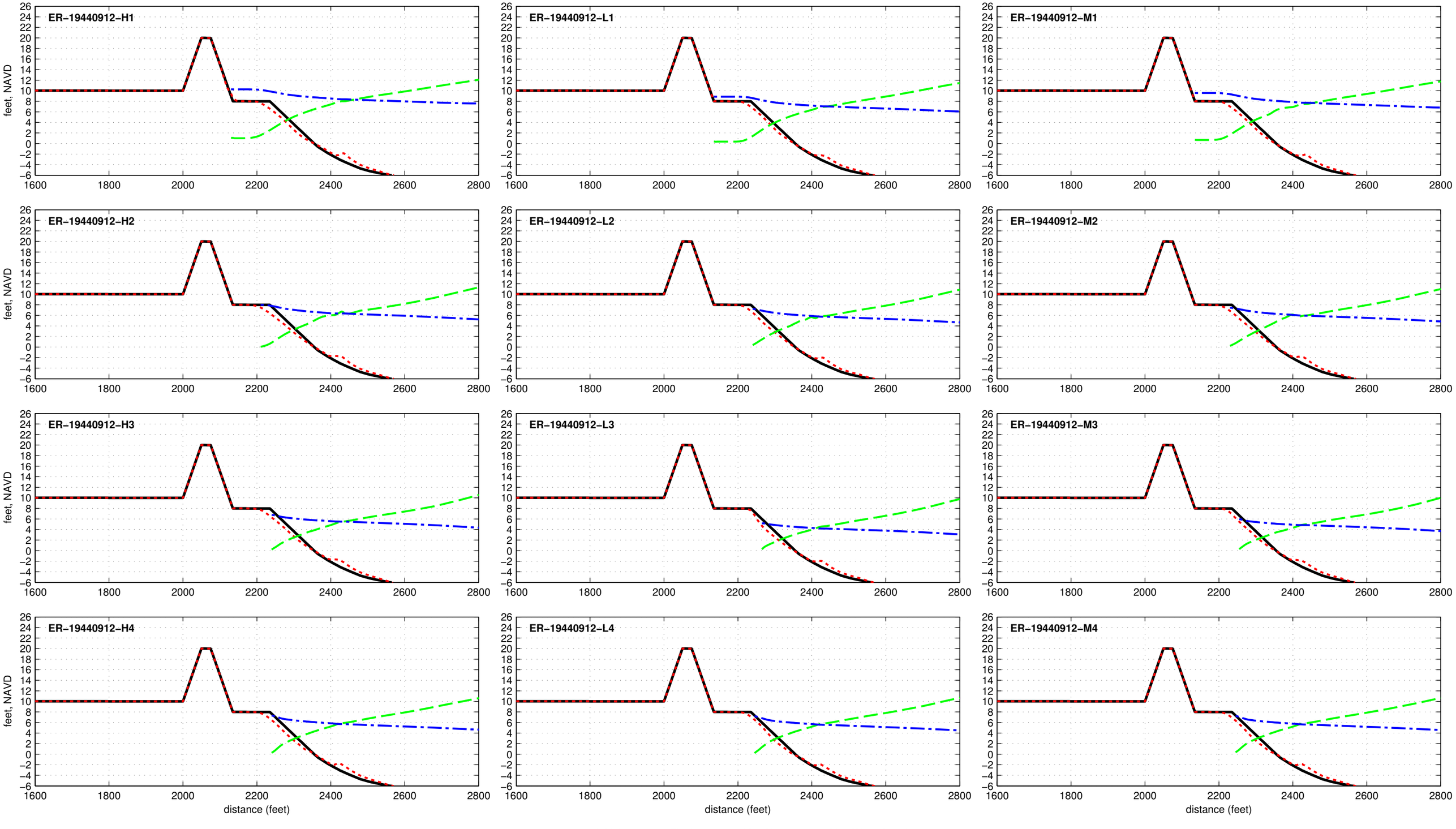


R2T1_20.0_025_100 - DUNE

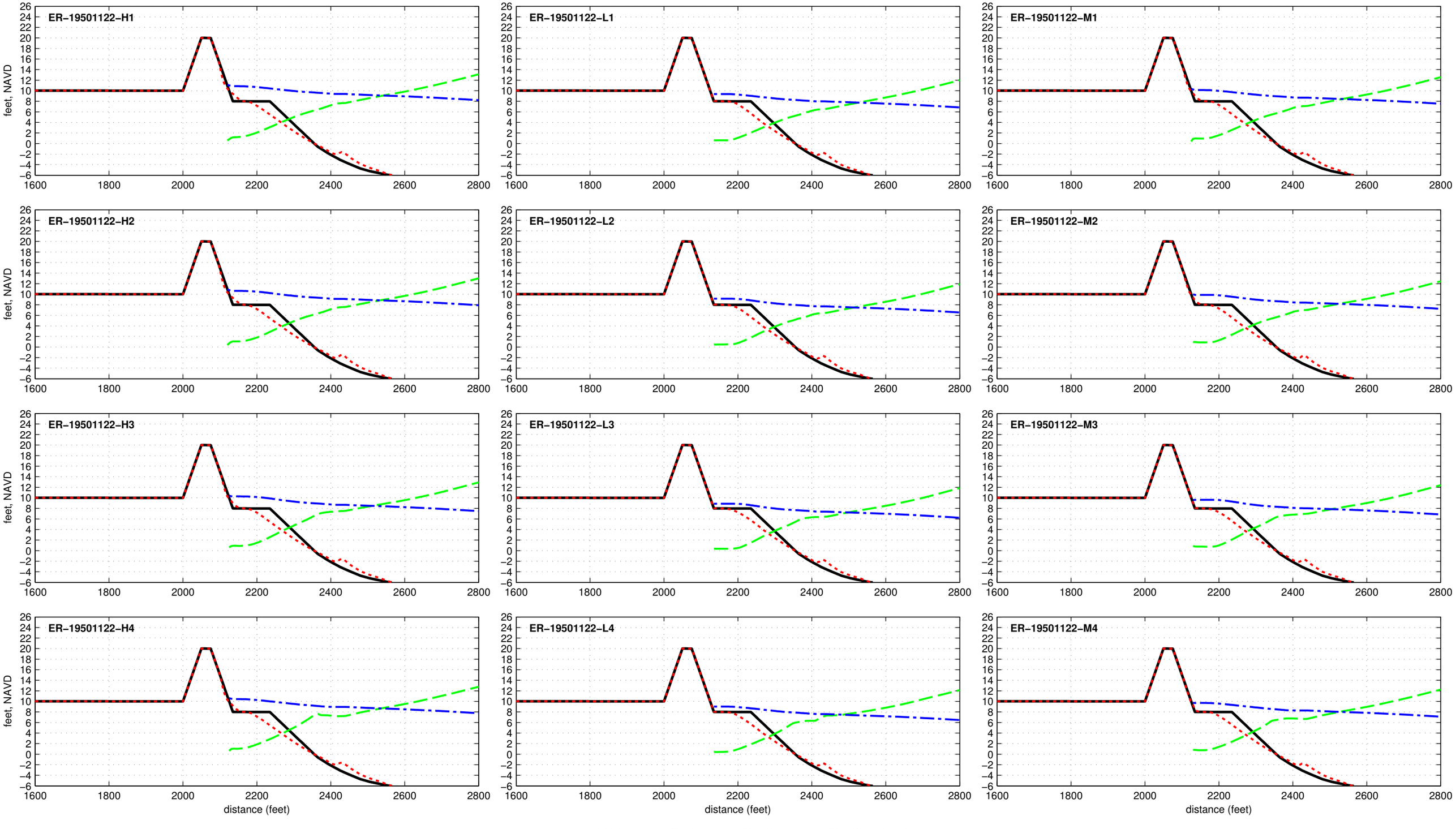
Dune R2T1-20.0-025-100 - ER-19380920



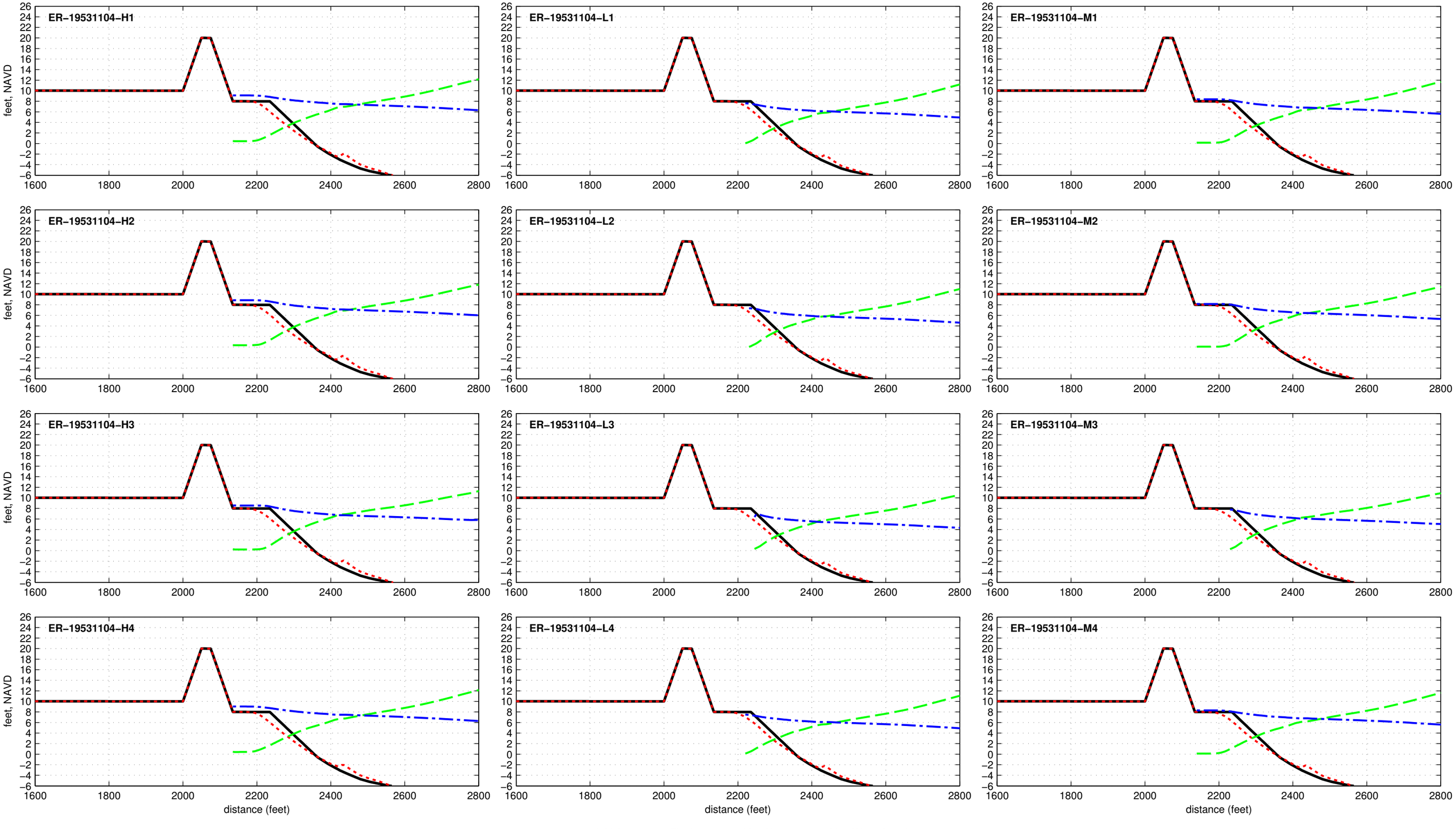
Dune R2T1-20.0-025-100 - ER-19440912



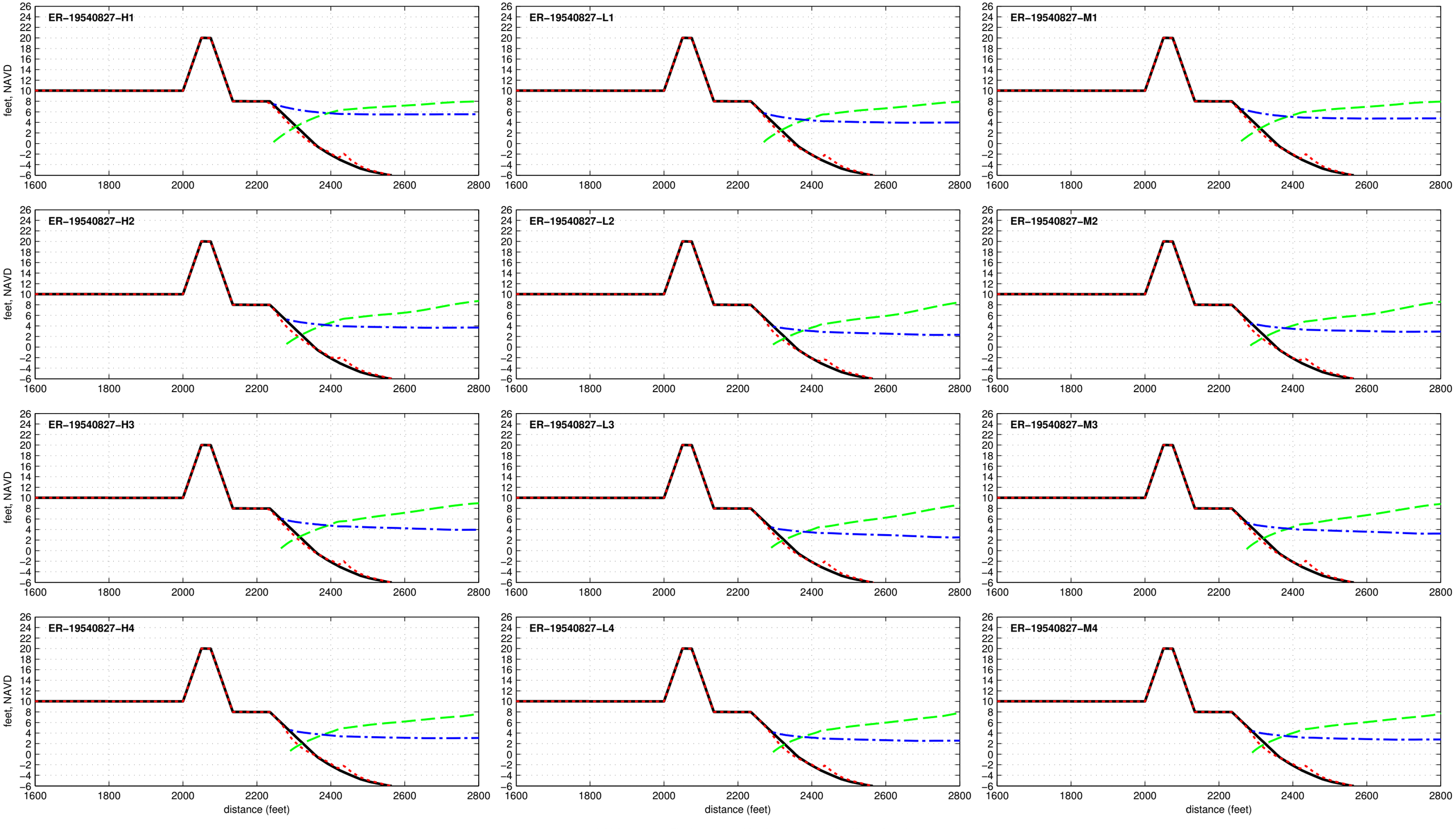
Dune R2T1-20.0-025-100 - ER-19501122



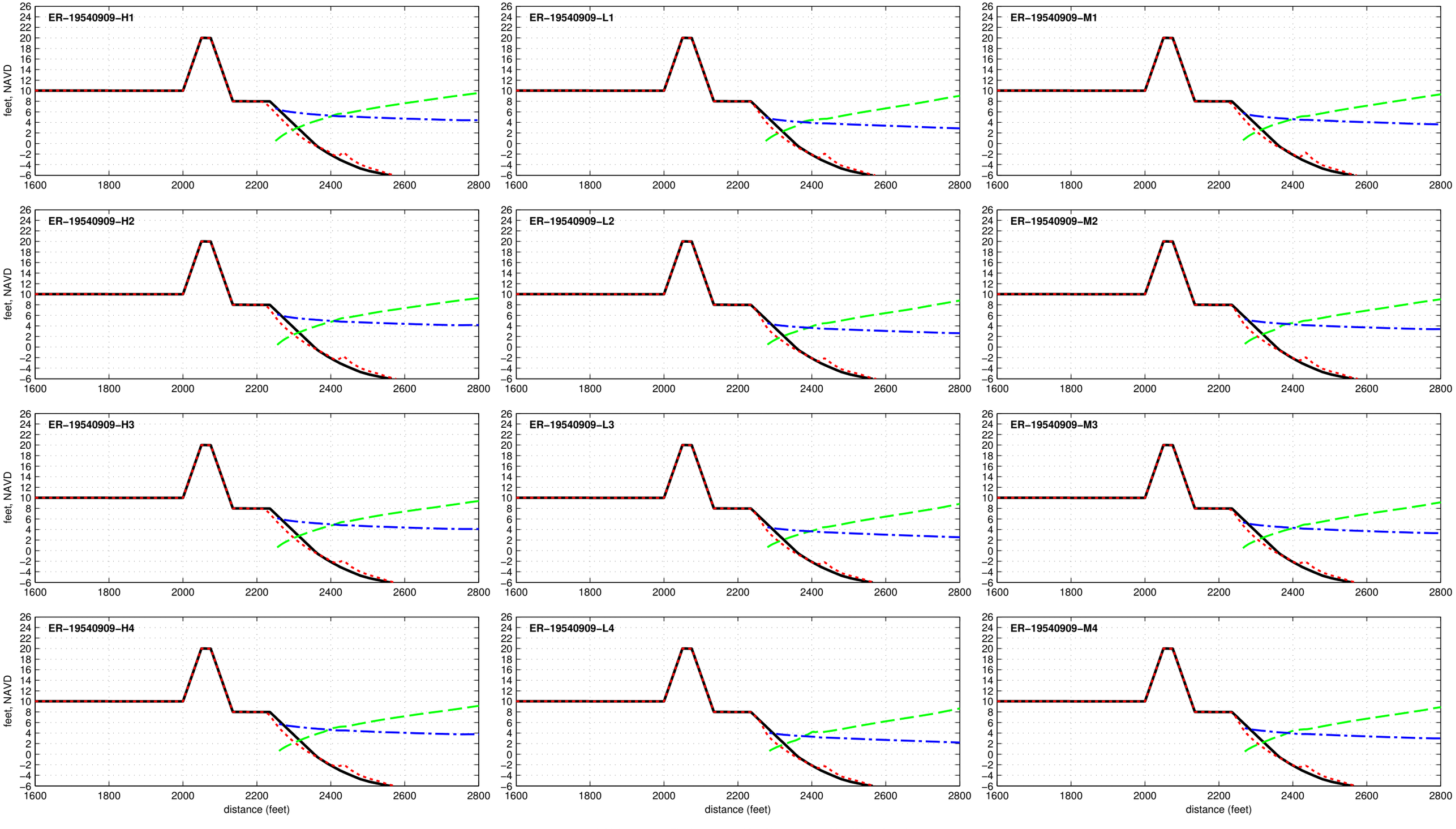
Dune R2T1-20.0-025-100 - ER-19531104



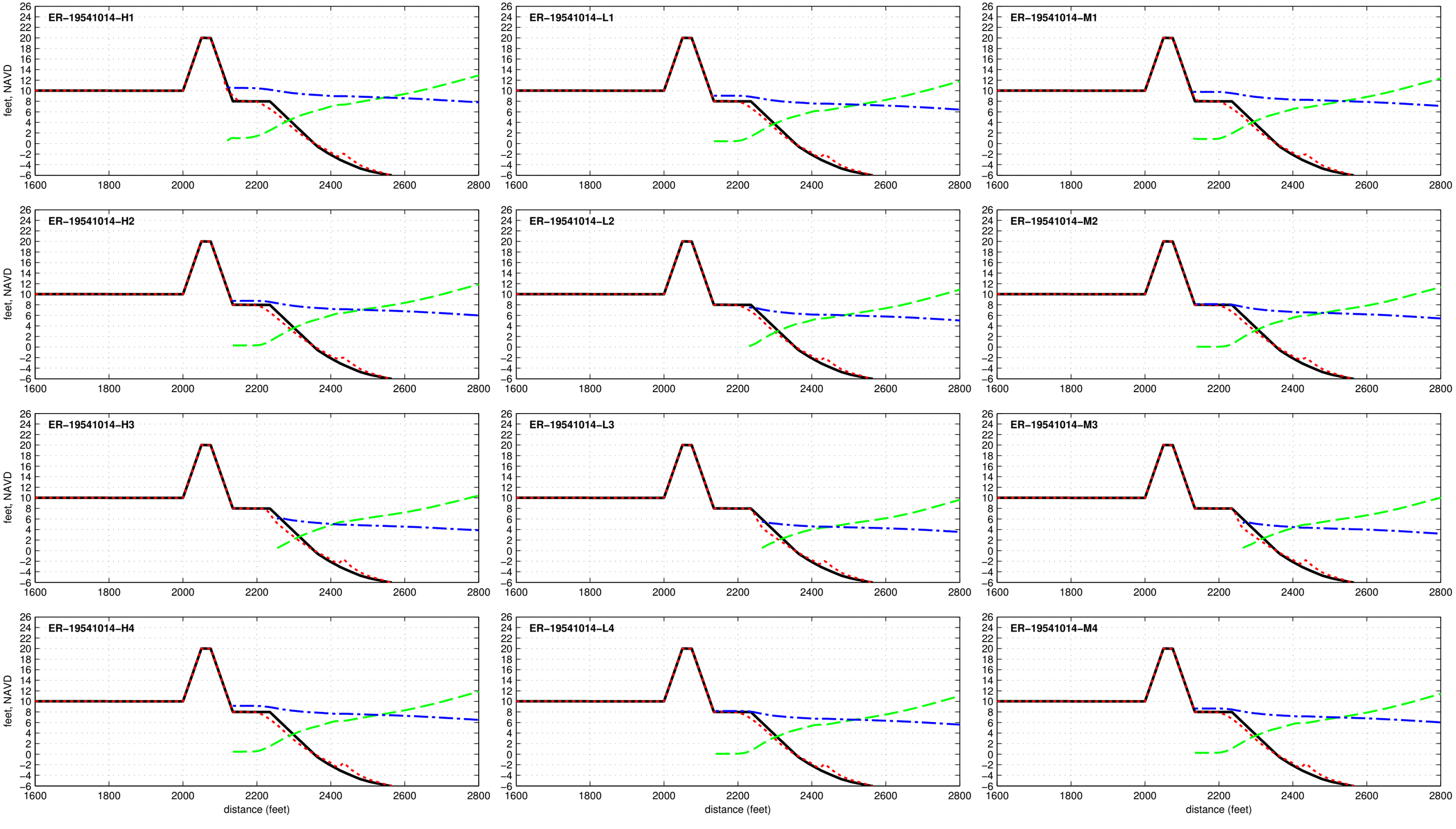
Dune R2T1–20.0–025–100 – ER–19540827



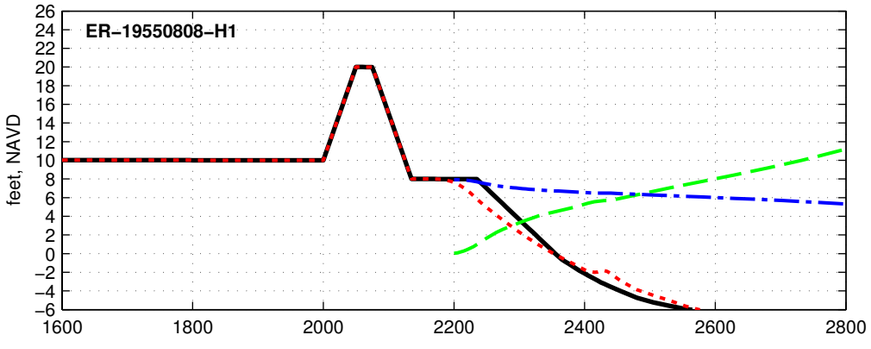
Dune R2T1-20.0-025-100 - ER-19540909

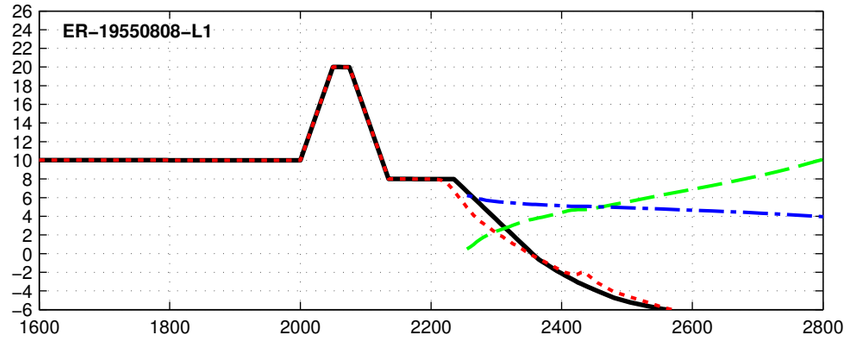


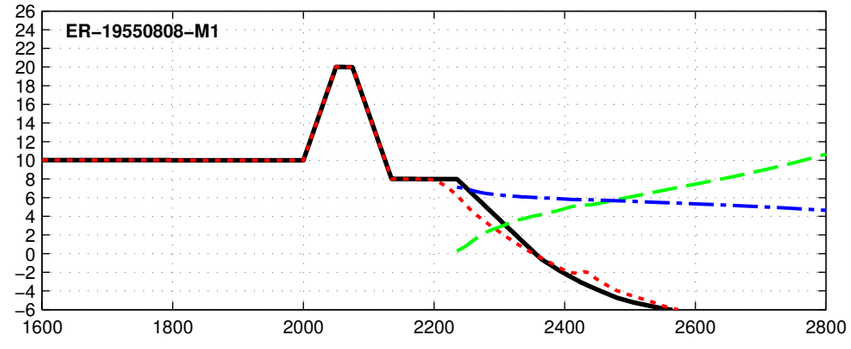
Dune R2T1–20.0–025–100 – ER–19541014

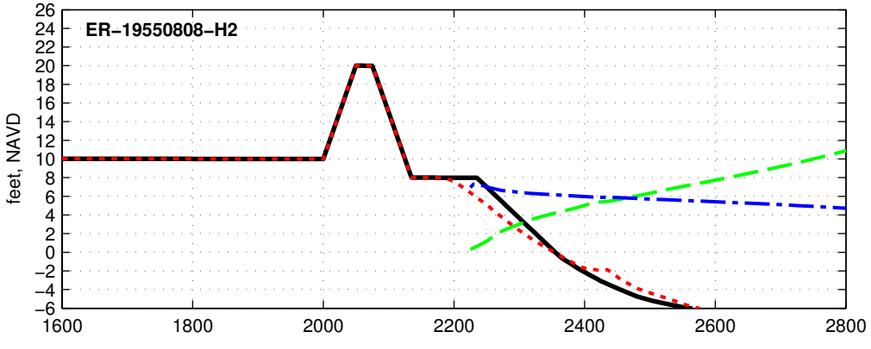


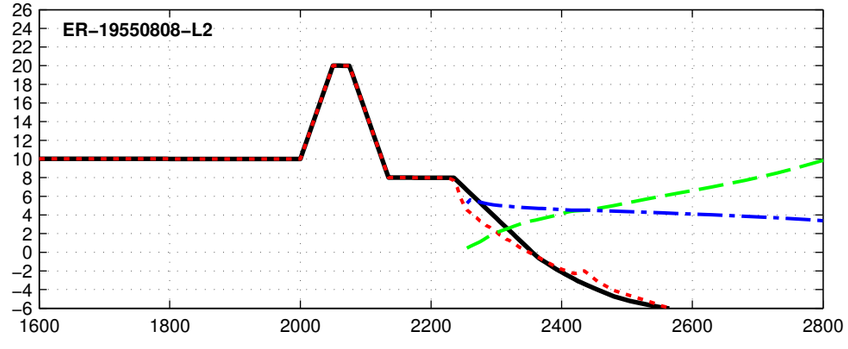
Dune R2T1-20.0-025-100 - ER-19550808

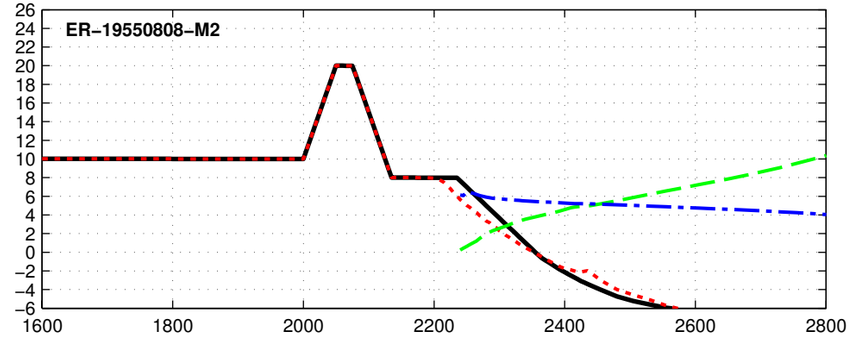


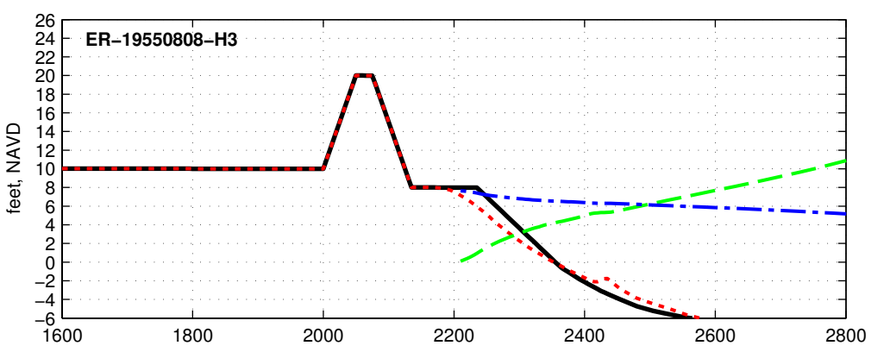


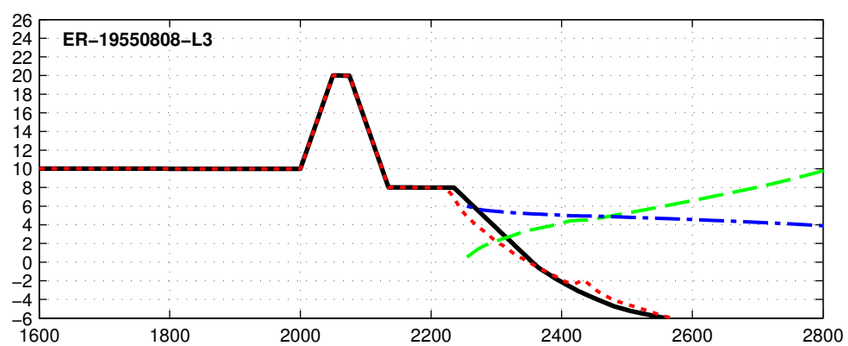


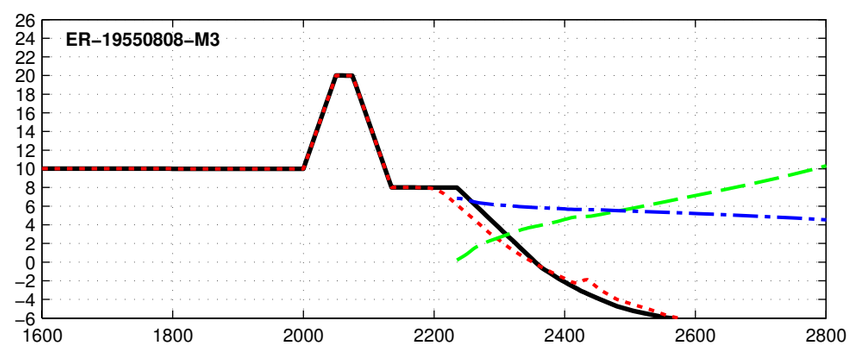


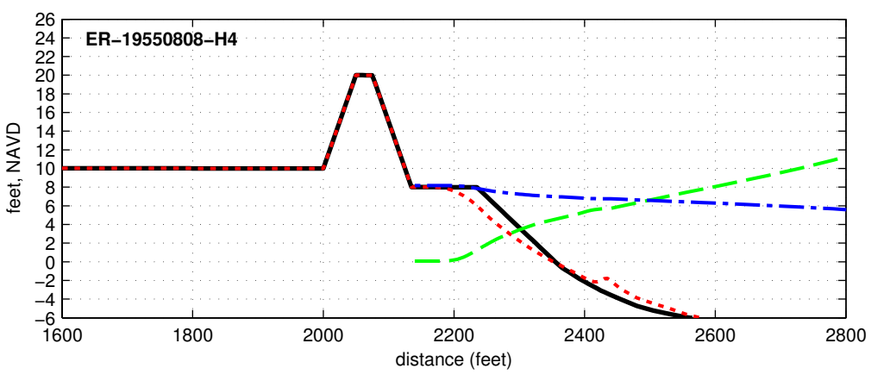


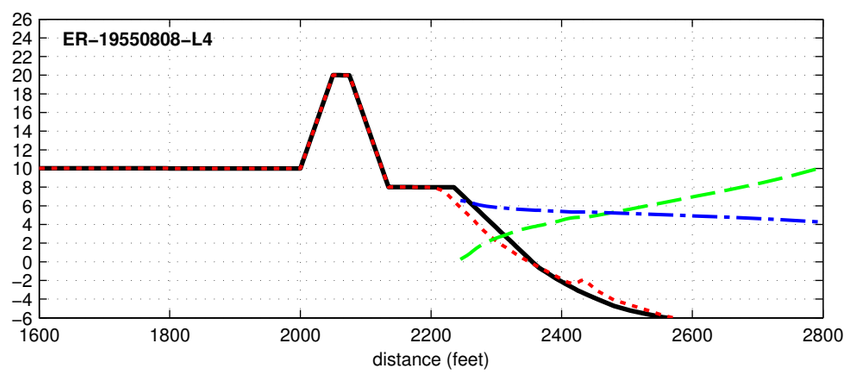


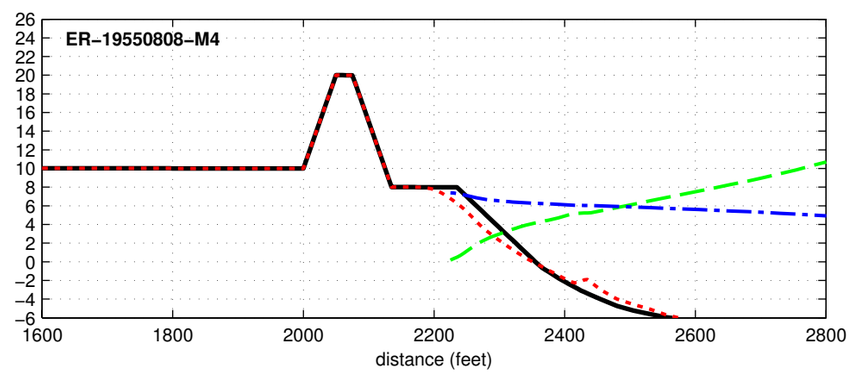






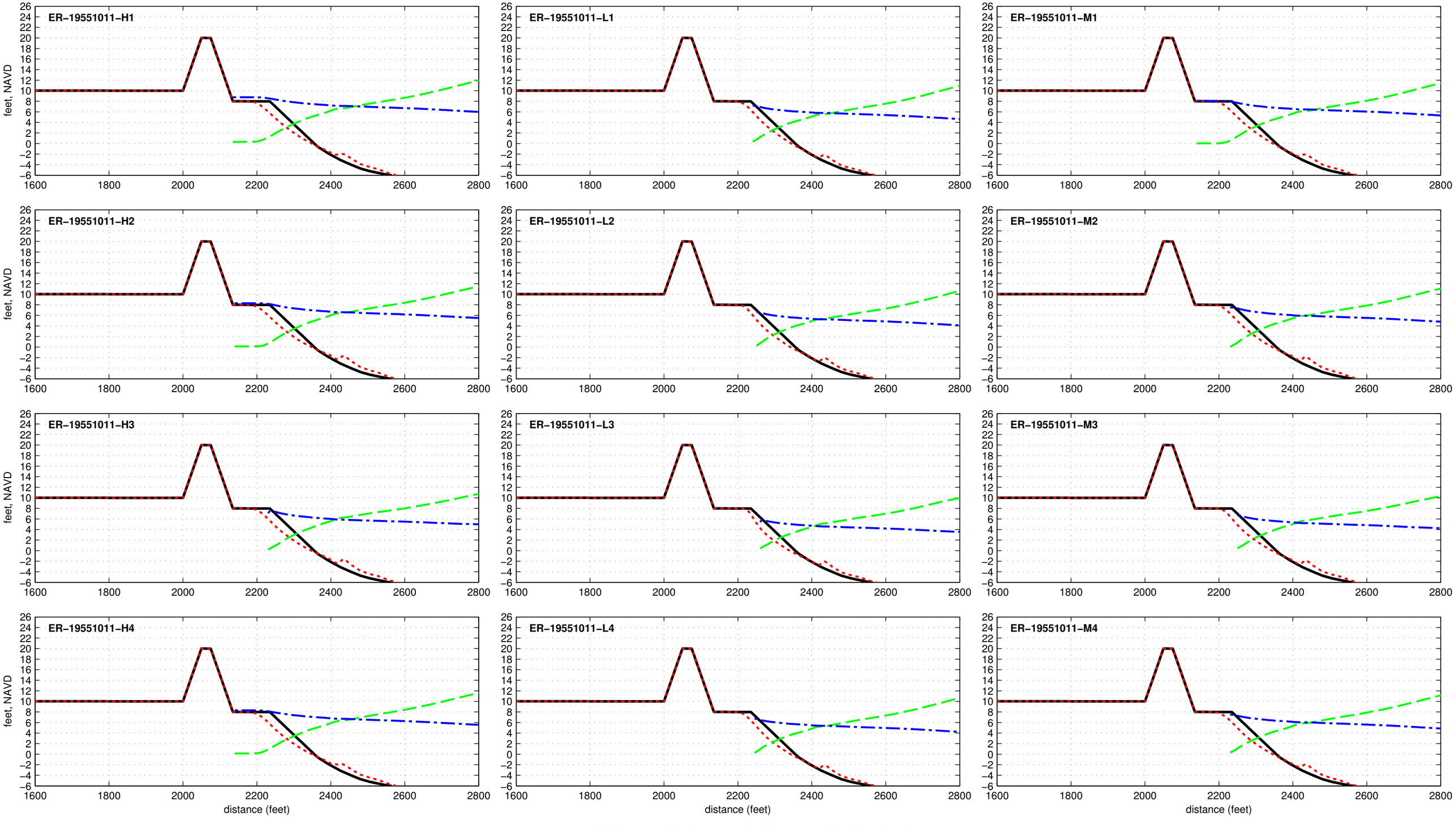




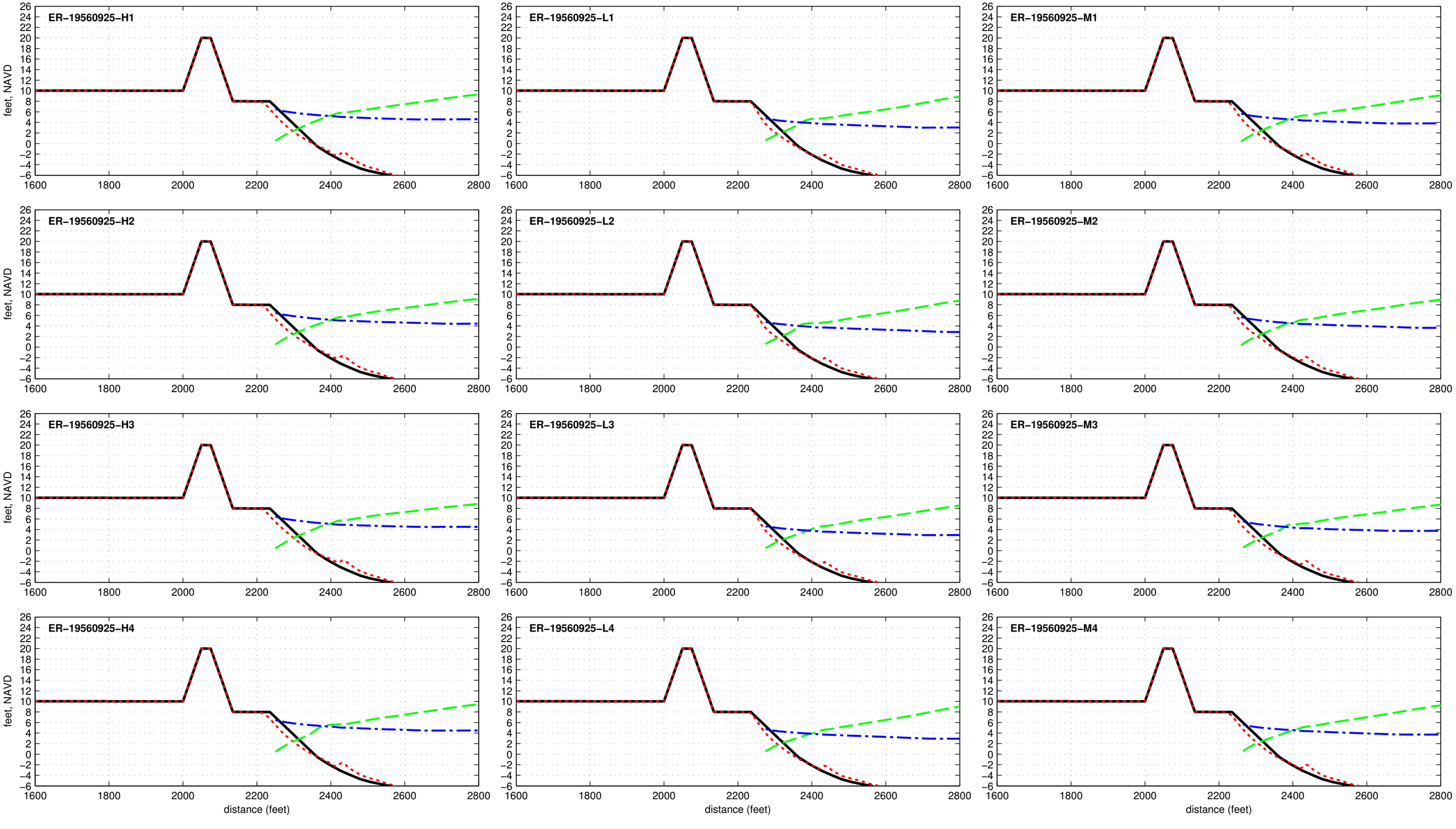


Initial Final Max Hs Max Water Level

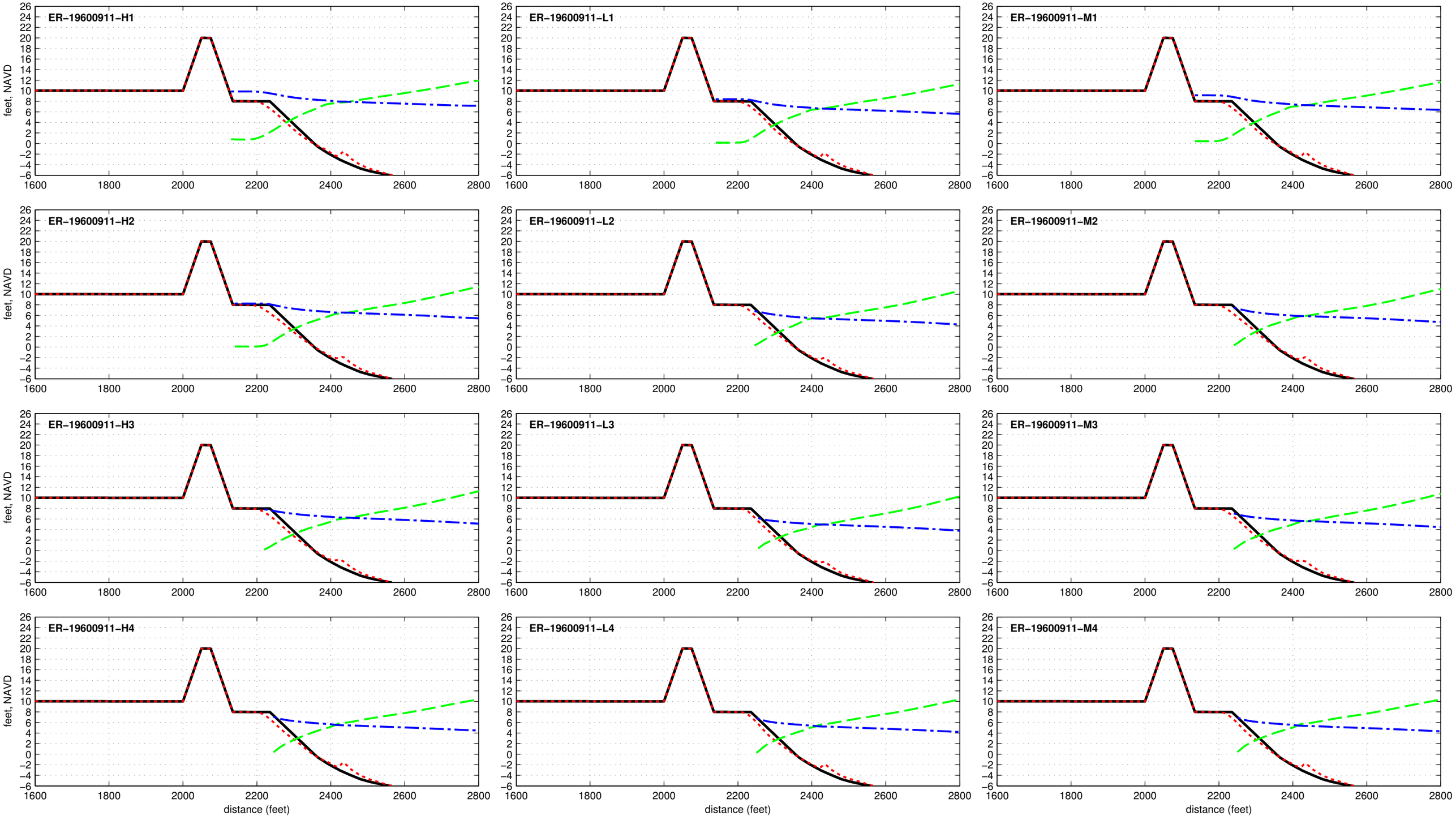
Dune R2T1-20.0-025-100 - ER-19551011



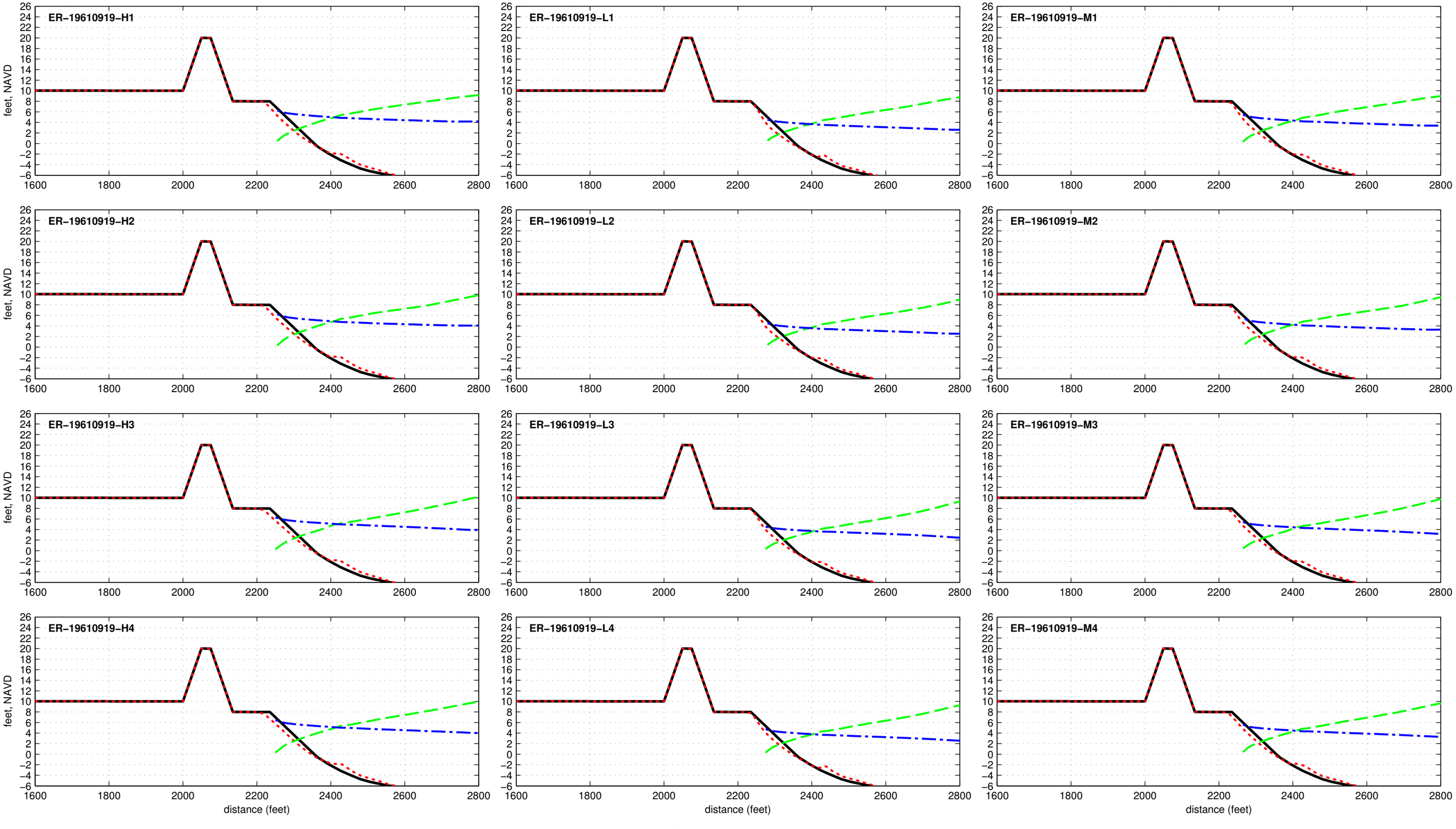
Dune R2T1-20.0-025-100 - ER-19560925



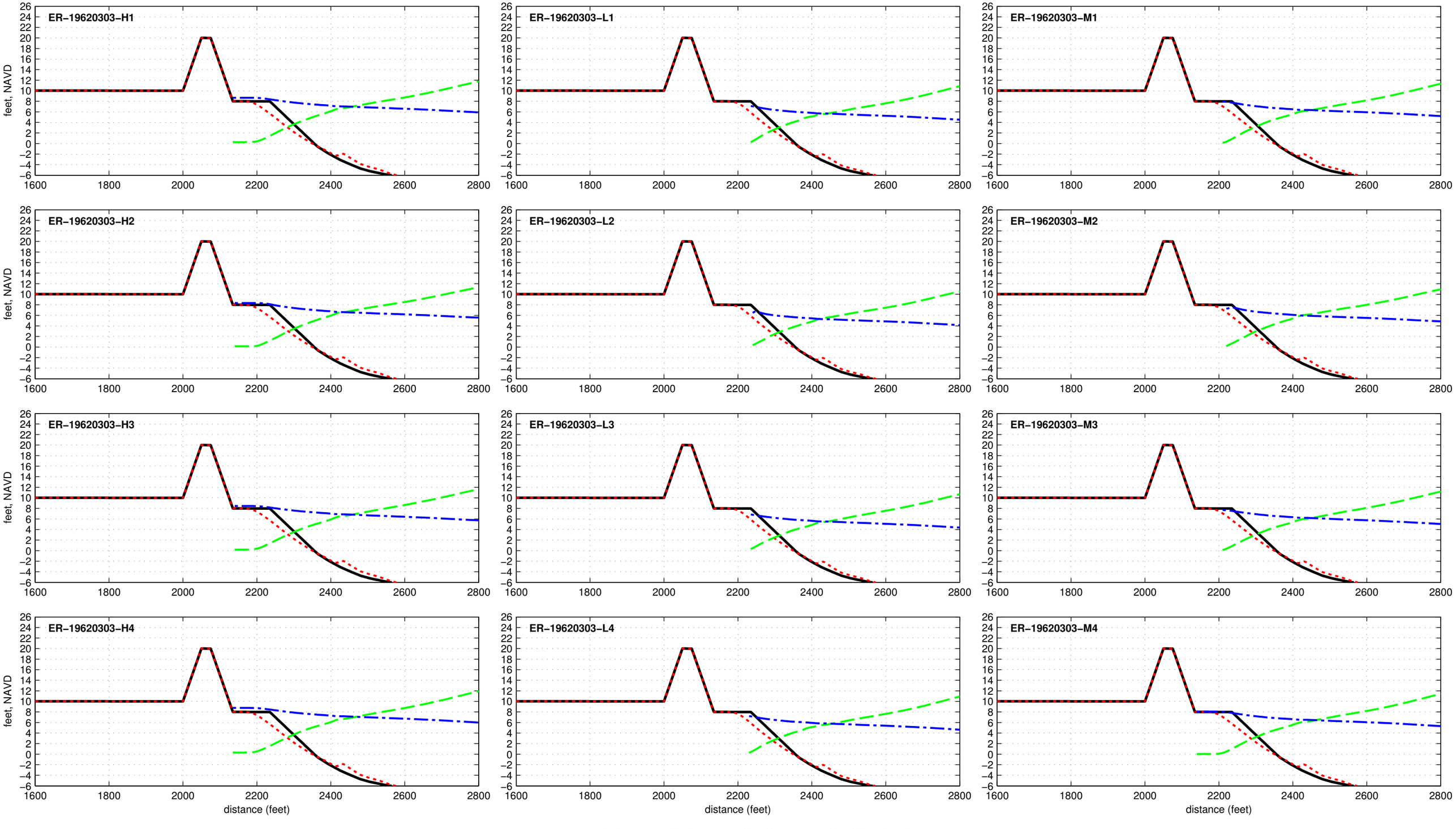
Dune R2T1-20.0-025-100 - ER-19600911



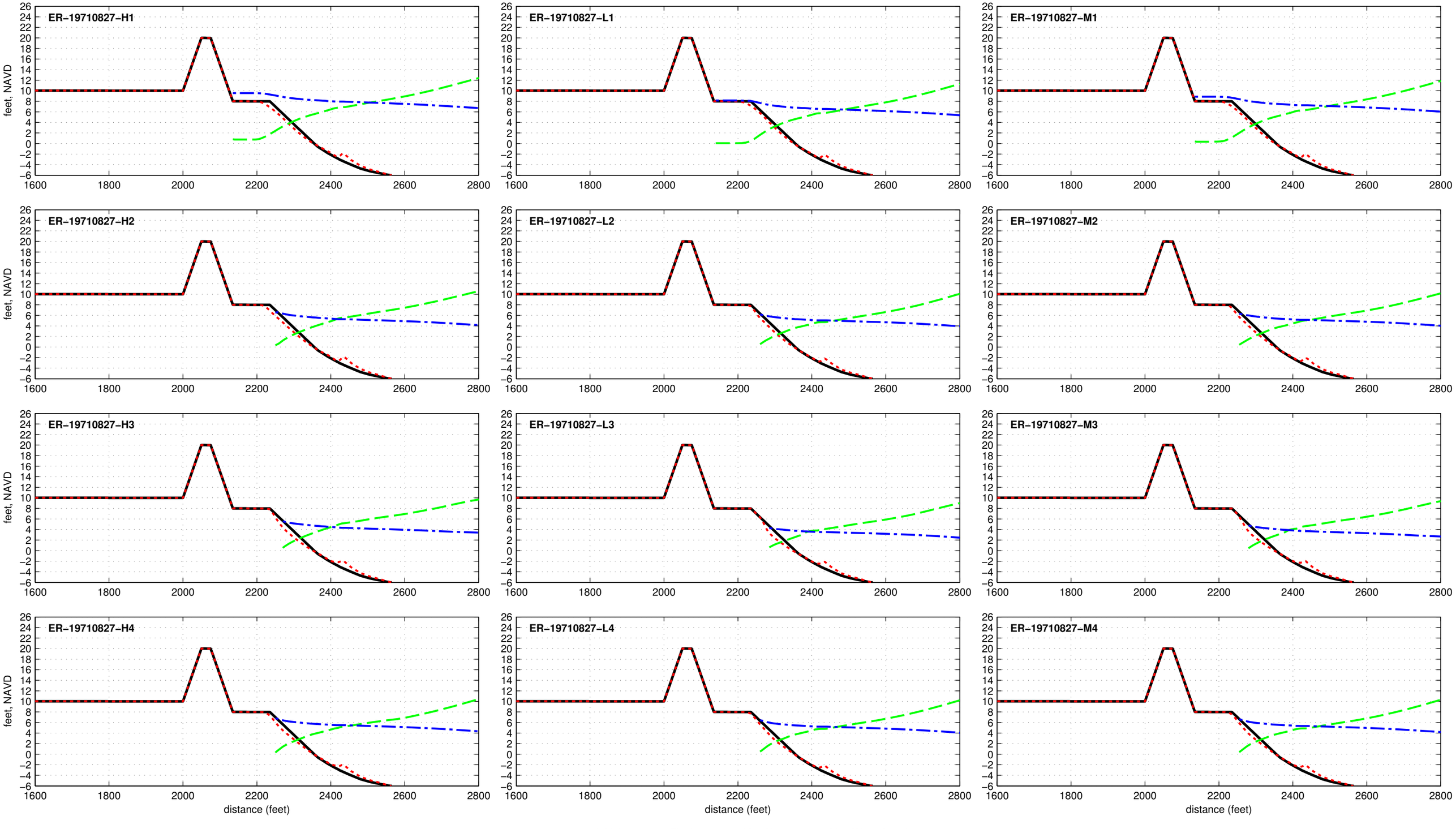
Dune R2T1-20.0-025-100 - ER-19610919



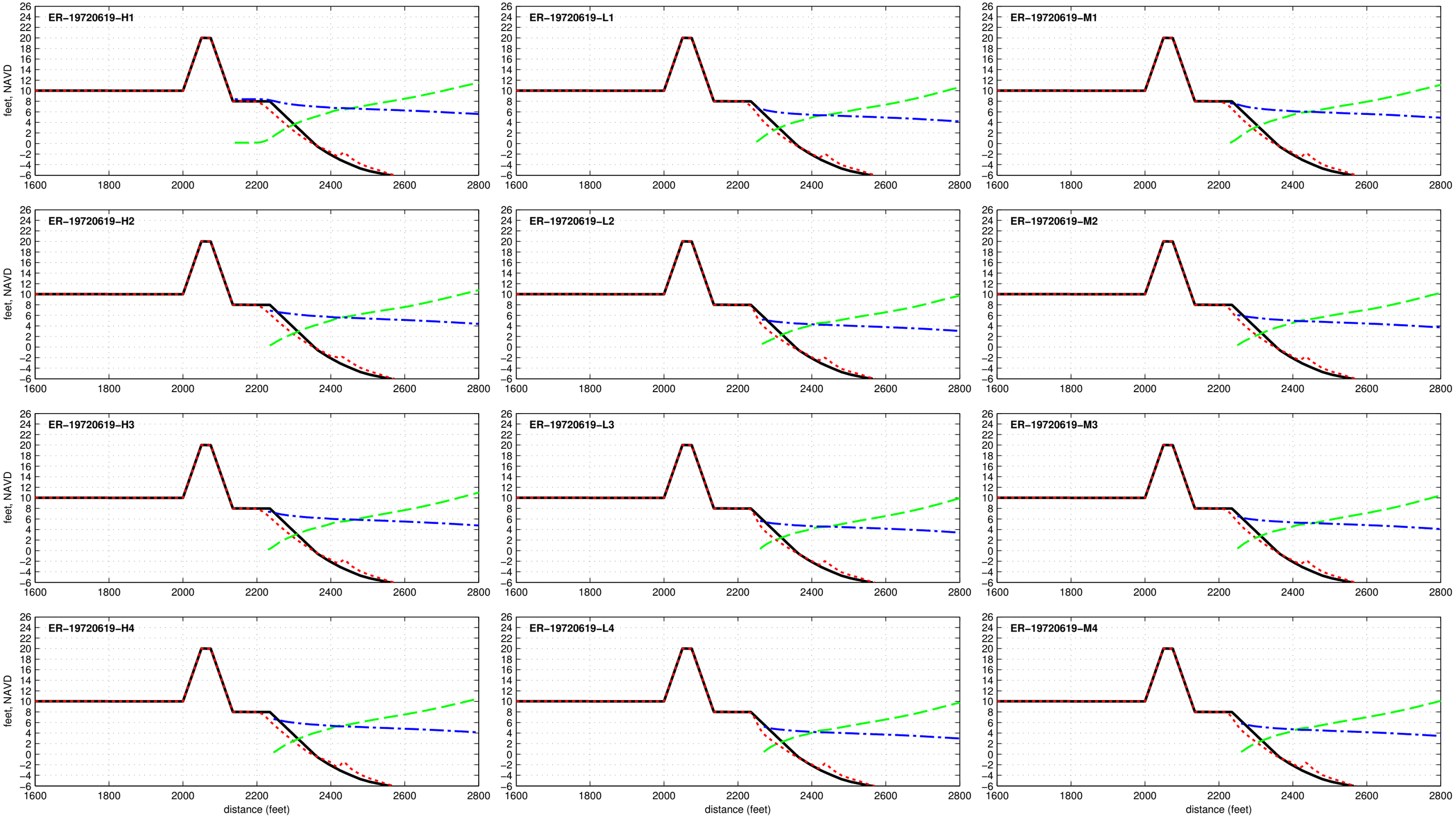
Dune R2T1-20.0-025-100 - ER-19620303



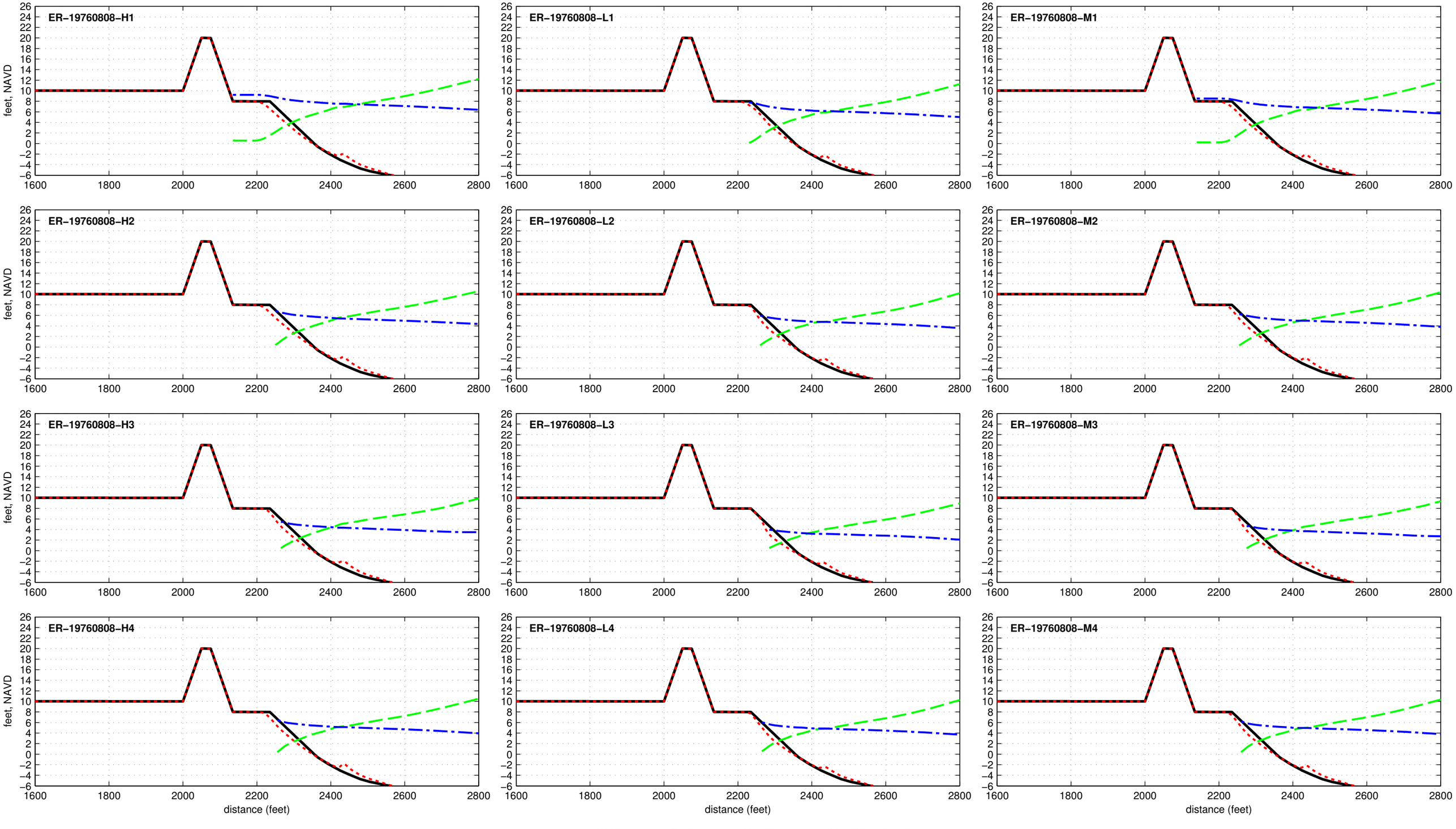
Dune R2T1–20.0–025–100 – ER–19710827



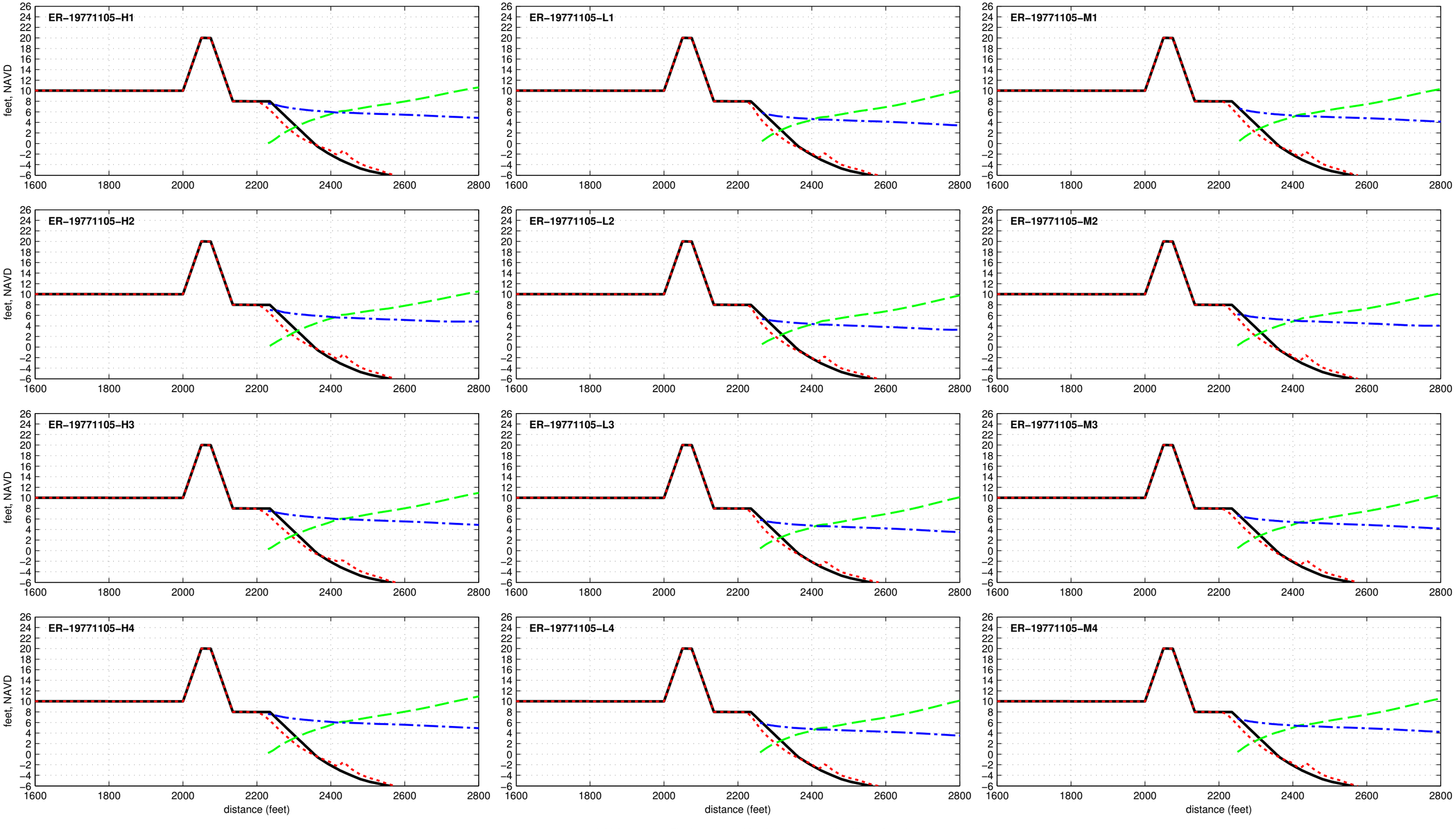
Dune R2T1-20.0-025-100 - ER-19720619



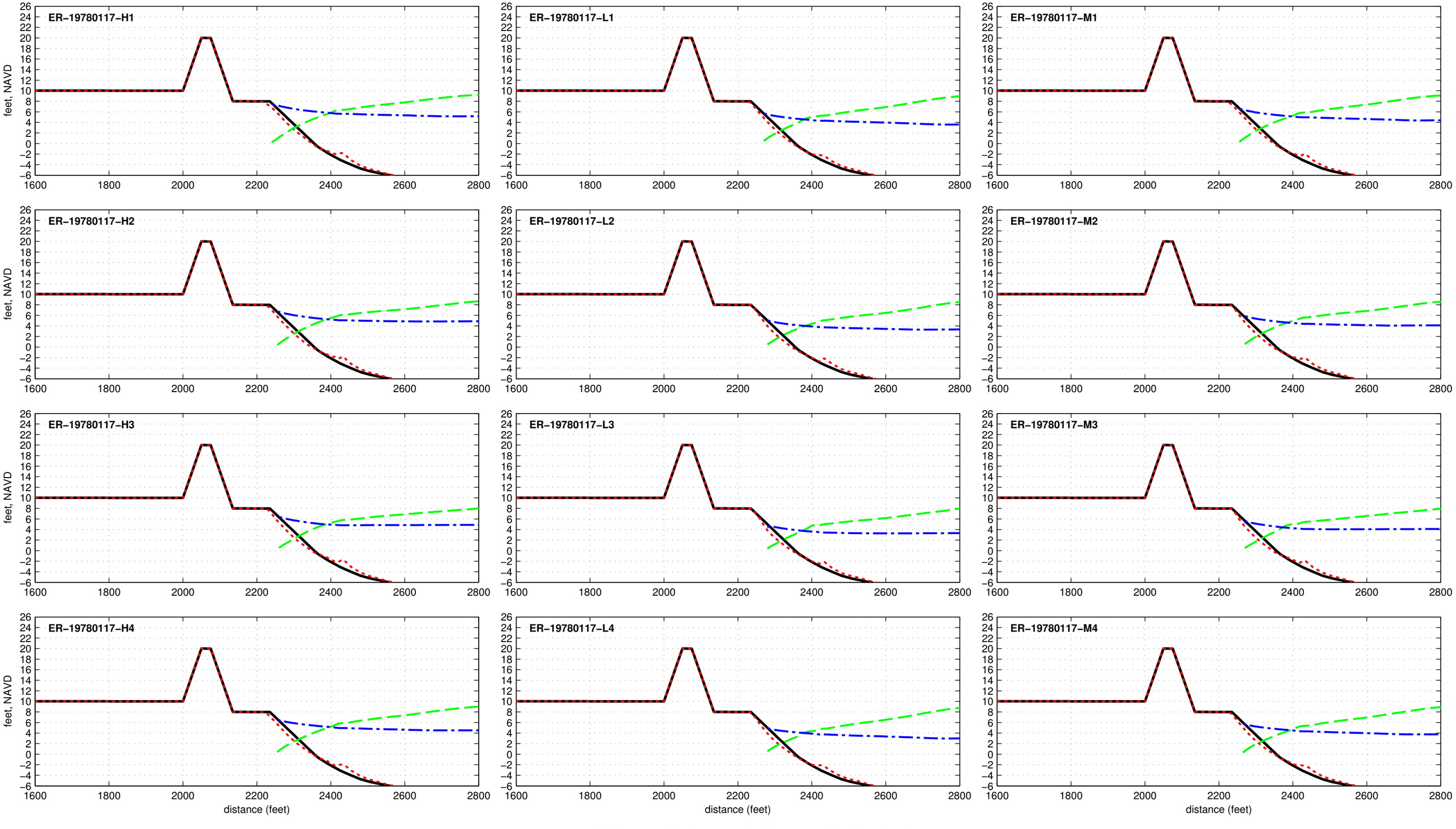
Dune R2T1–20.0–025–100 – ER–19760808



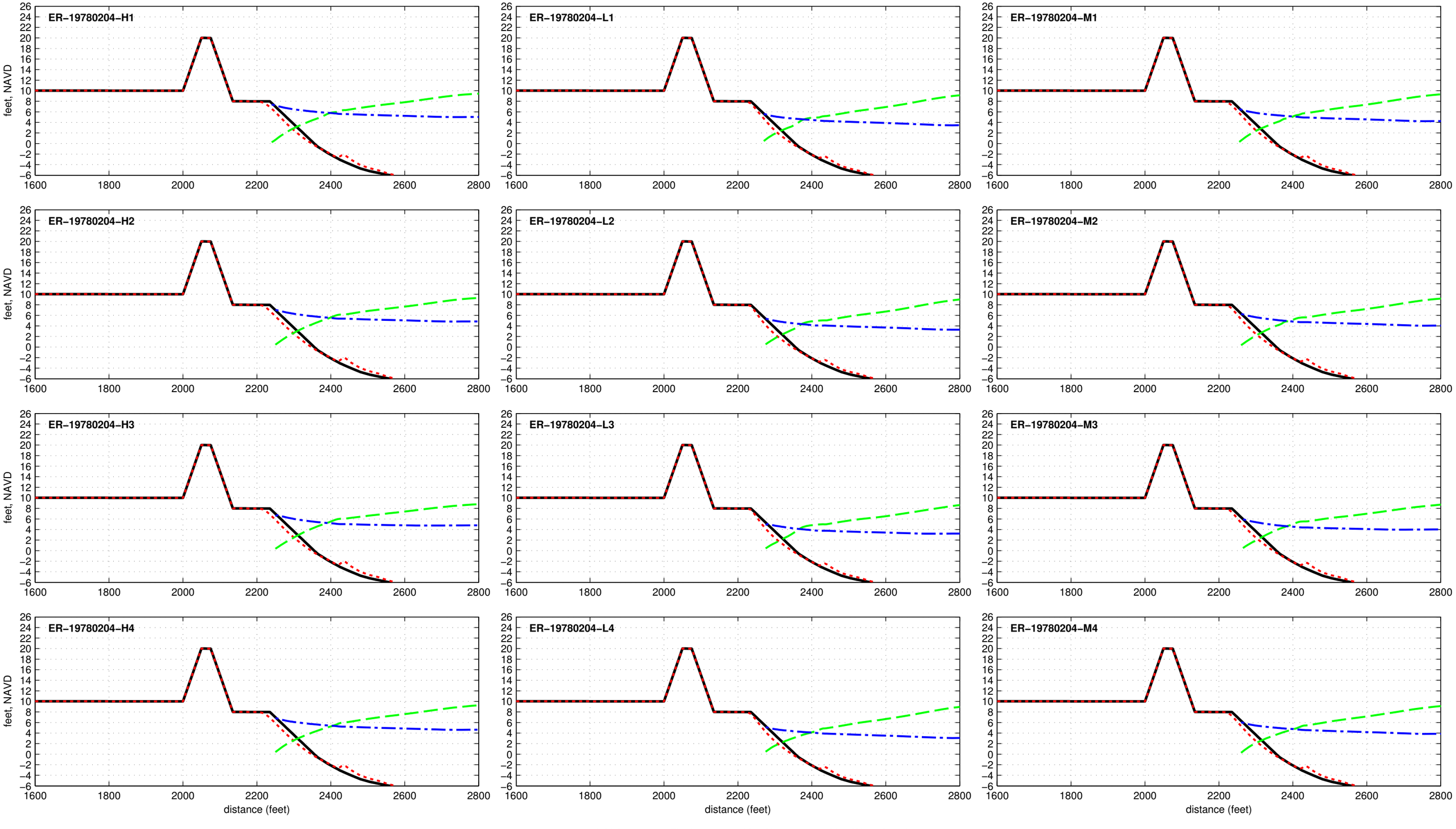
Dune R2T1-20.0-025-100 - ER-19771105



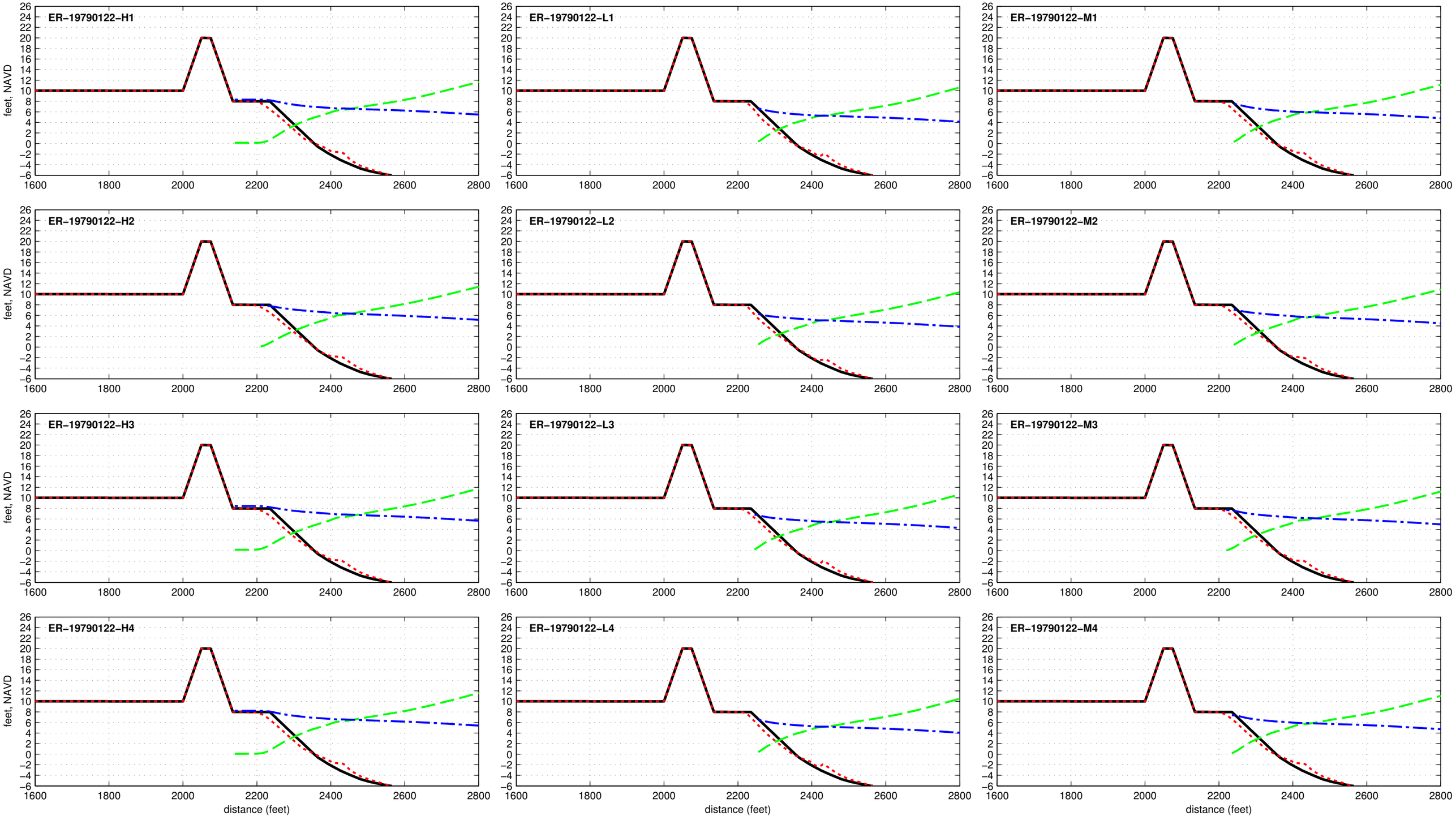
Dune R2T1–20.0–025–100 – ER–19780117



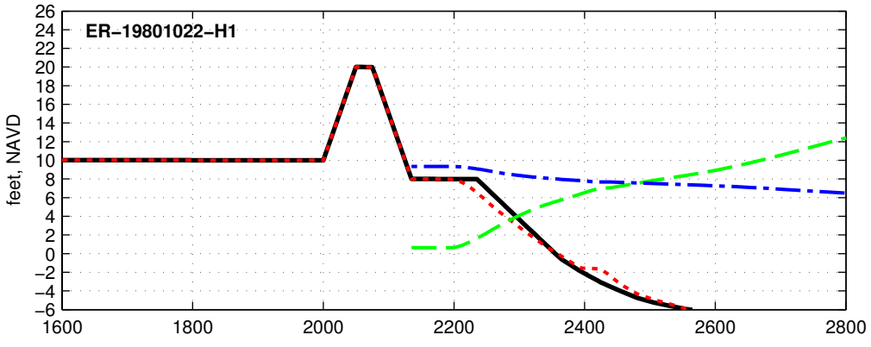
Dune R2T1-20.0-025-100 - ER-19780204

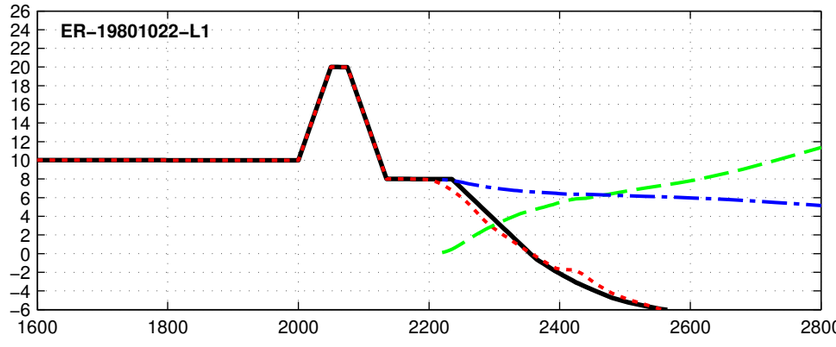


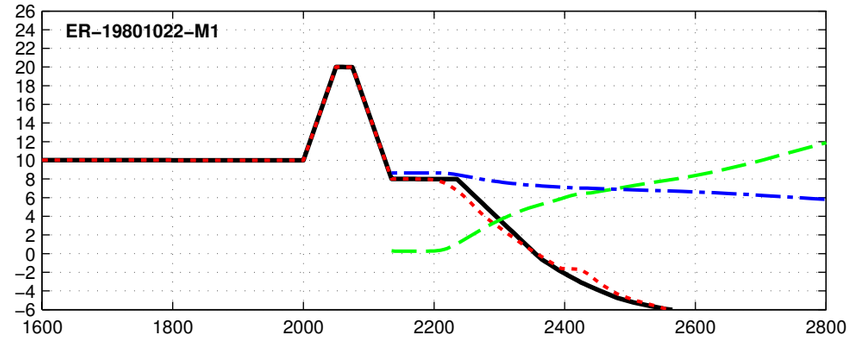
Dune R2T1-20.0-025-100 - ER-19790122

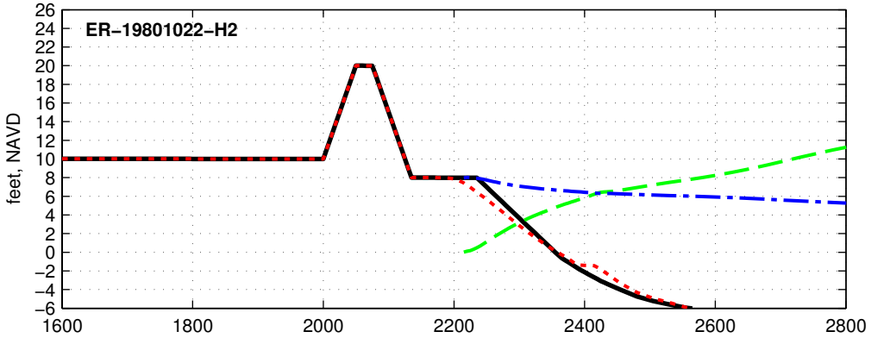


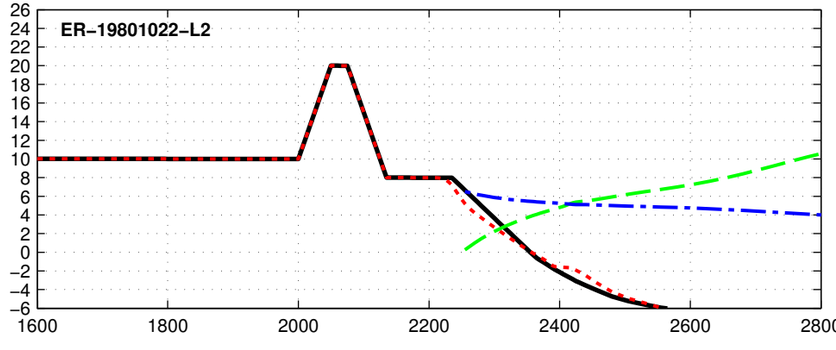
Dune R2T1-20.0-025-100 - ER-19801022

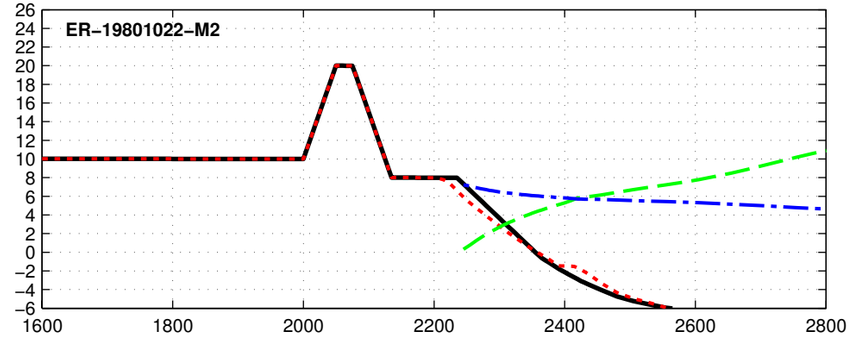


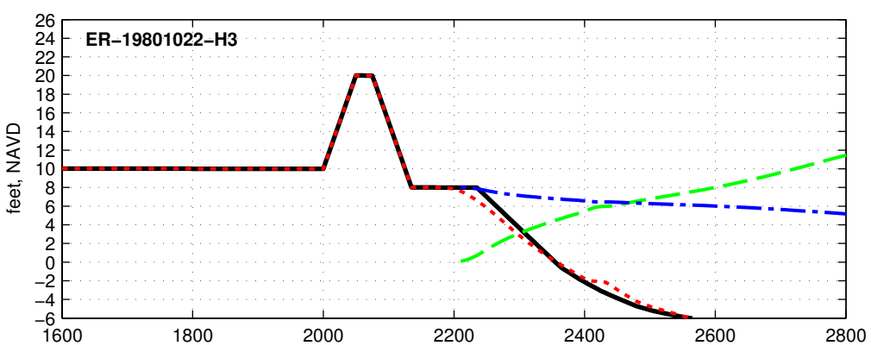


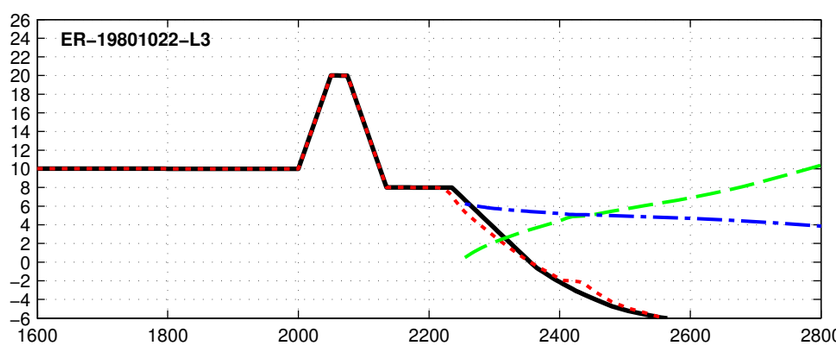


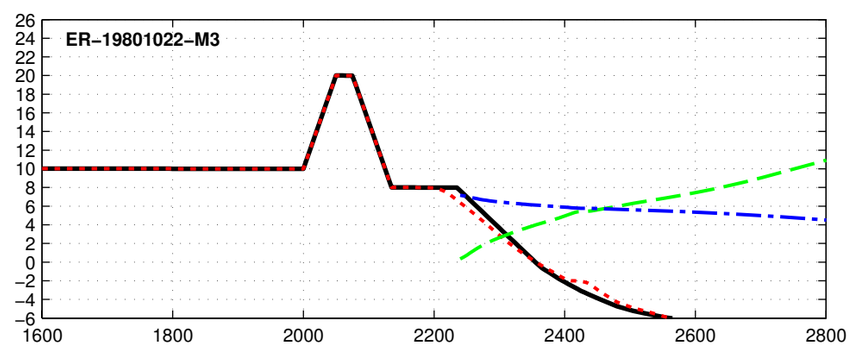


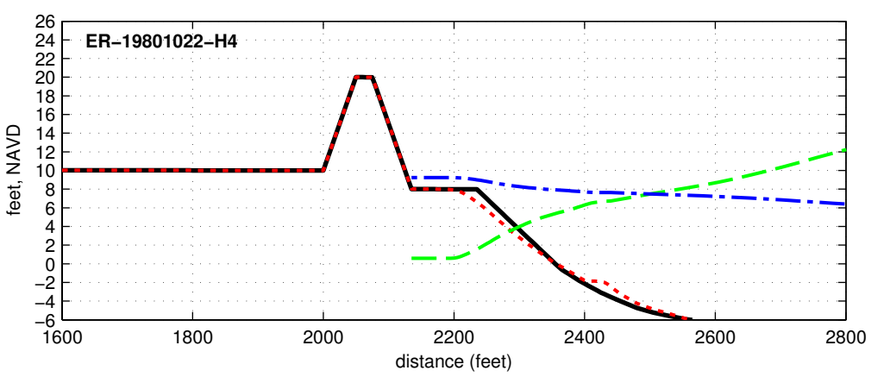


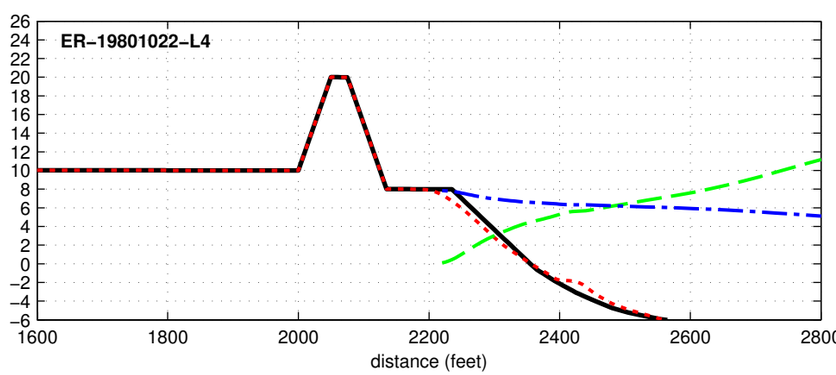


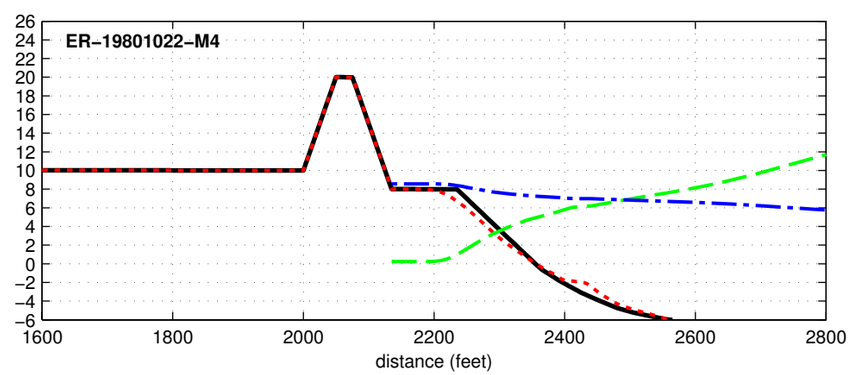










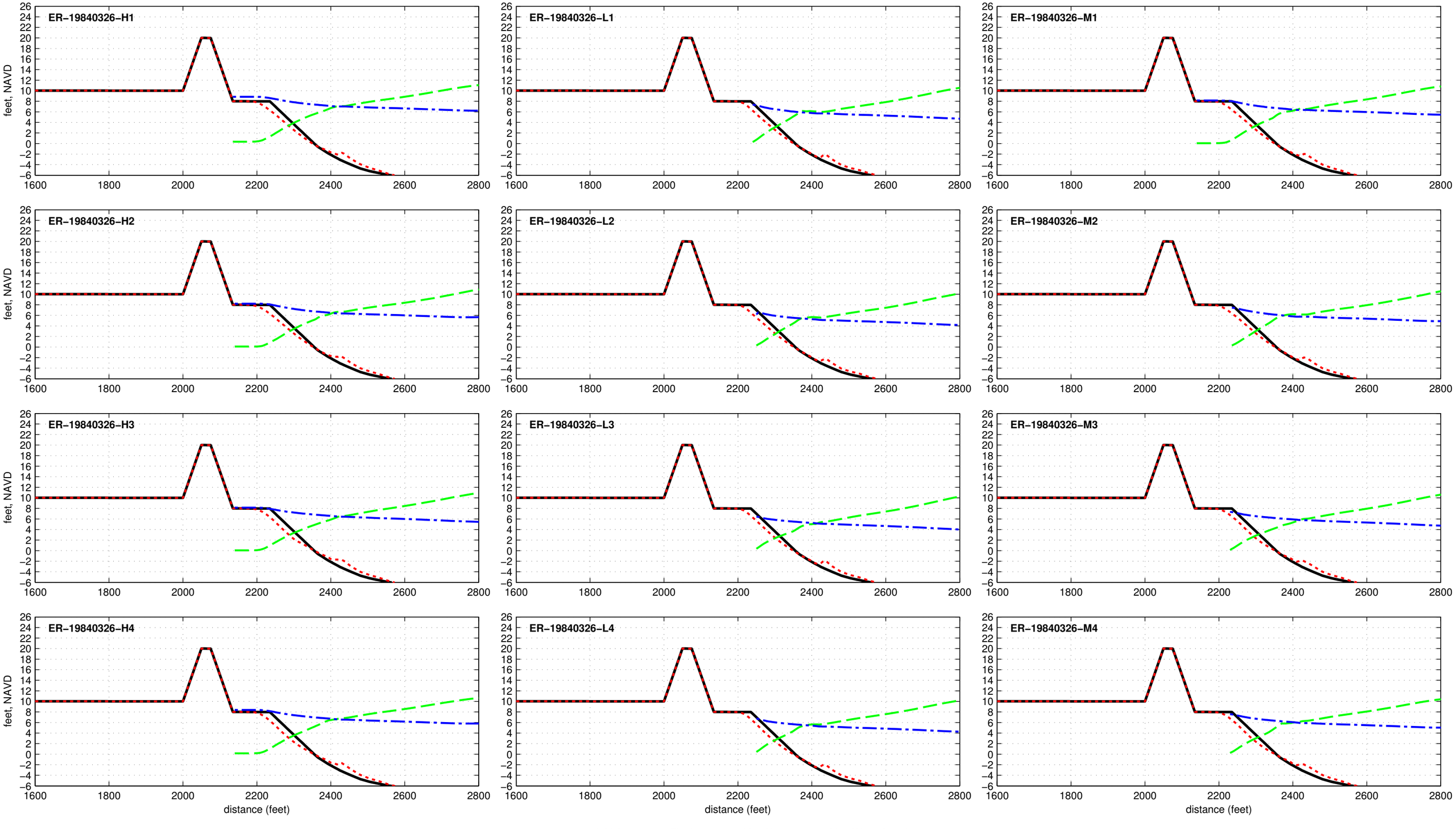


feet, NAVD

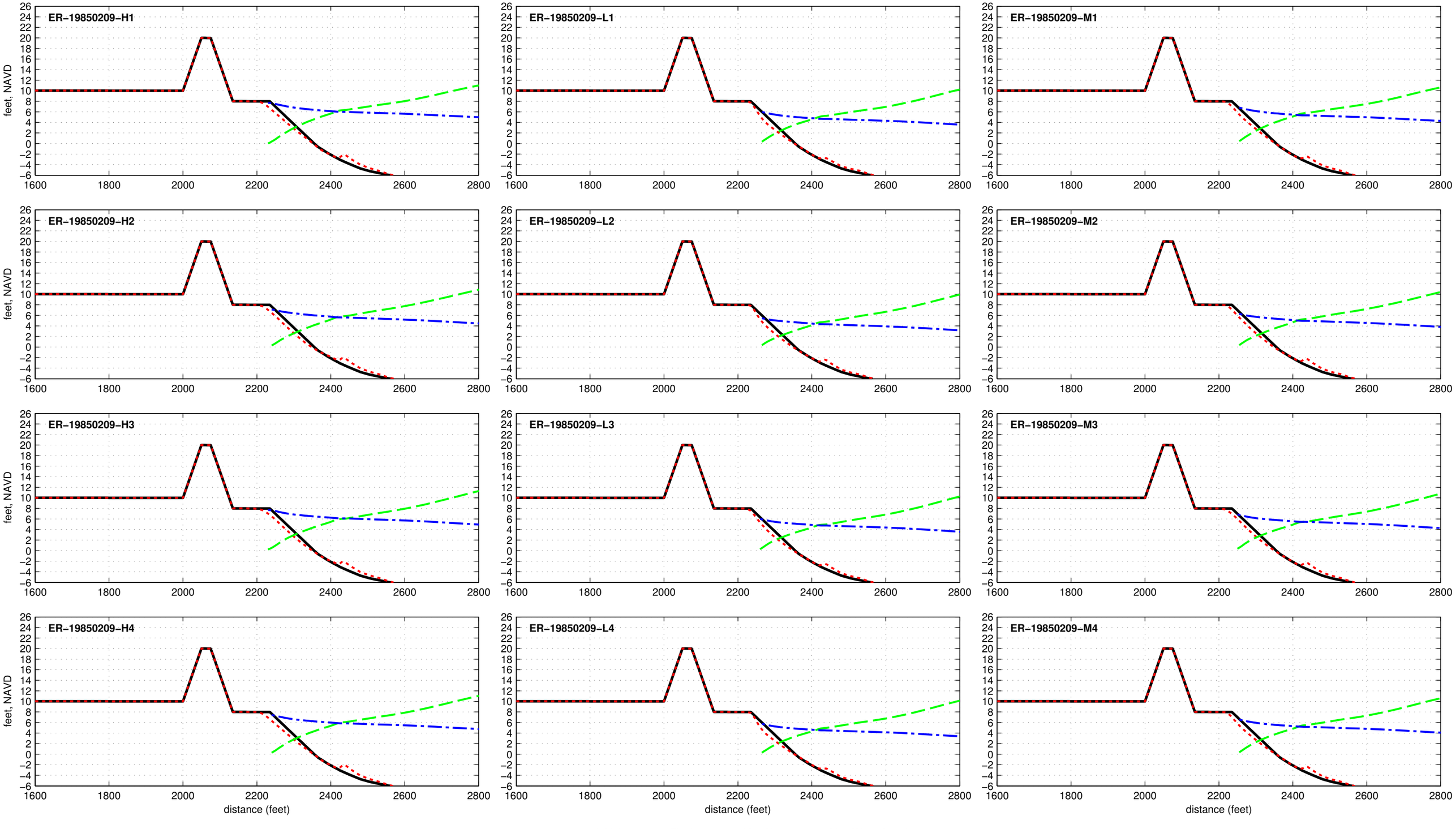
distance (feet)

Initial Final Max Hs Max Water Level

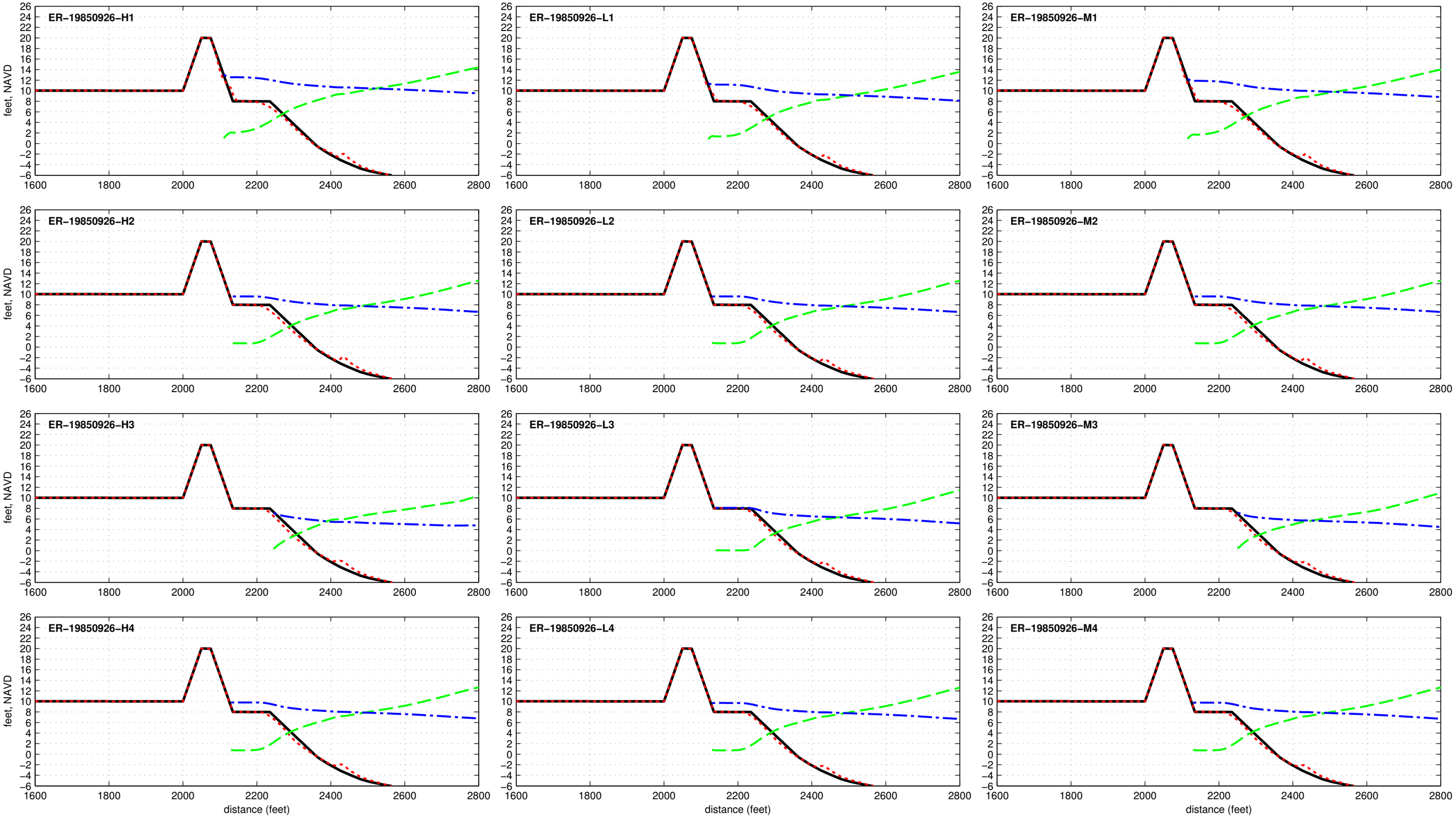
Dune R2T1–20.0–025–100 – ER–19840326



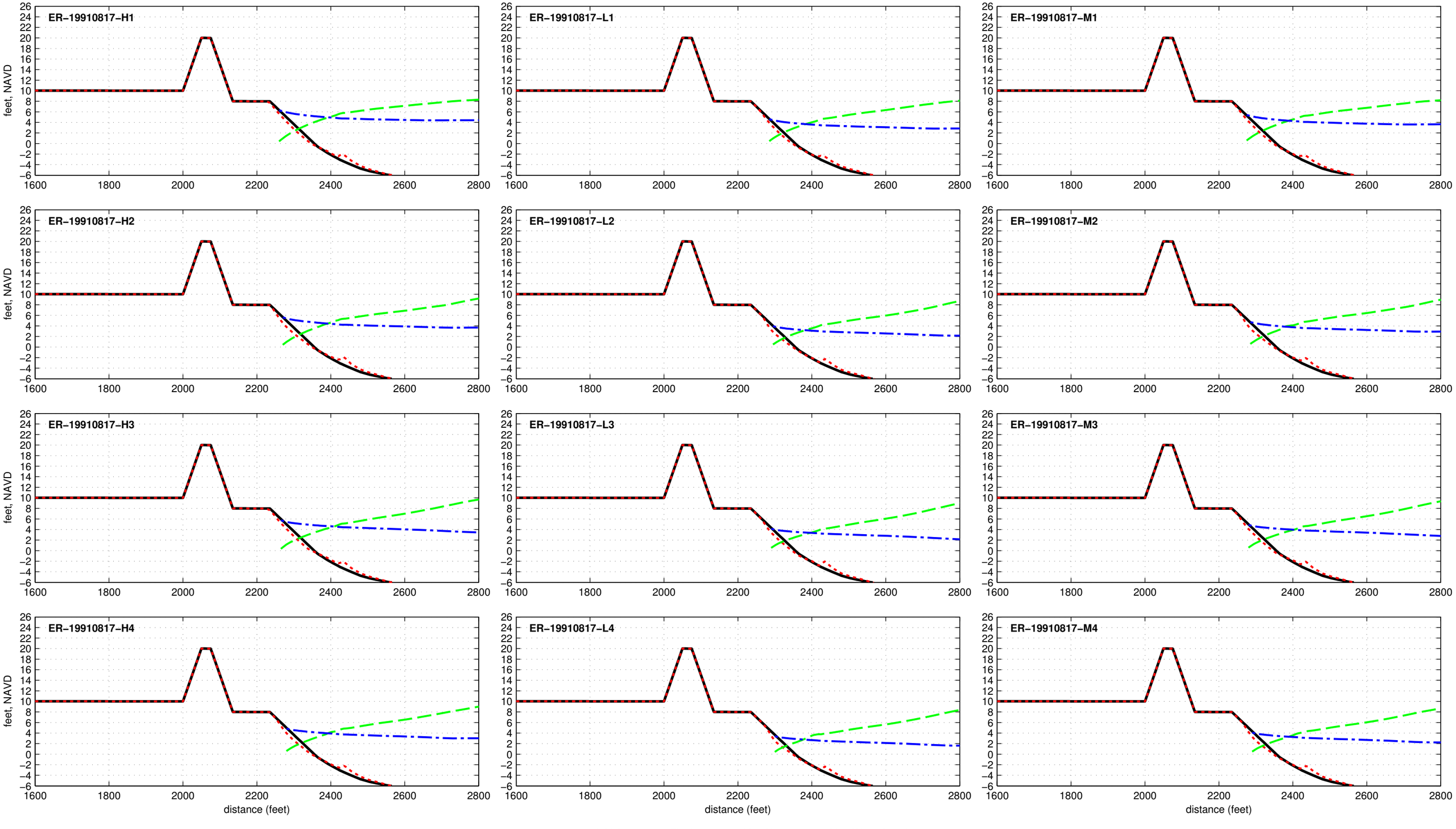
Dune R2T1-20.0-025-100 - ER-19850209



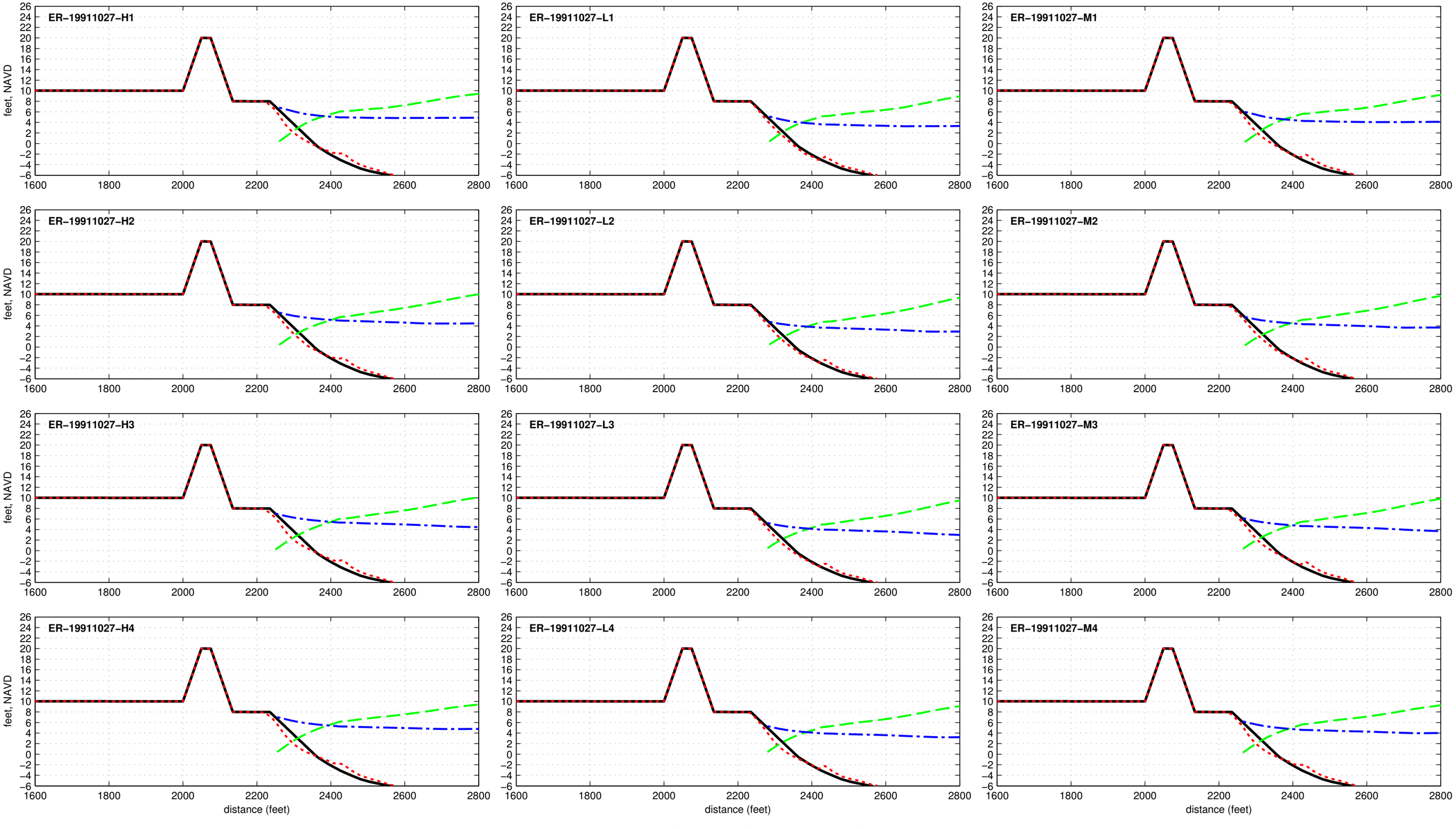
Dune R2T1-20.0-025-100 - ER-19850926



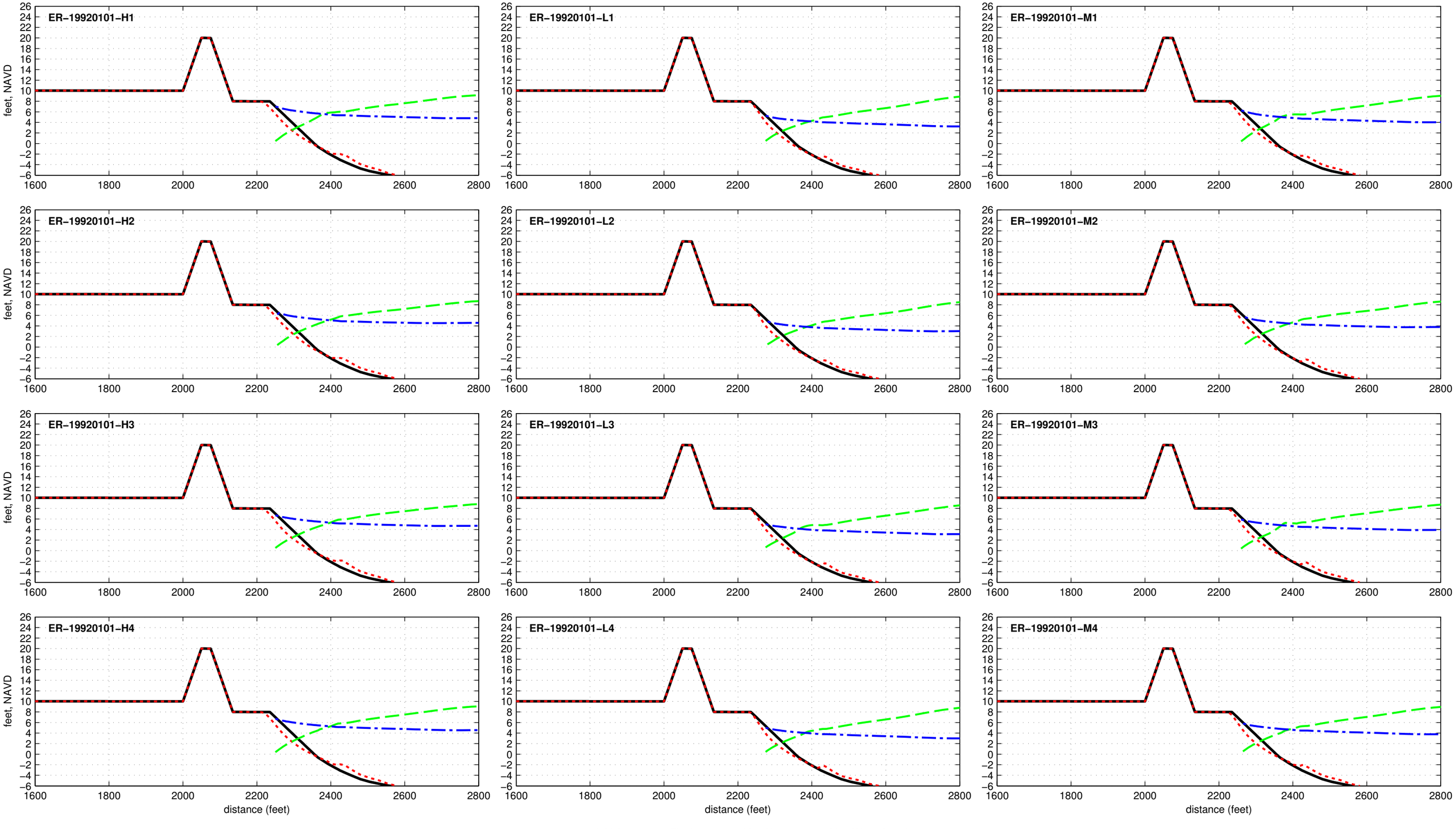
Dune R2T1–20.0–025–100 – ER–19910817



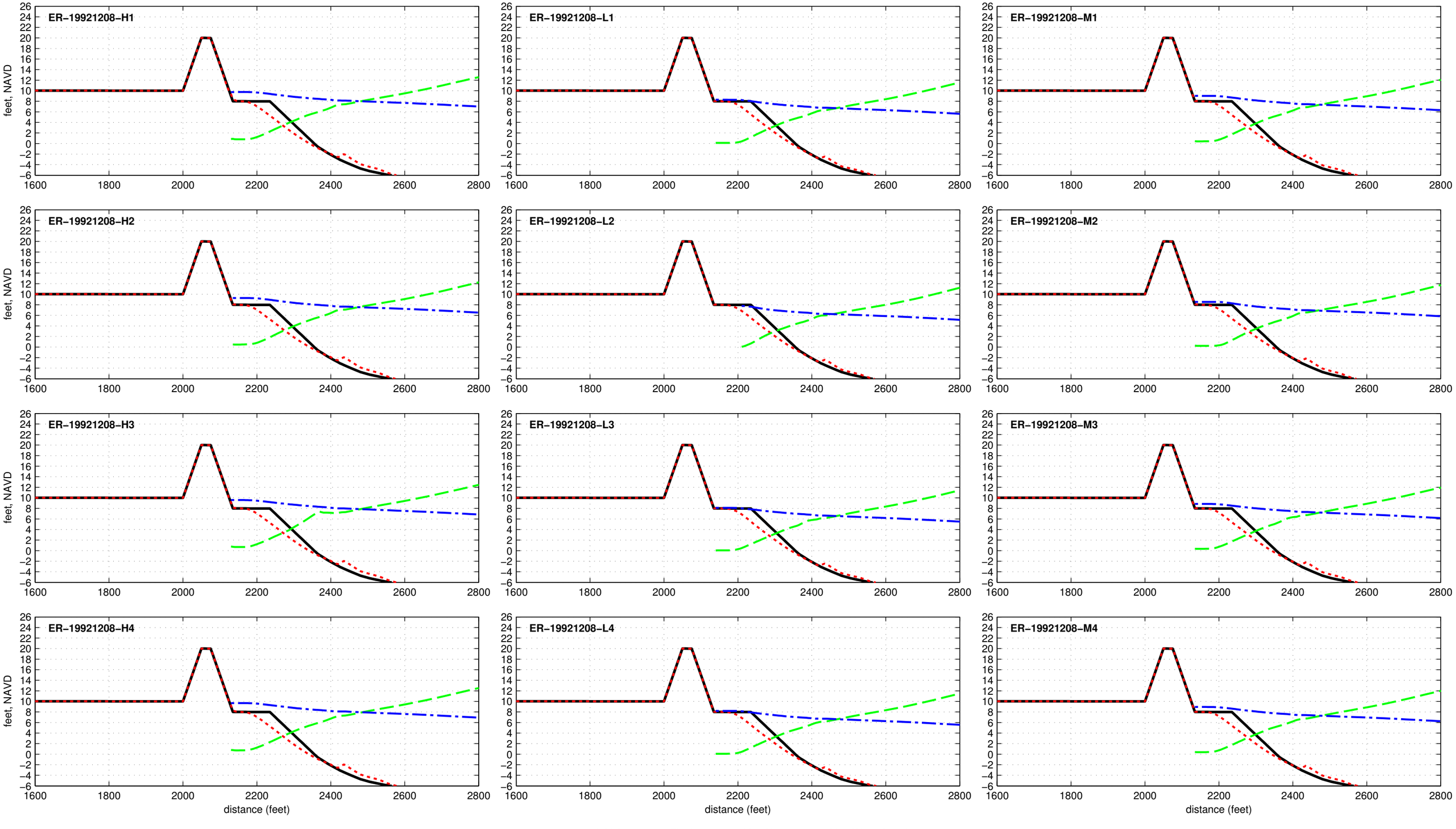
Dune R2T1–20.0–025–100 – ER–19911027



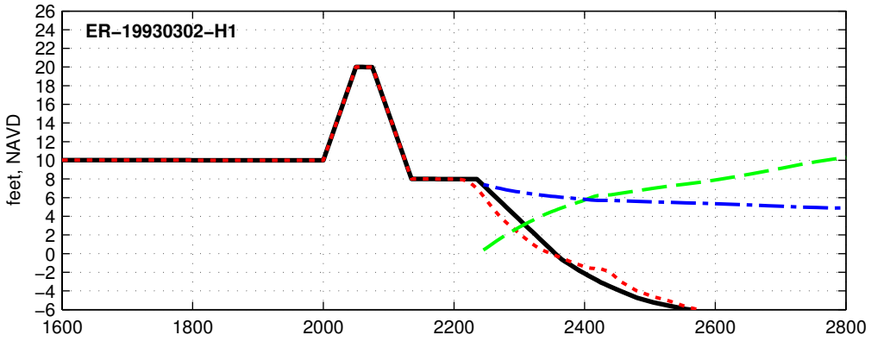
Dune R2T1-20.0-025-100 - ER-19920101

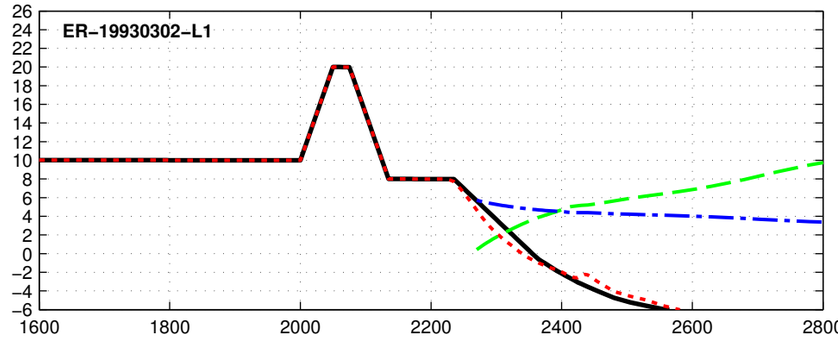


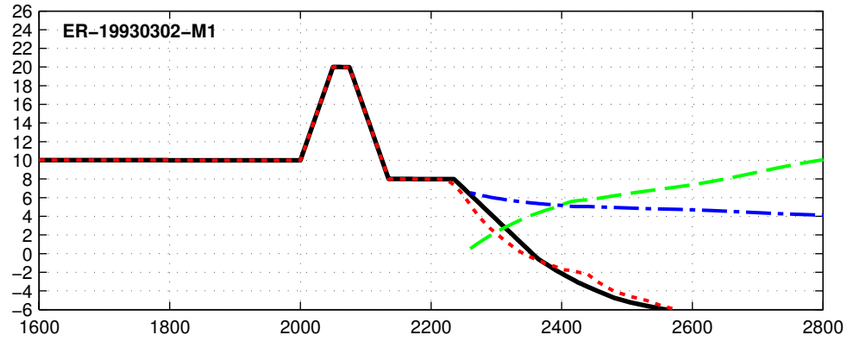
Dune R2T1–20.0–025–100 – ER–19921208

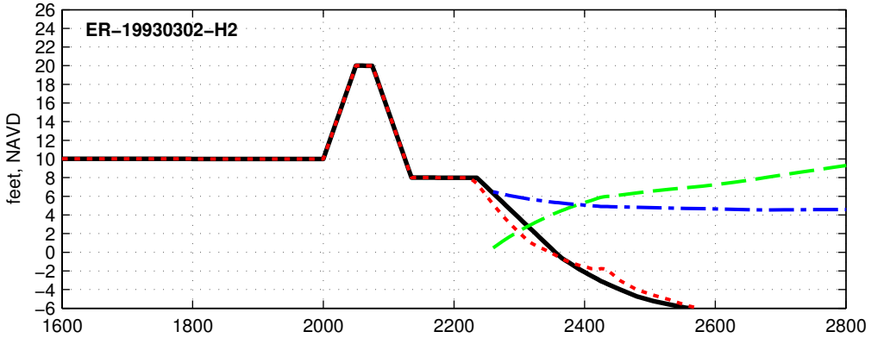


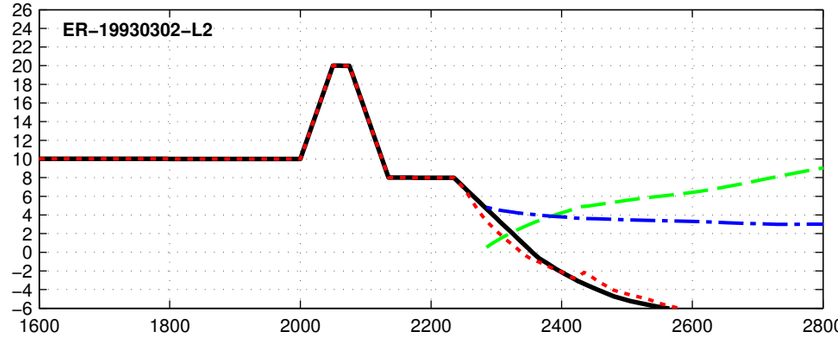
Dune R2T1–20.0–025–100 – ER–19930302

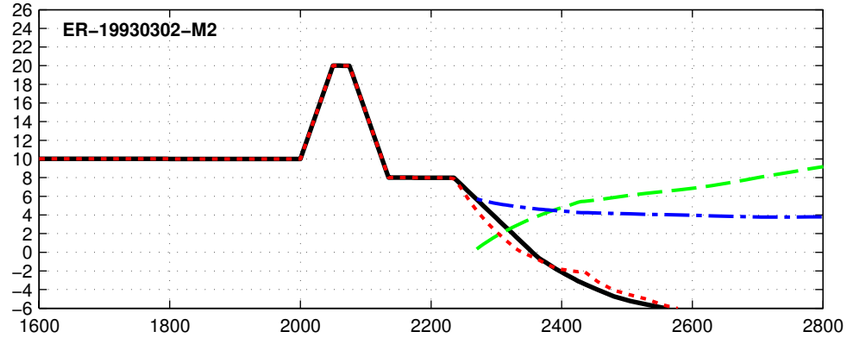


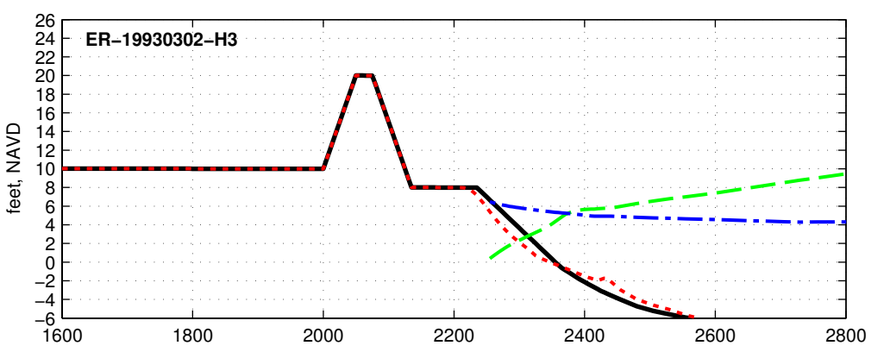


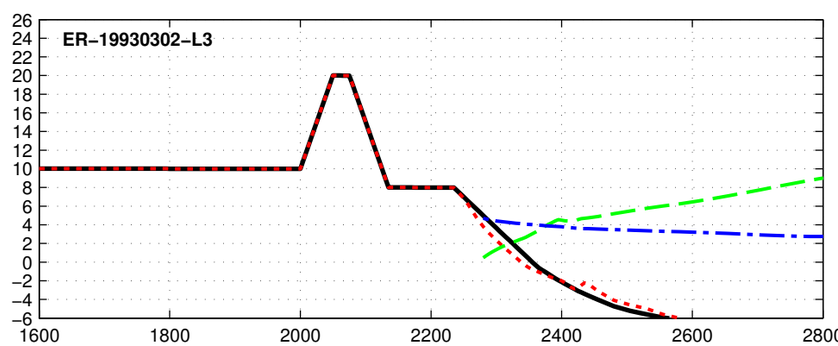


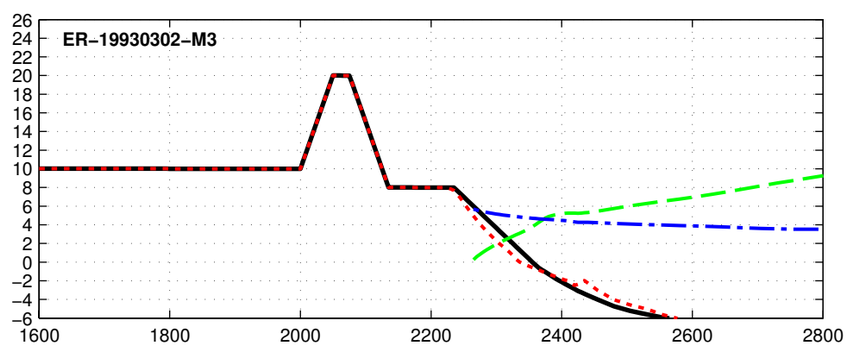


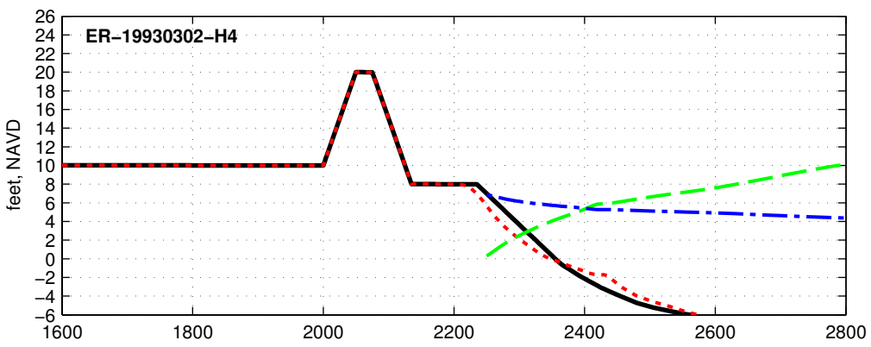


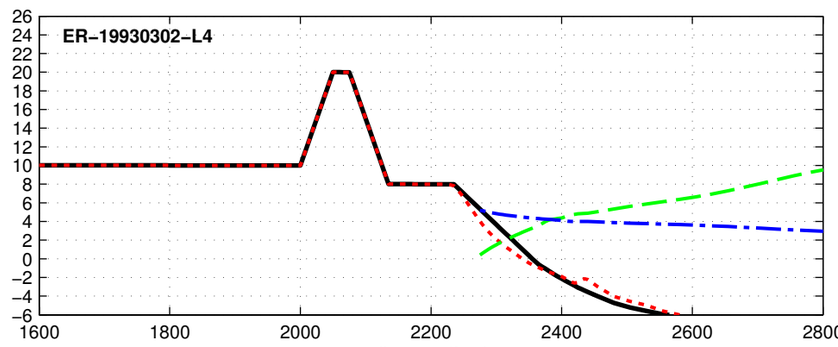


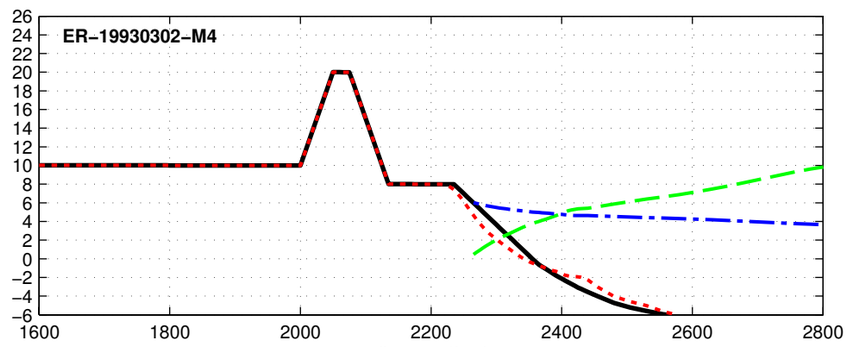










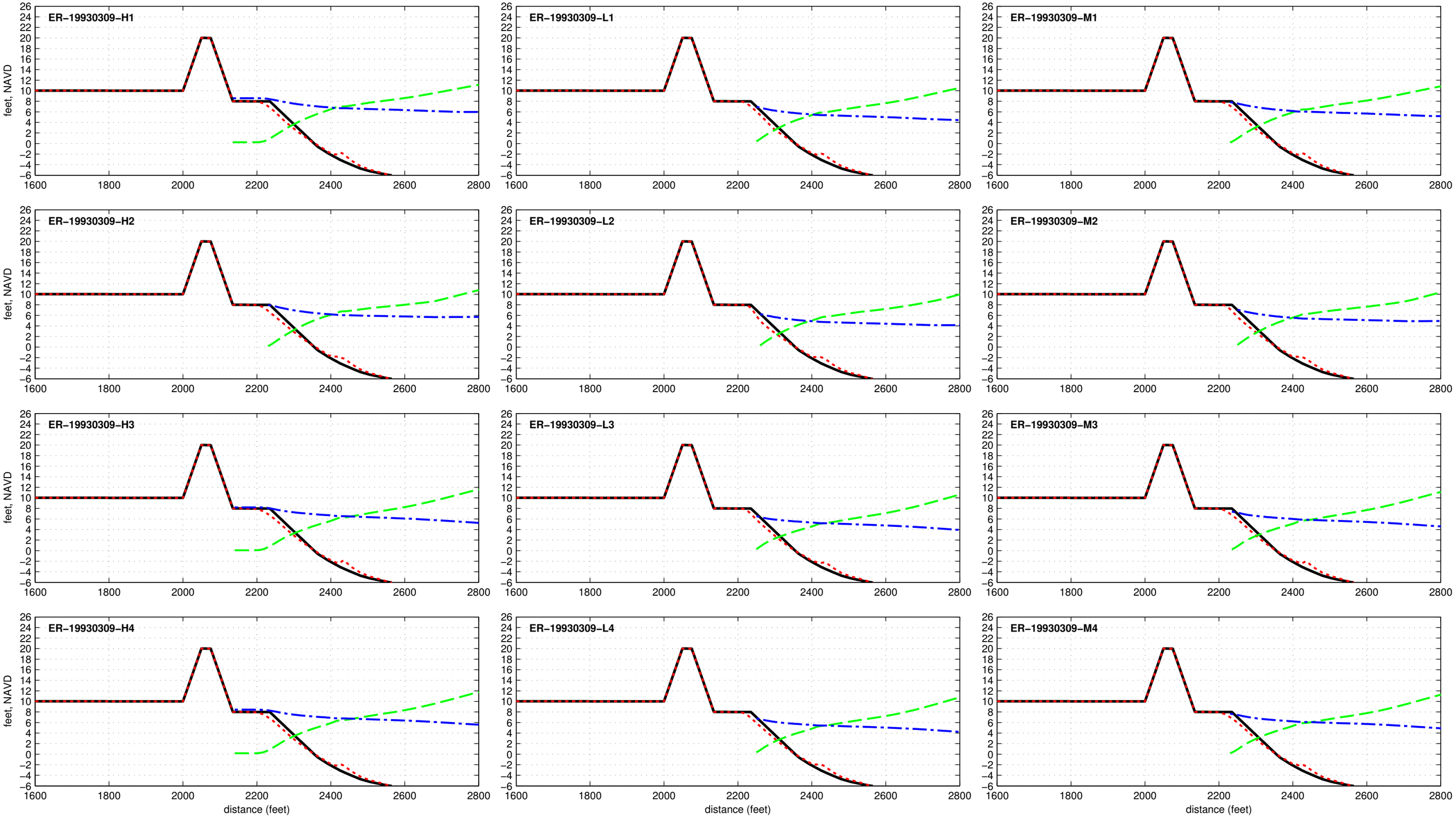


feet, NAVD

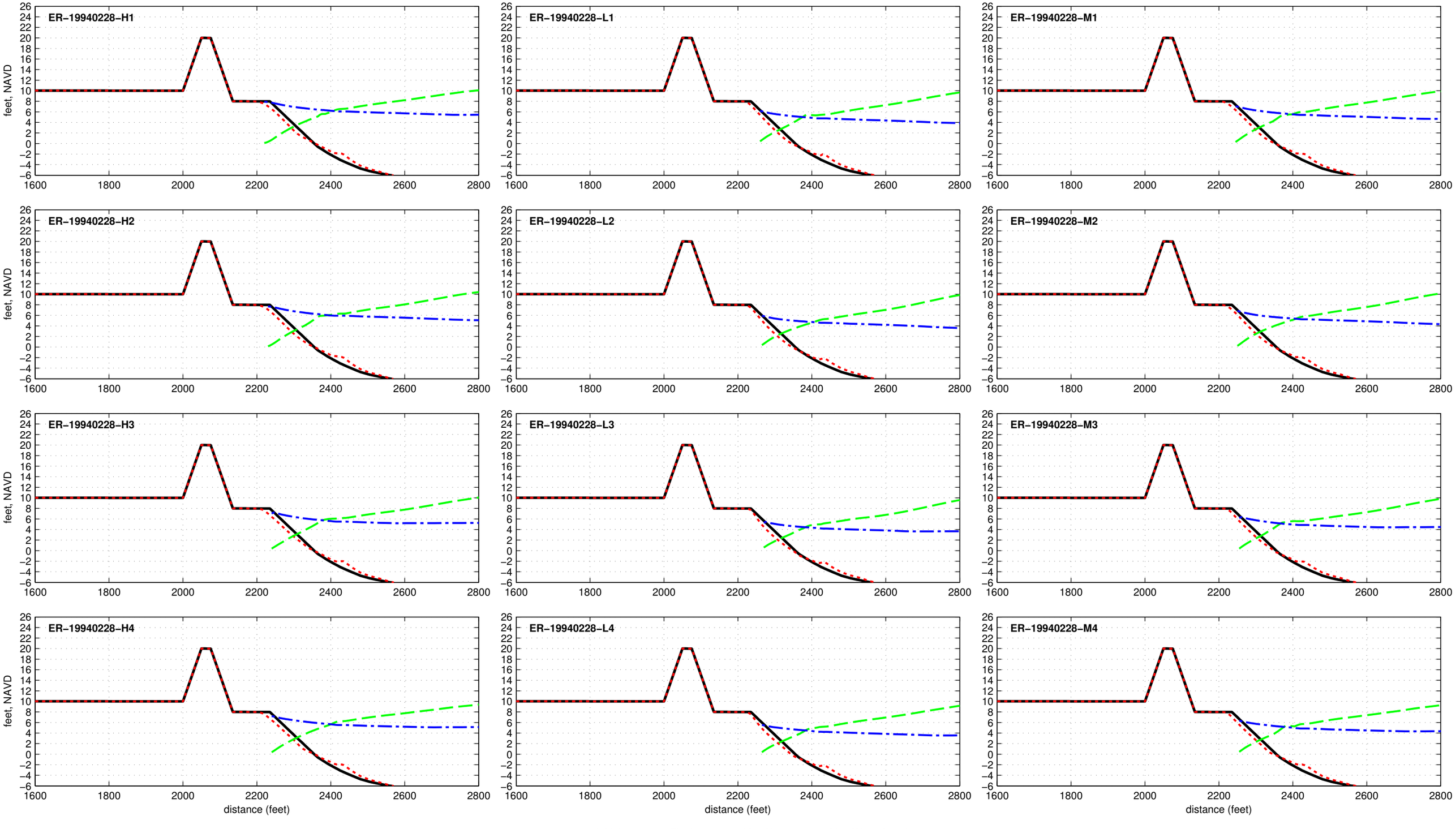
distance (feet)

Initial Final Max Hs Max Water Level

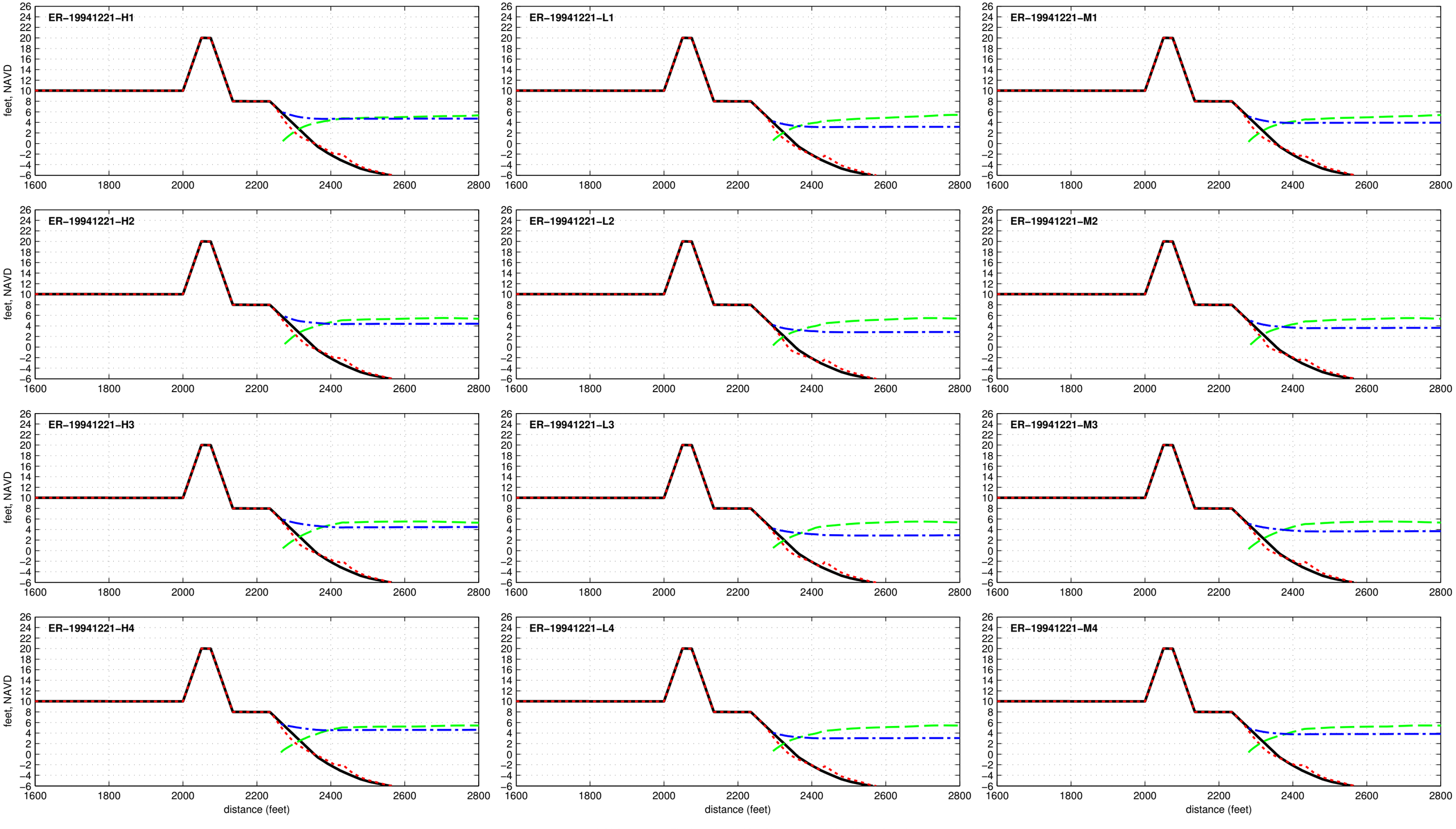
Dune R2T1-20.0-025-100 - ER-19930309



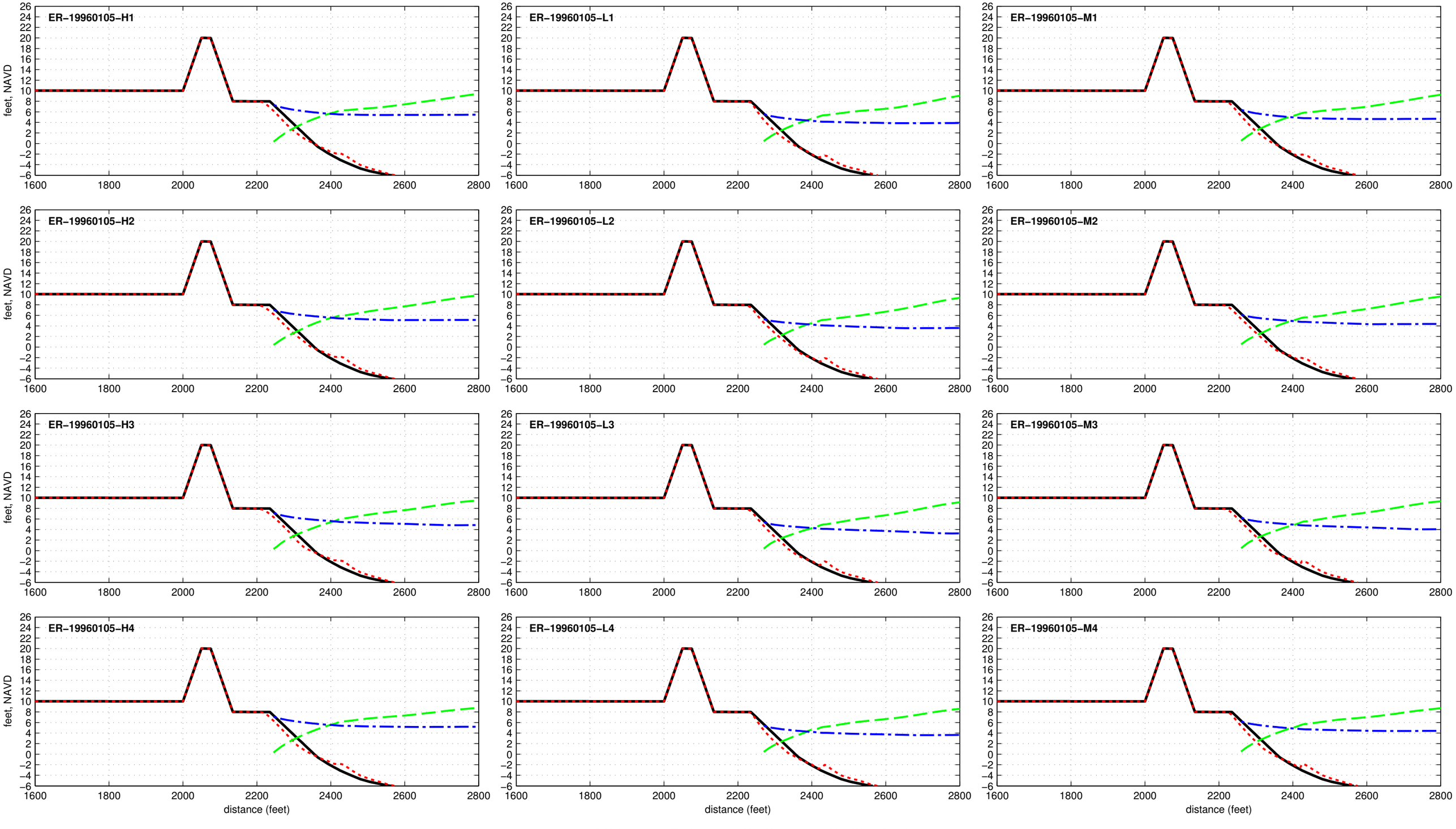
Dune R2T1–20.0–025–100 – ER–19940228



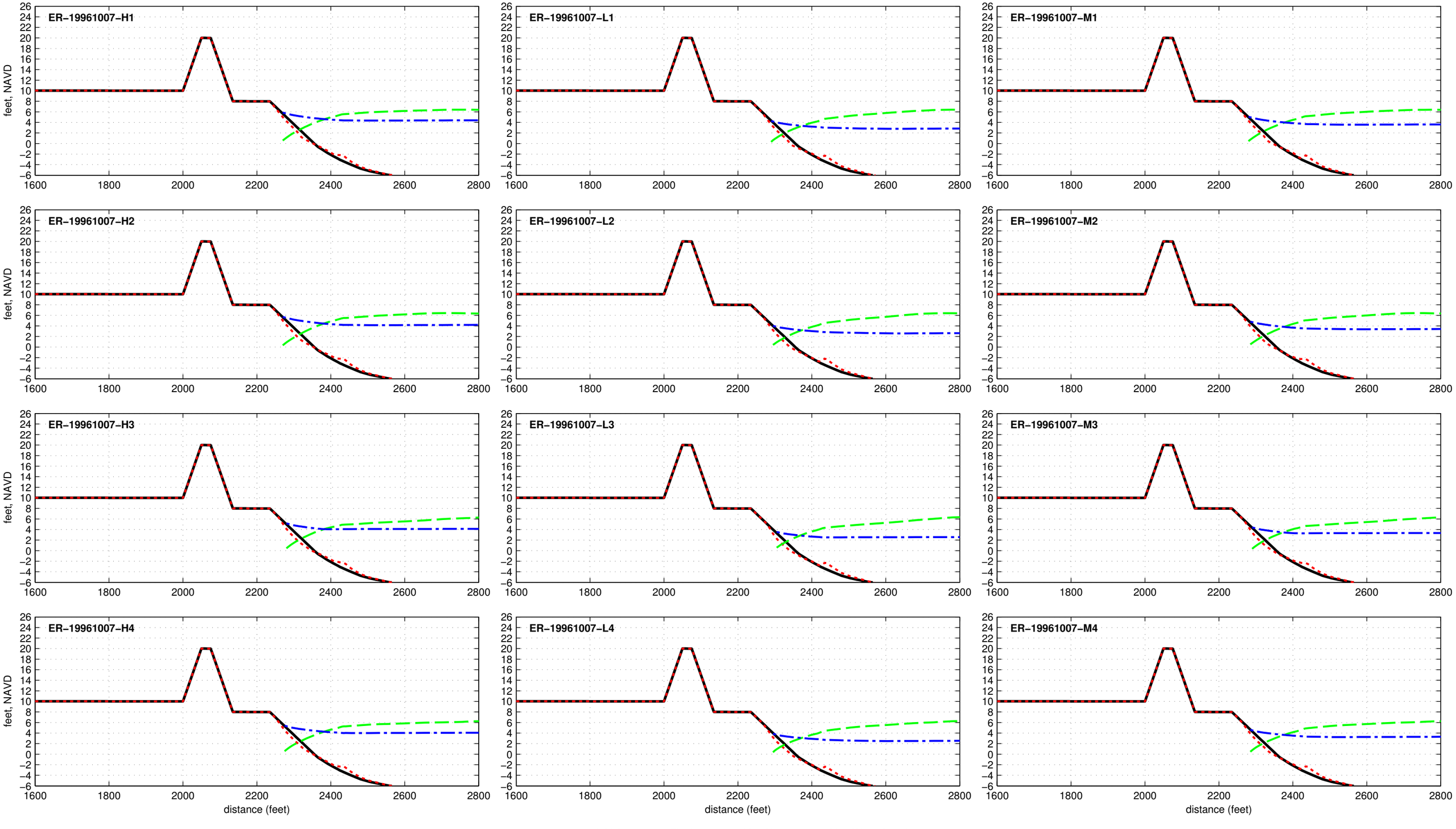
Dune R2T1-20.0-025-100 - ER-19941221



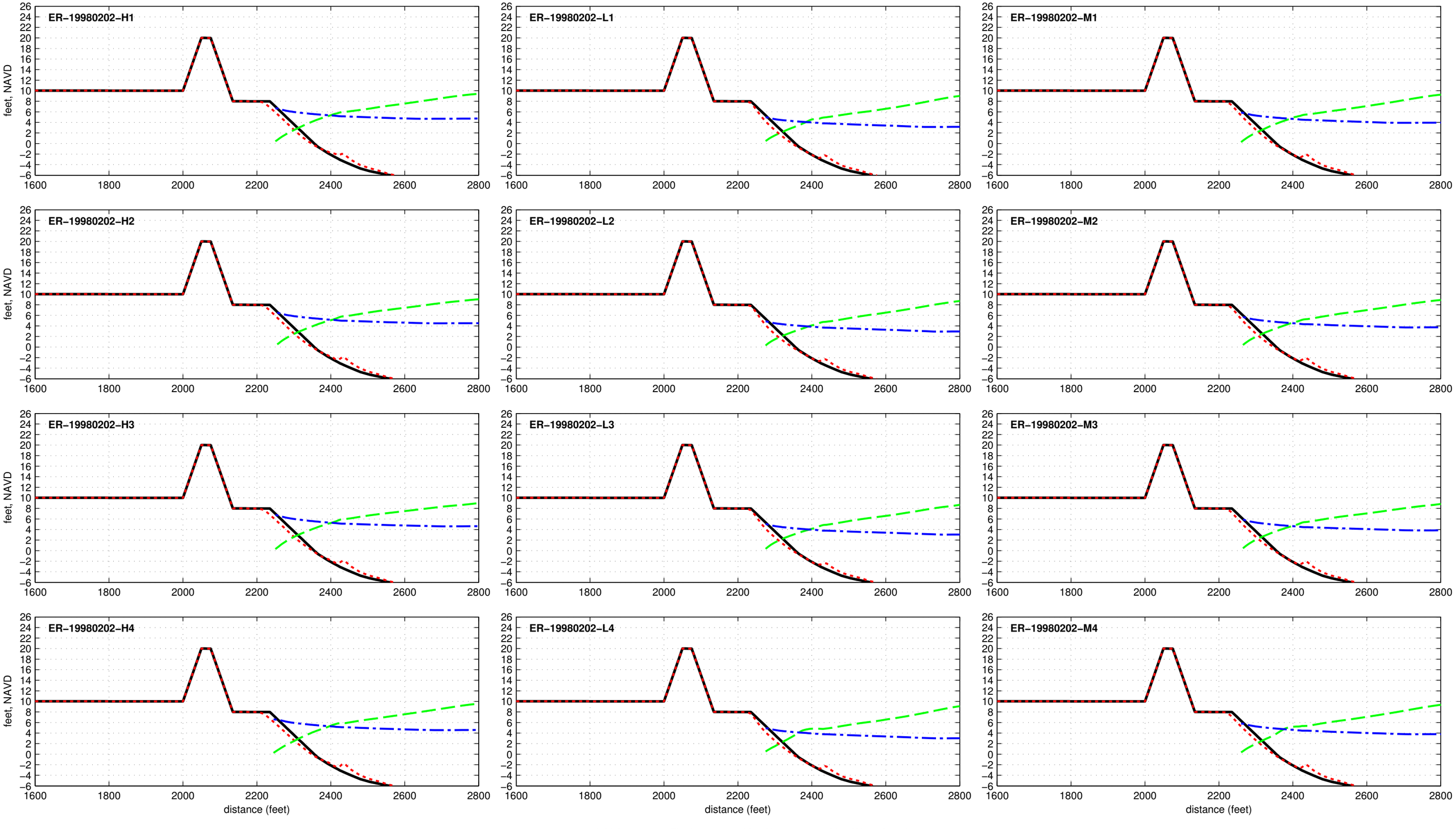
Dune R2T1-20.0-025-100 - ER-19960105



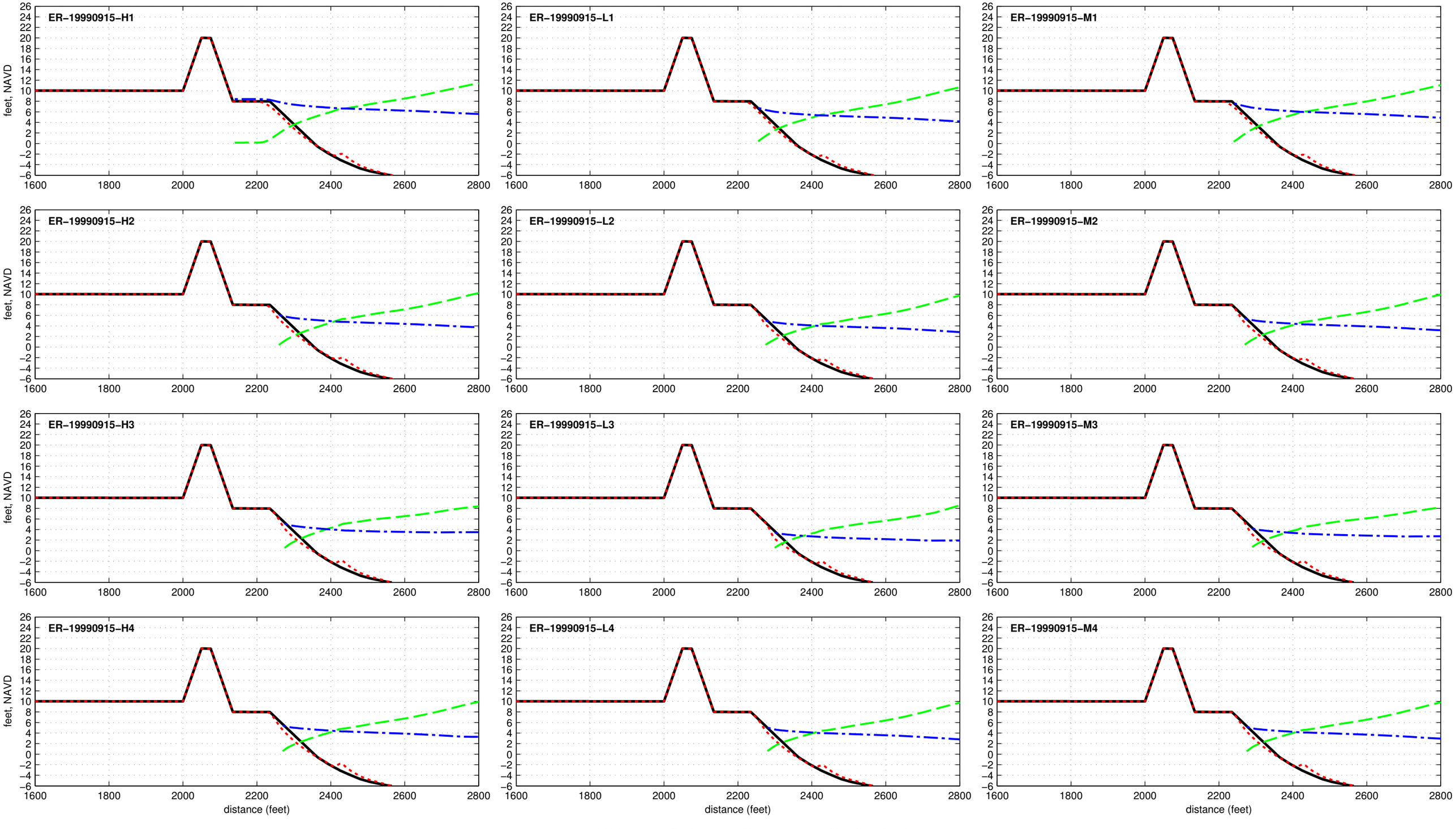
Dune R2T1-20.0-025-100 - ER-19961007



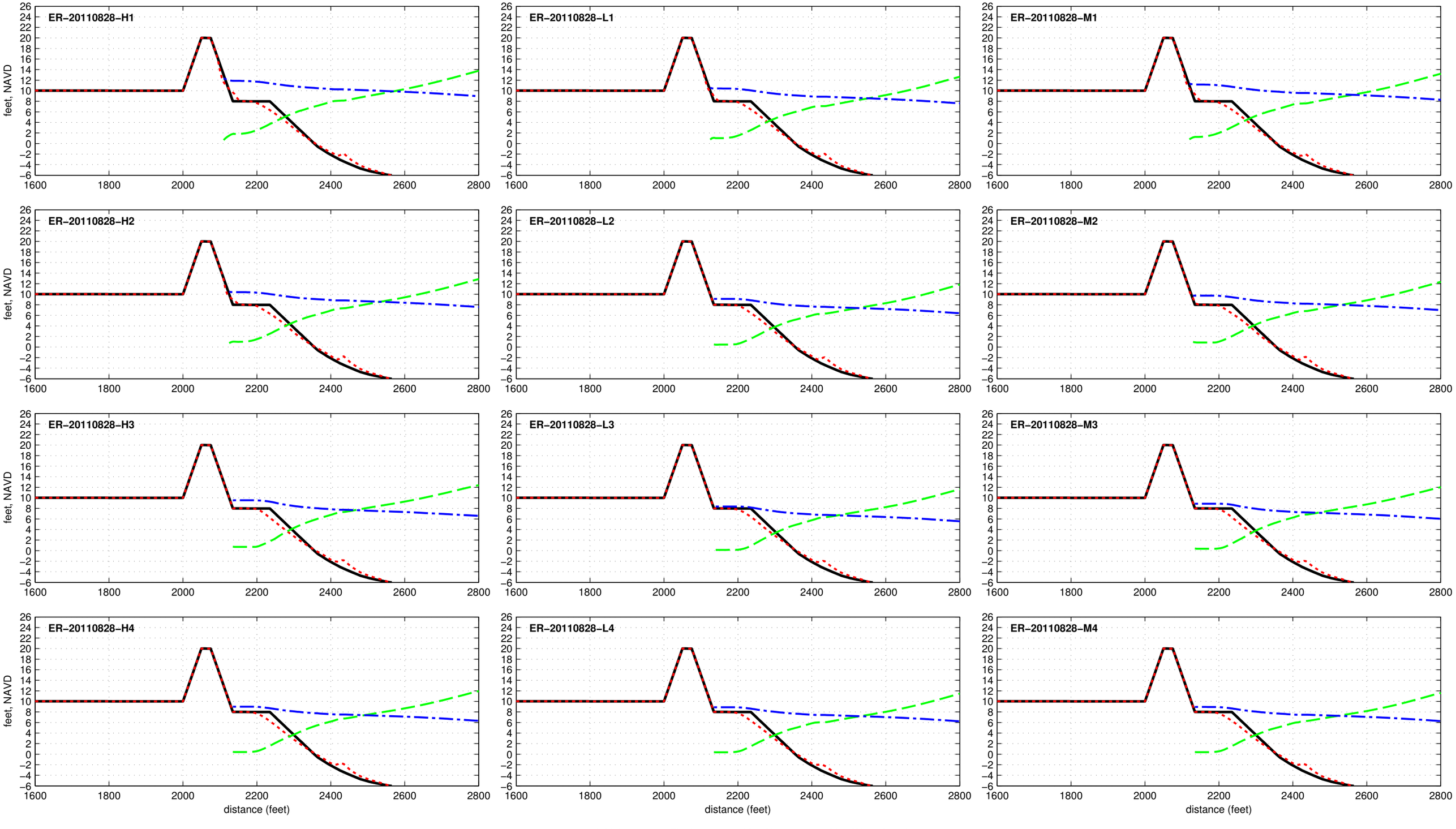
Dune R2T1-20.0-025-100 - ER-19980202



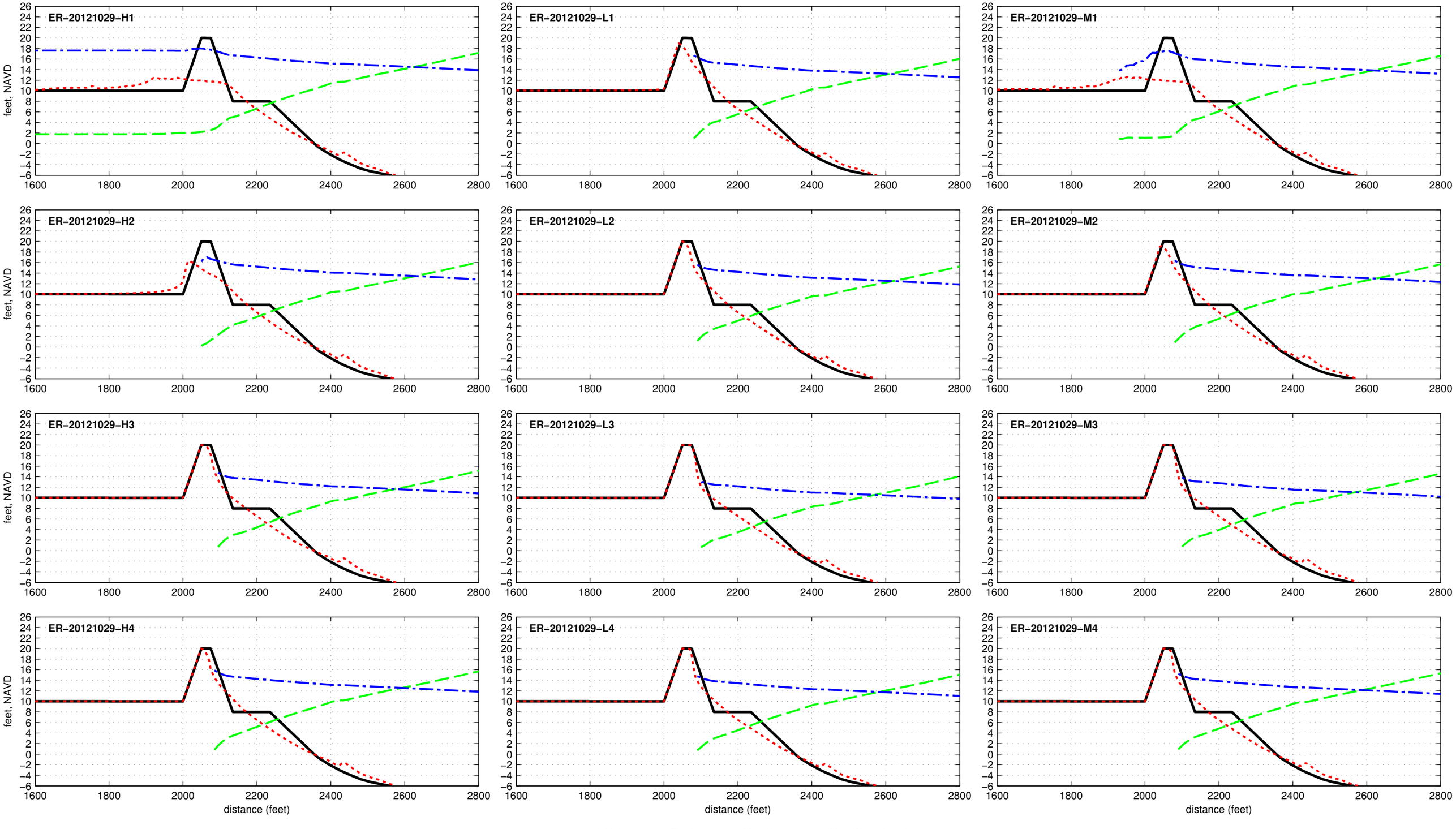
Dune R2T1-20.0-025-100 - ER-19990915



Dune R2T1–20.0–025–100 – ER–20110828

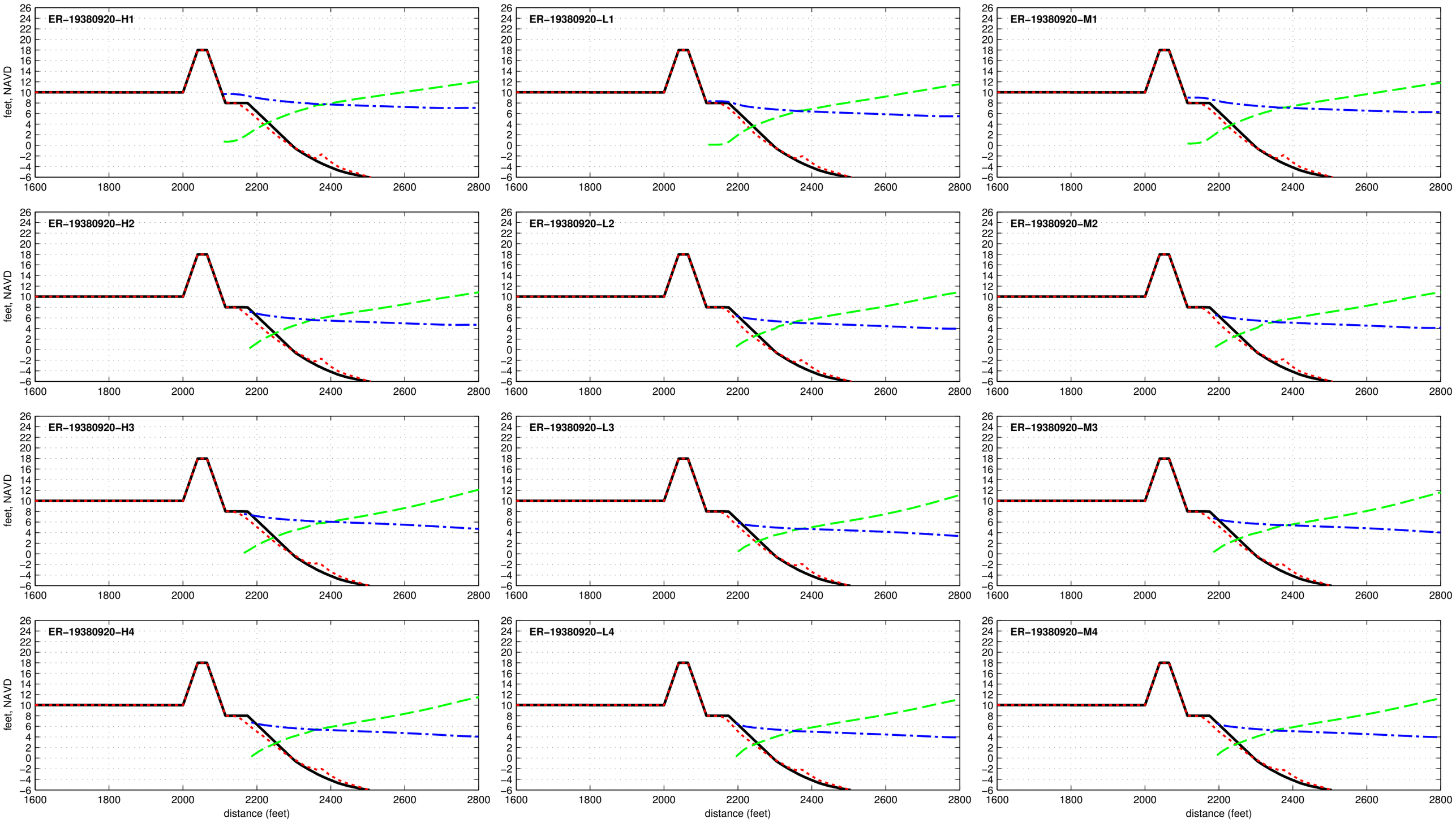


Dune R2T1-20.0-025-100 - ER-20121029

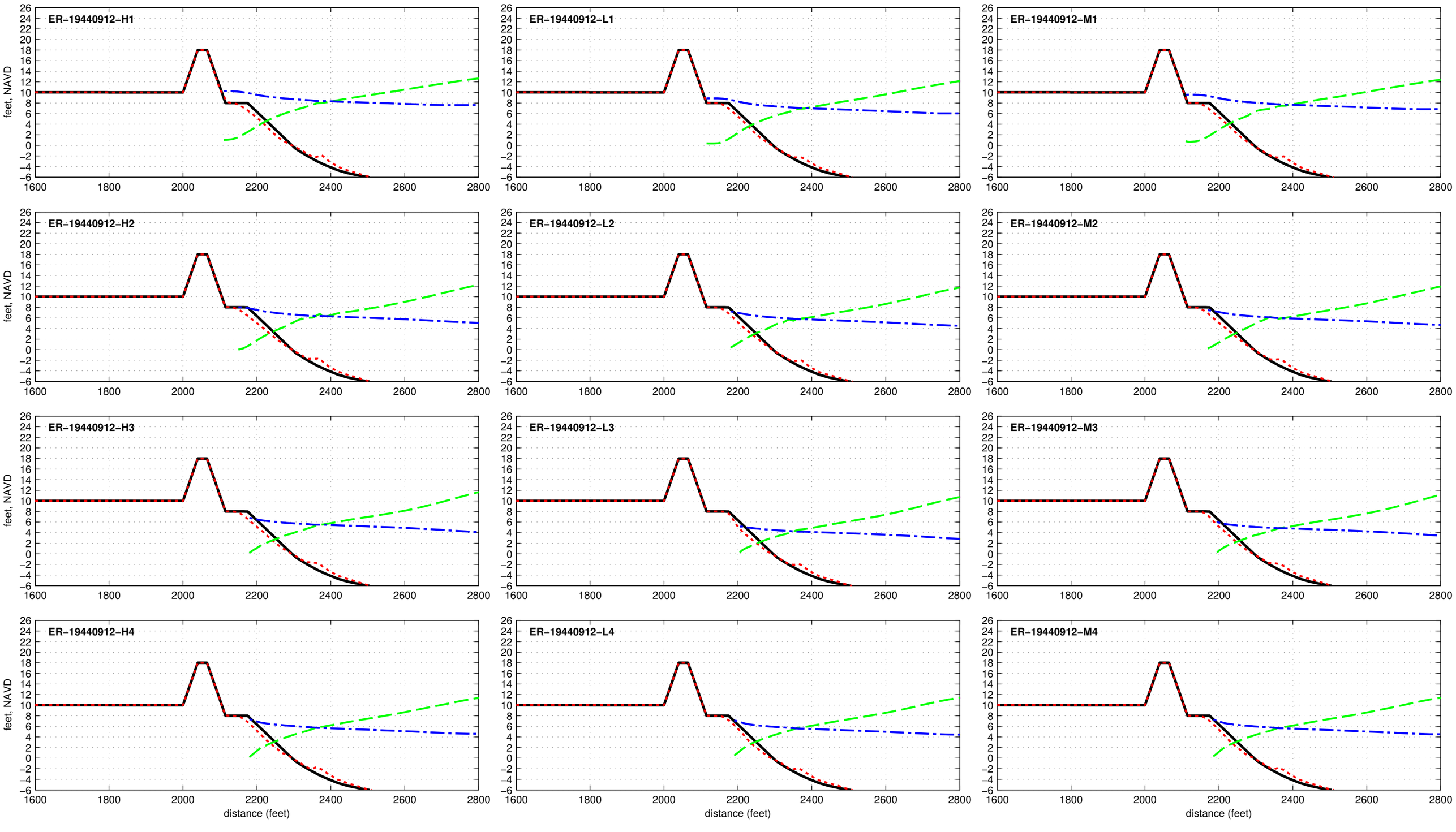


R2T1_18.0_025_060 – BURIED SEAWALL

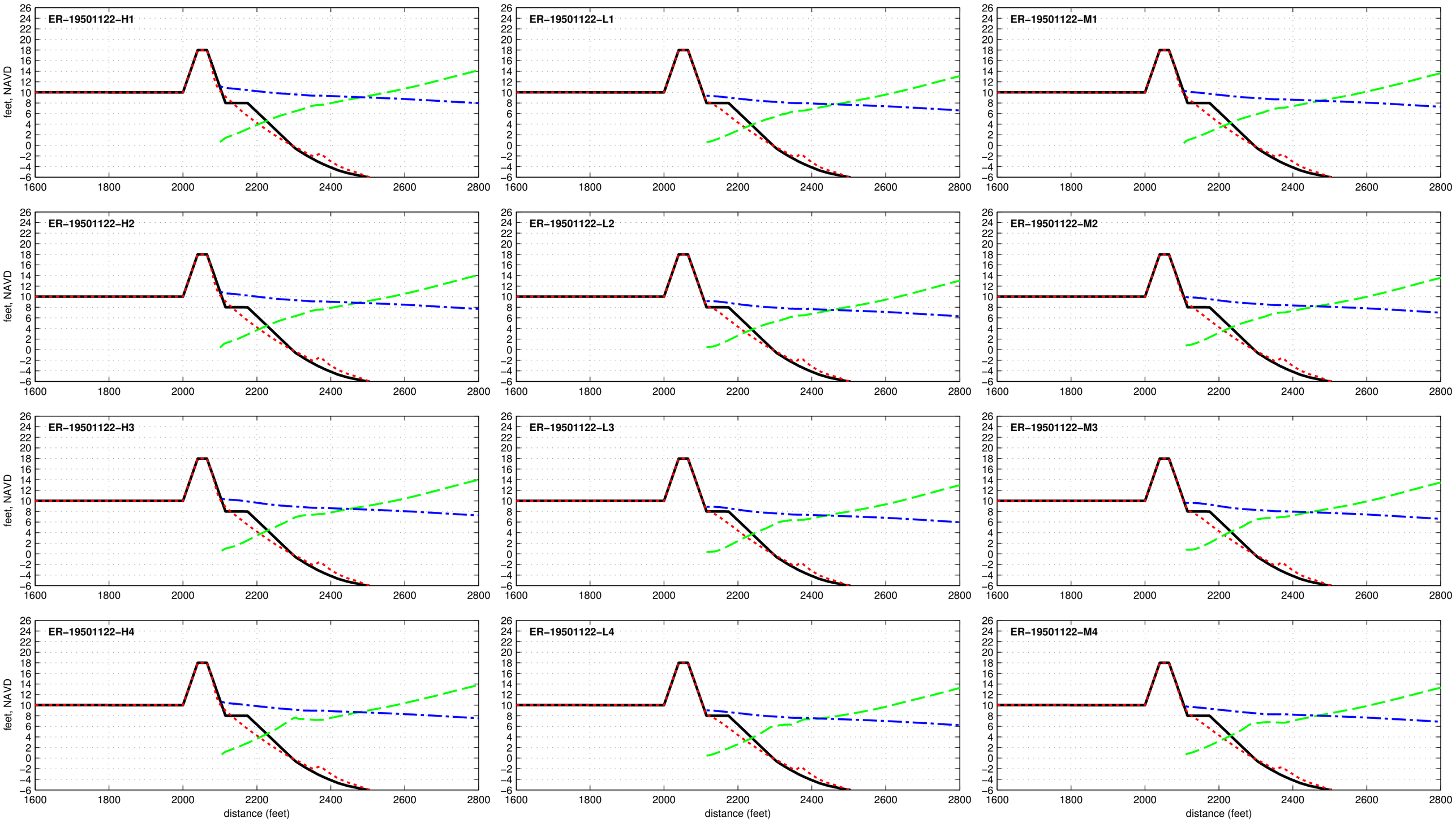
Buried Seawall R2T1-18.0-025-060 - ER-19380920



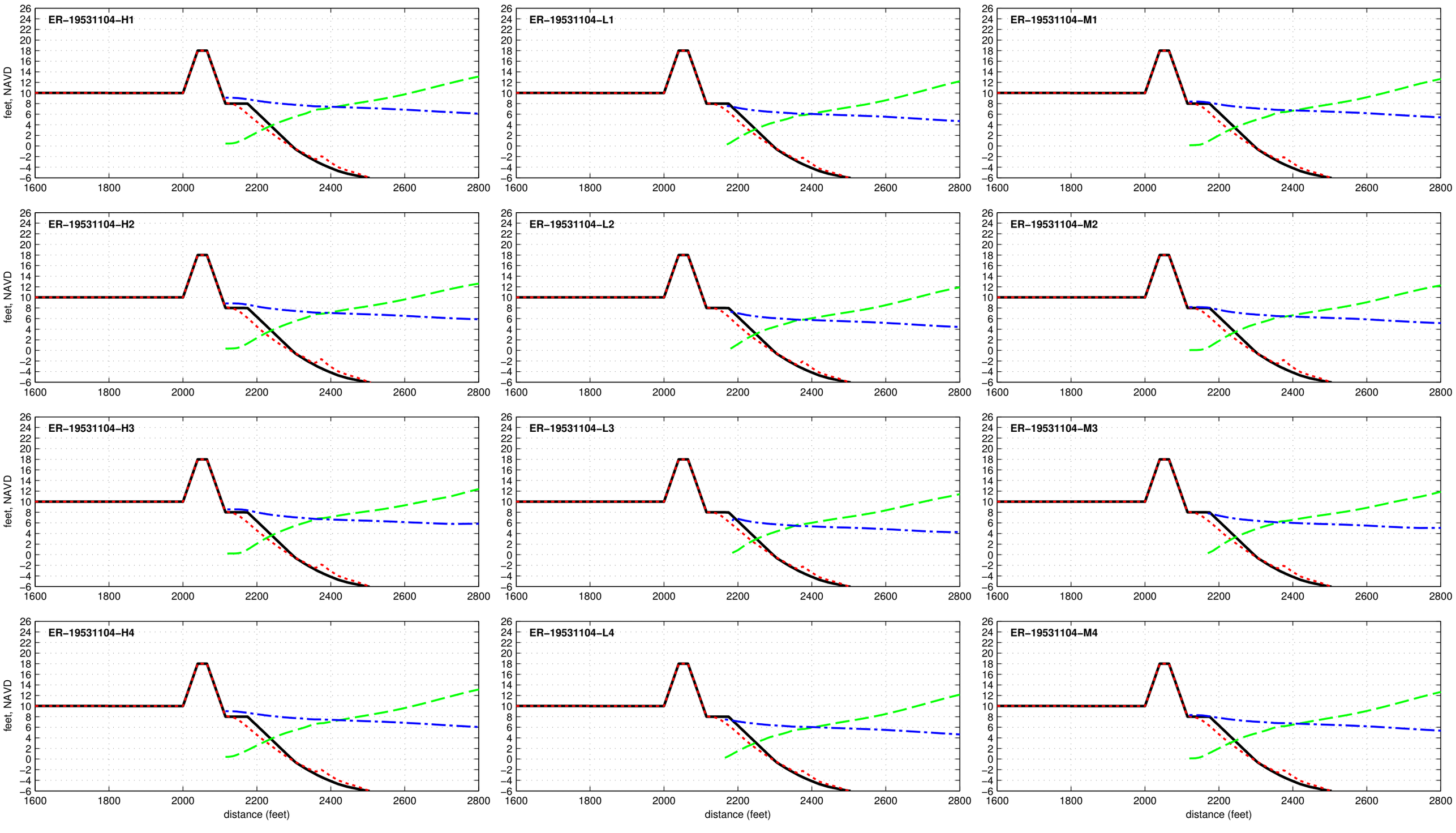
Buried Seawall R2T1-18.0-025-060 - ER-19440912



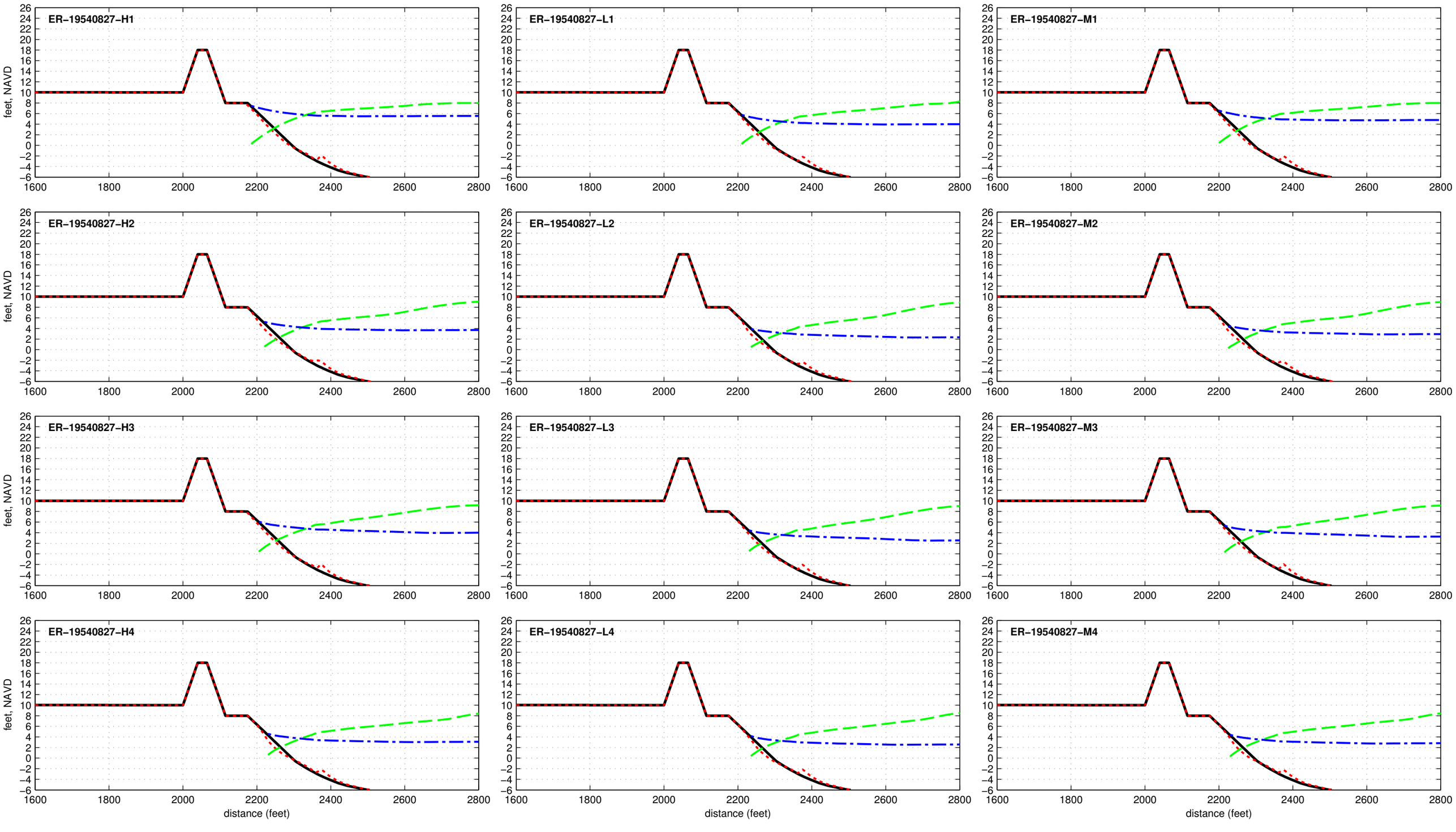
Buried Seawall R2T1-18.0-025-060 - ER-19501122



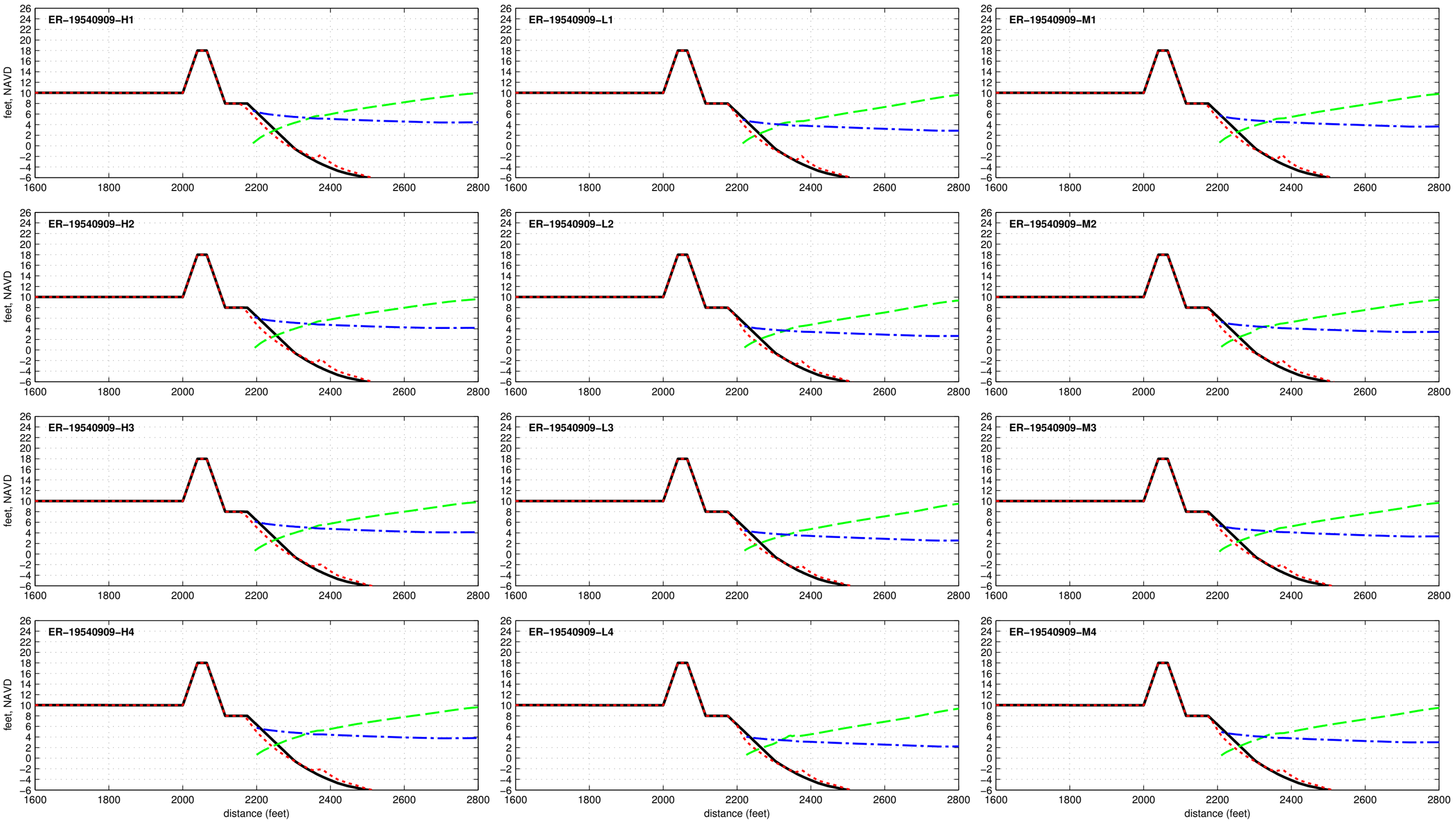
Buried Seawall R2T1-18.0-025-060 - ER-19531104



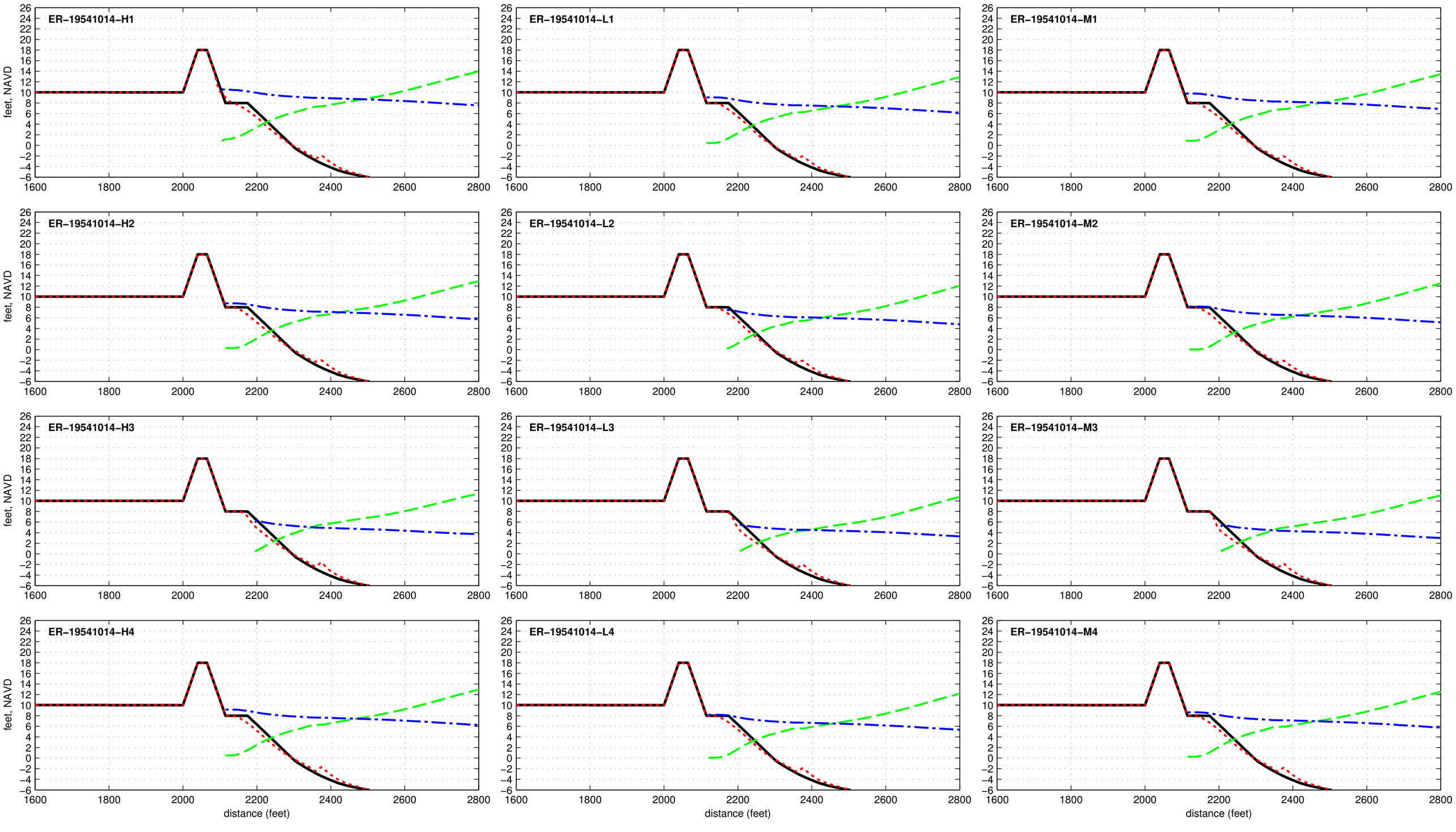
Buried Seawall R2T1-18.0-025-060 - ER-19540827



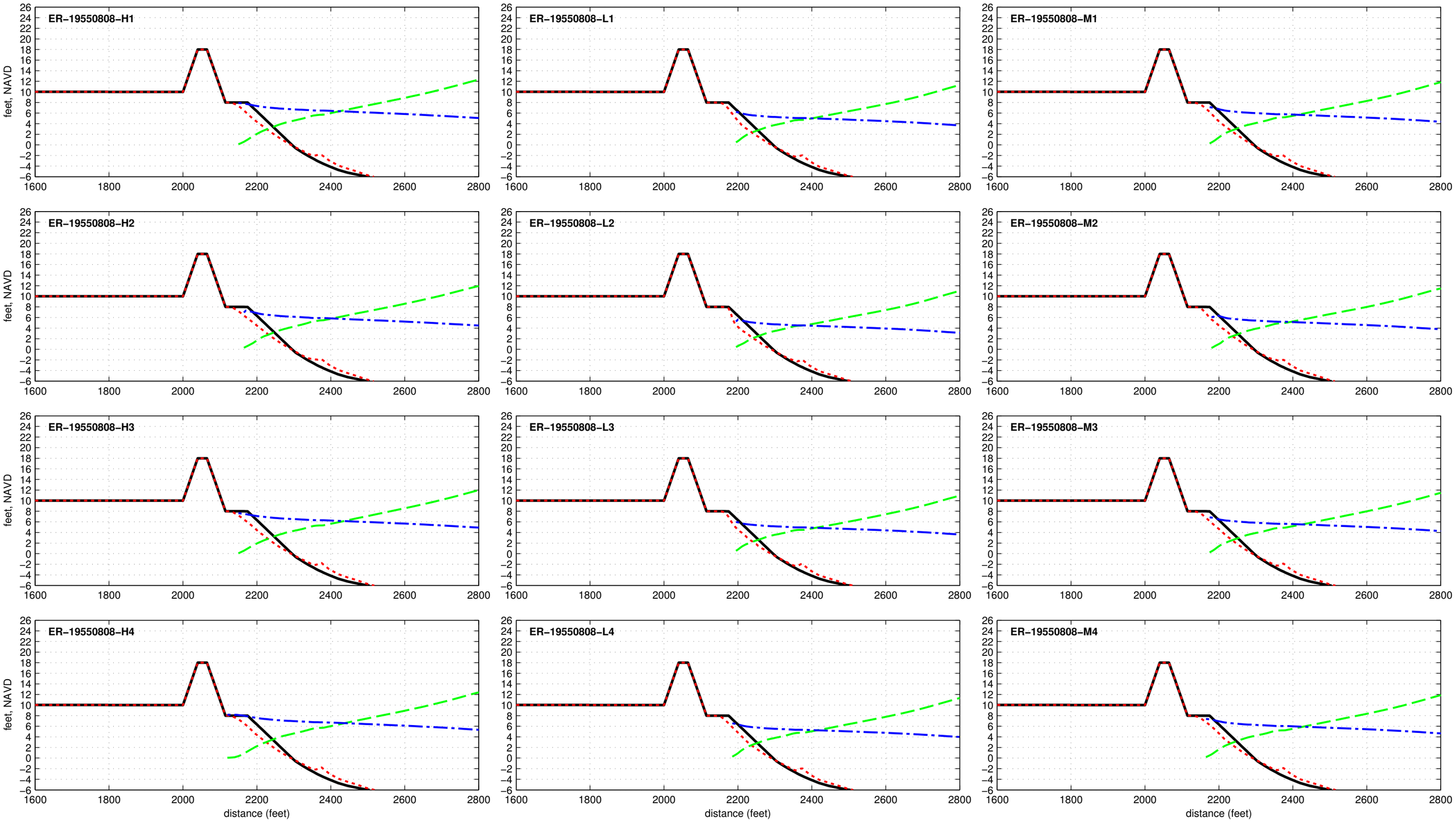
Buried Seawall R2T1-18.0-025-060 - ER-19540909



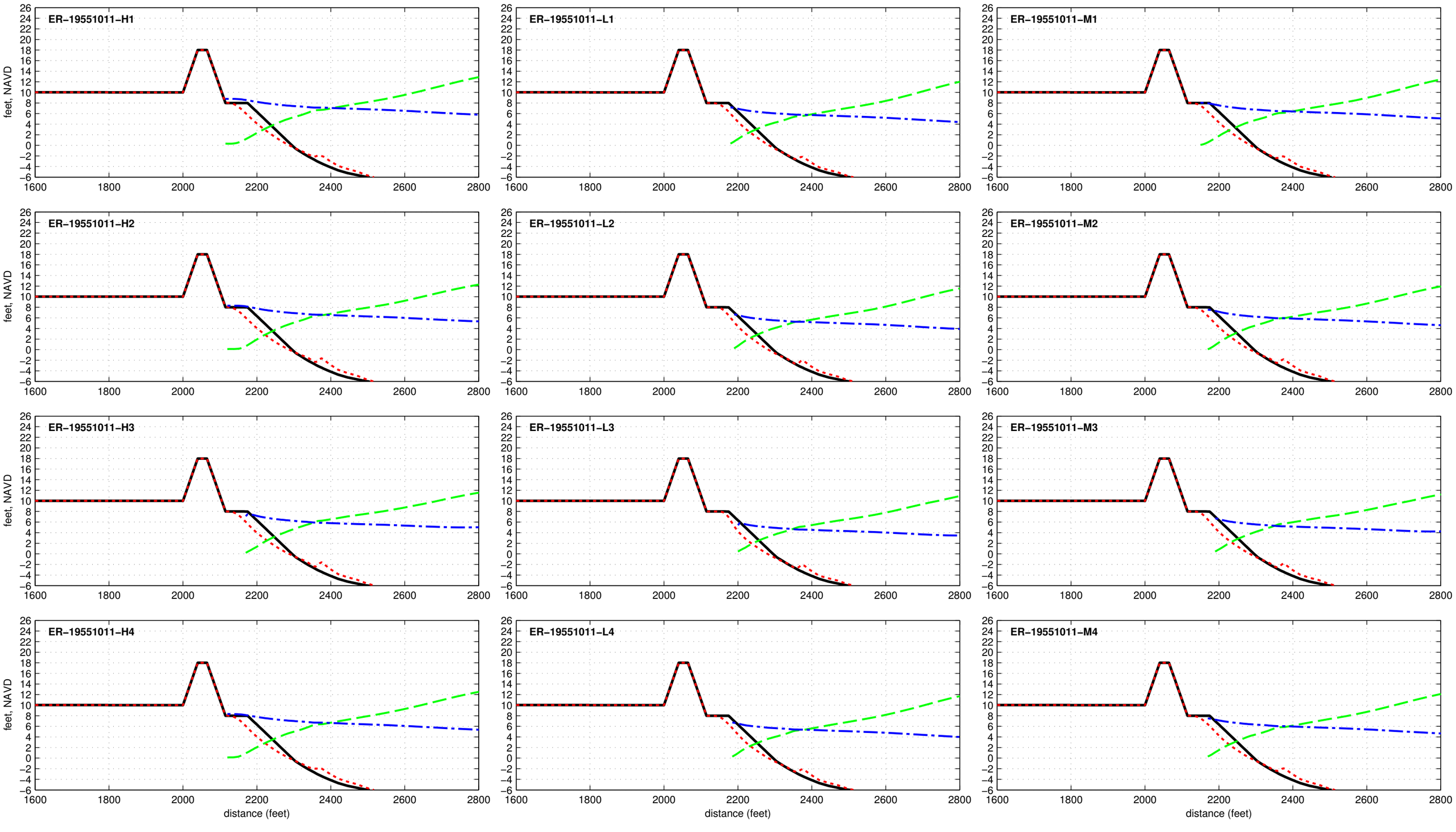
Buried Seawall R2T1-18.0-025-060 - ER-19541014



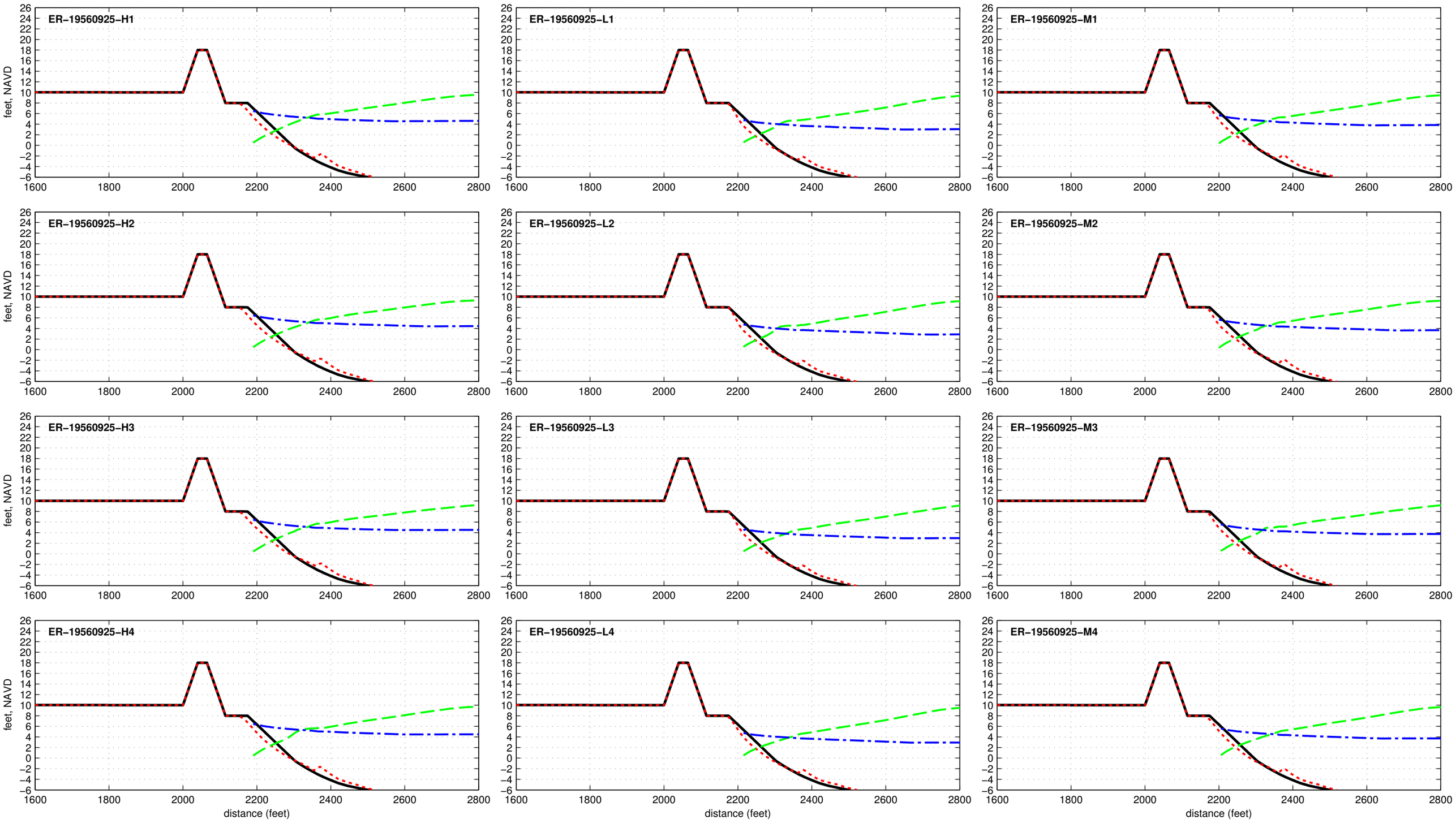
Buried Seawall R2T1-18.0-025-060 - ER-19550808



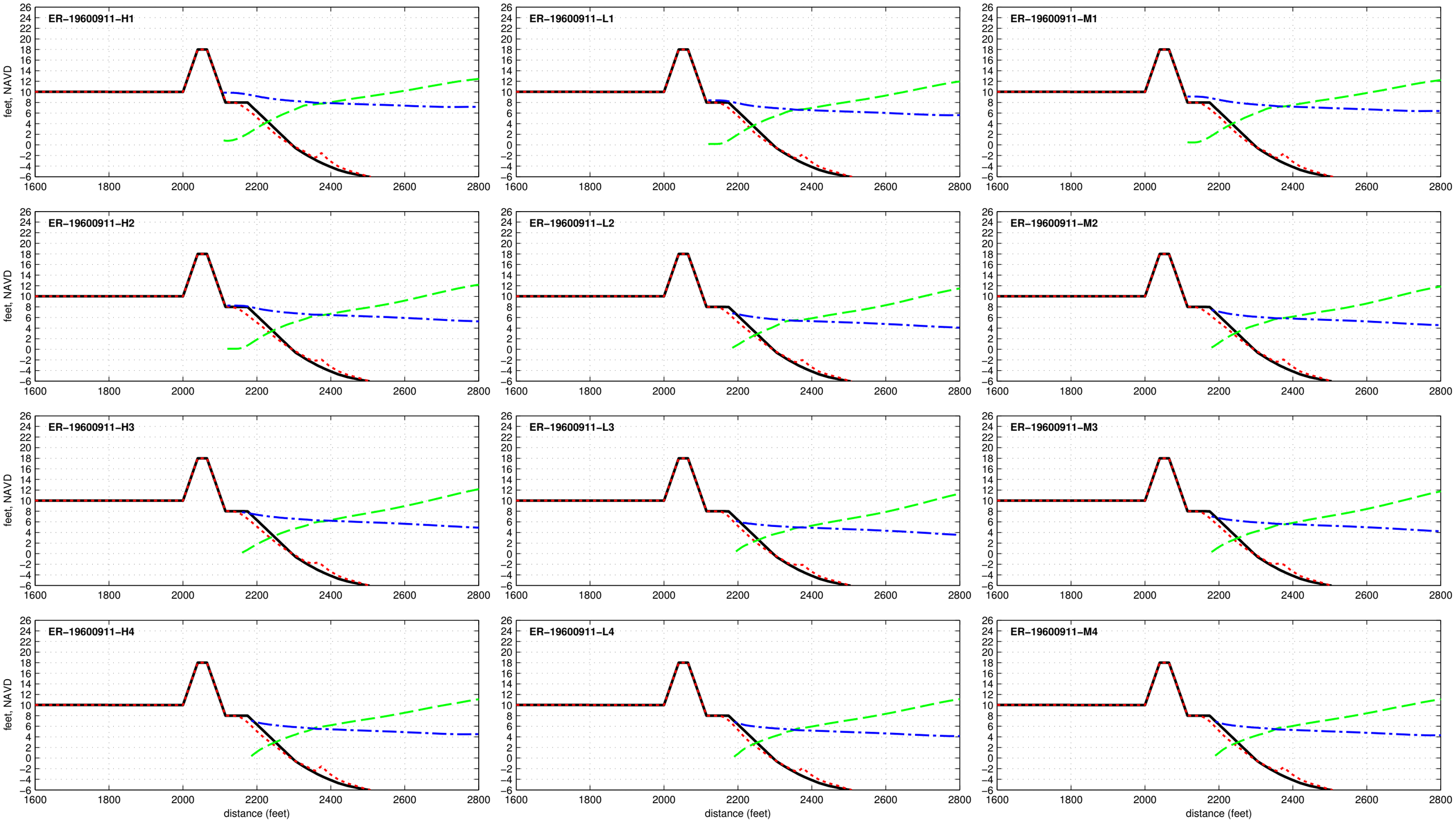
Buried Seawall R2T1-18.0-025-060 - ER-19551011



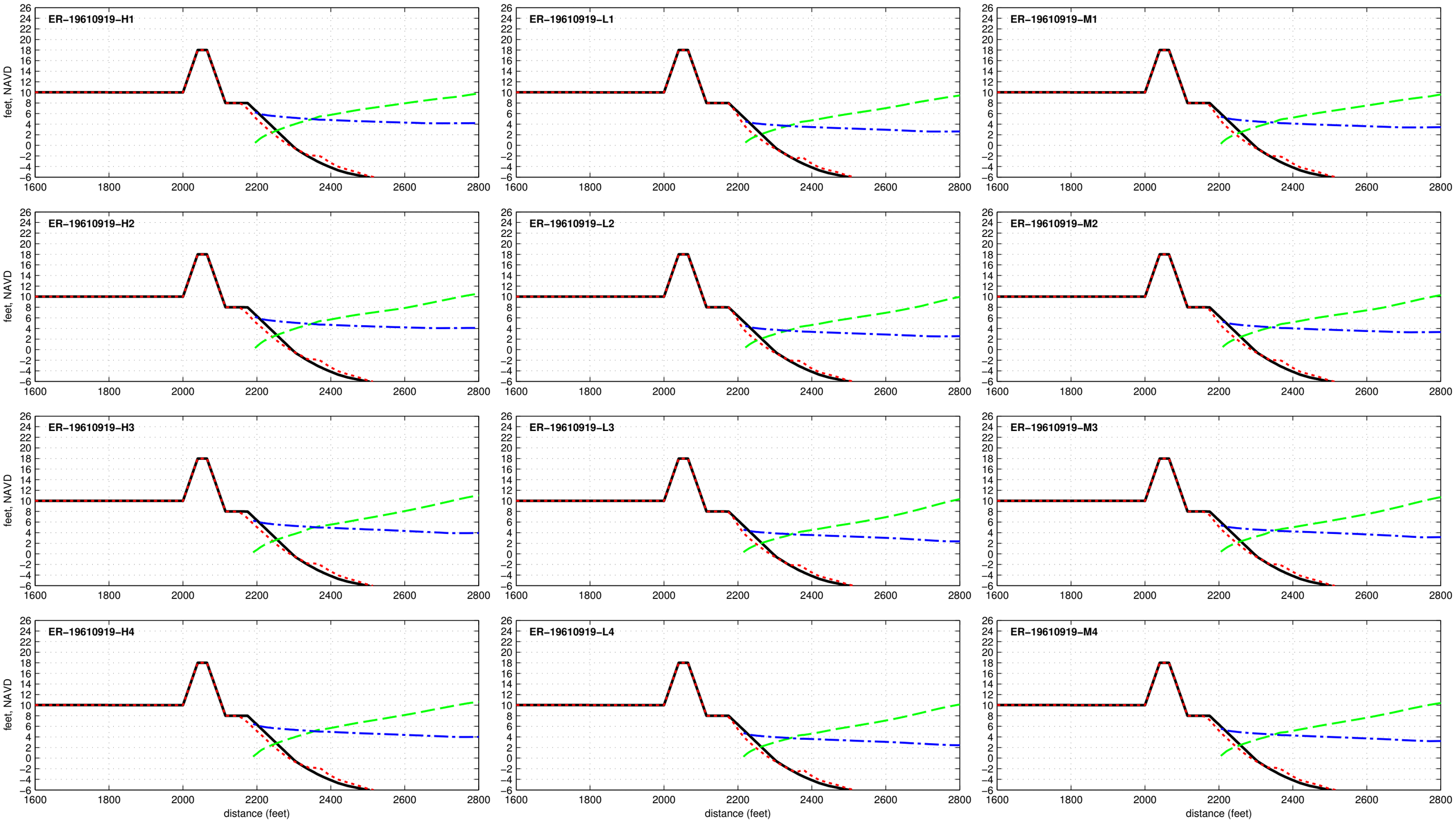
Buried Seawall R2T1-18.0-025-060 - ER-19560925



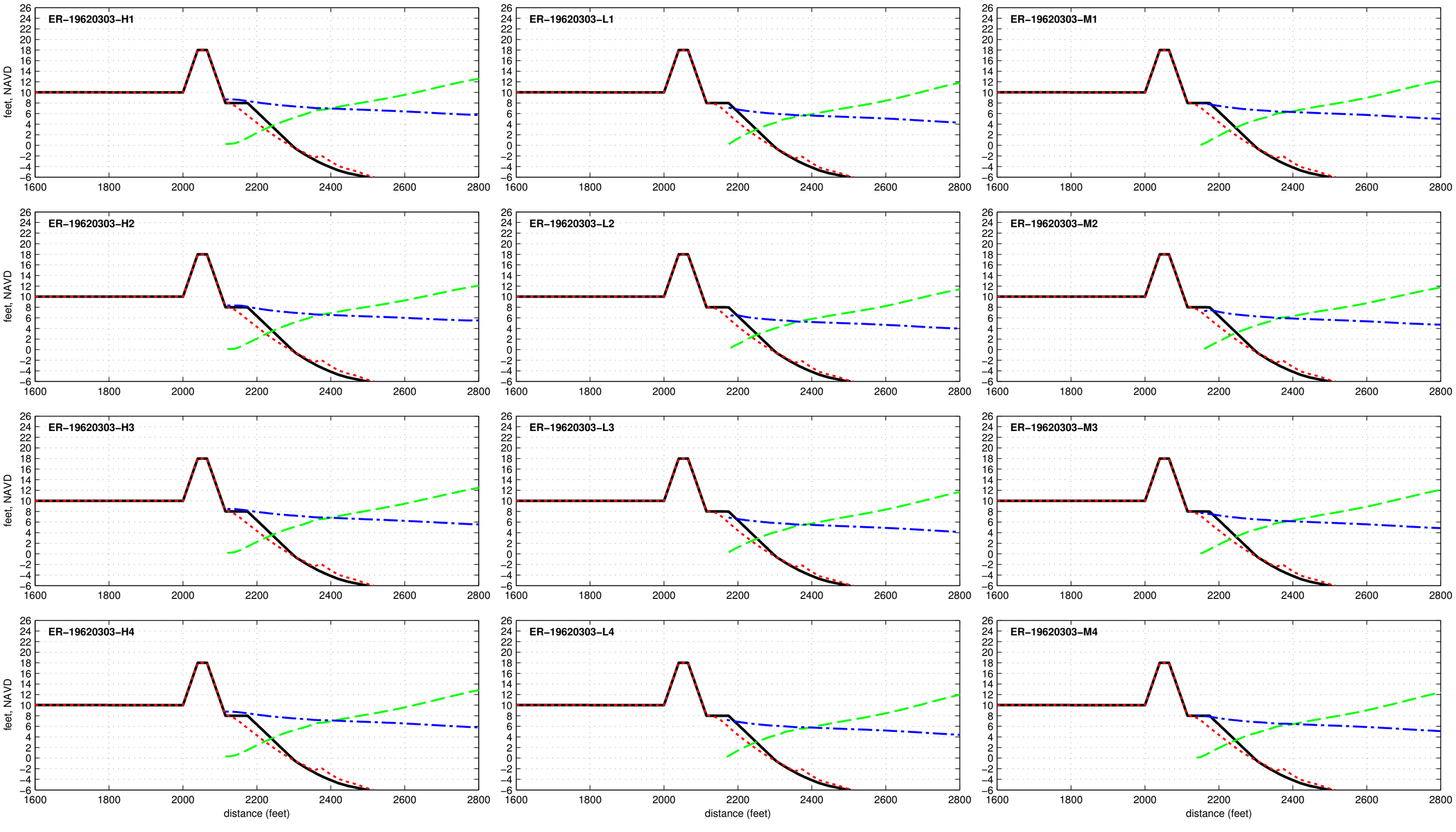
Buried Seawall R2T1-18.0-025-060 - ER-19600911



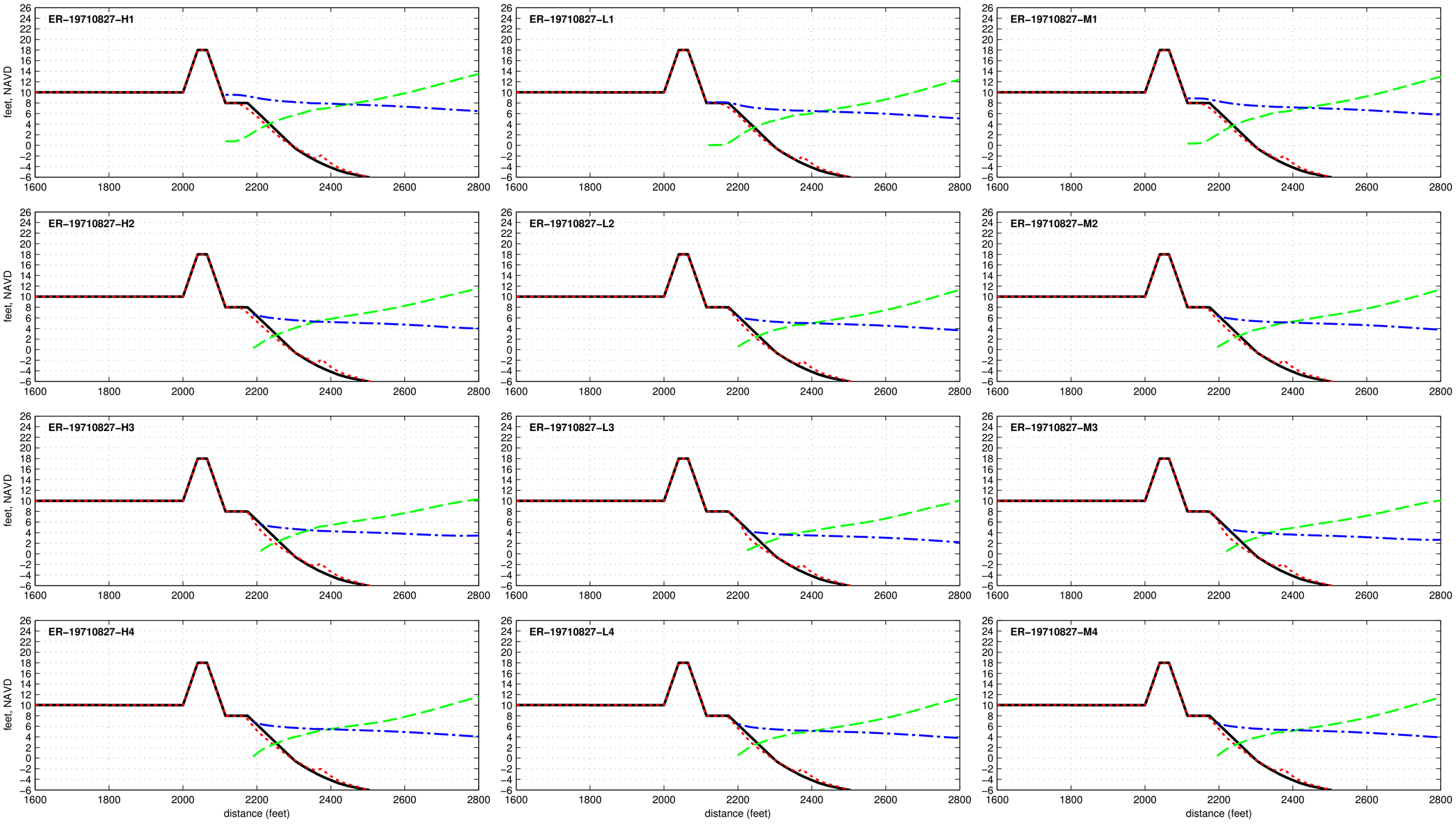
Buried Seawall R2T1-18.0-025-060 - ER-19610919



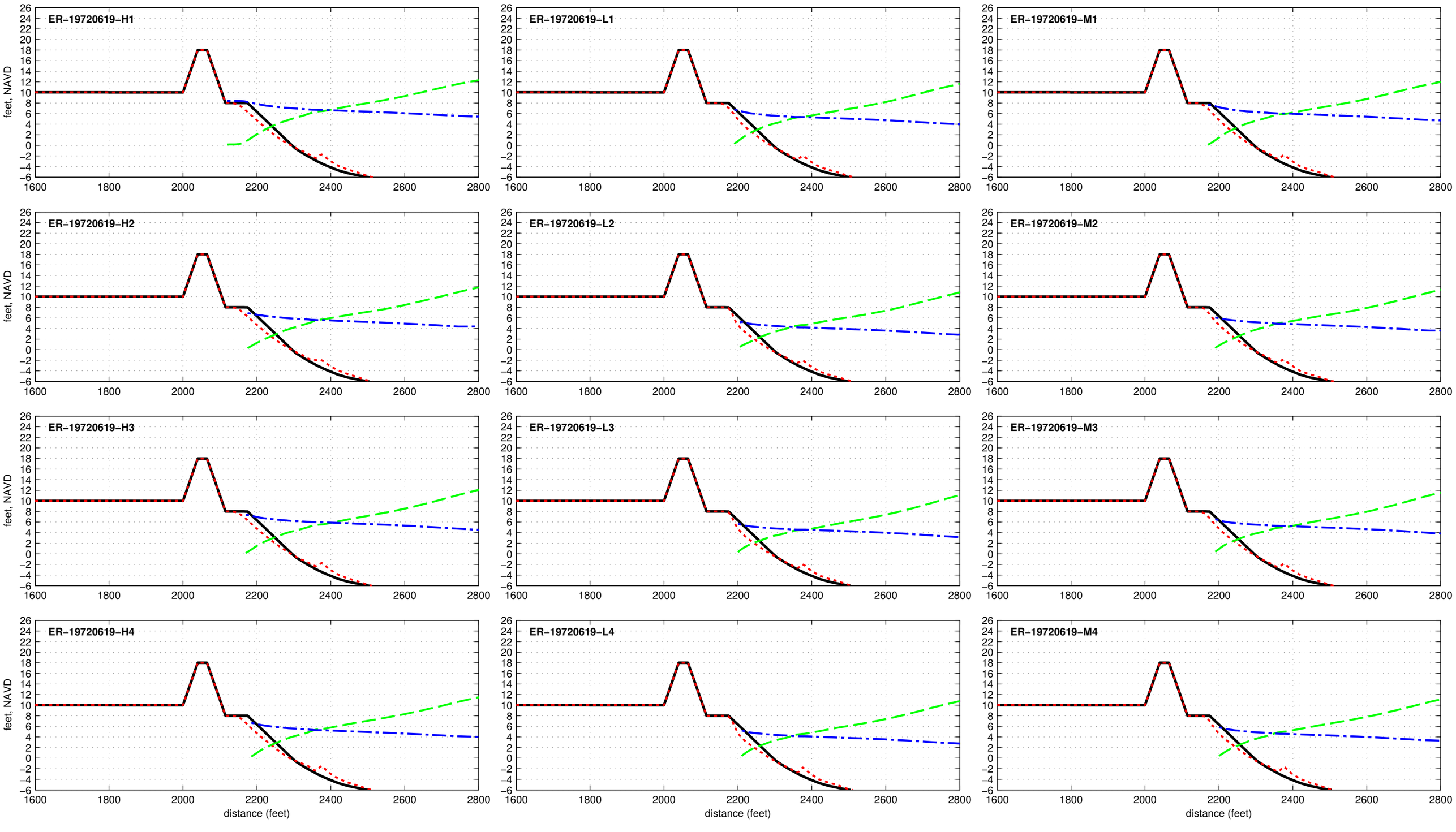
Buried Seawall R2T1-18.0-025-060 - ER-19620303



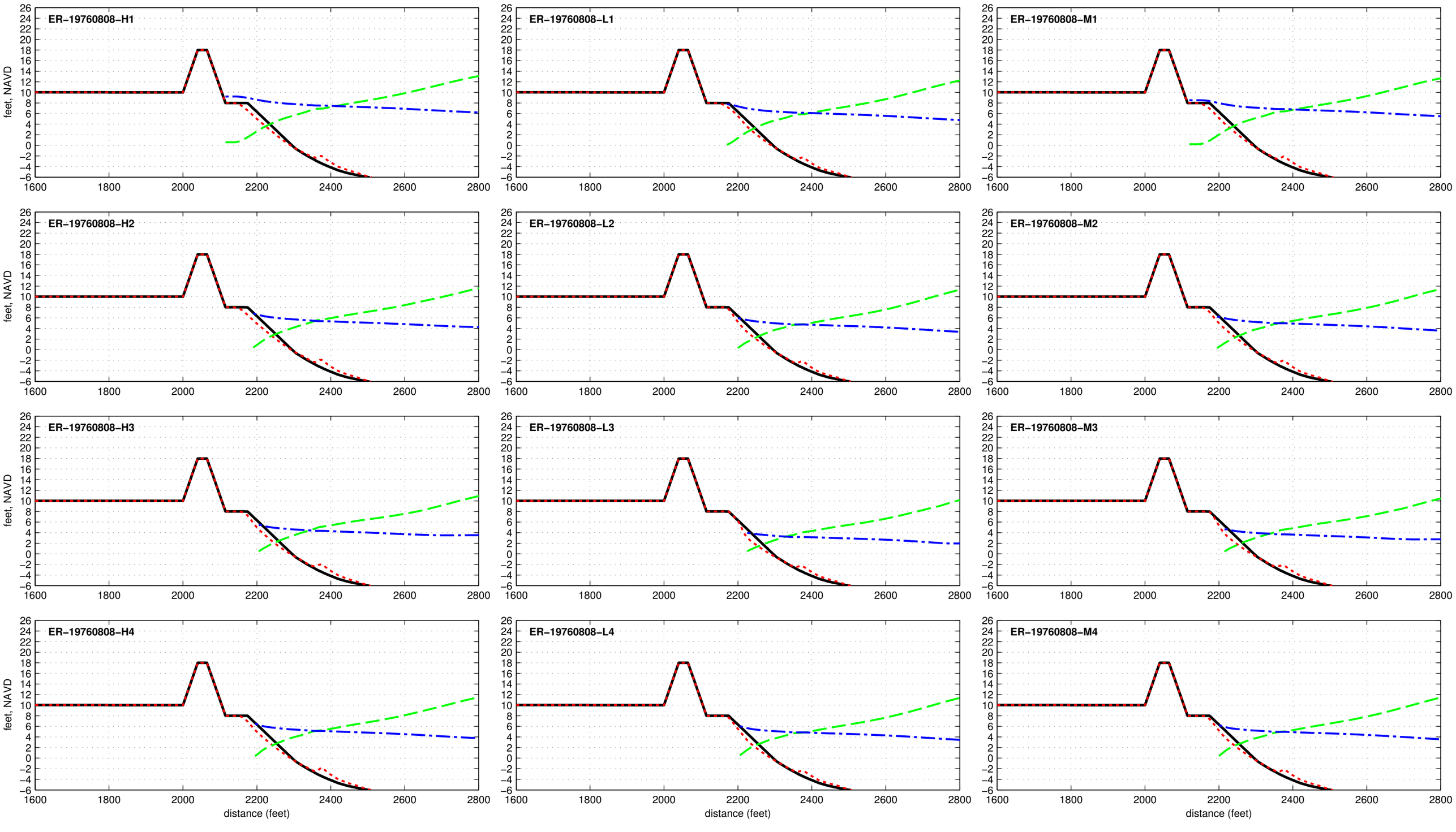
Buried Seawall R2T1-18.0-025-060 - ER-19710827



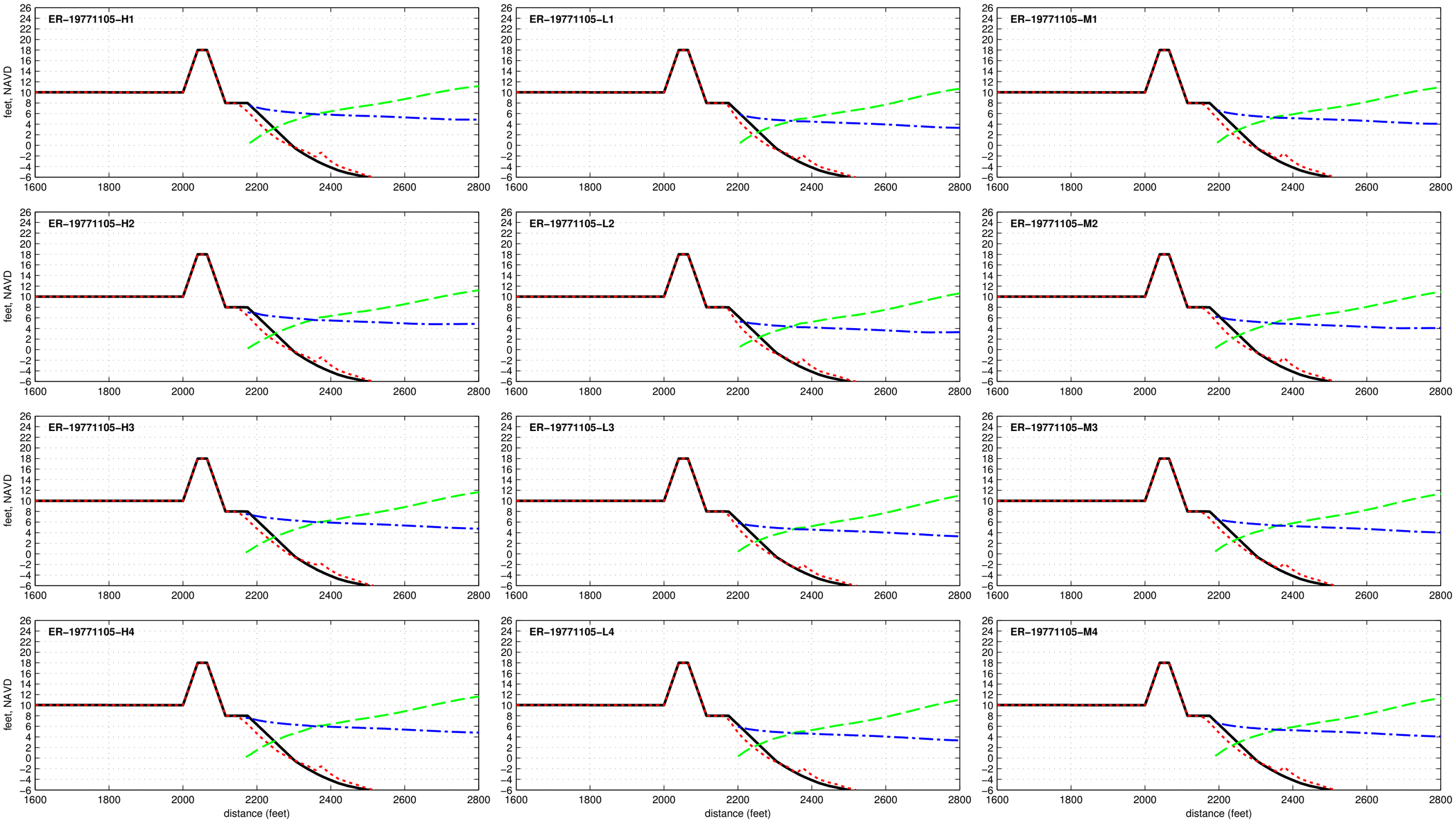
Buried Seawall R2T1-18.0-025-060 - ER-19720619



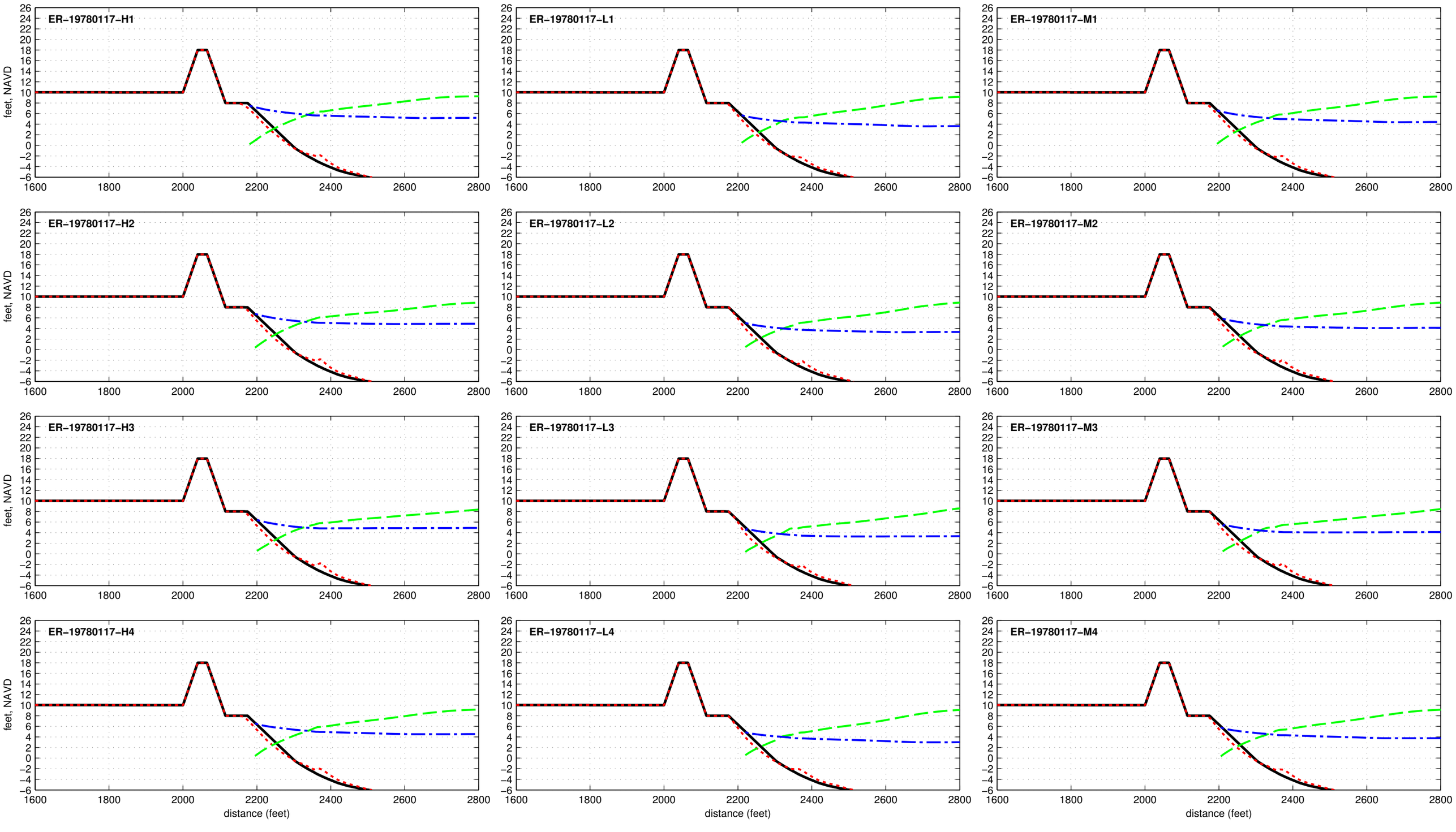
Buried Seawall R2T1-18.0-025-060 - ER-19760808



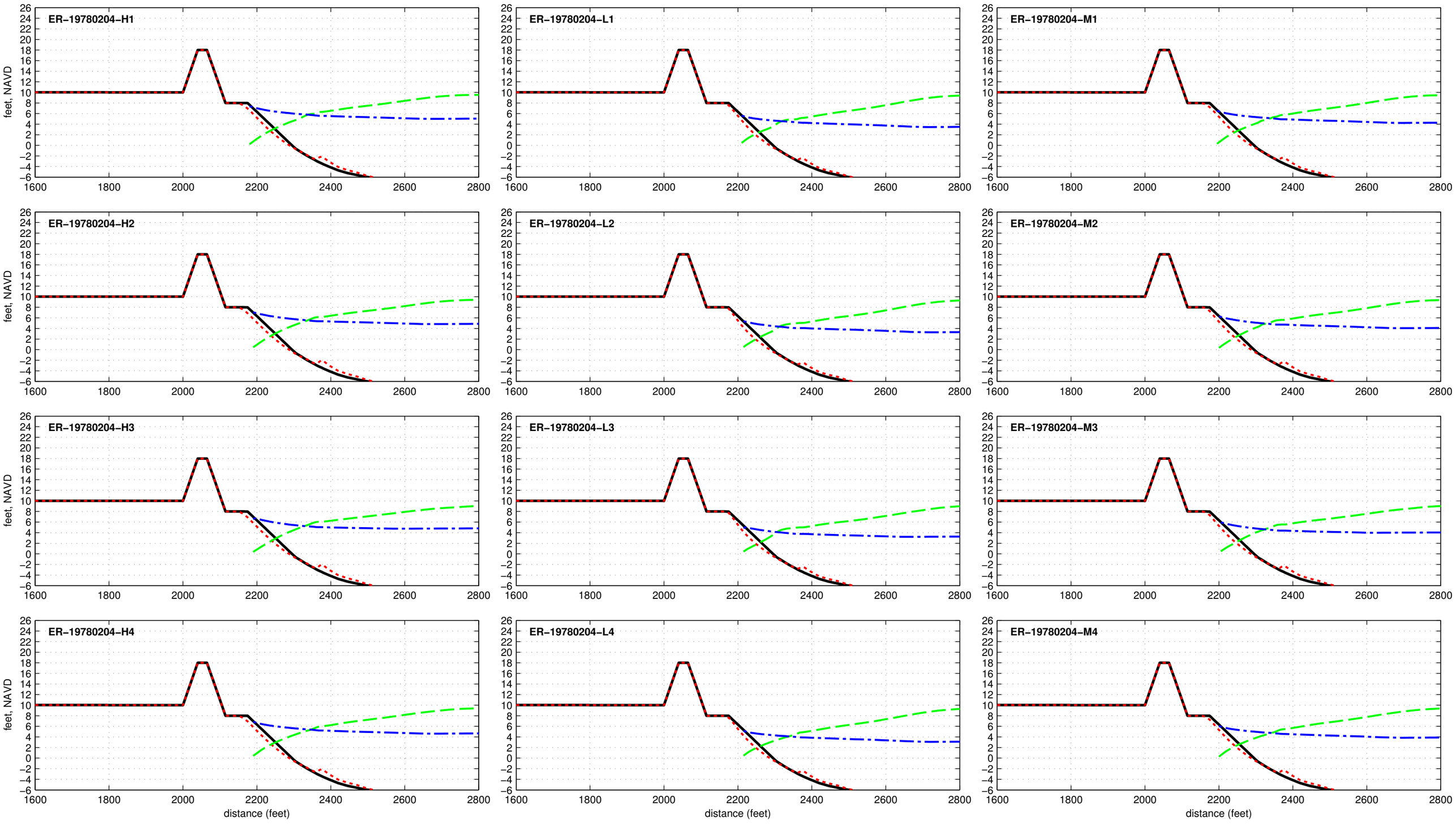
Buried Seawall R2T1-18.0-025-060 - ER-19771105



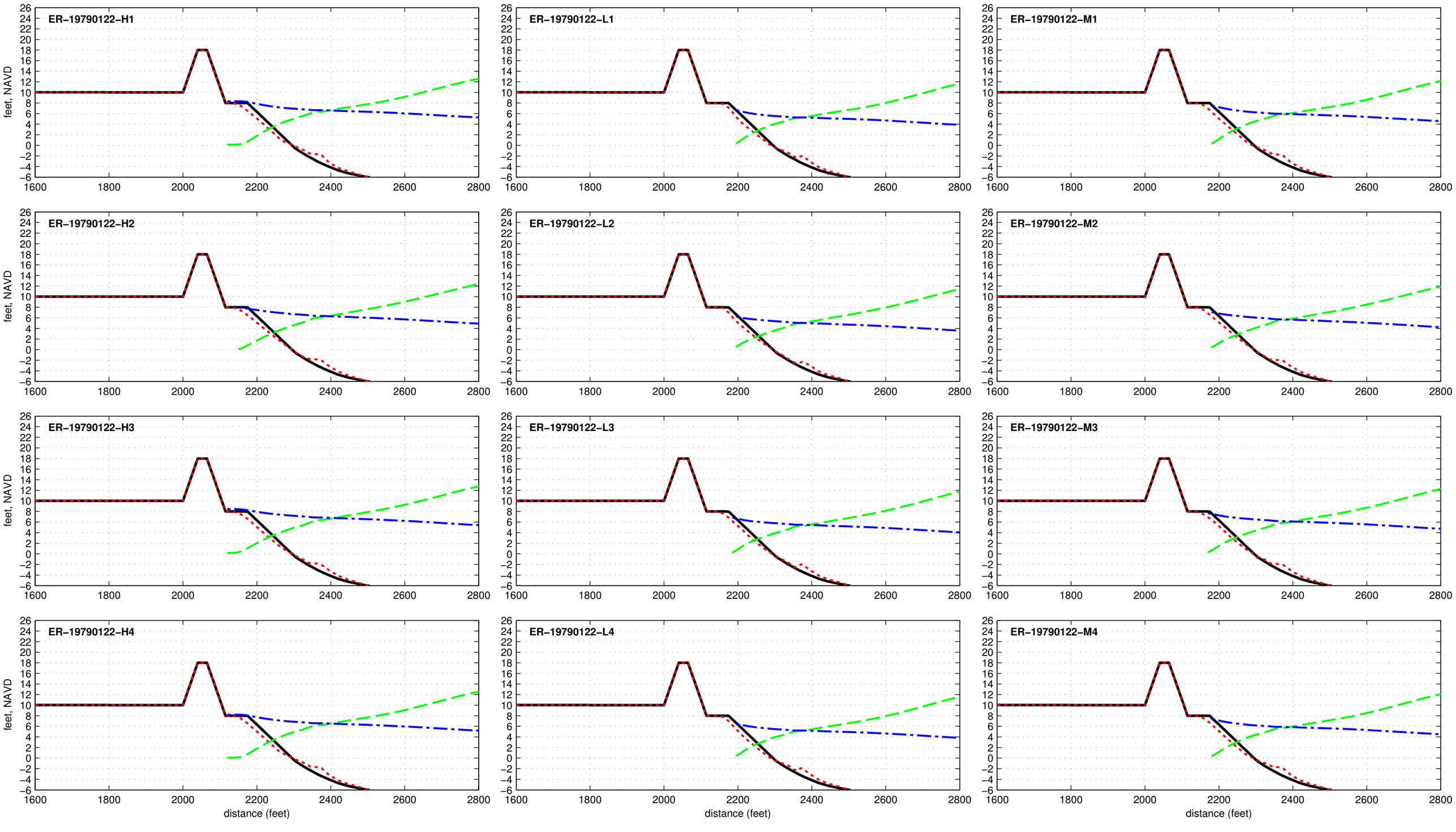
Buried Seawall R2T1-18.0-025-060 - ER-19780117



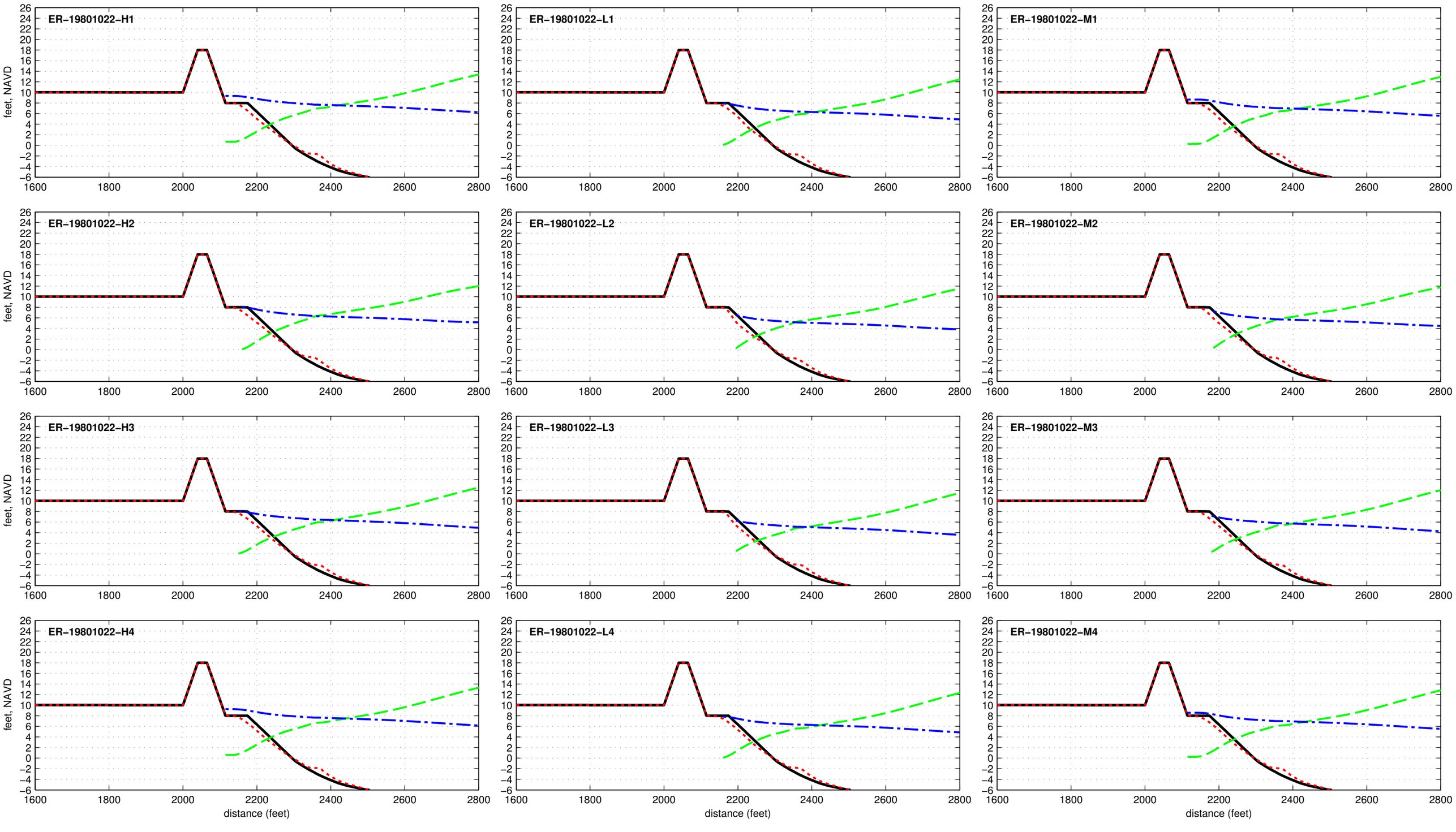
Buried Seawall R2T1-18.0-025-060 - ER-19780204



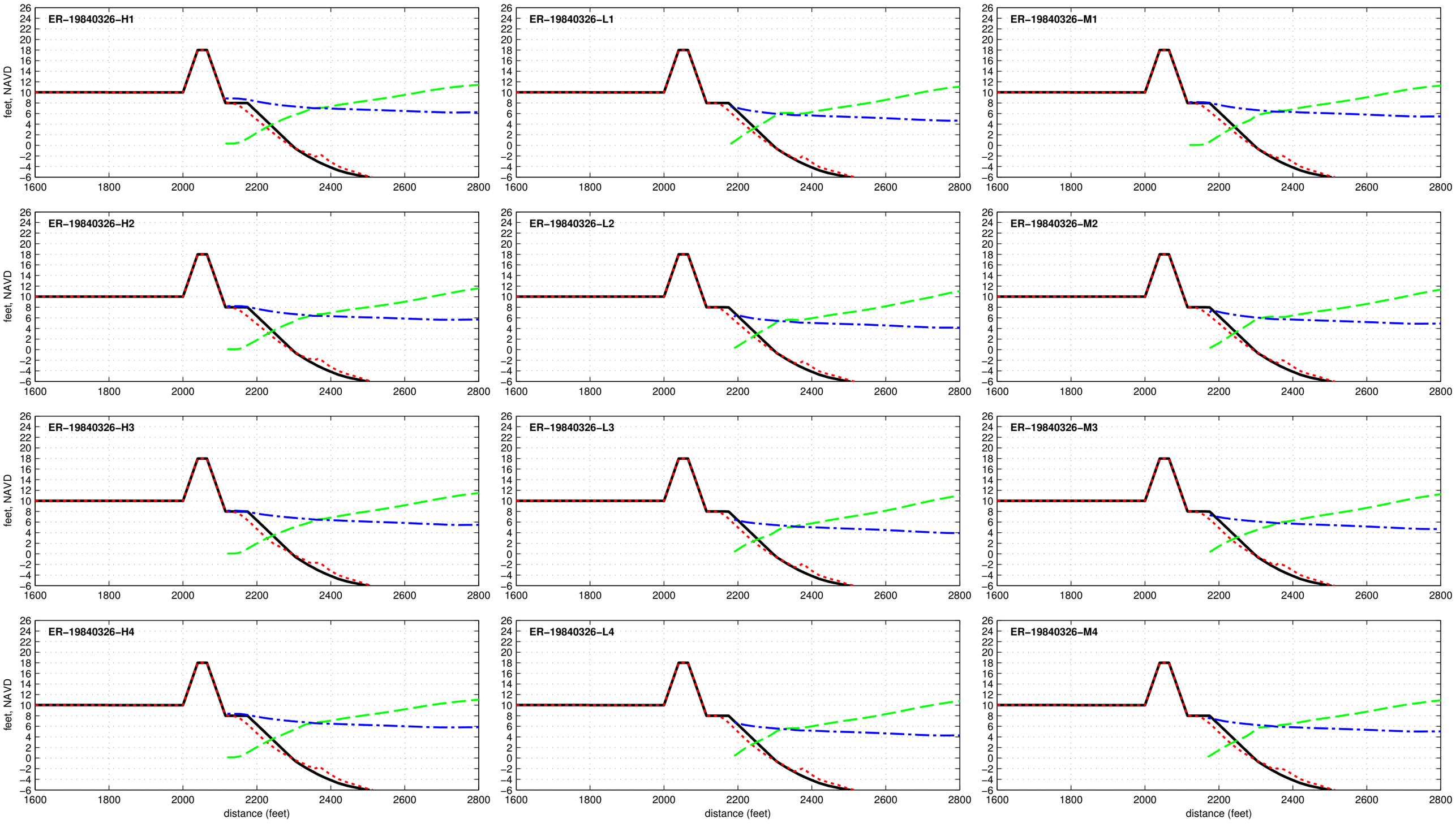
Buried Seawall R2T1-18.0-025-060 - ER-19790122



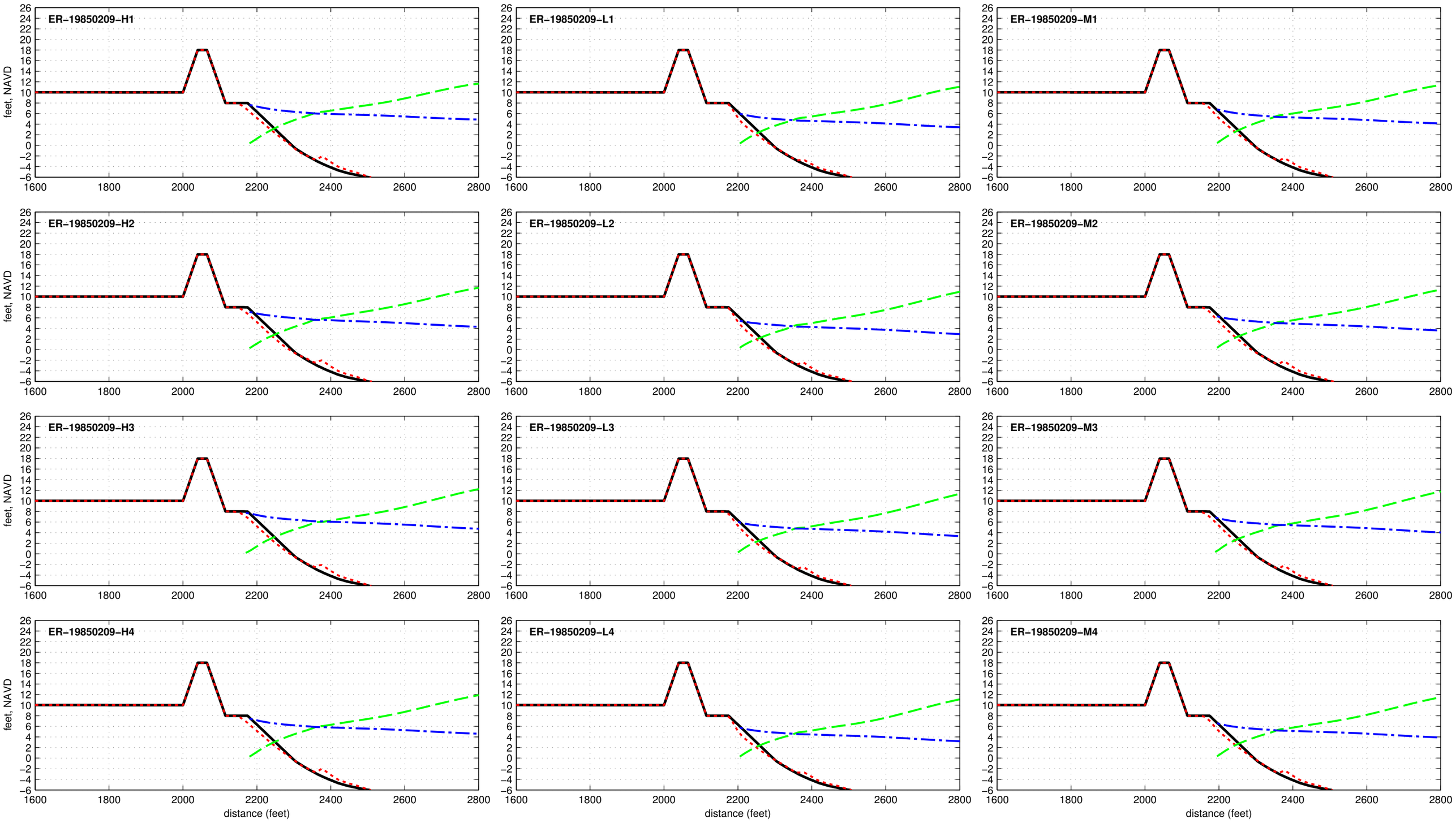
Buried Seawall R2T1-18.0-025-060 - ER-19801022



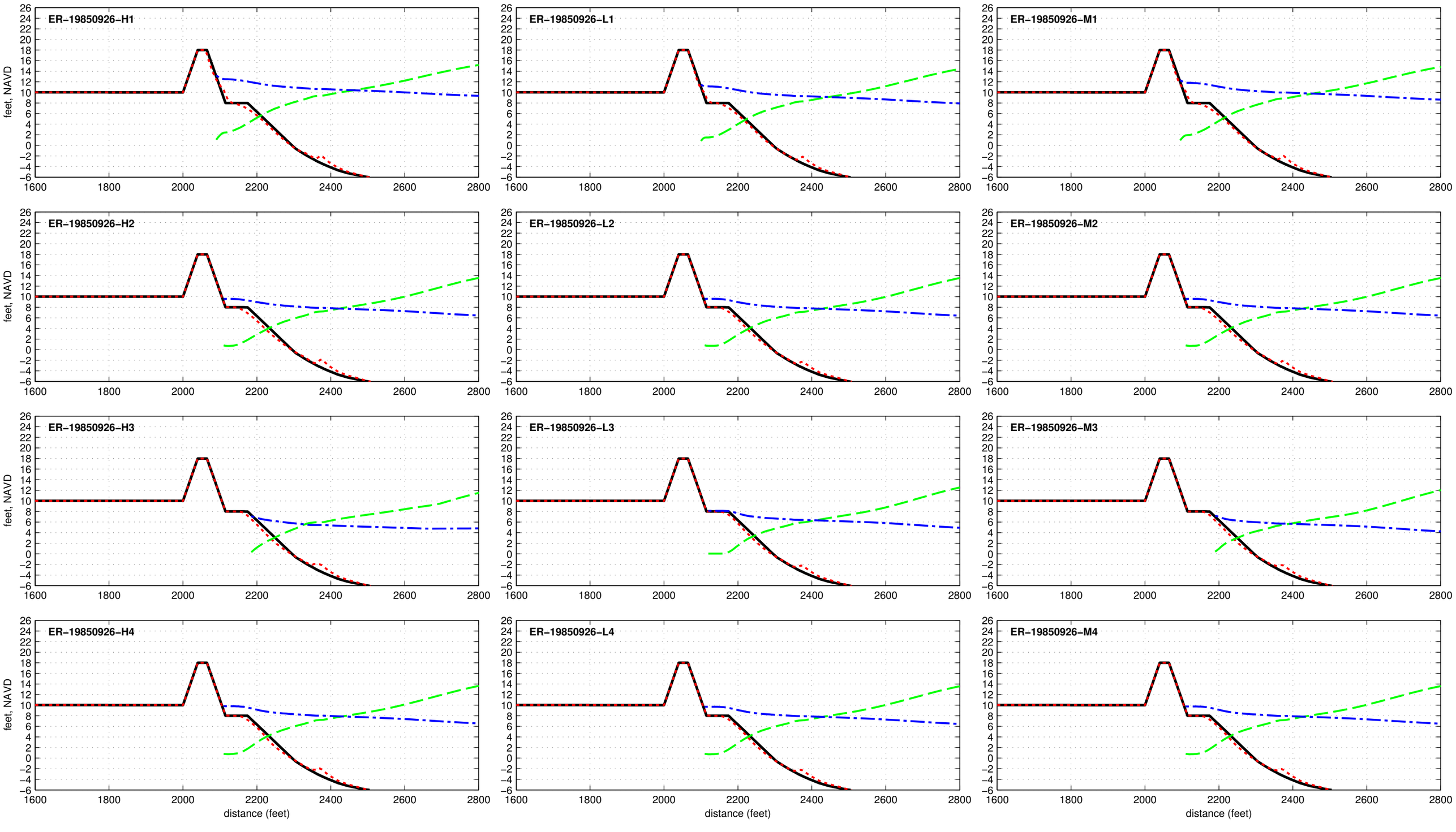
Buried Seawall R2T1-18.0-025-060 - ER-19840326



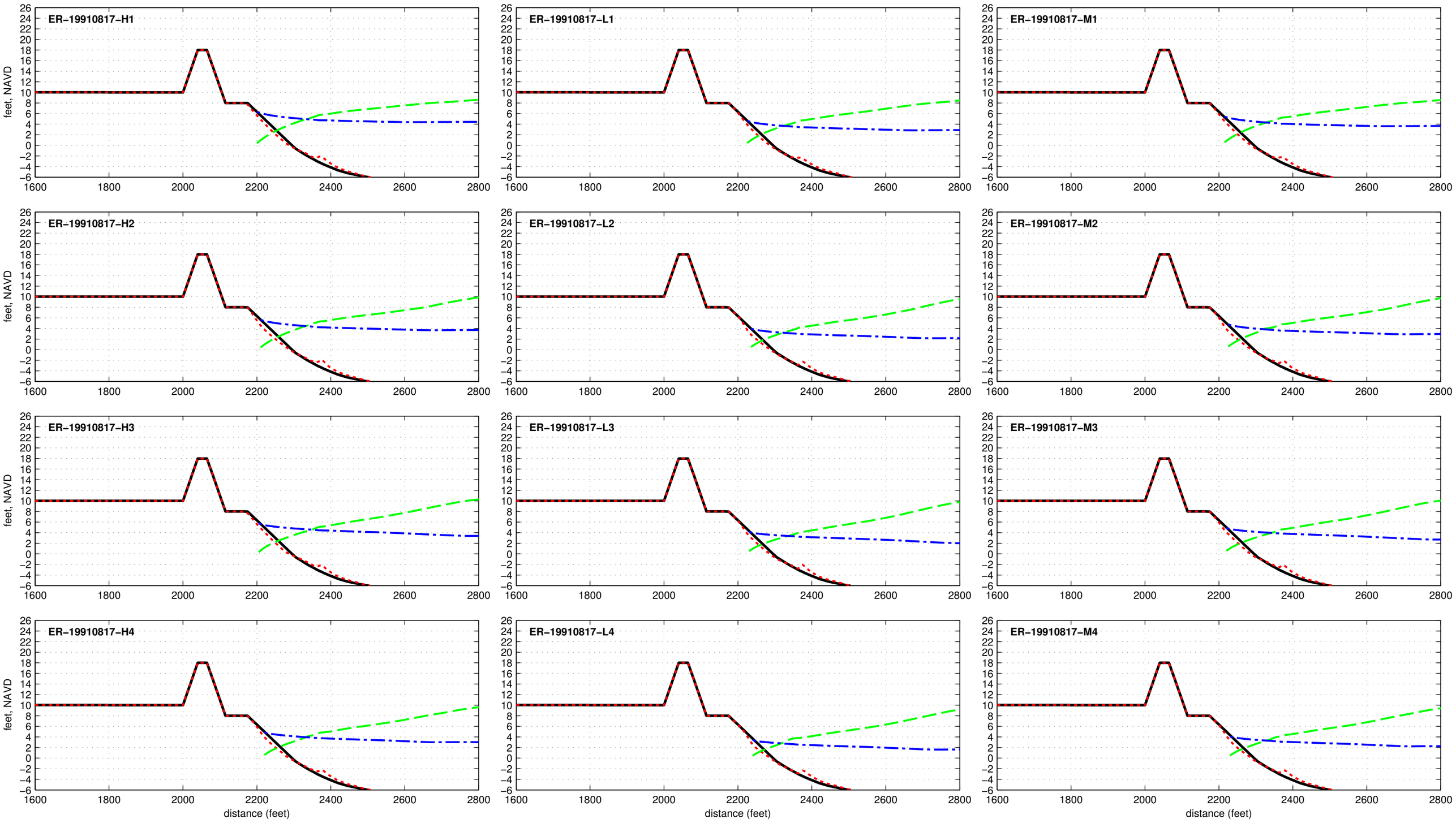
Buried Seawall R2T1-18.0-025-060 - ER-19850209



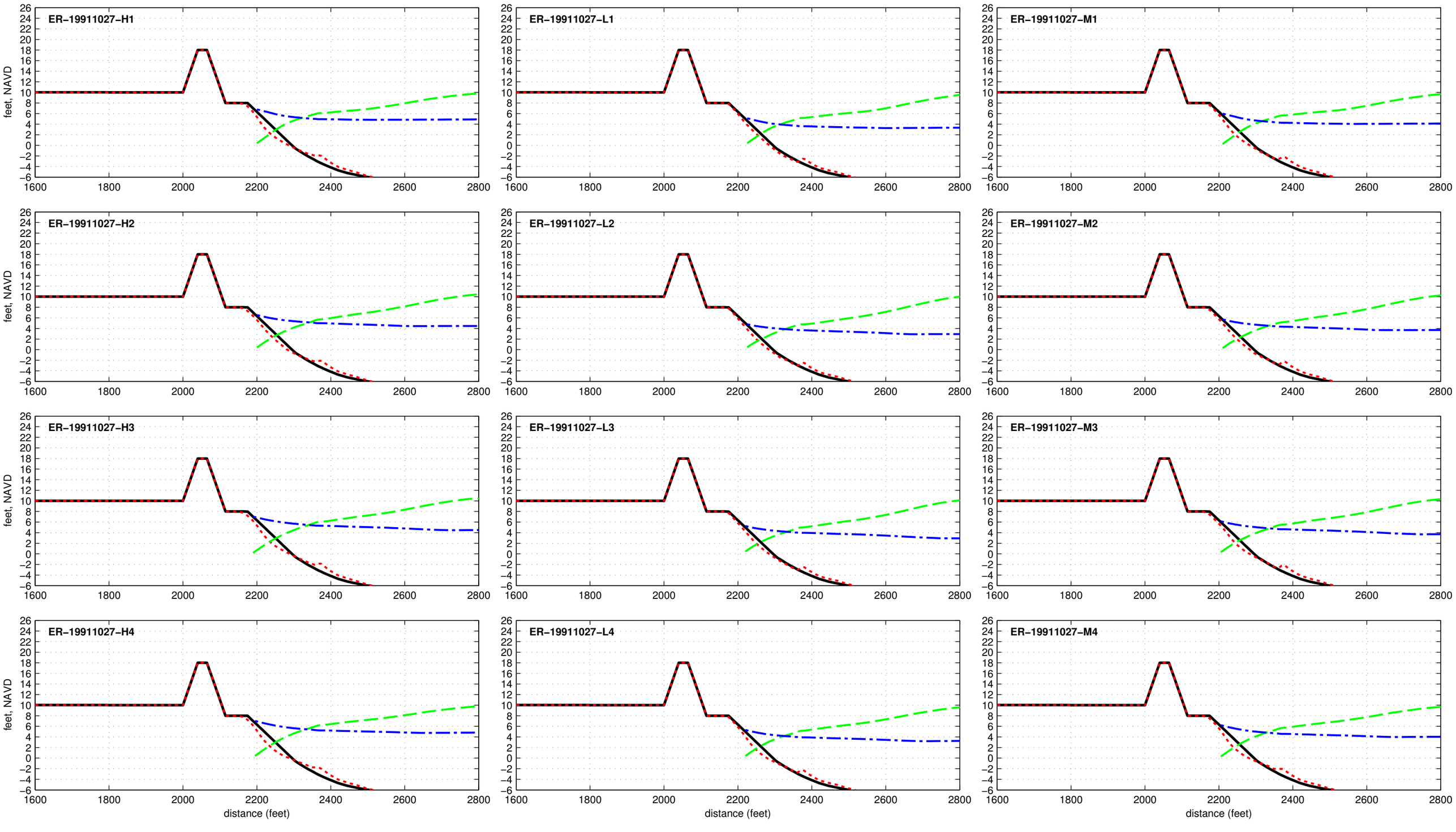
Buried Seawall R2T1-18.0-025-060 - ER-19850926



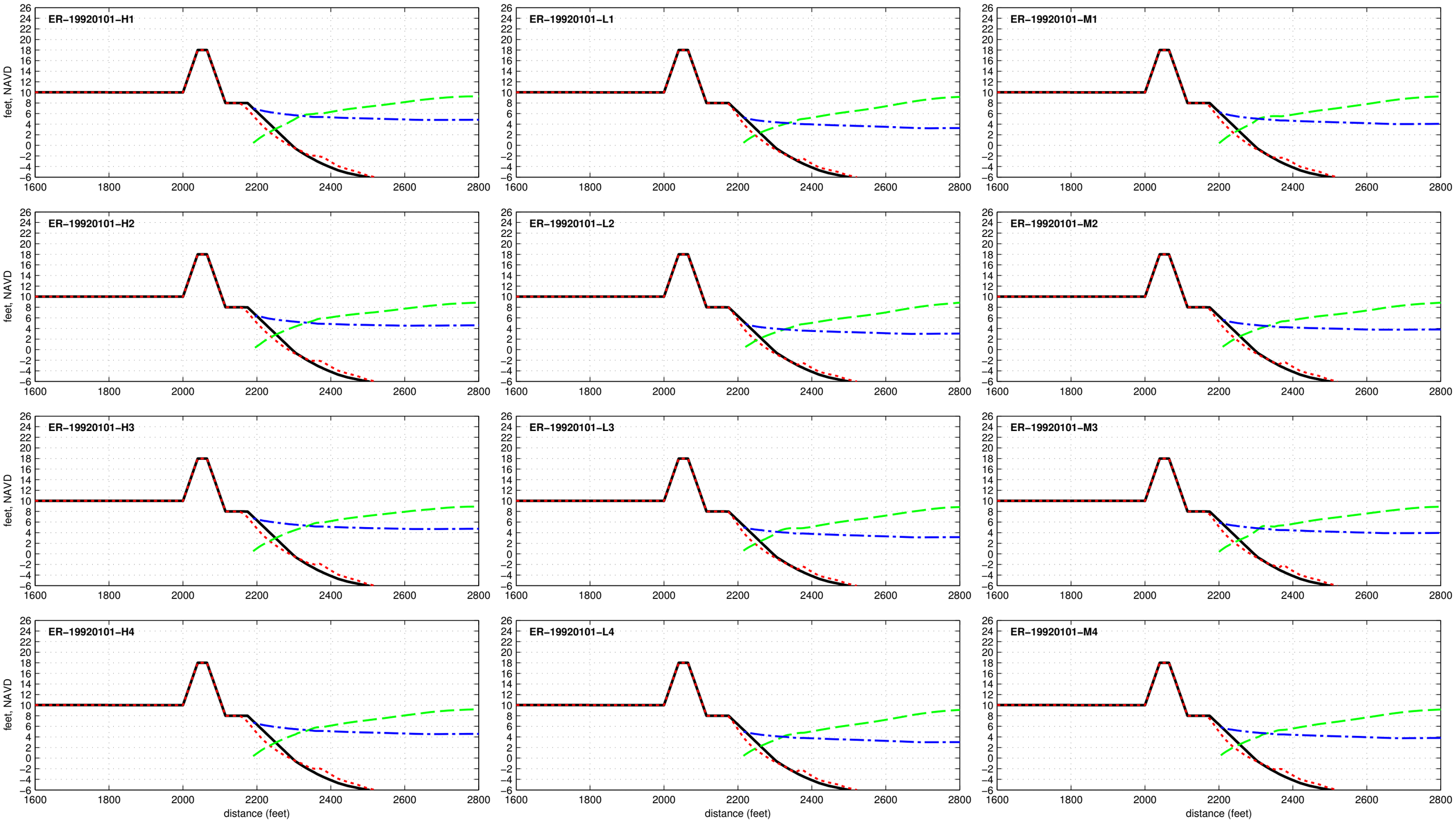
Buried Seawall R2T1-18.0-025-060 - ER-19910817



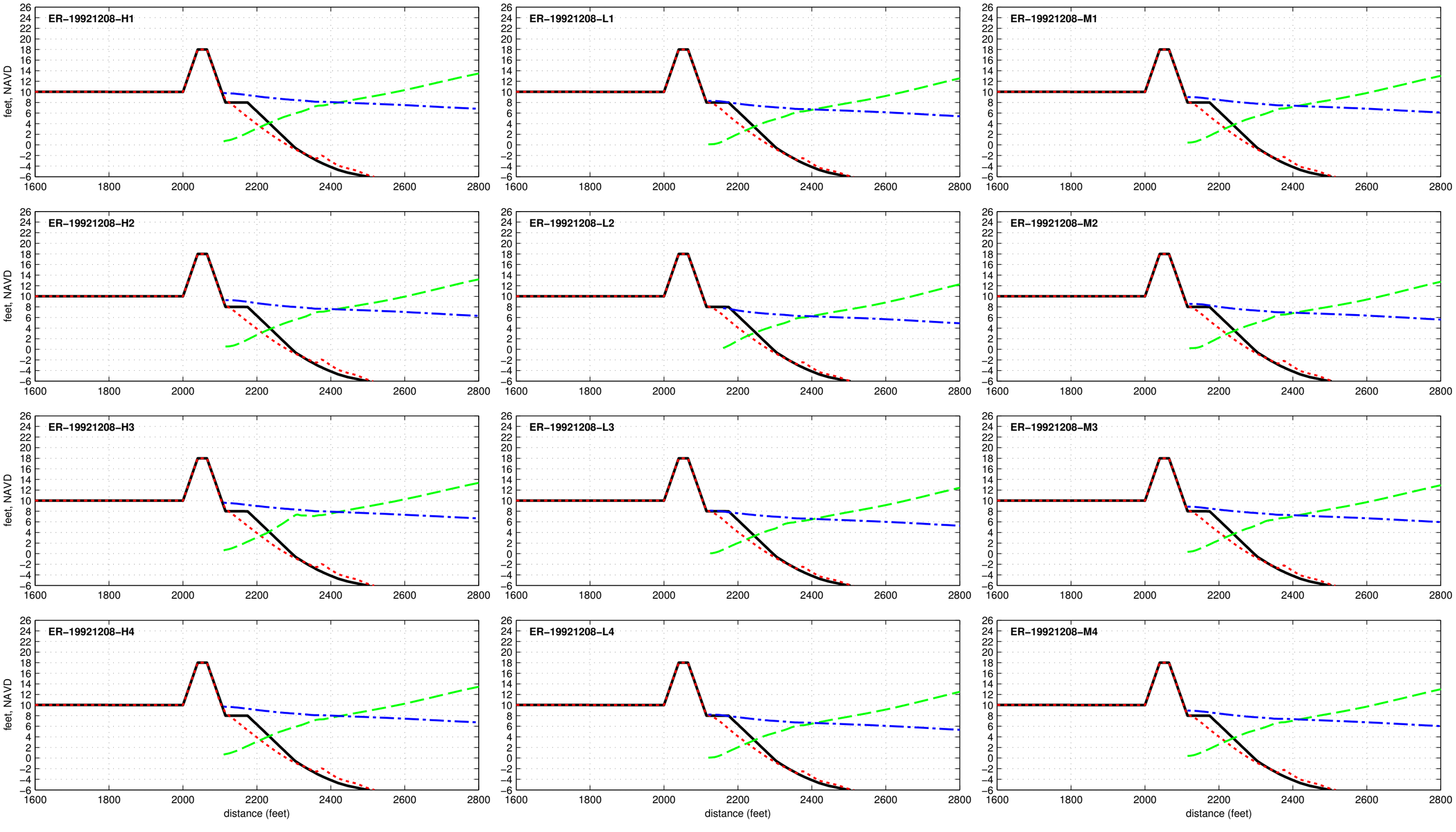
Buried Seawall R2T1-18.0-025-060 - ER-19911027



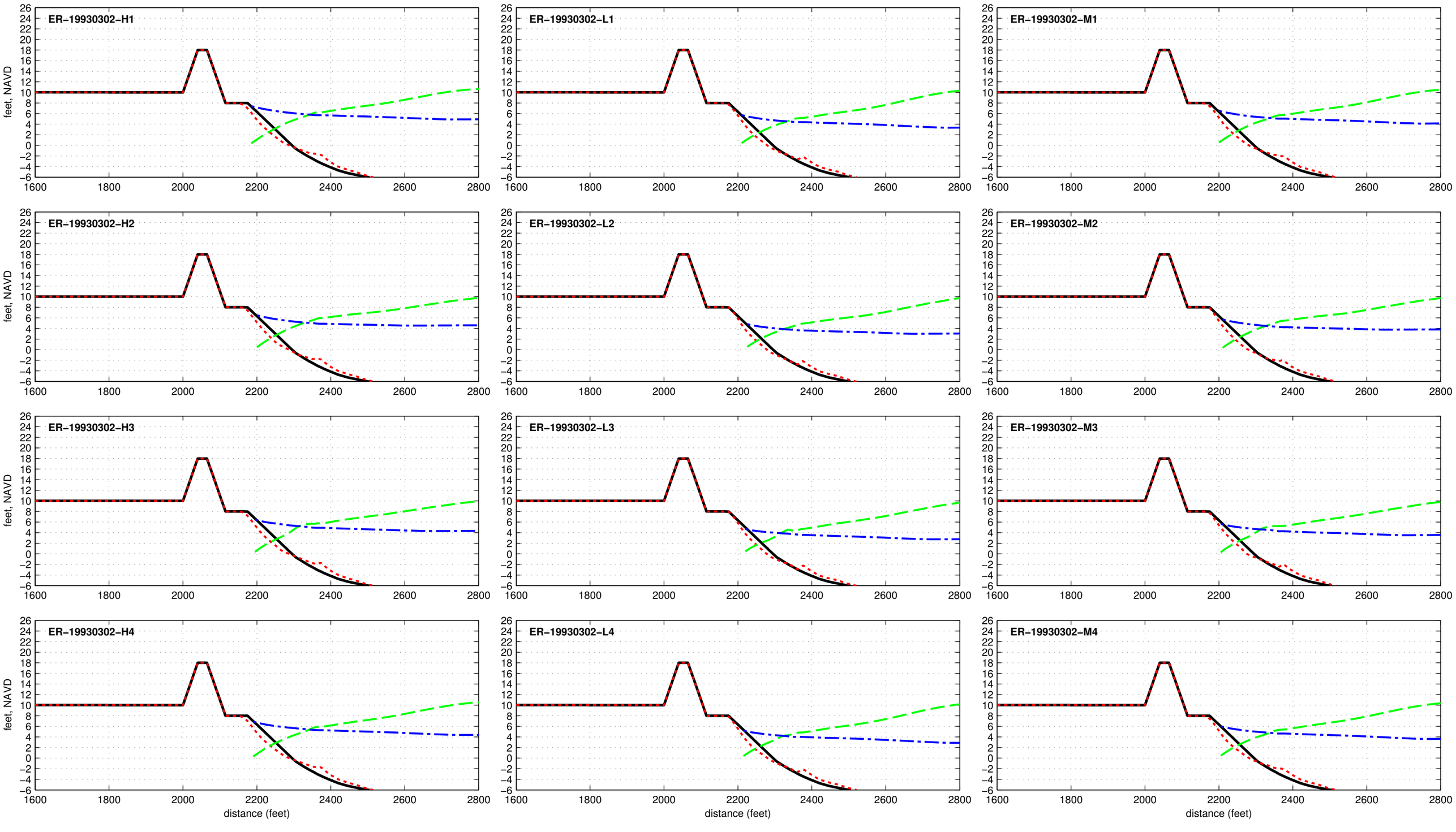
Buried Seawall R2T1-18.0-025-060 - ER-19920101



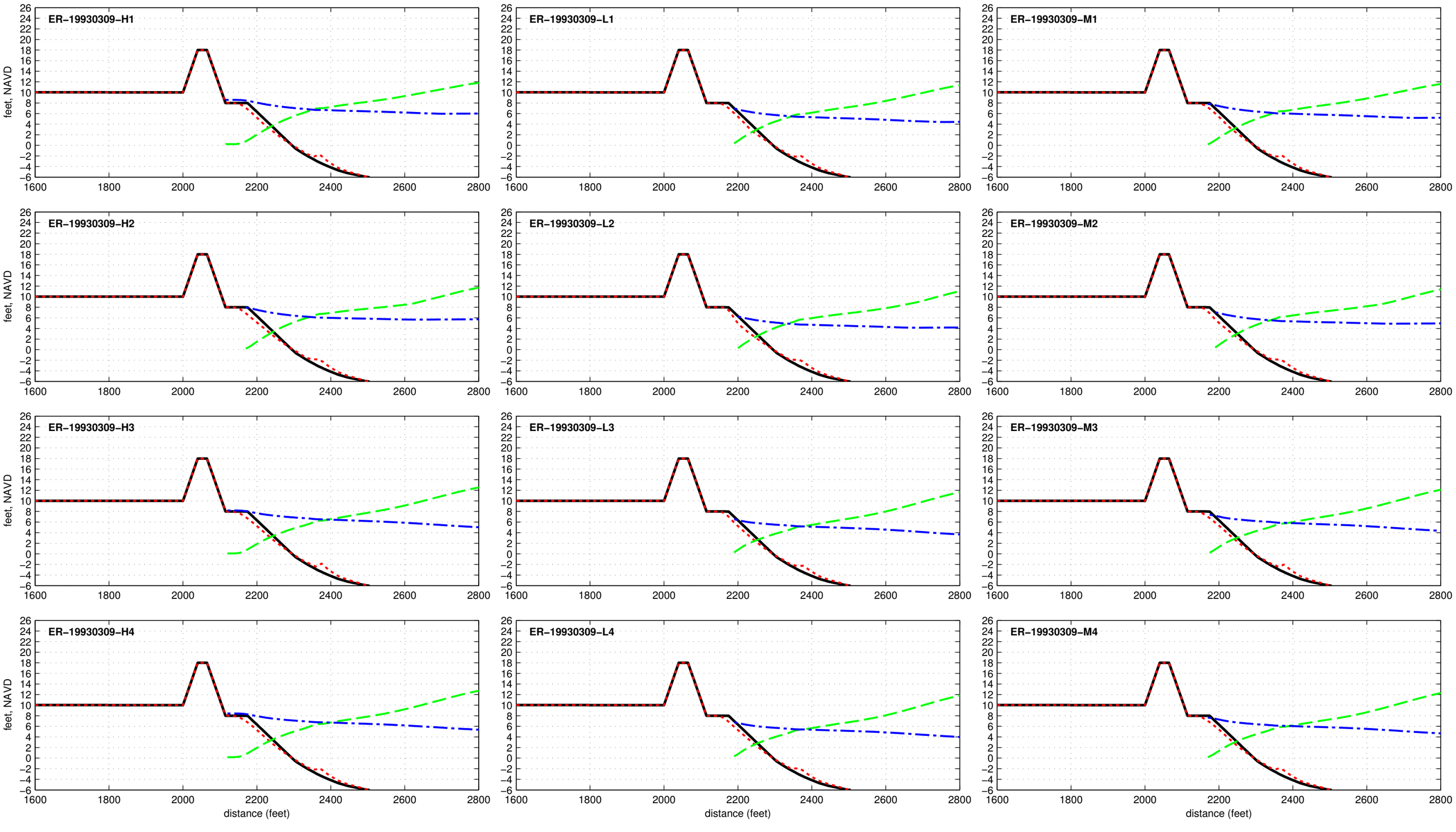
Buried Seawall R2T1-18.0-025-060 - ER-19921208



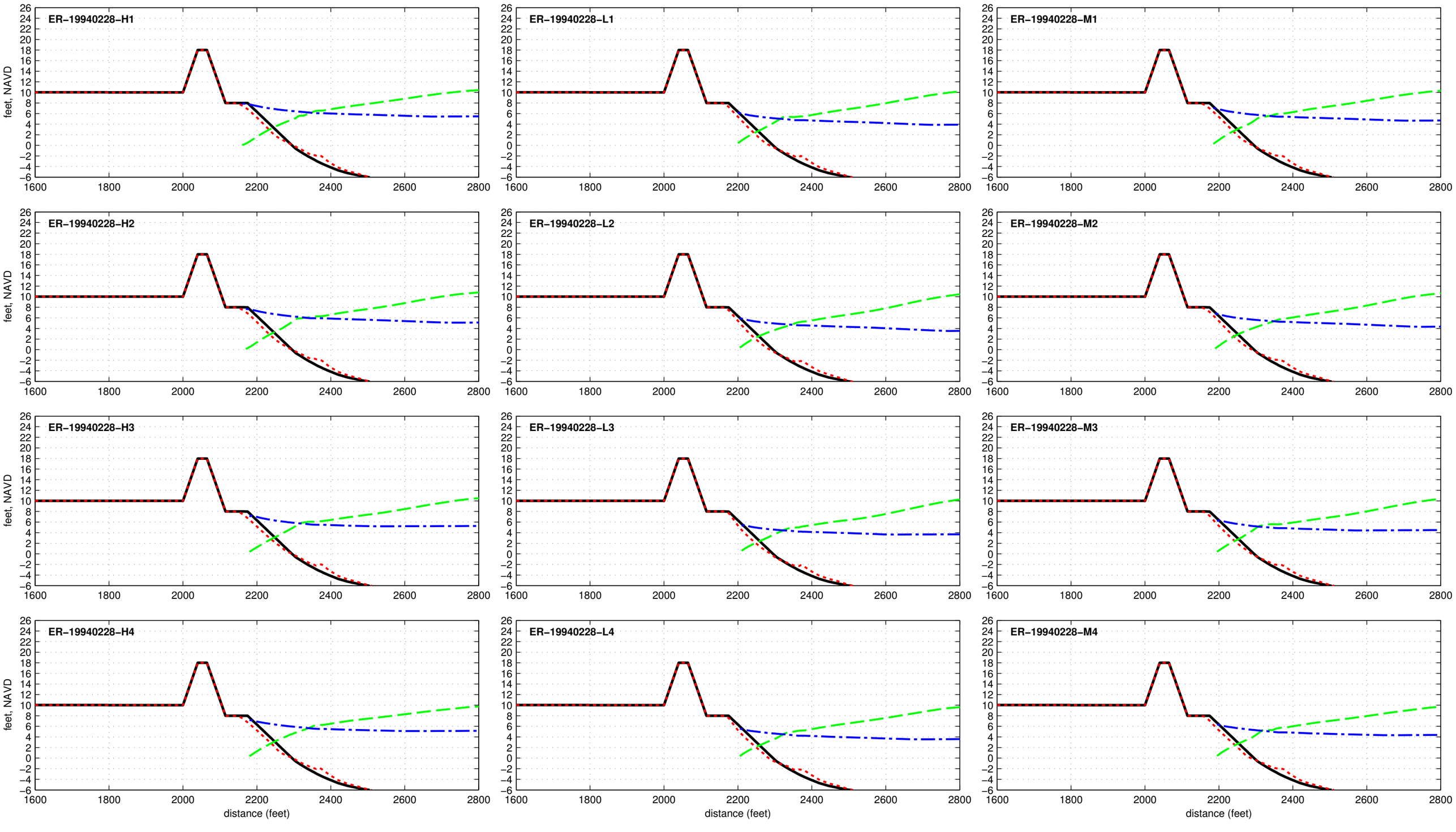
Buried Seawall R2T1-18.0-025-060 - ER-19930302



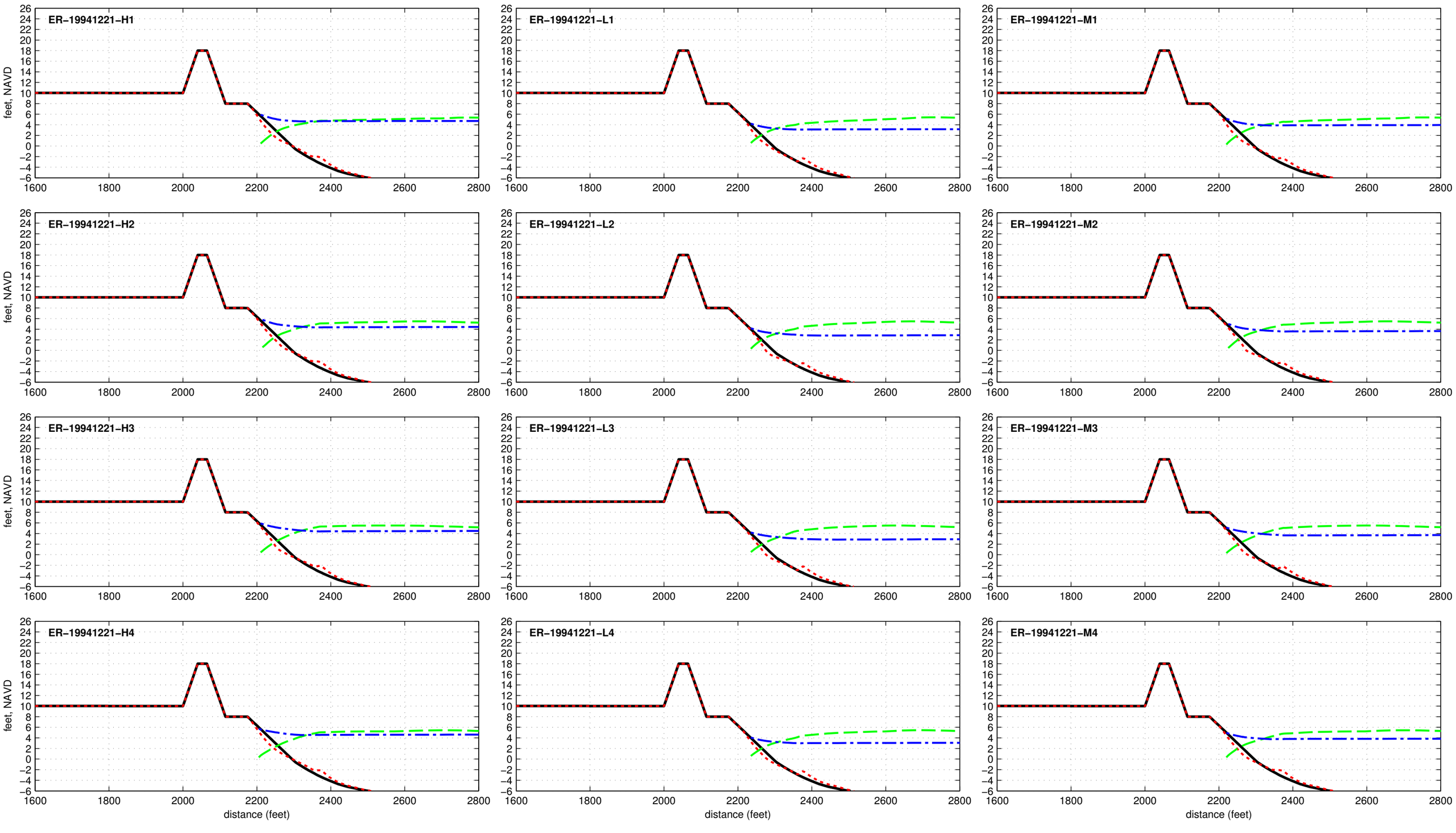
Buried Seawall R2T1-18.0-025-060 - ER-19930309



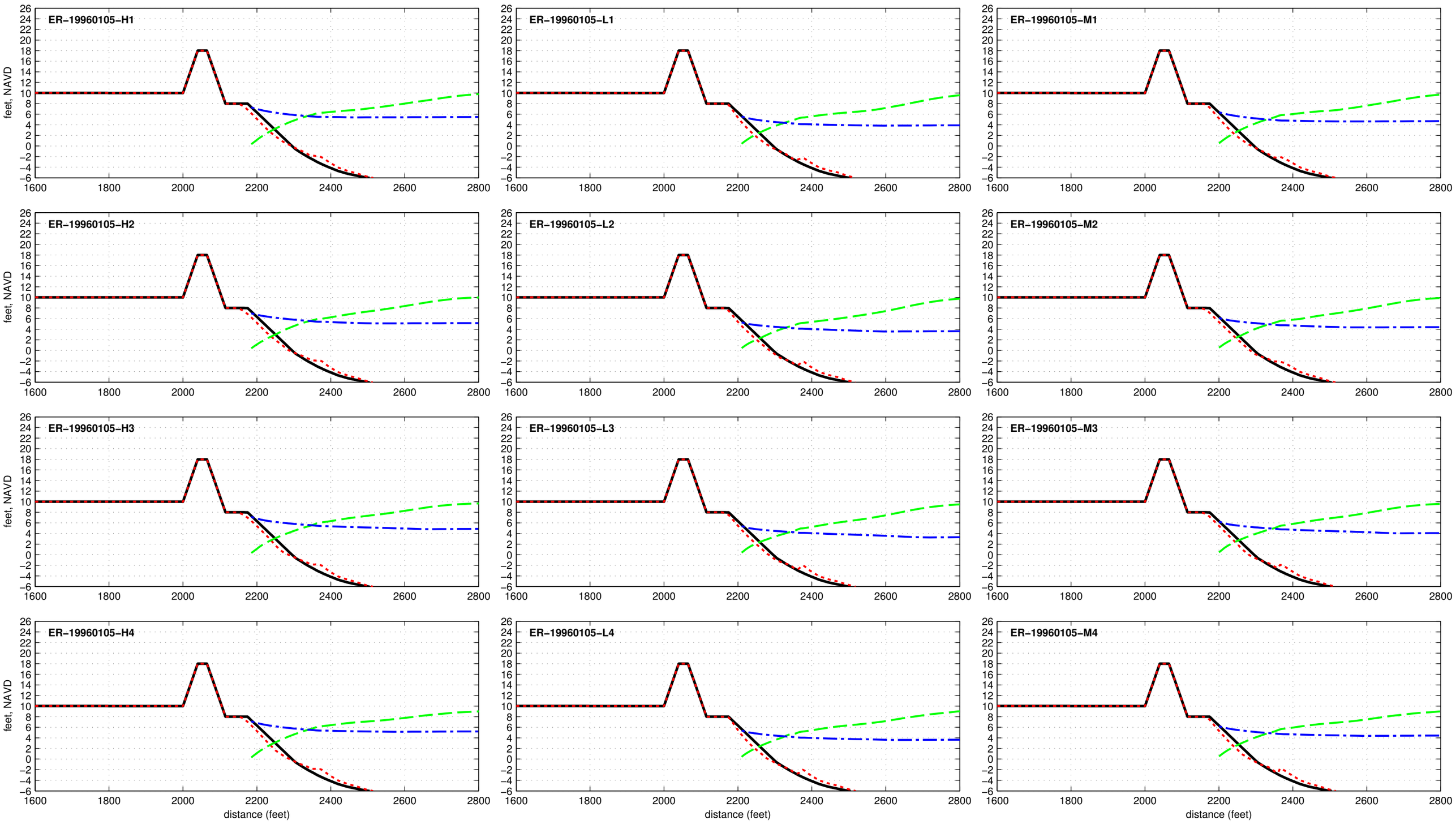
Buried Seawall R2T1-18.0-025-060 - ER-19940228



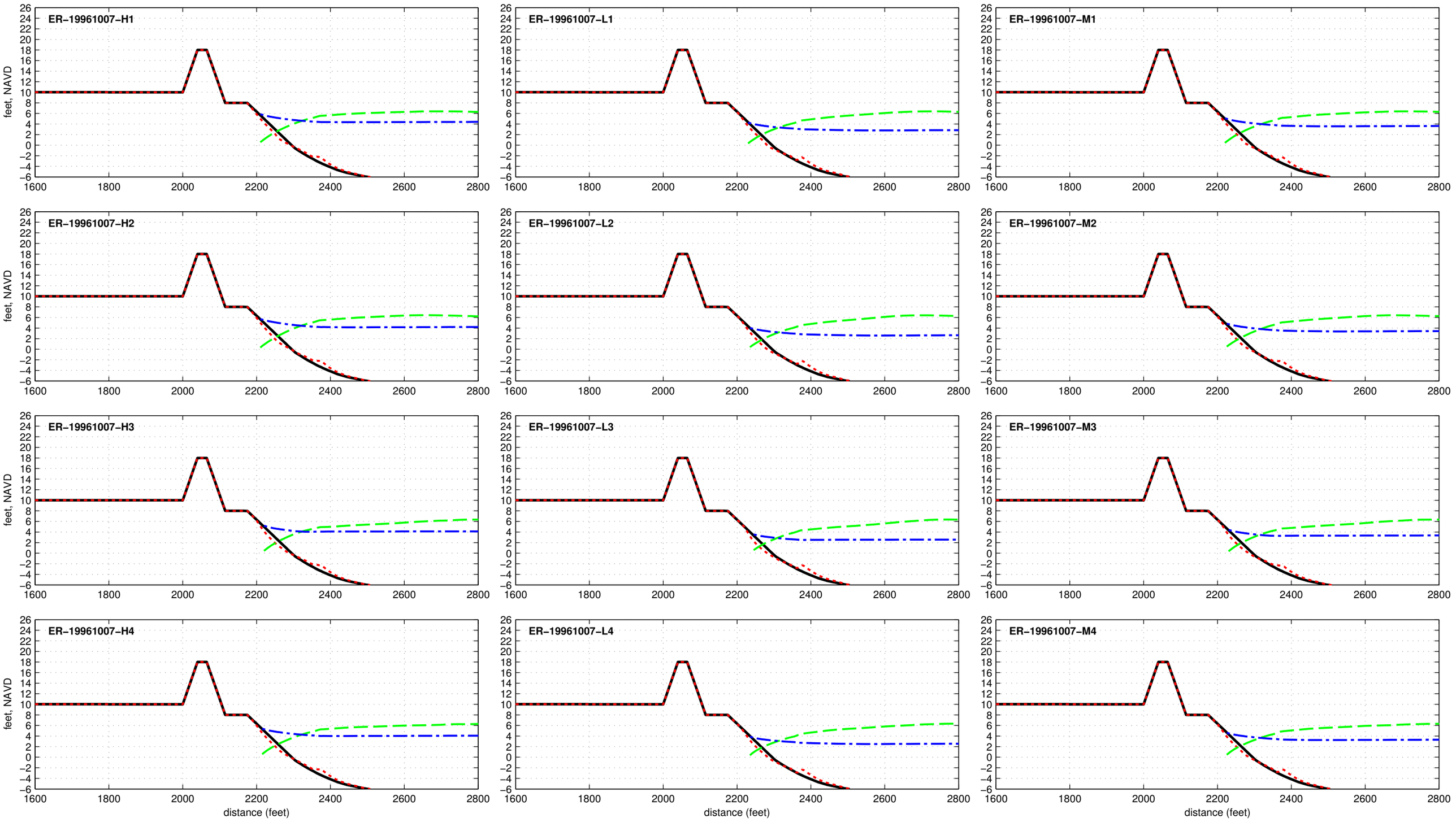
Buried Seawall R2T1-18.0-025-060 - ER-19941221



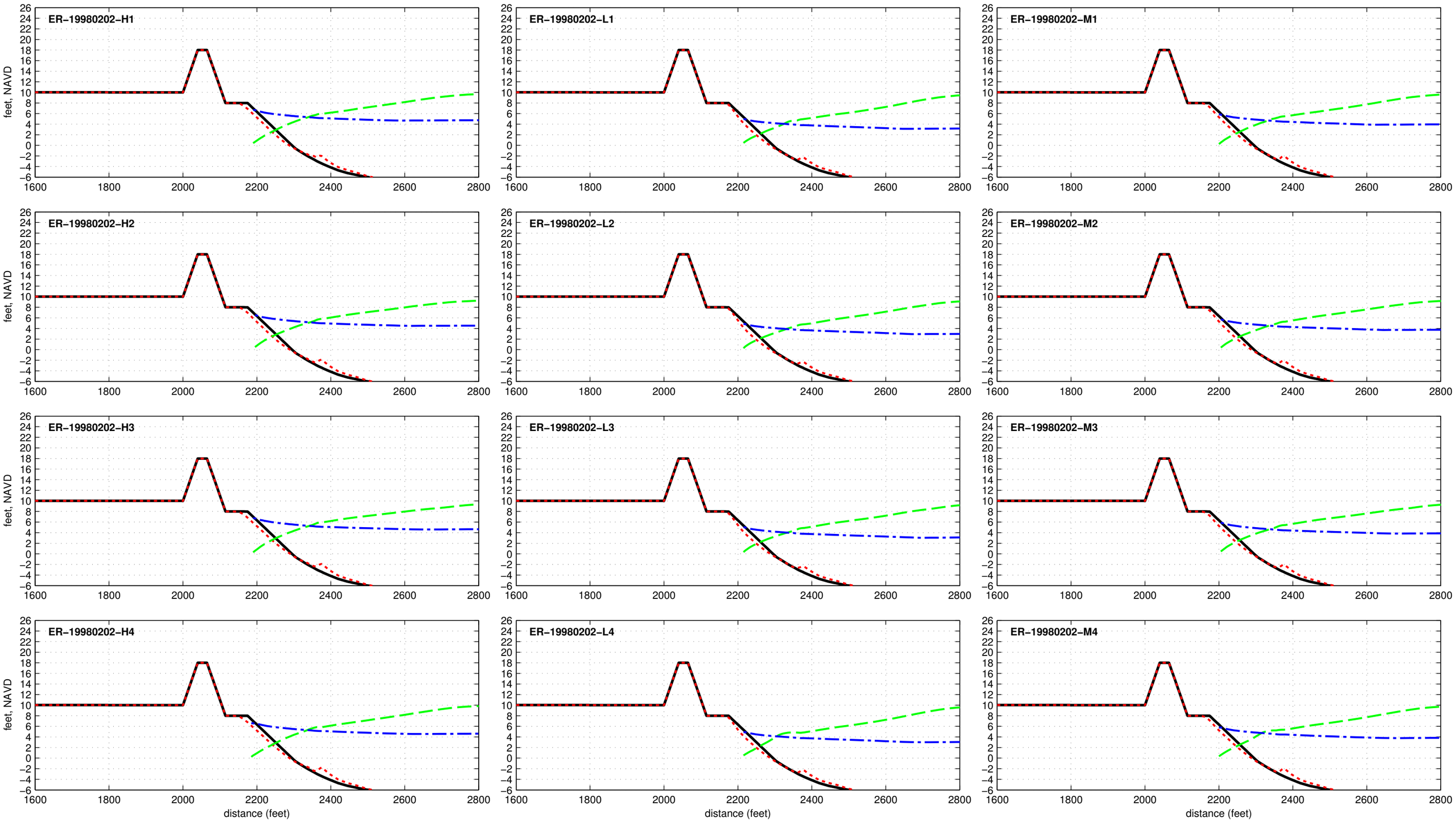
Buried Seawall R2T1-18.0-025-060 - ER-19960105



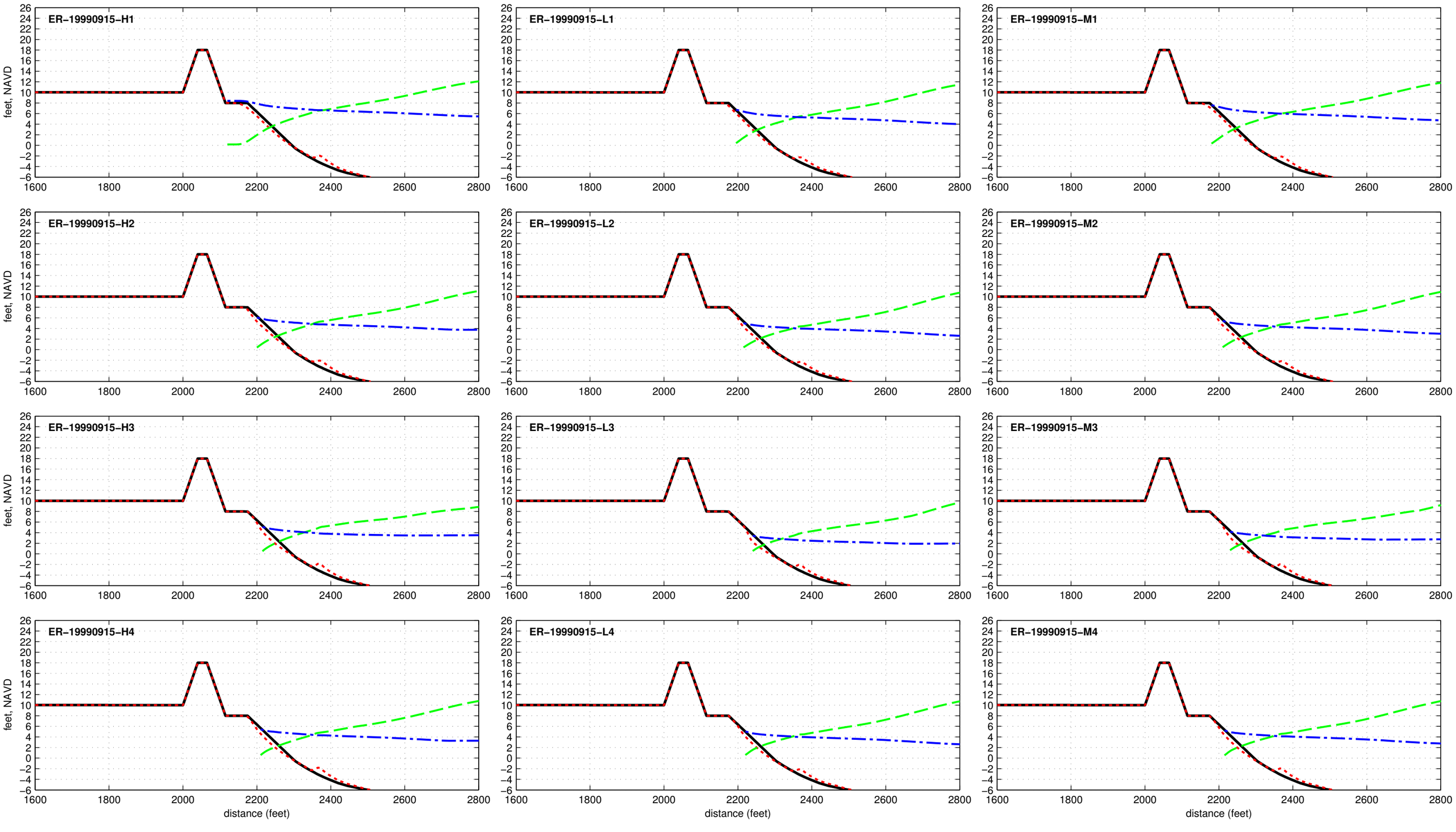
Buried Seawall R2T1–18.0–025–060 – ER–19961007



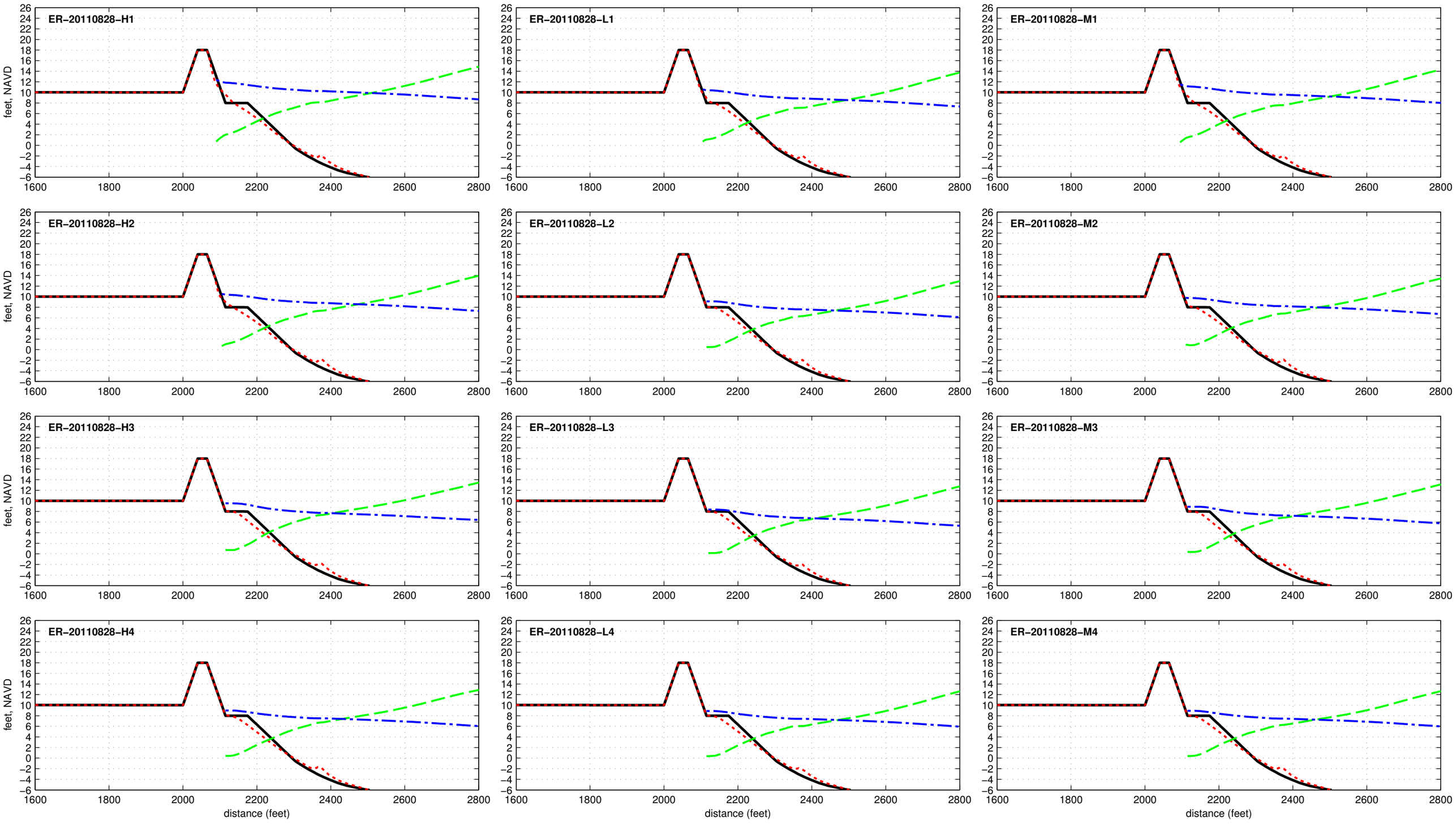
Buried Seawall R2T1-18.0-025-060 - ER-19980202



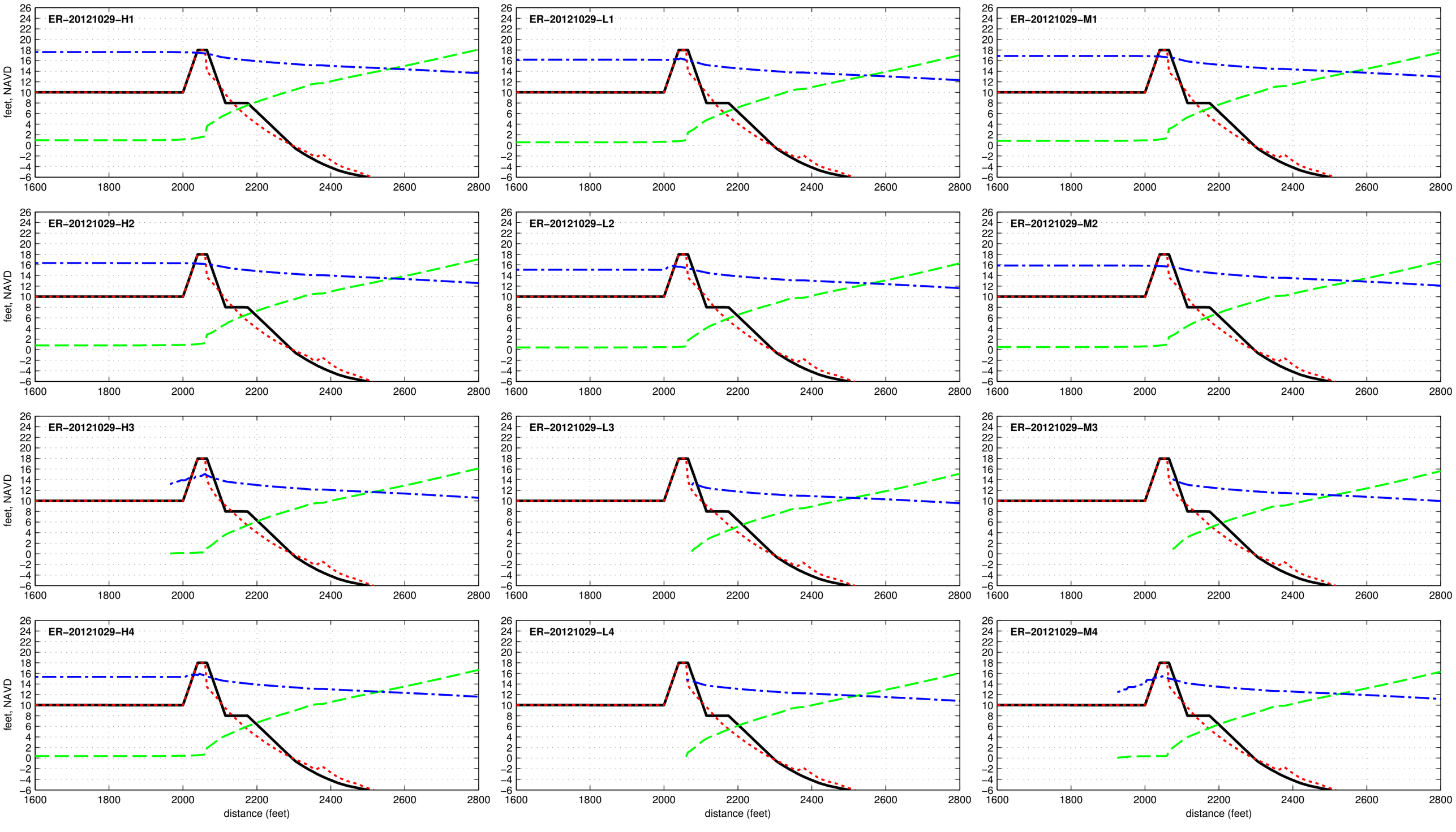
Buried Seawall R2T1-18.0-025-060 - ER-19990915



Buried Seawall R2T1-18.0-025-060 - ER-20110828

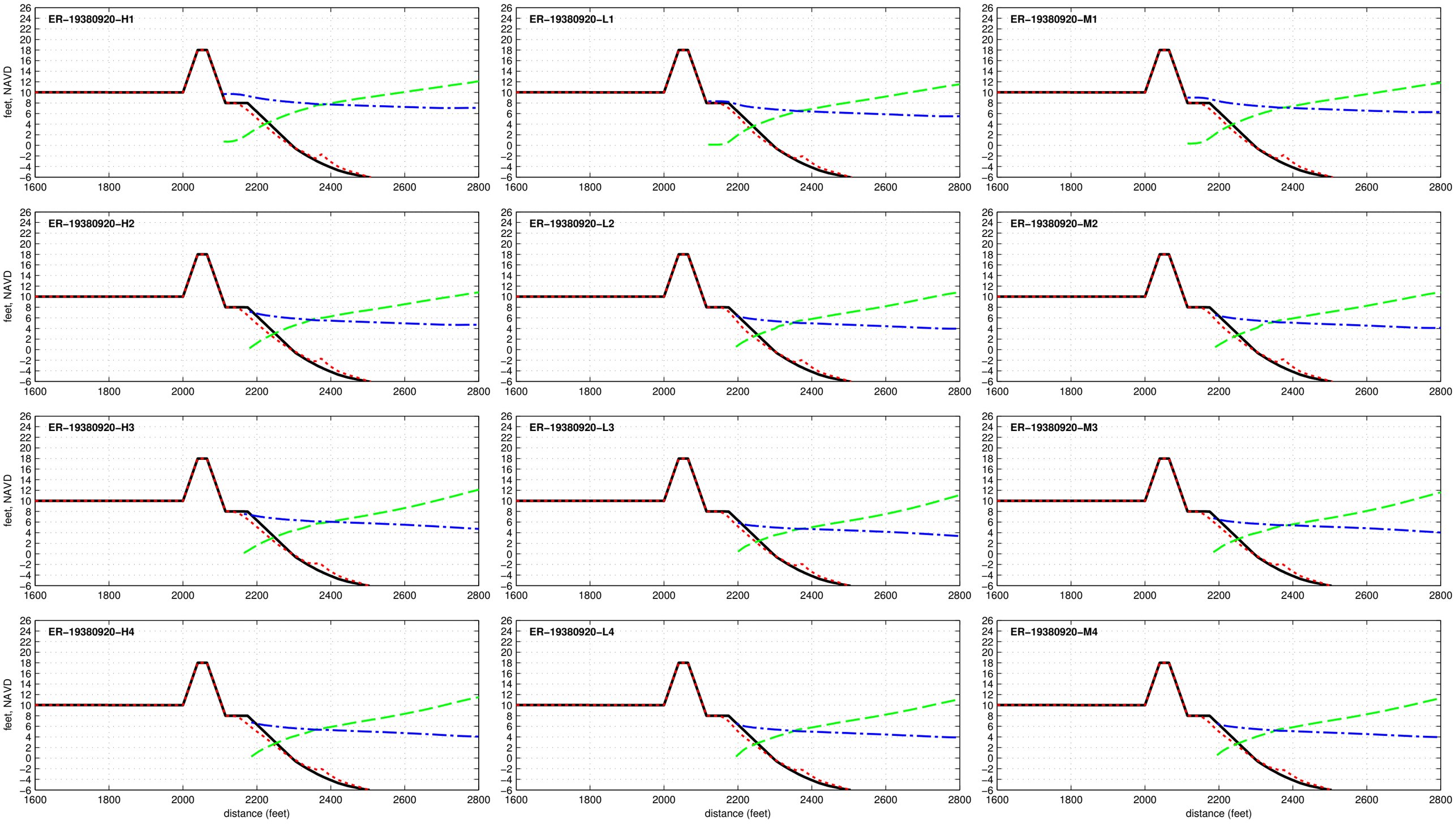


Buried Seawall R2T1-18.0-025-060 - ER-20121029

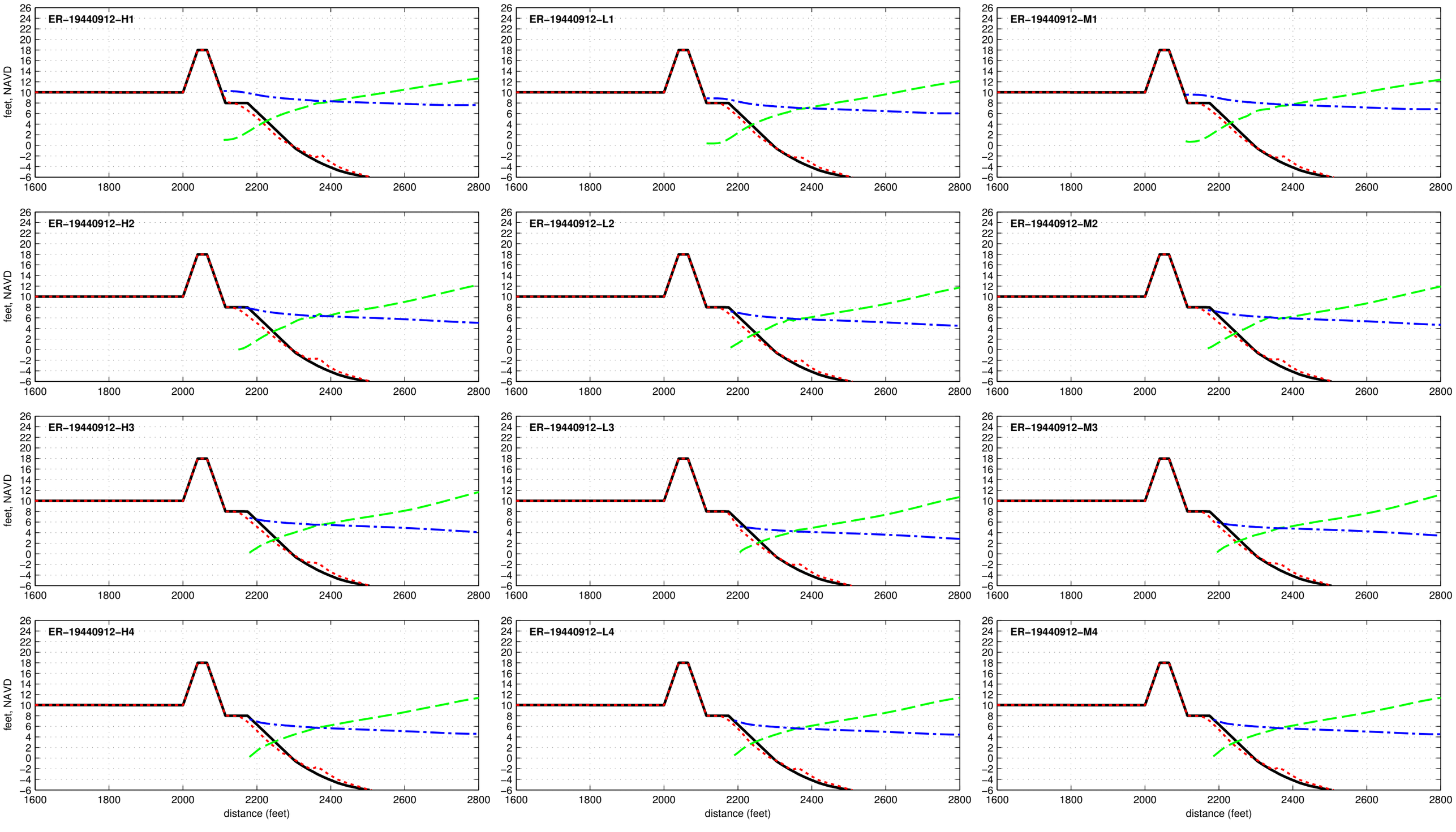


R2T1_18.0_025_060 – COMPOSITE SEAWALL

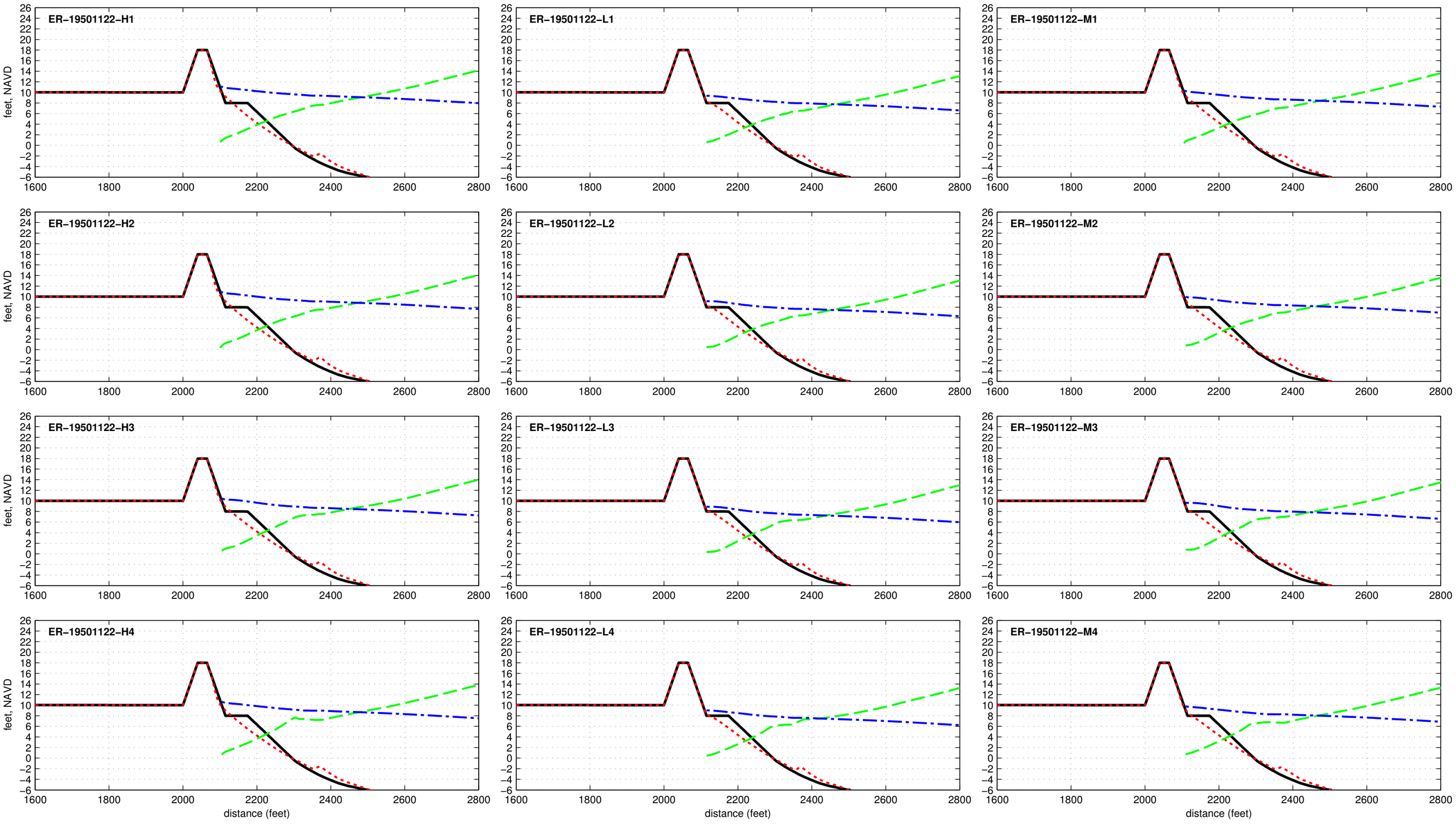
Composite Seawall R2T1-18.0-025-060 - ER-19380920



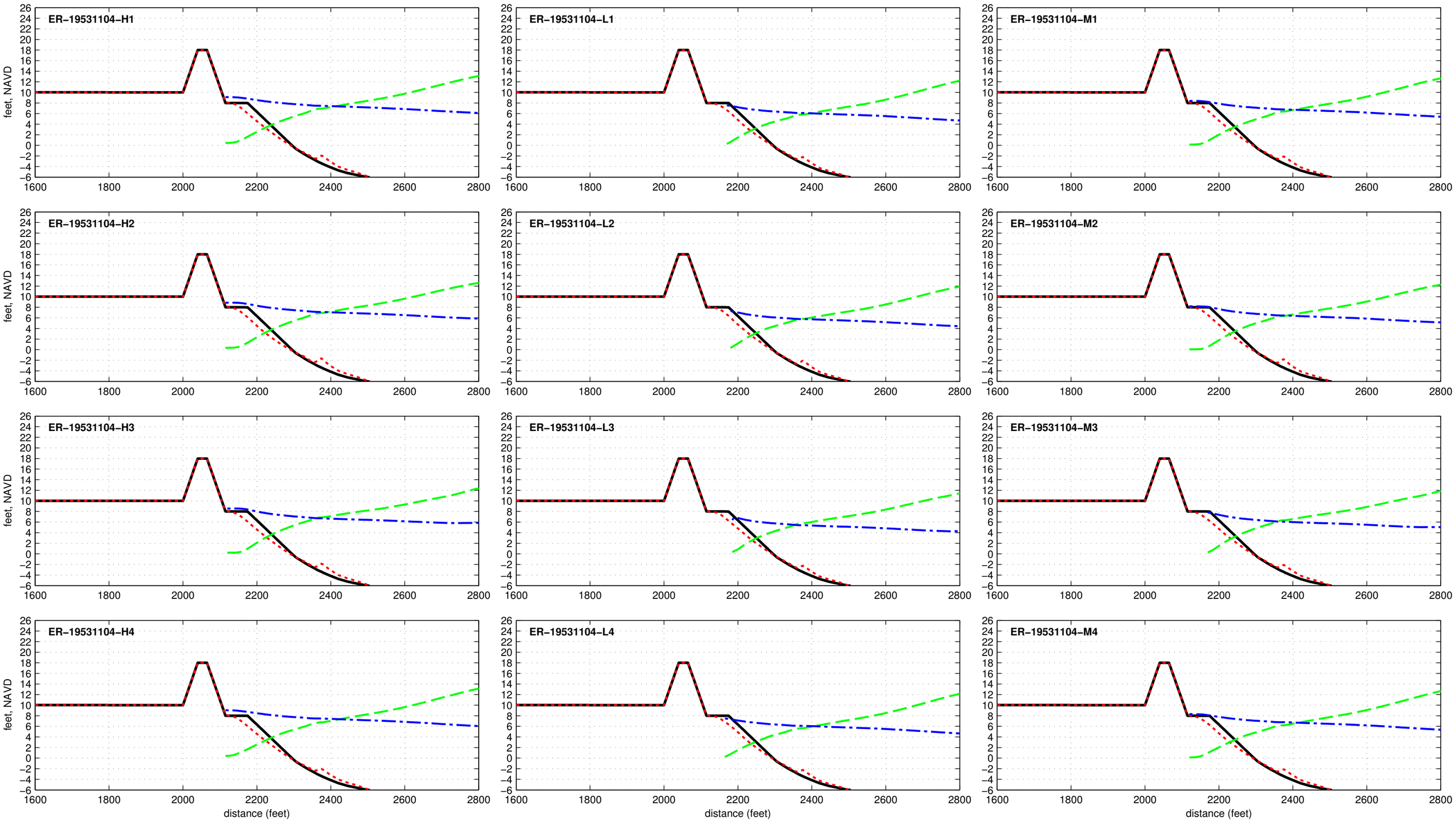
Composite Seawall R2T1-18.0-025-060 - ER-19440912



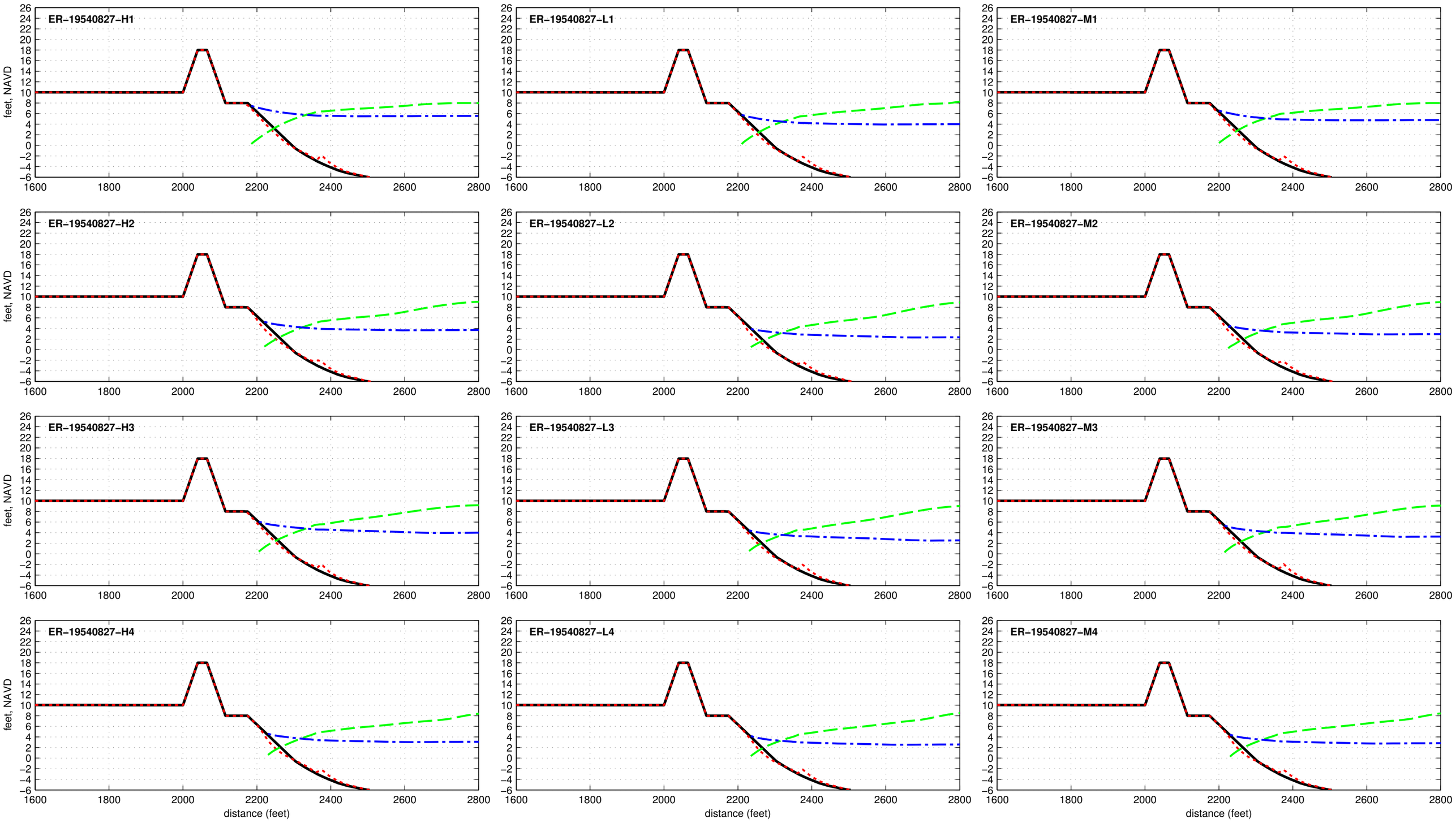
Composite Seawall R2T1-18.0-025-060 - ER-19501122



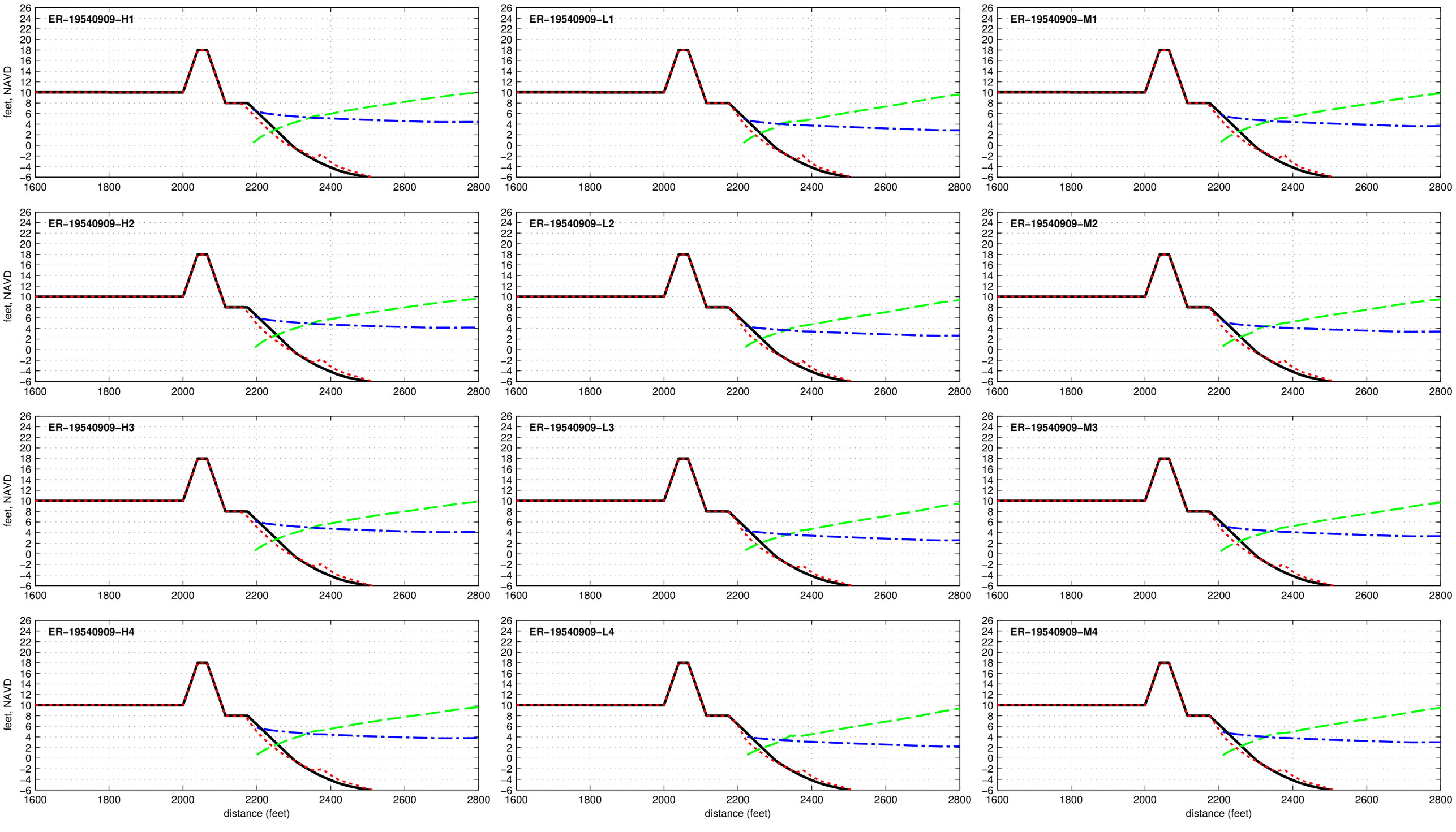
Composite Seawall R2T1-18.0-025-060 - ER-19531104



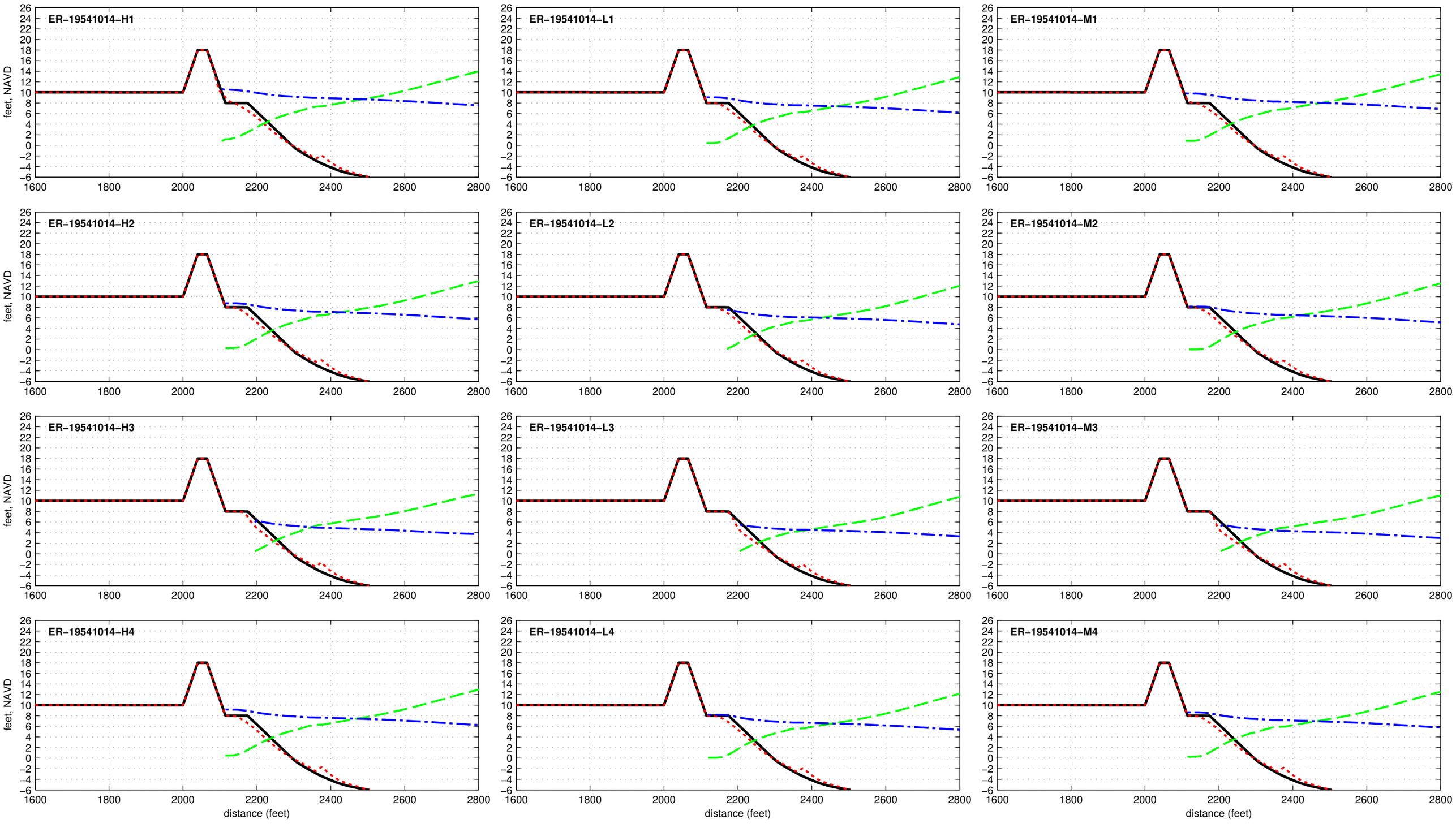
Composite Seawall R2T1-18.0-025-060 - ER-19540827



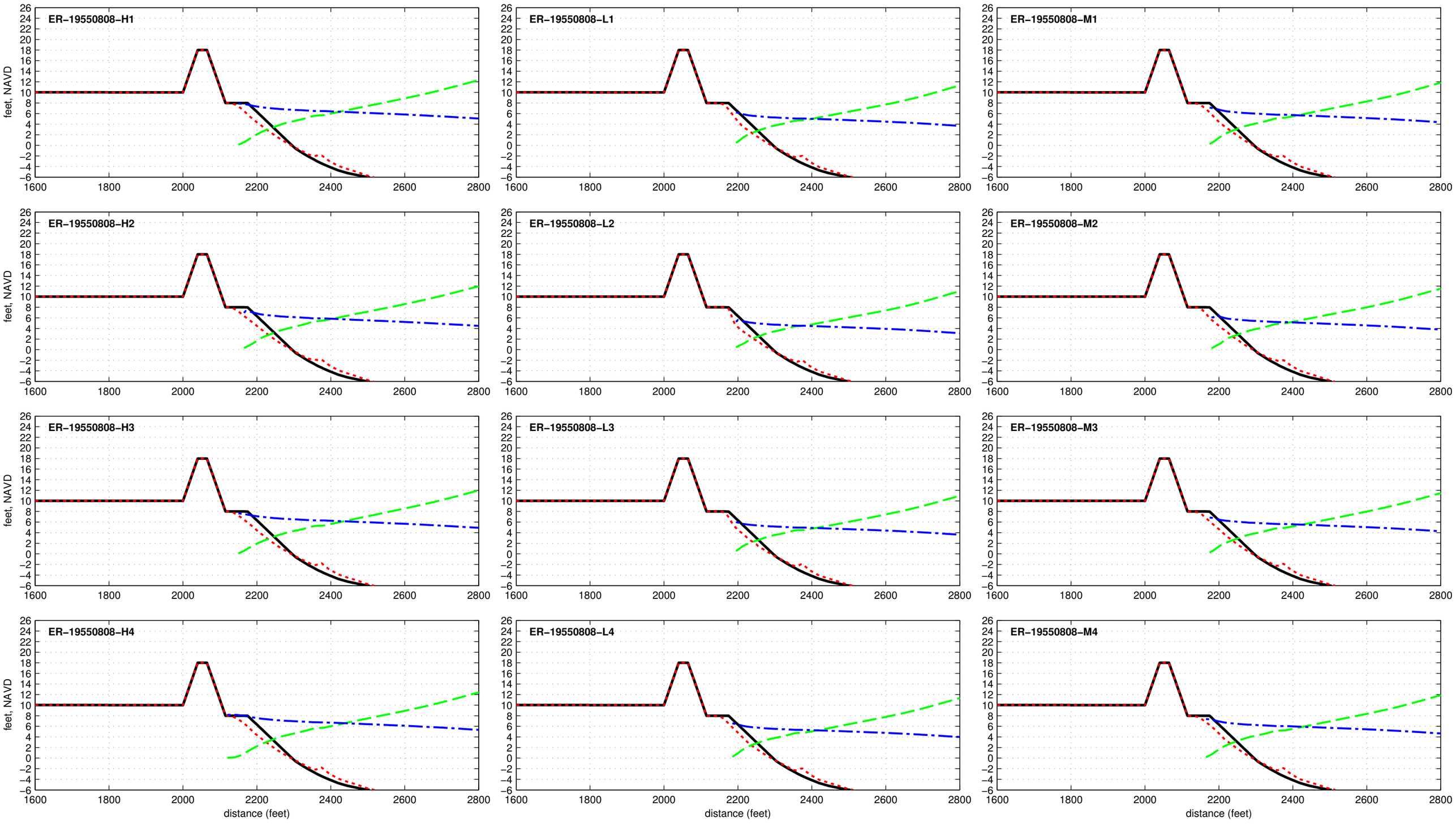
Composite Seawall R2T1-18.0-025-060 - ER-19540909



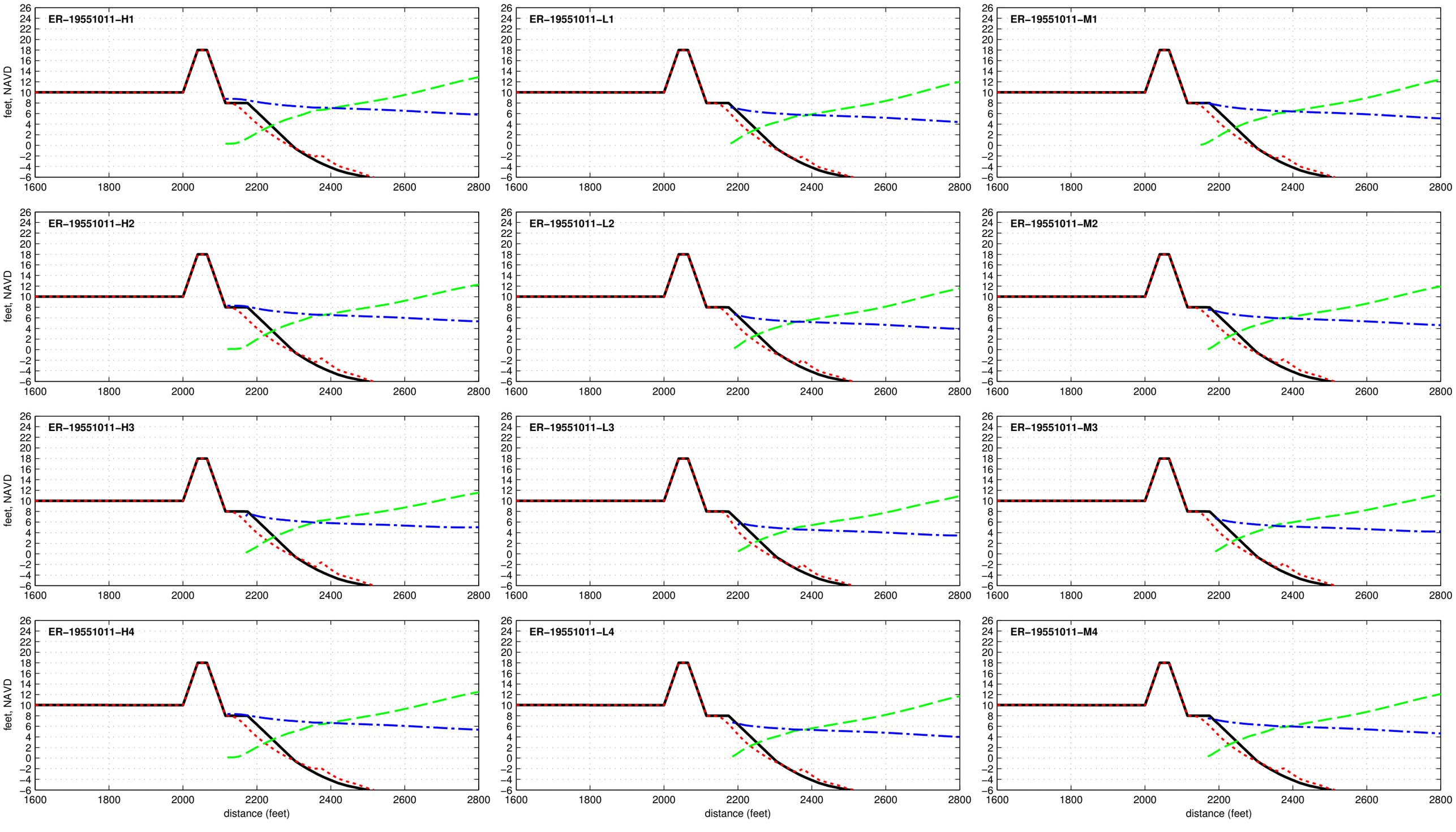
Composite Seawall R2T1-18.0-025-060 - ER-19541014



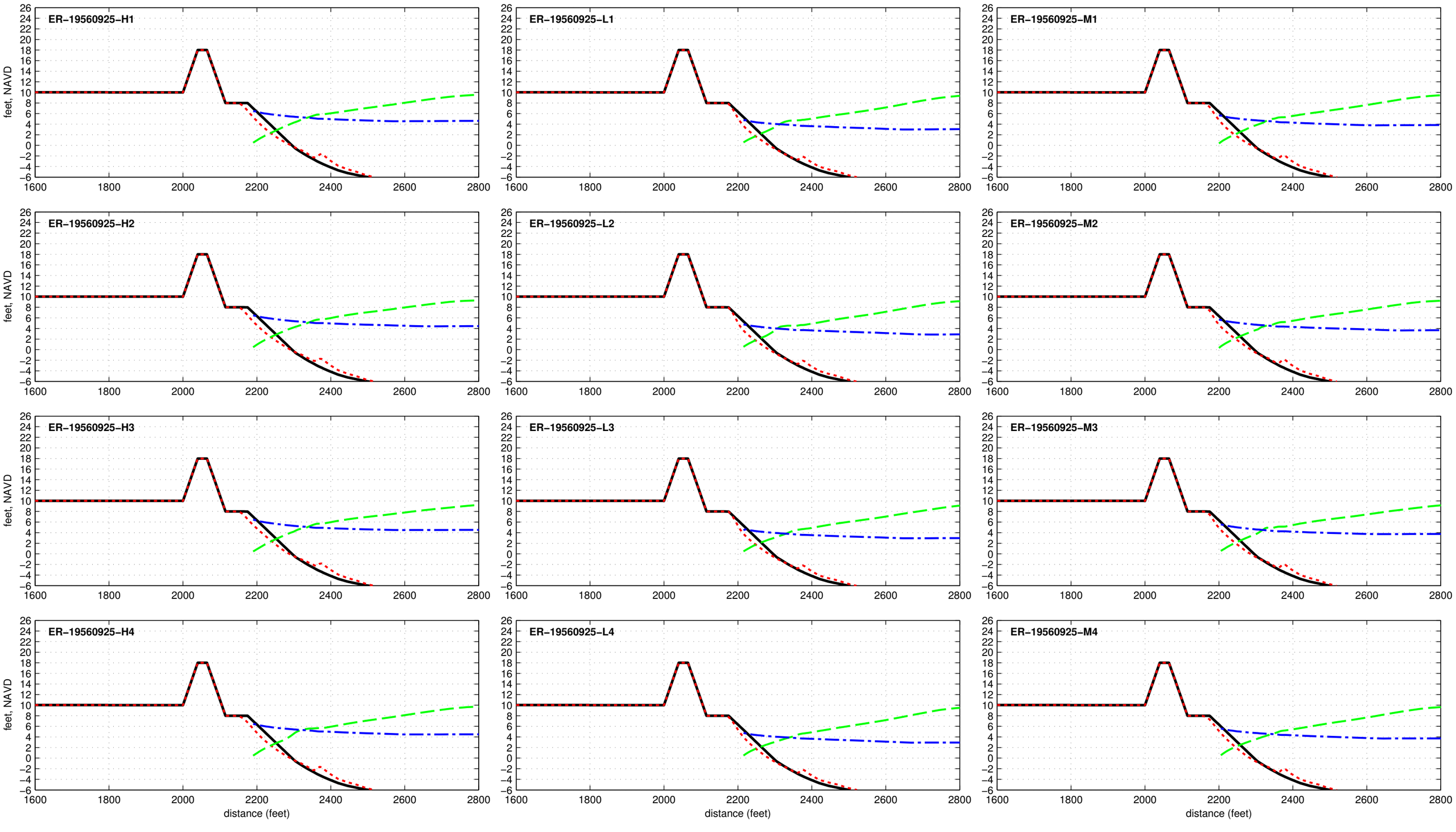
Composite Seawall R2T1-18.0-025-060 - ER-19550808



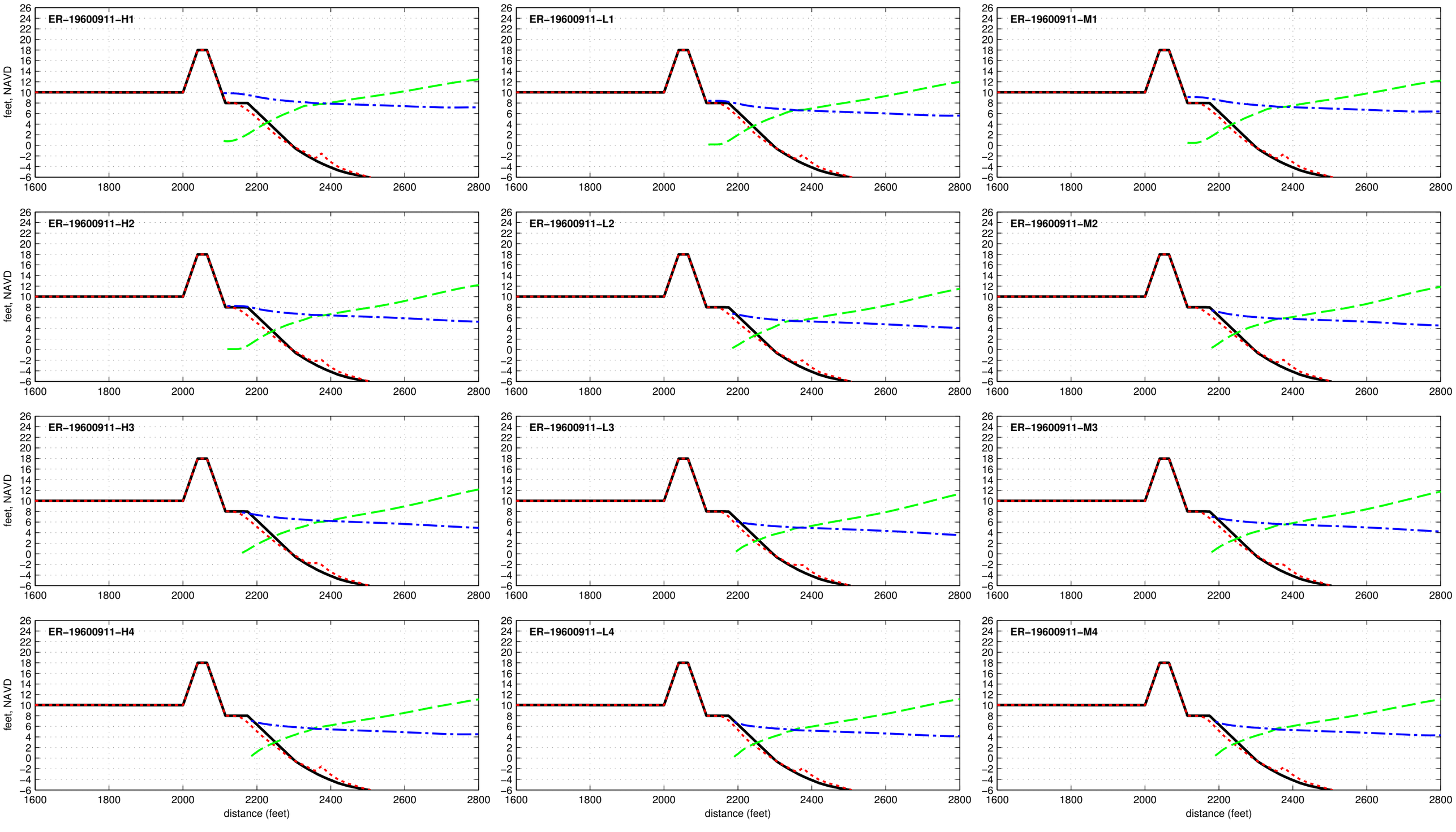
Composite Seawall R2T1-18.0-025-060 - ER-19551011



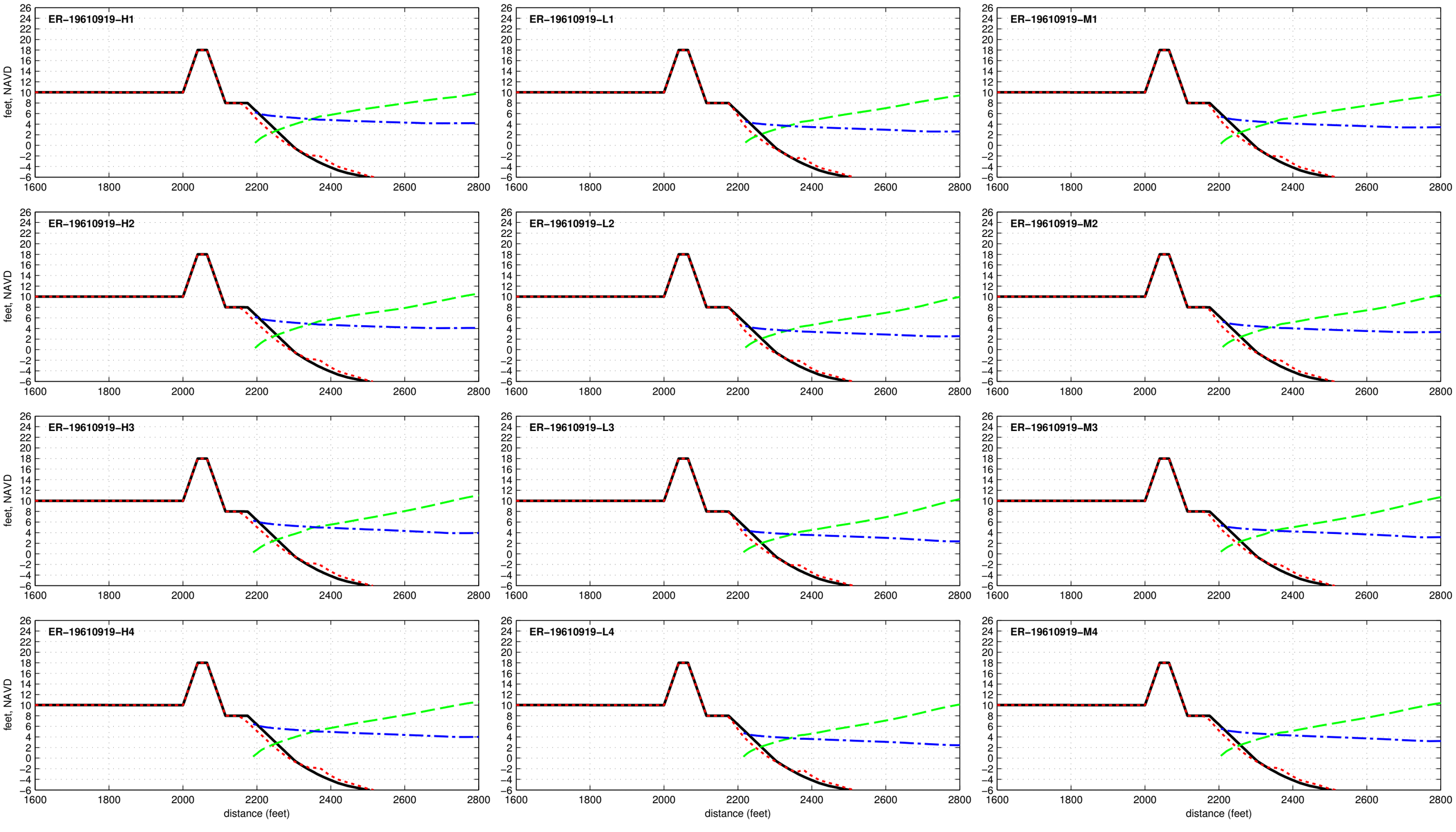
Composite Seawall R2T1-18.0-025-060 - ER-19560925



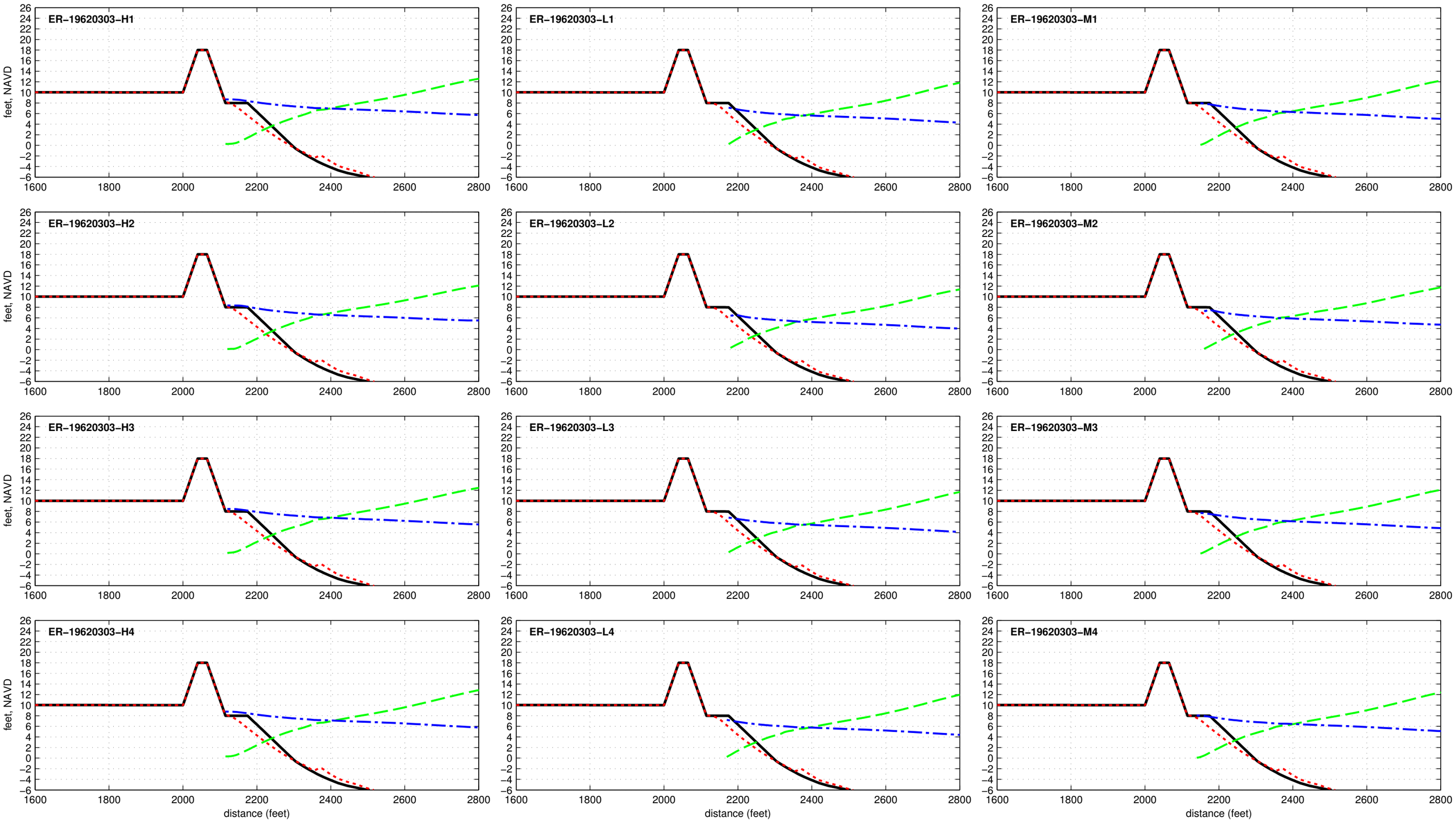
Composite Seawall R2T1-18.0-025-060 - ER-19600911



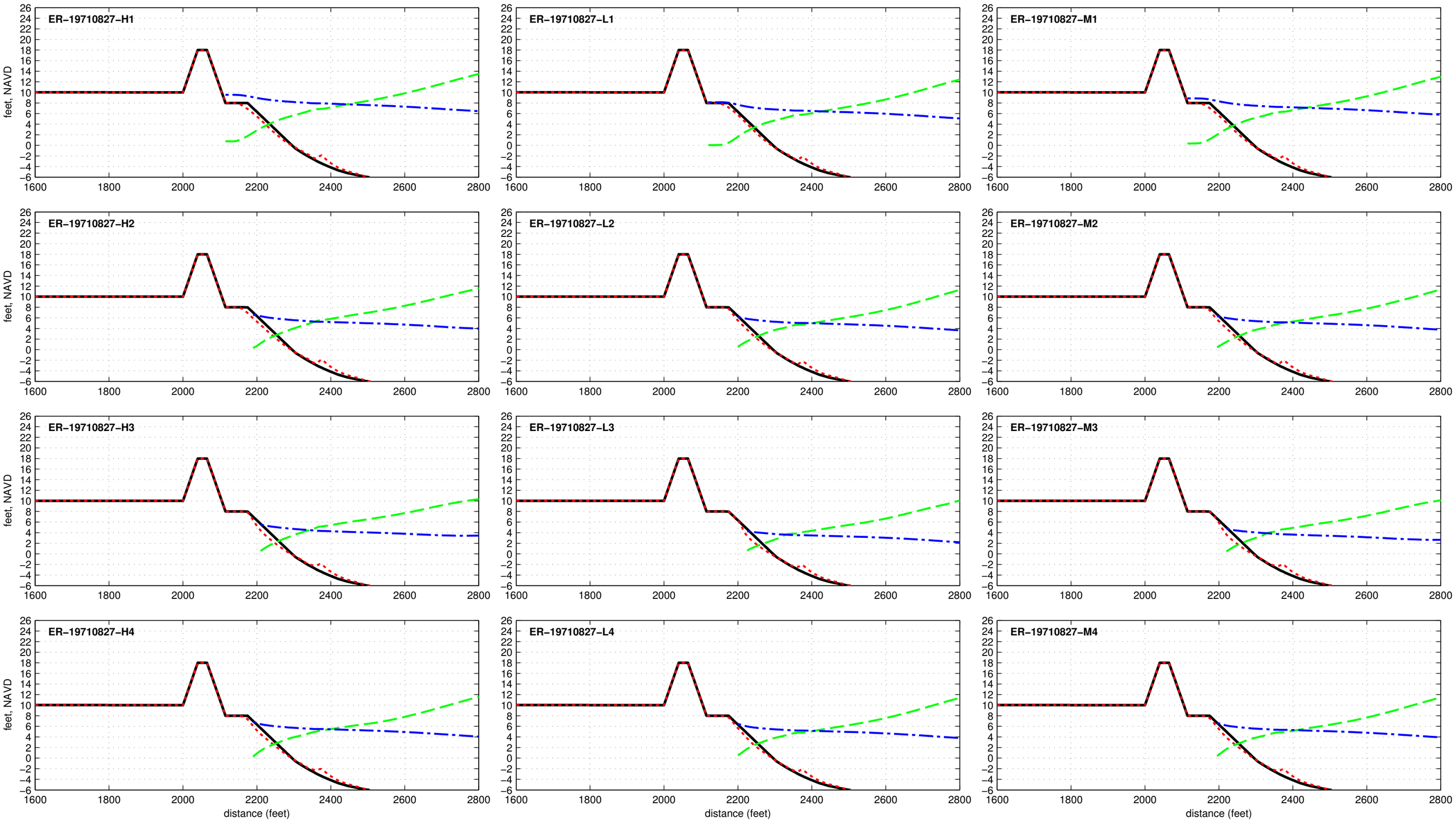
Composite Seawall R2T1-18.0-025-060 - ER-19610919



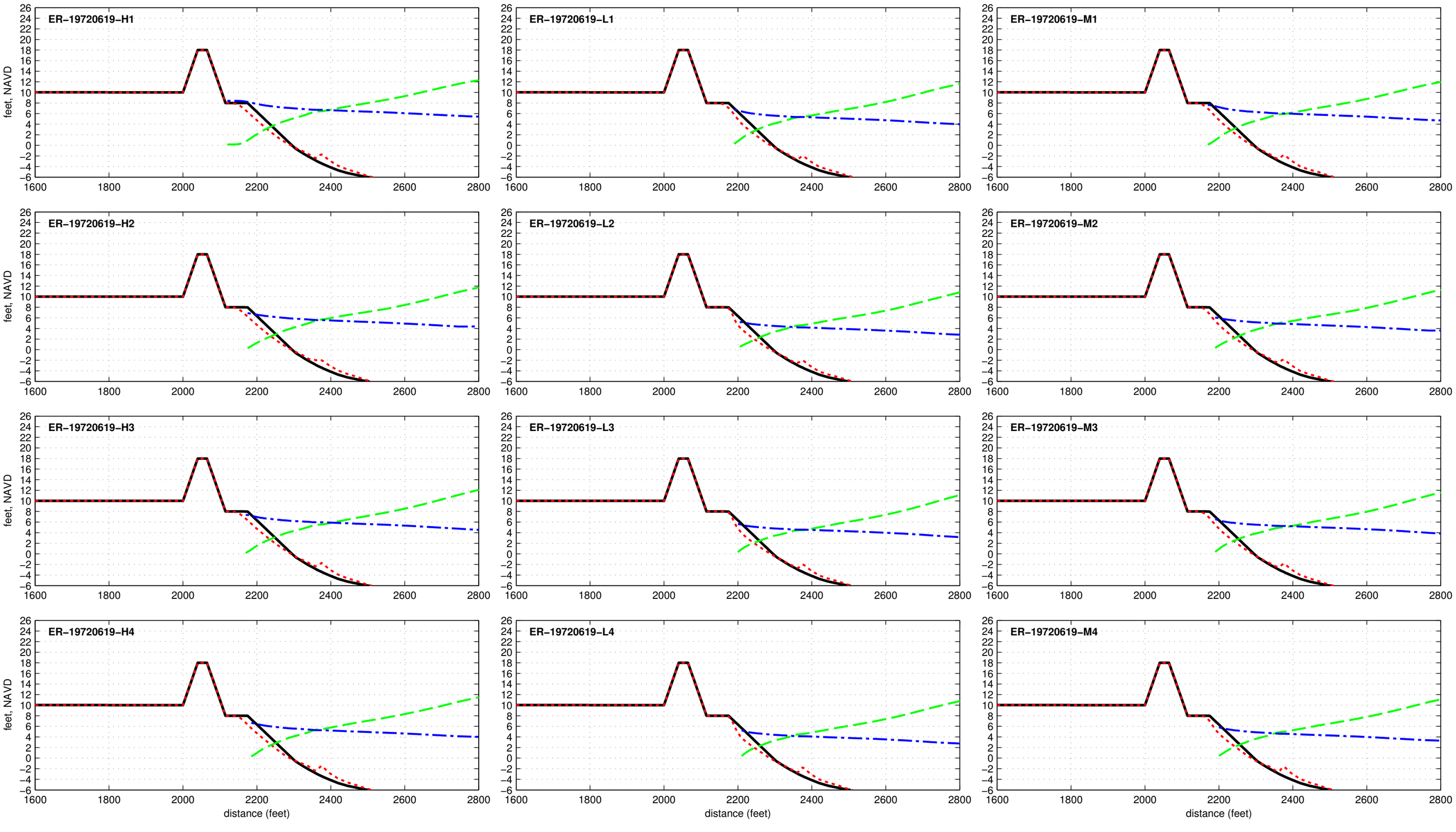
Composite Seawall R2T1-18.0-025-060 - ER-19620303



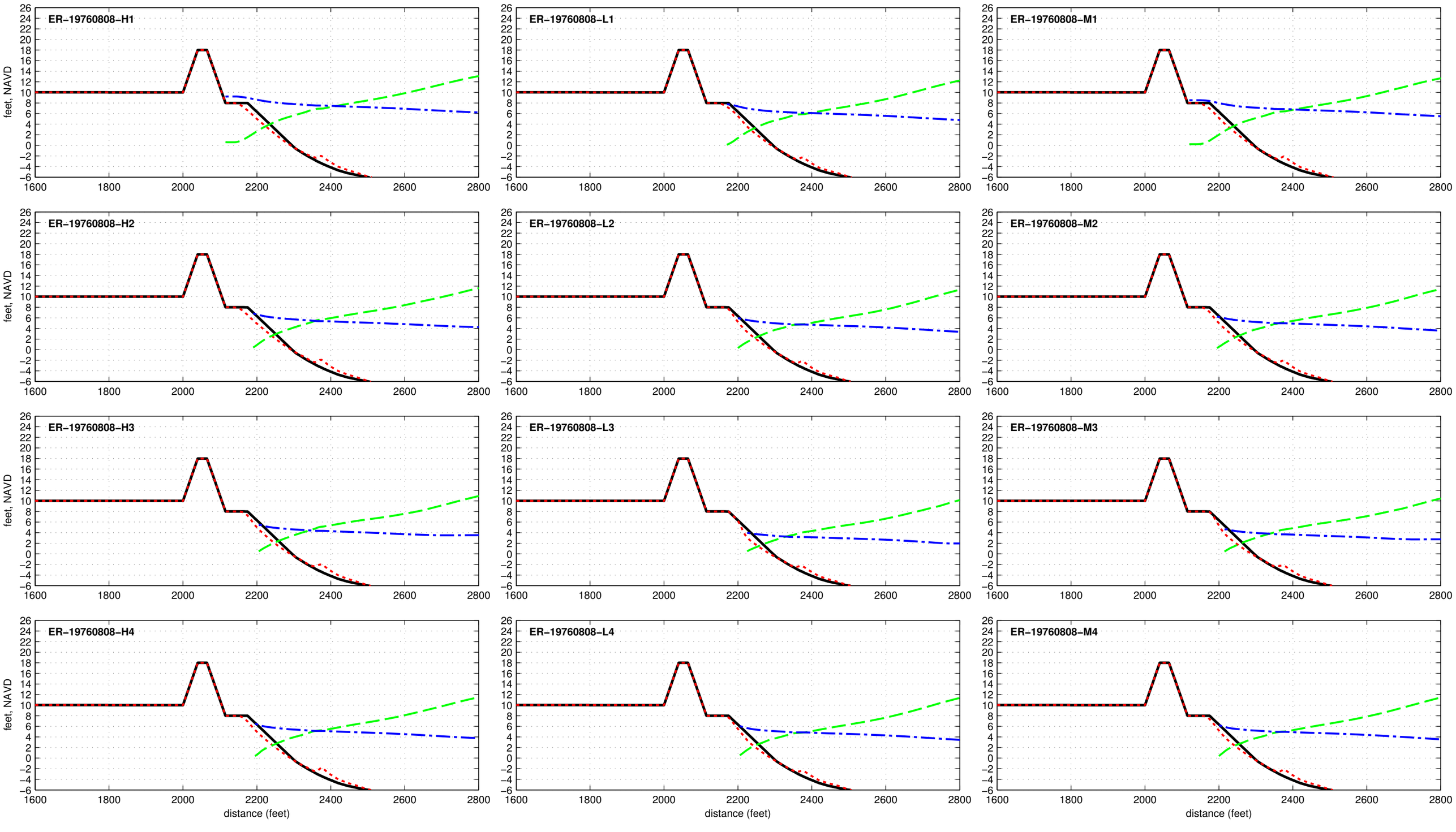
Composite Seawall R2T1-18.0-025-060 - ER-19710827



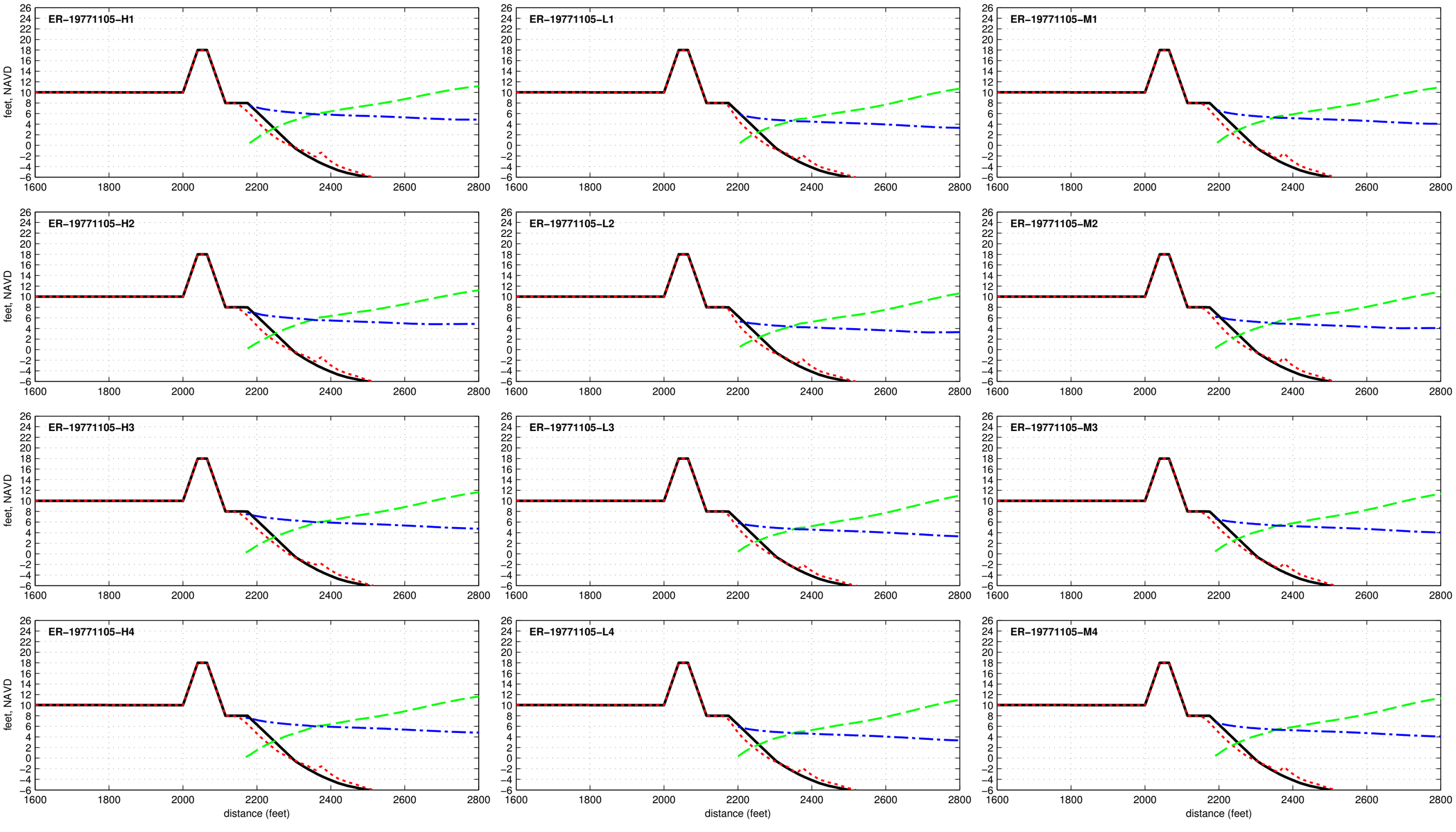
Composite Seawall R2T1-18.0-025-060 - ER-19720619



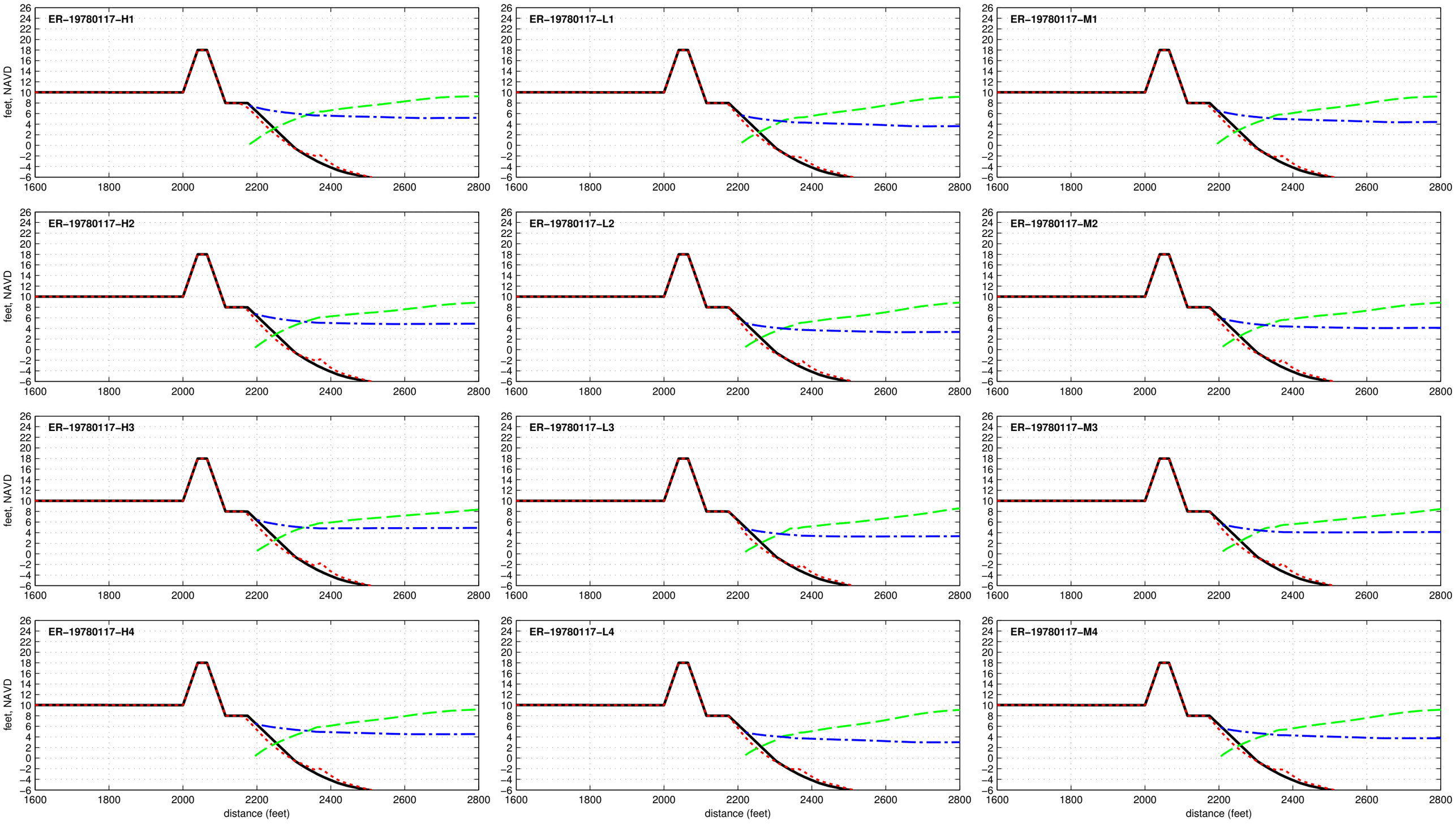
Composite Seawall R2T1-18.0-025-060 - ER-19760808



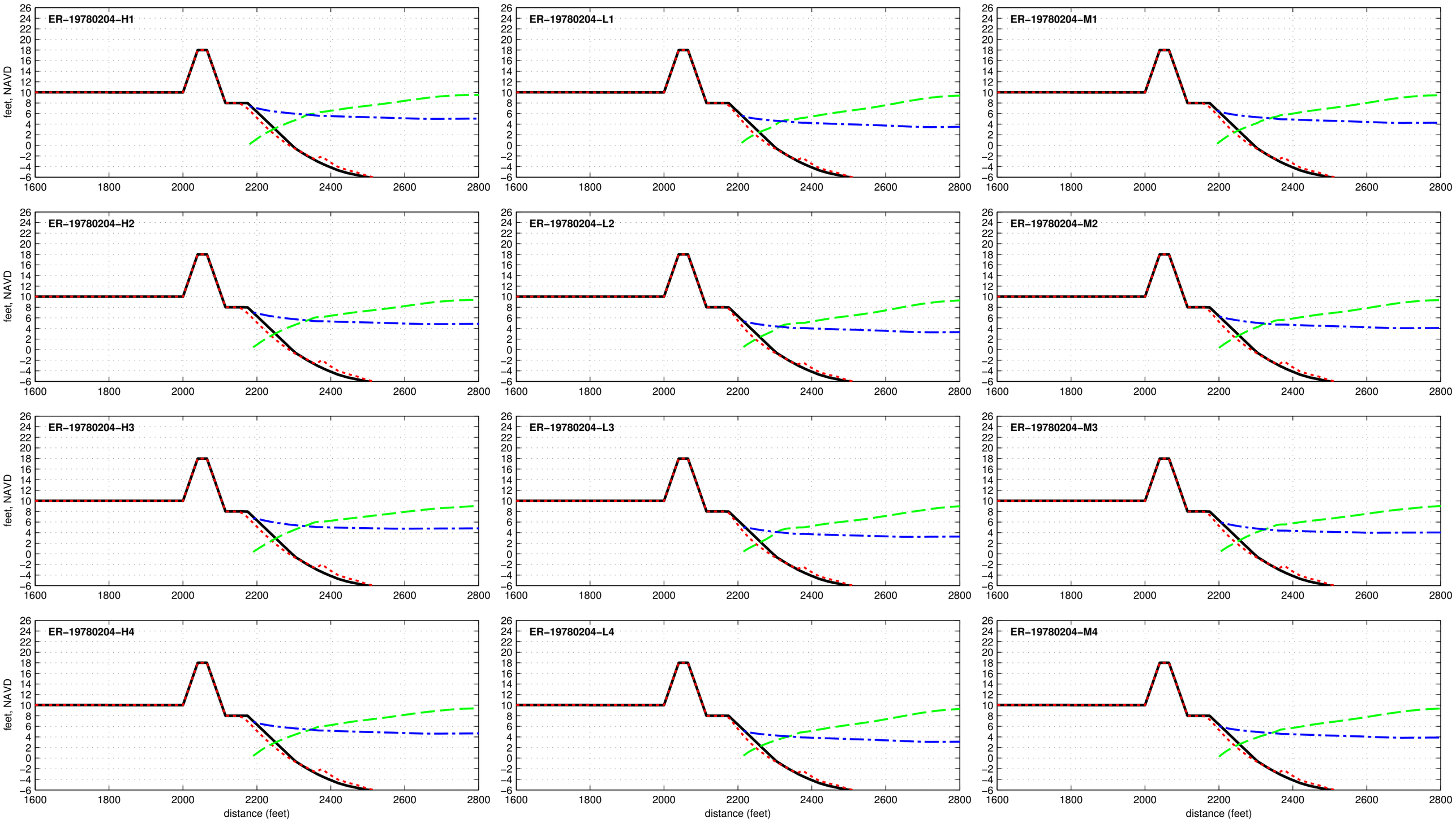
Composite Seawall R2T1-18.0-025-060 - ER-19771105



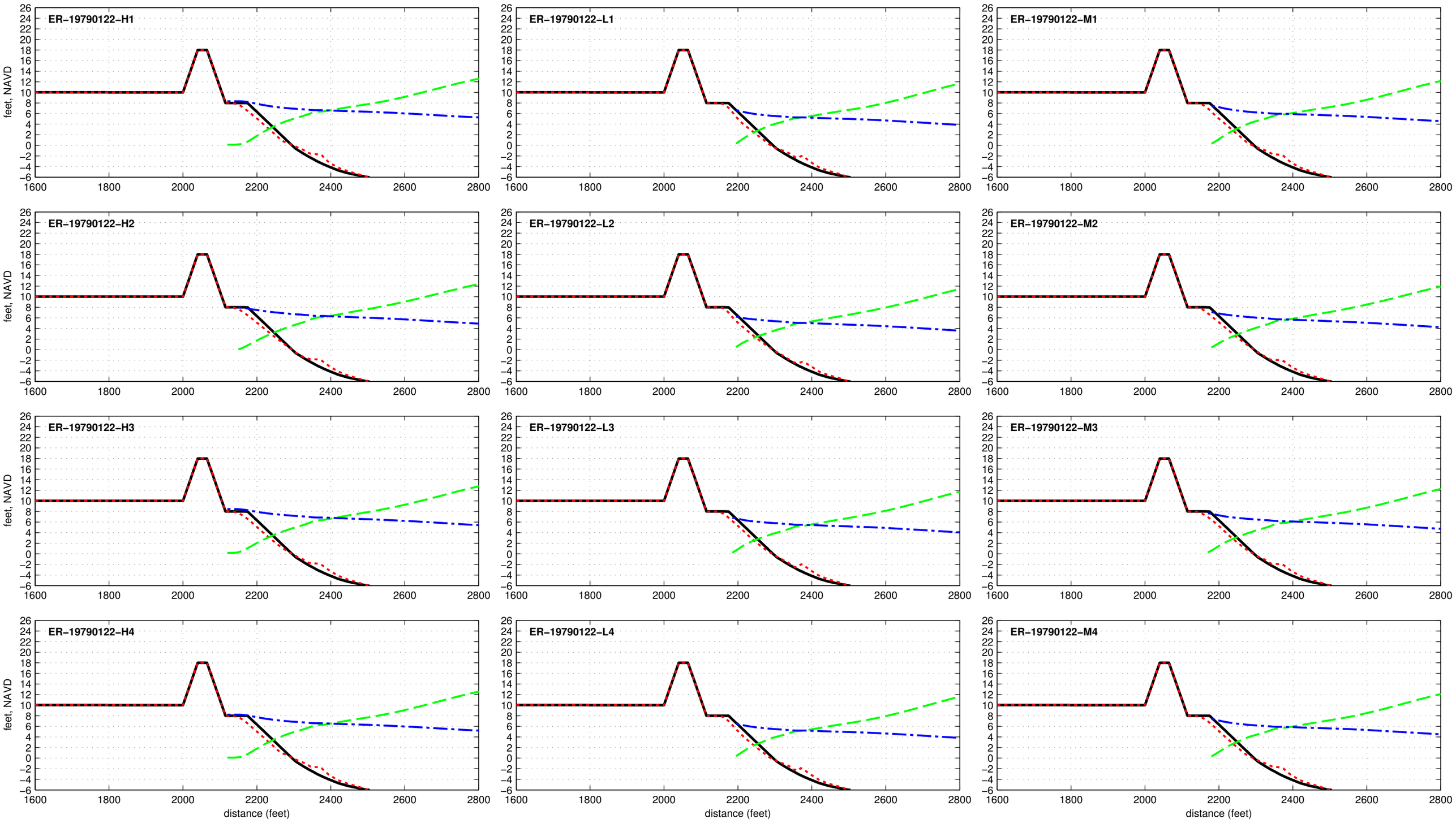
Composite Seawall R2T1-18.0-025-060 - ER-19780117



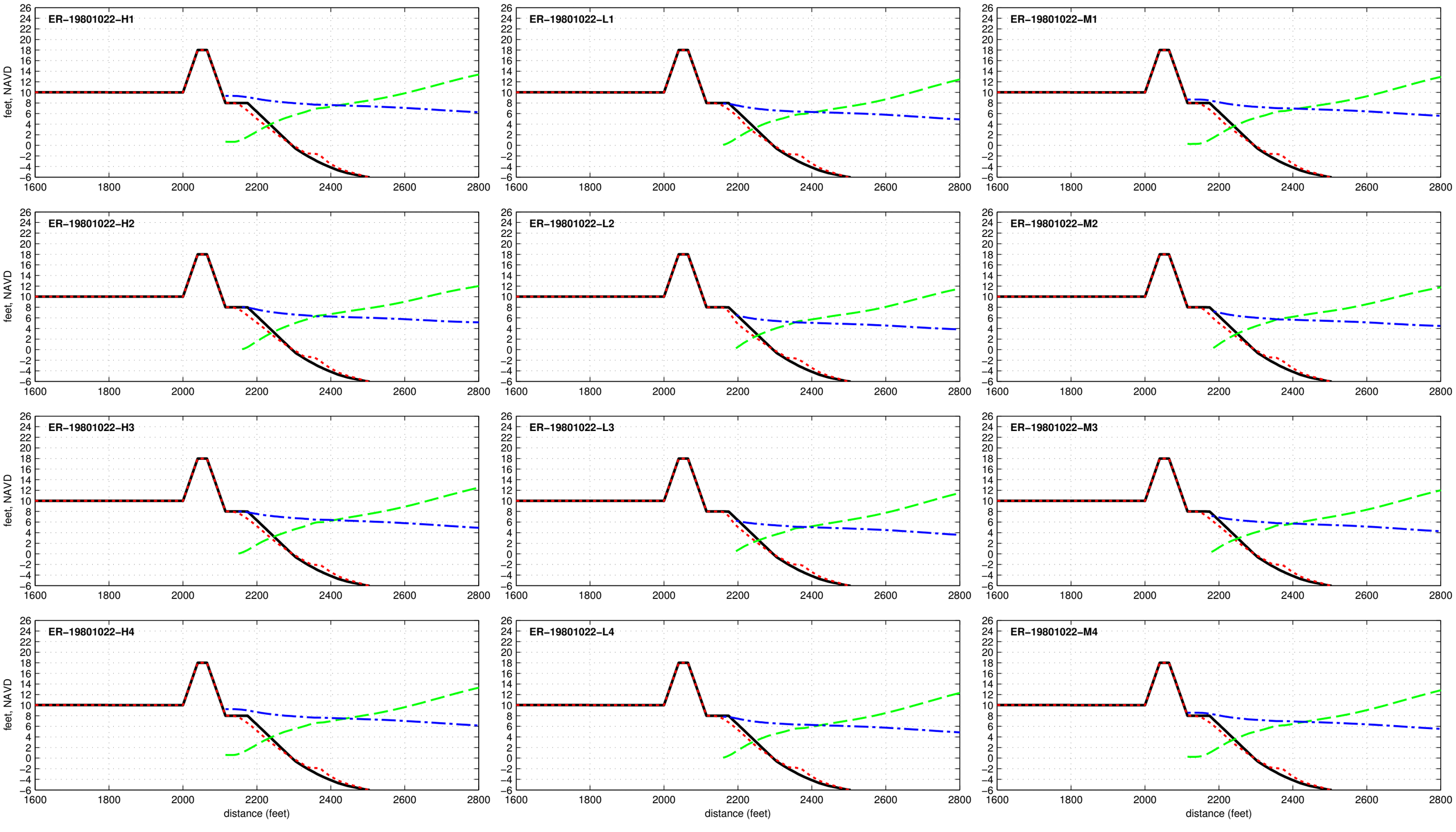
Composite Seawall R2T1-18.0-025-060 - ER-19780204



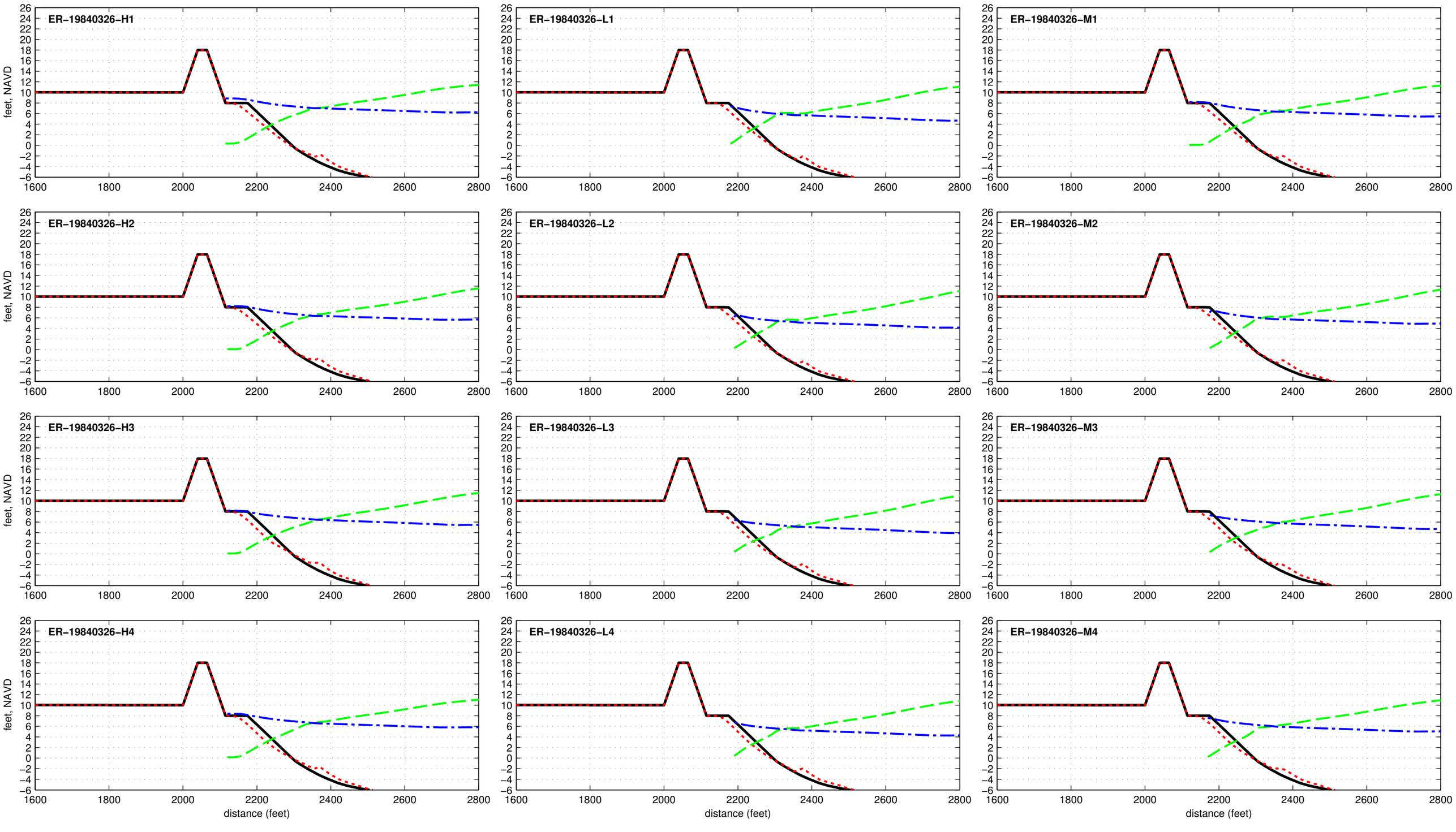
Composite Seawall R2T1-18.0-025-060 - ER-19790122



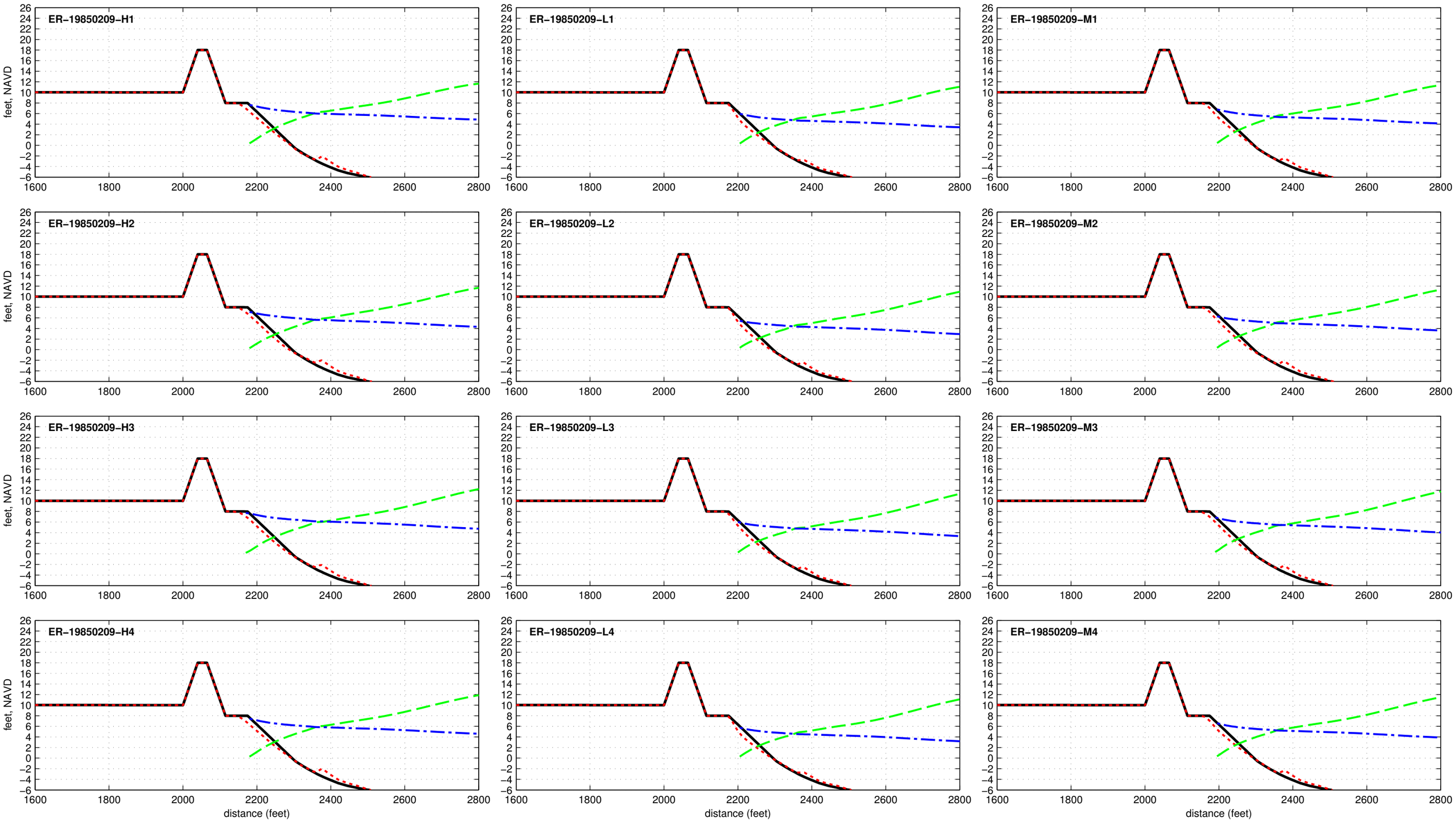
Composite Seawall R2T1-18.0-025-060 - ER-19801022



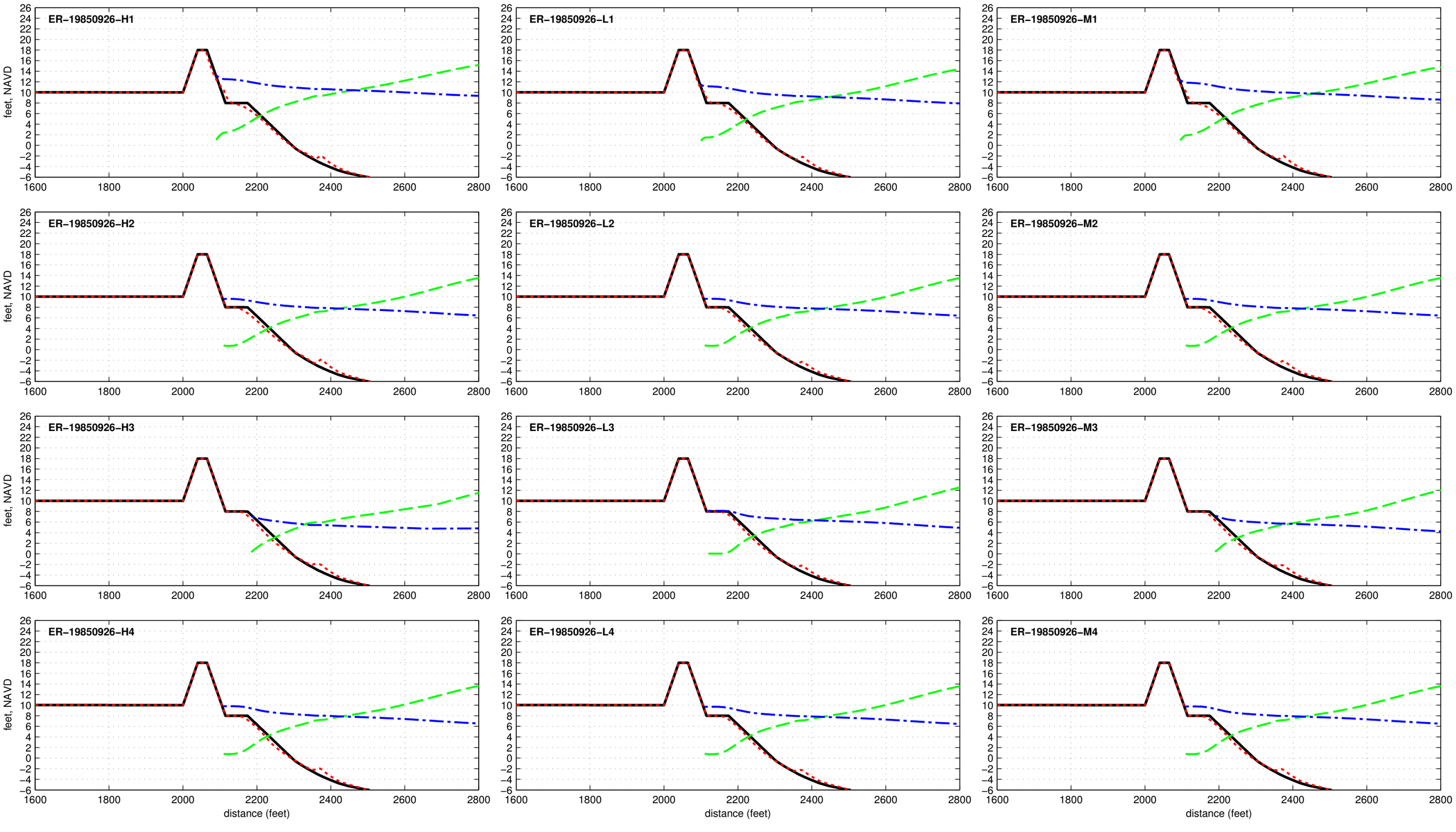
Composite Seawall R2T1-18.0-025-060 - ER-19840326



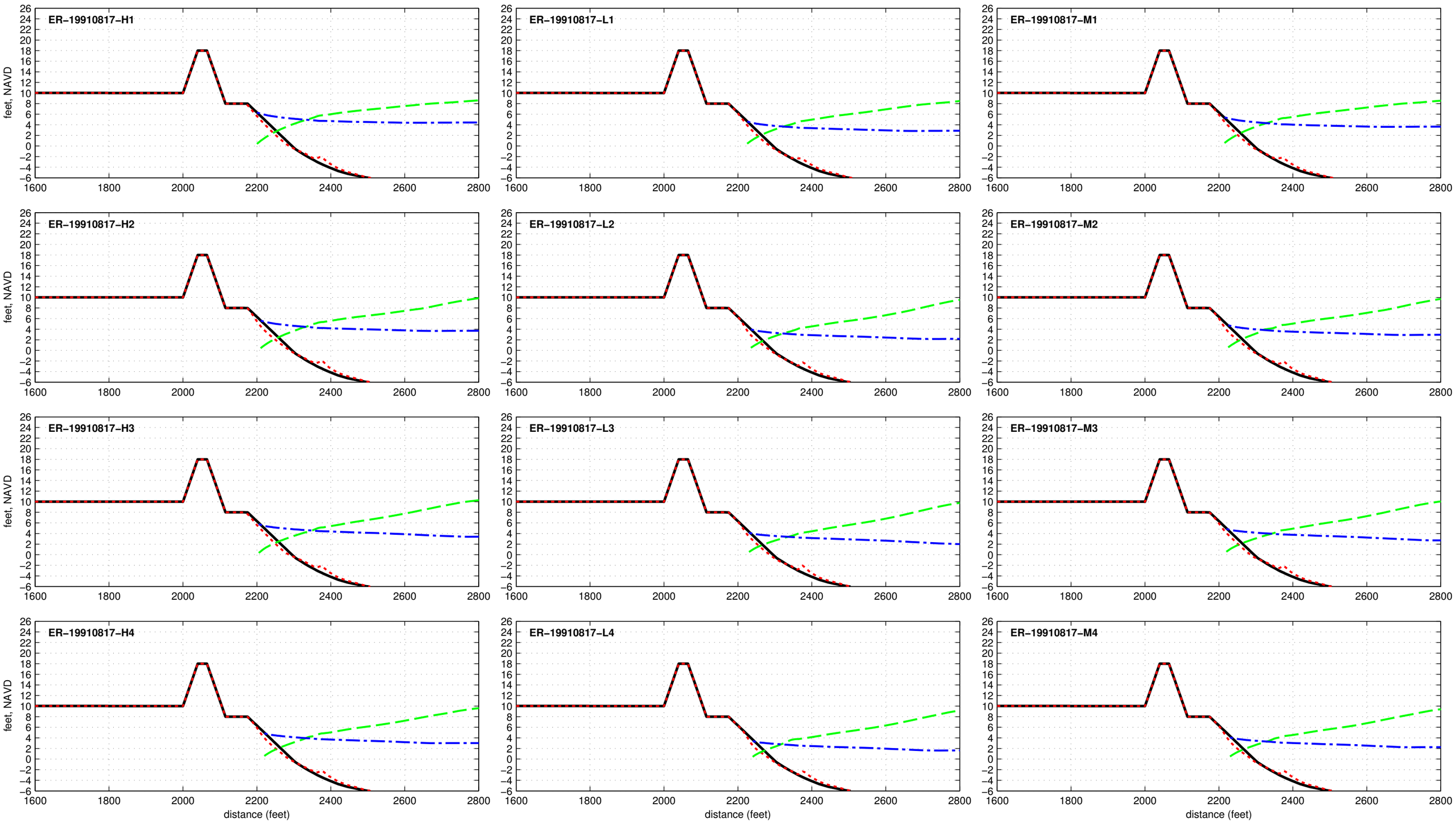
Composite Seawall R2T1-18.0-025-060 - ER-19850209



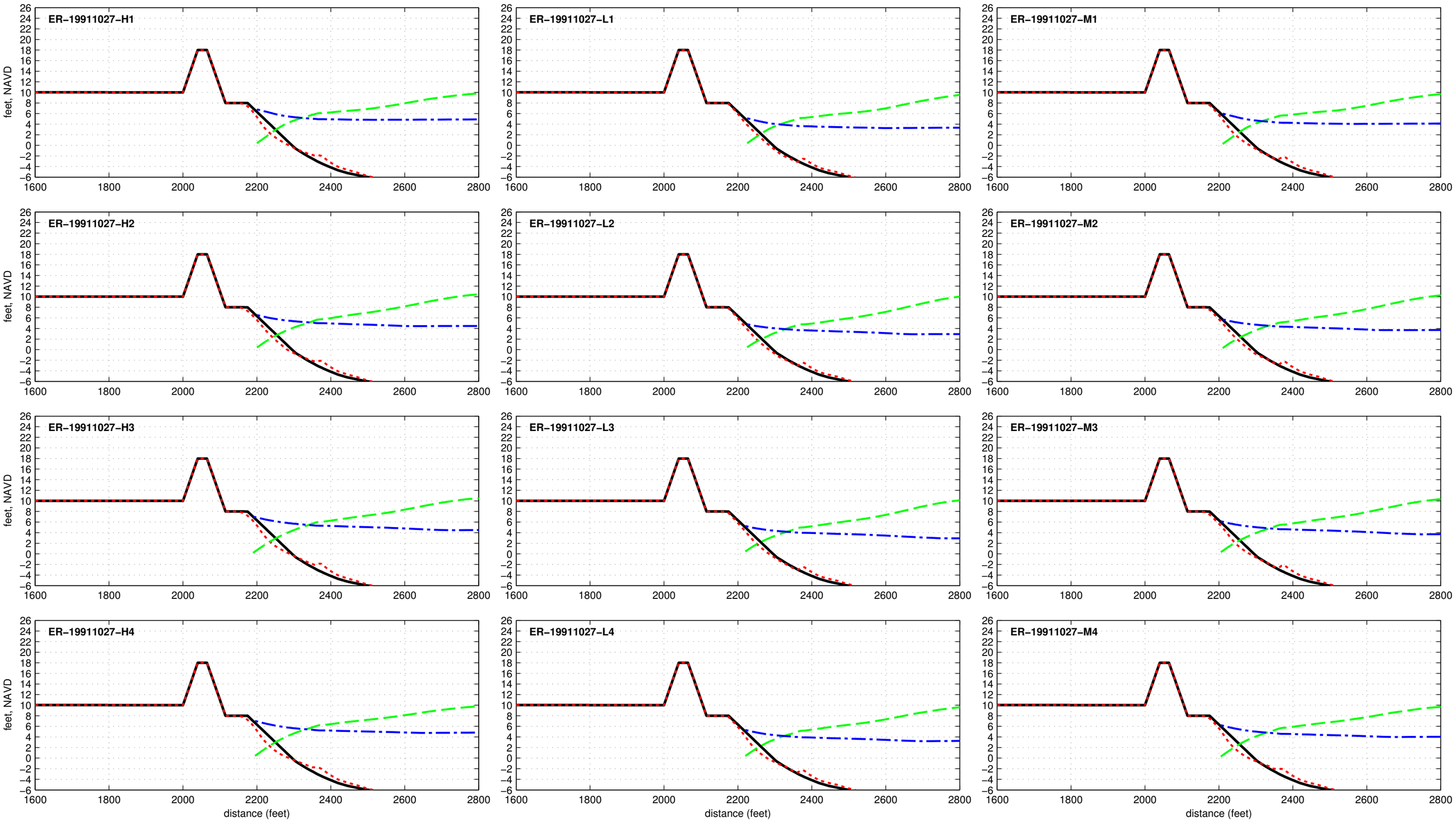
Composite Seawall R2T1-18.0-025-060 - ER-19850926



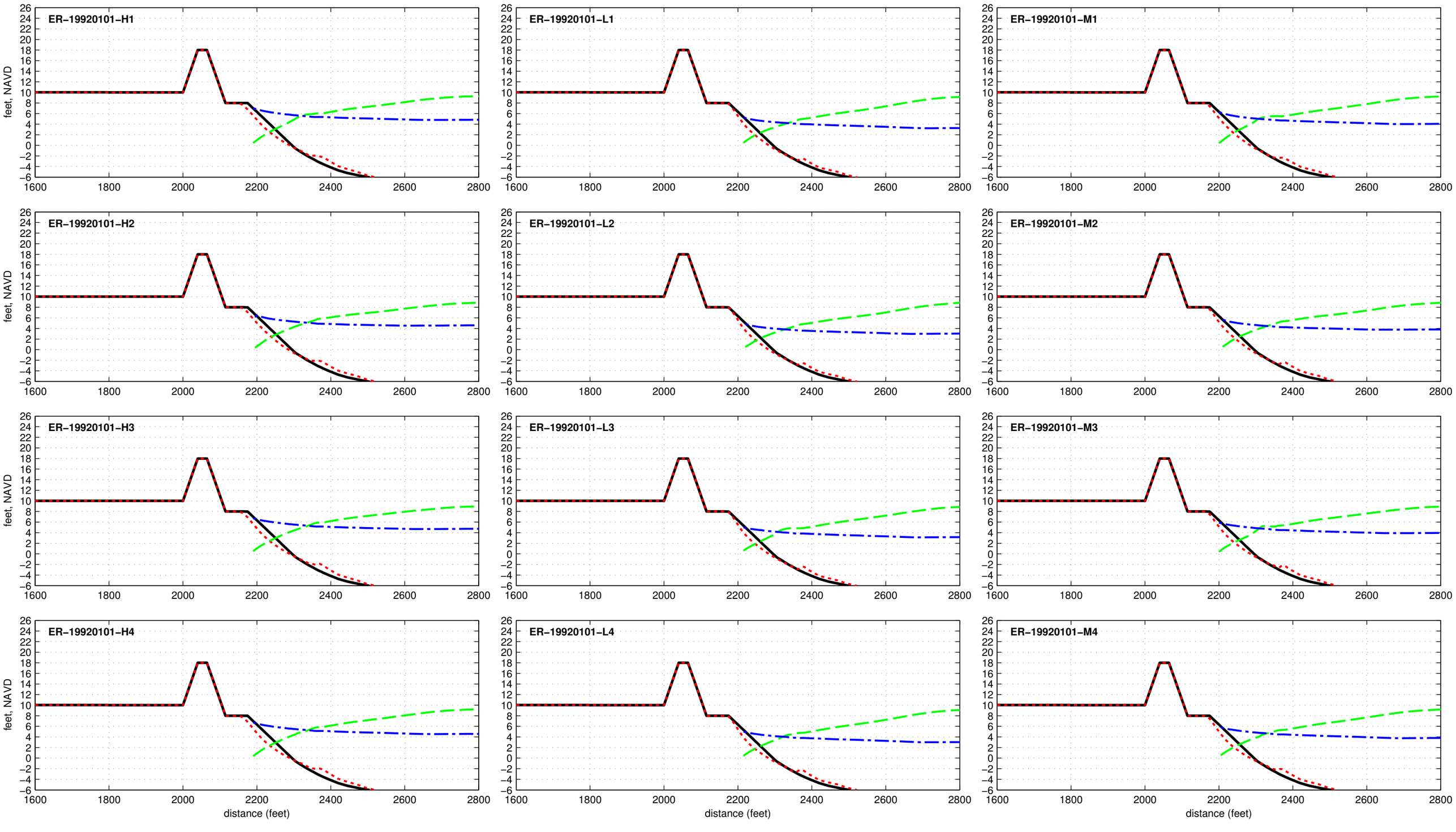
Composite Seawall R2T1-18.0-025-060 - ER-19910817



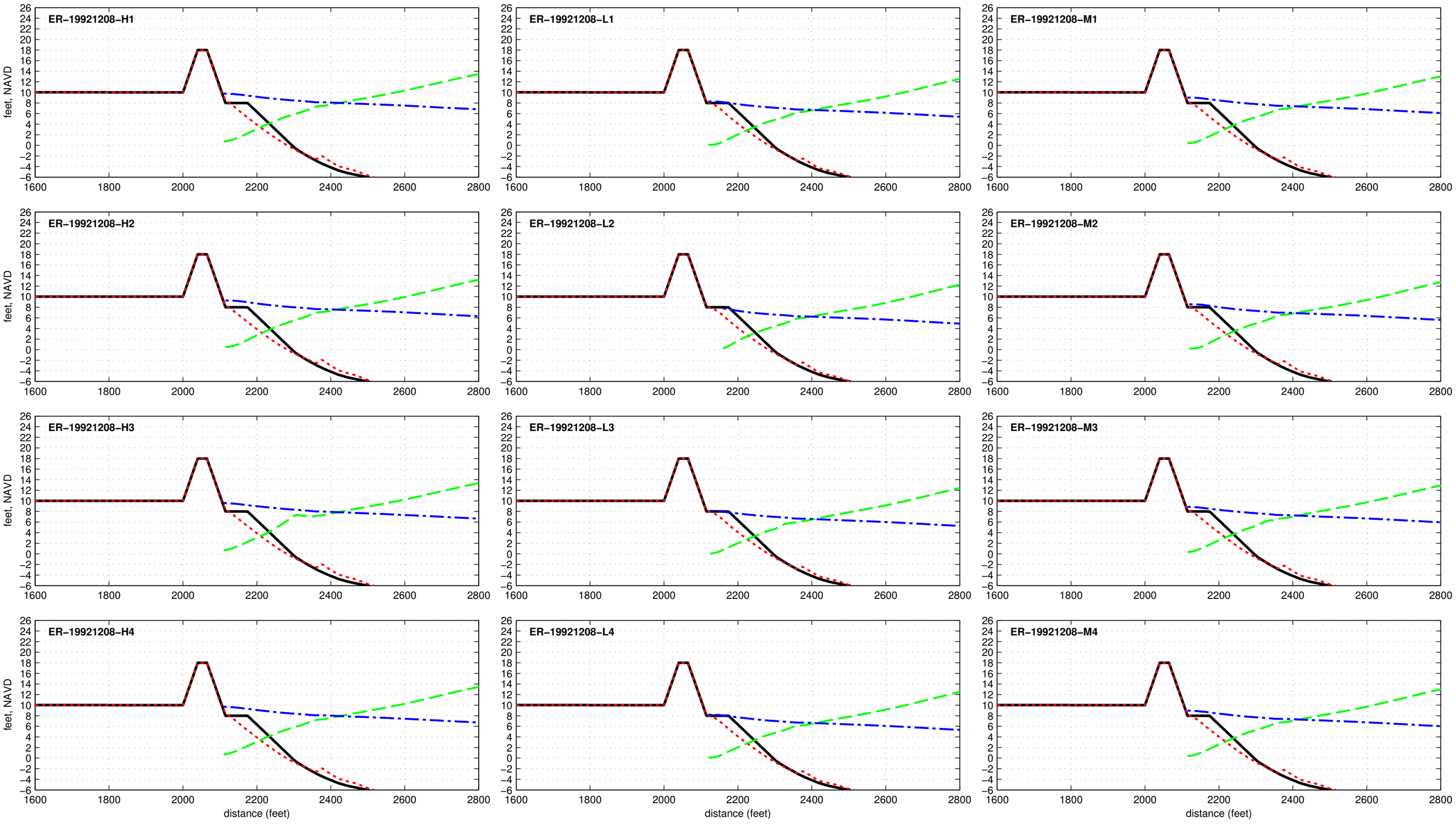
Composite Seawall R2T1-18.0-025-060 - ER-19911027



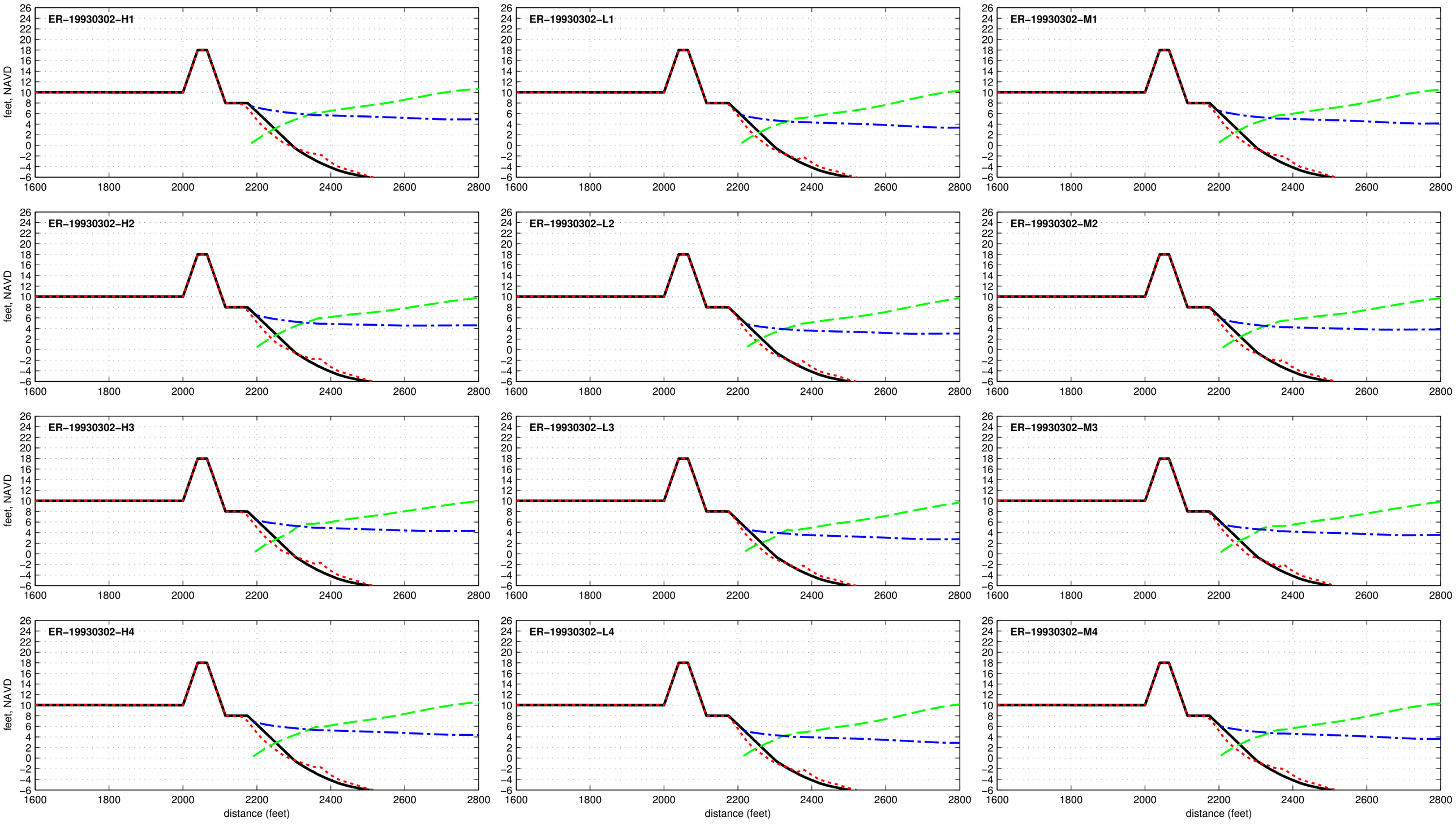
Composite Seawall R2T1-18.0-025-060 - ER-19920101



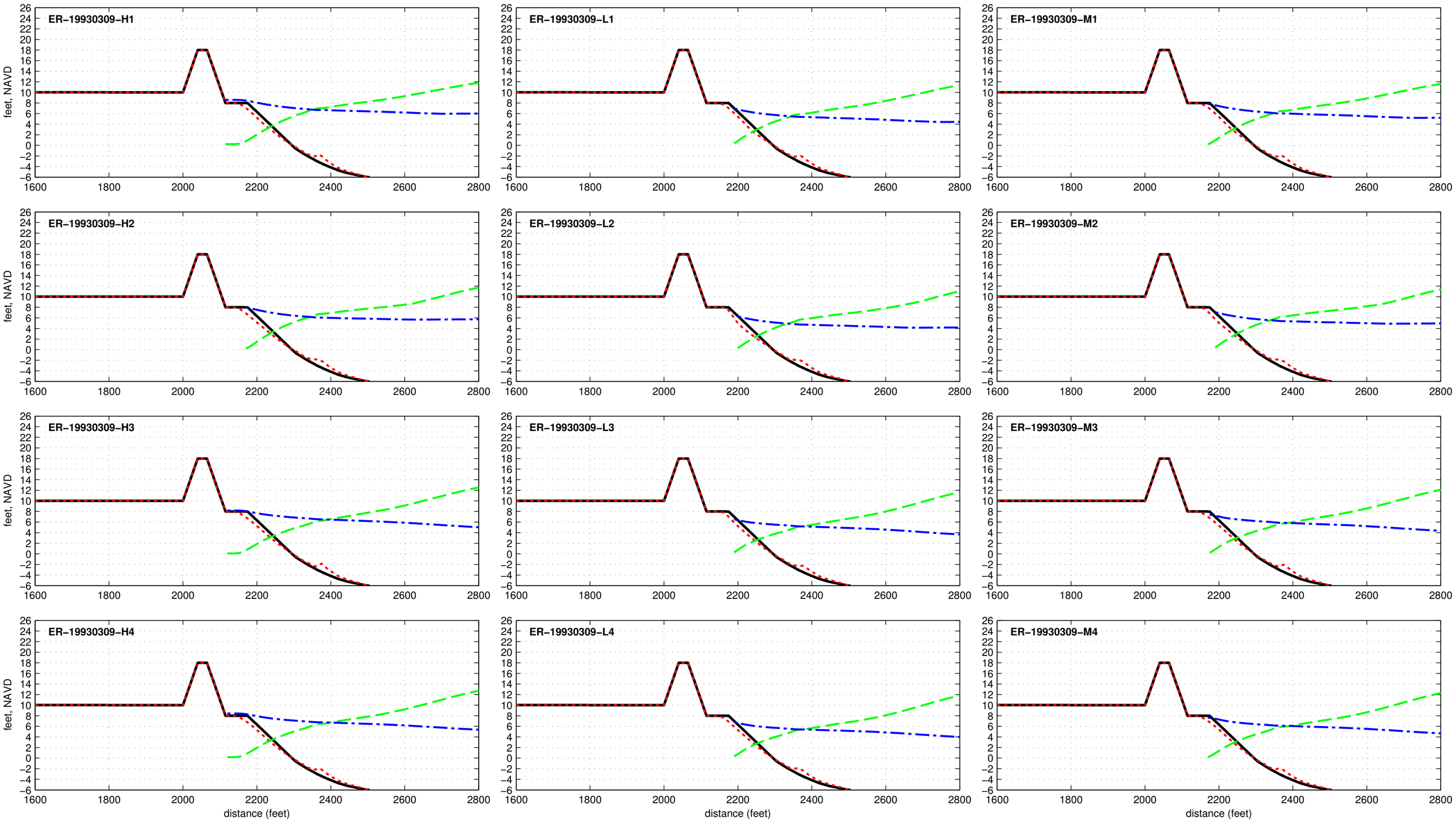
Composite Seawall R2T1-18.0-025-060 - ER-19921208



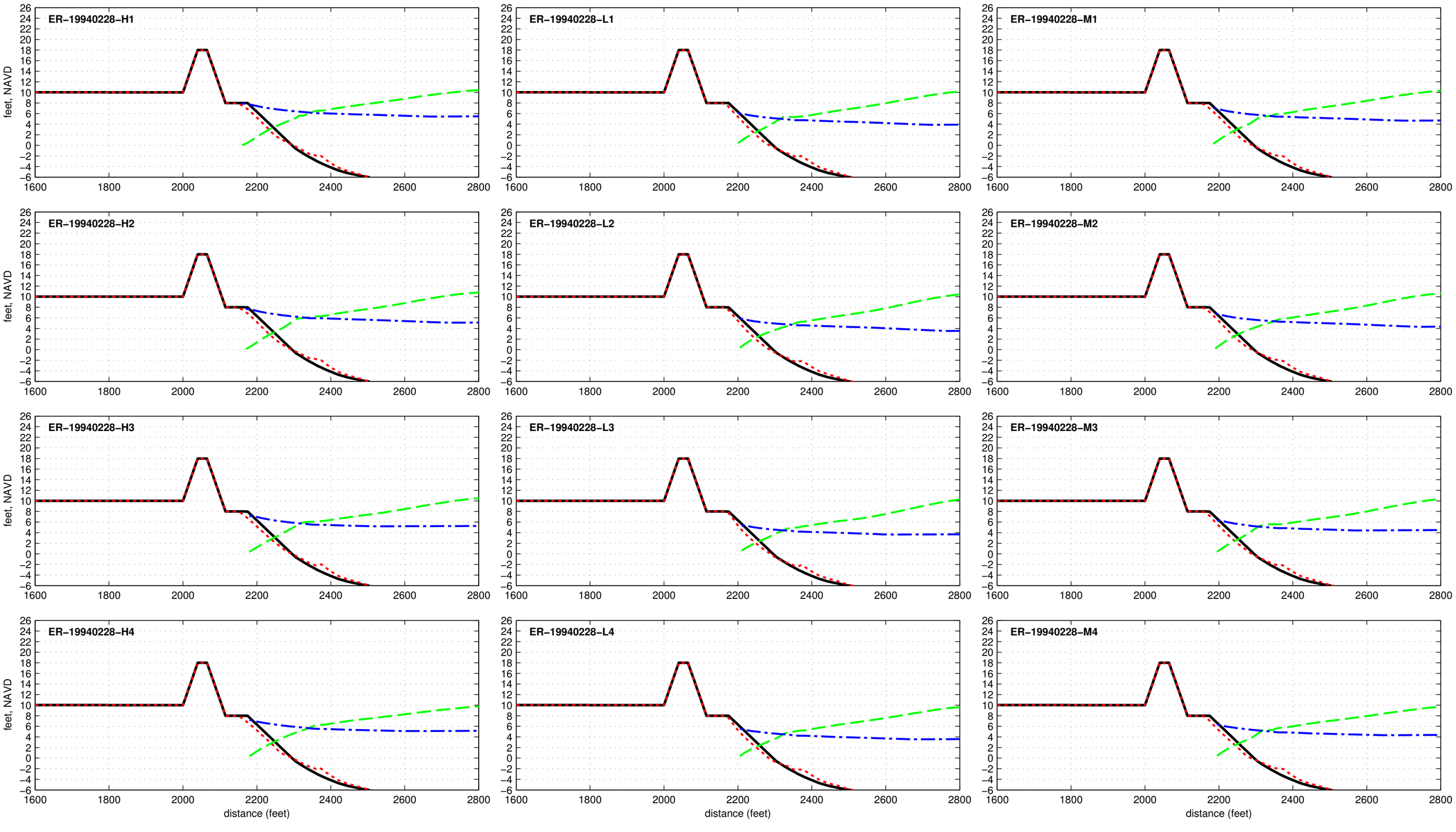
Composite Seawall R2T1-18.0-025-060 - ER-19930302



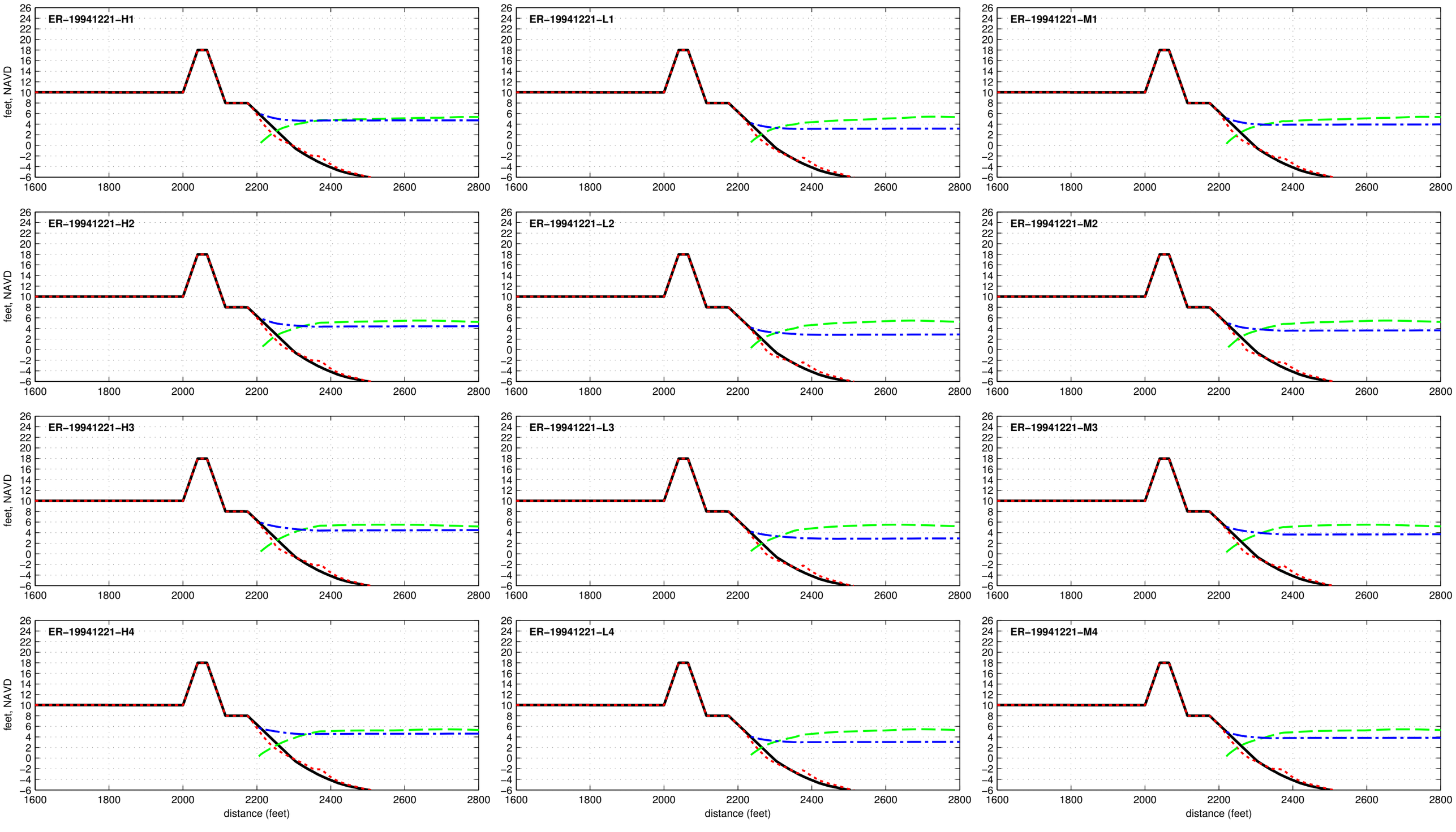
Composite Seawall R2T1-18.0-025-060 - ER-19930309



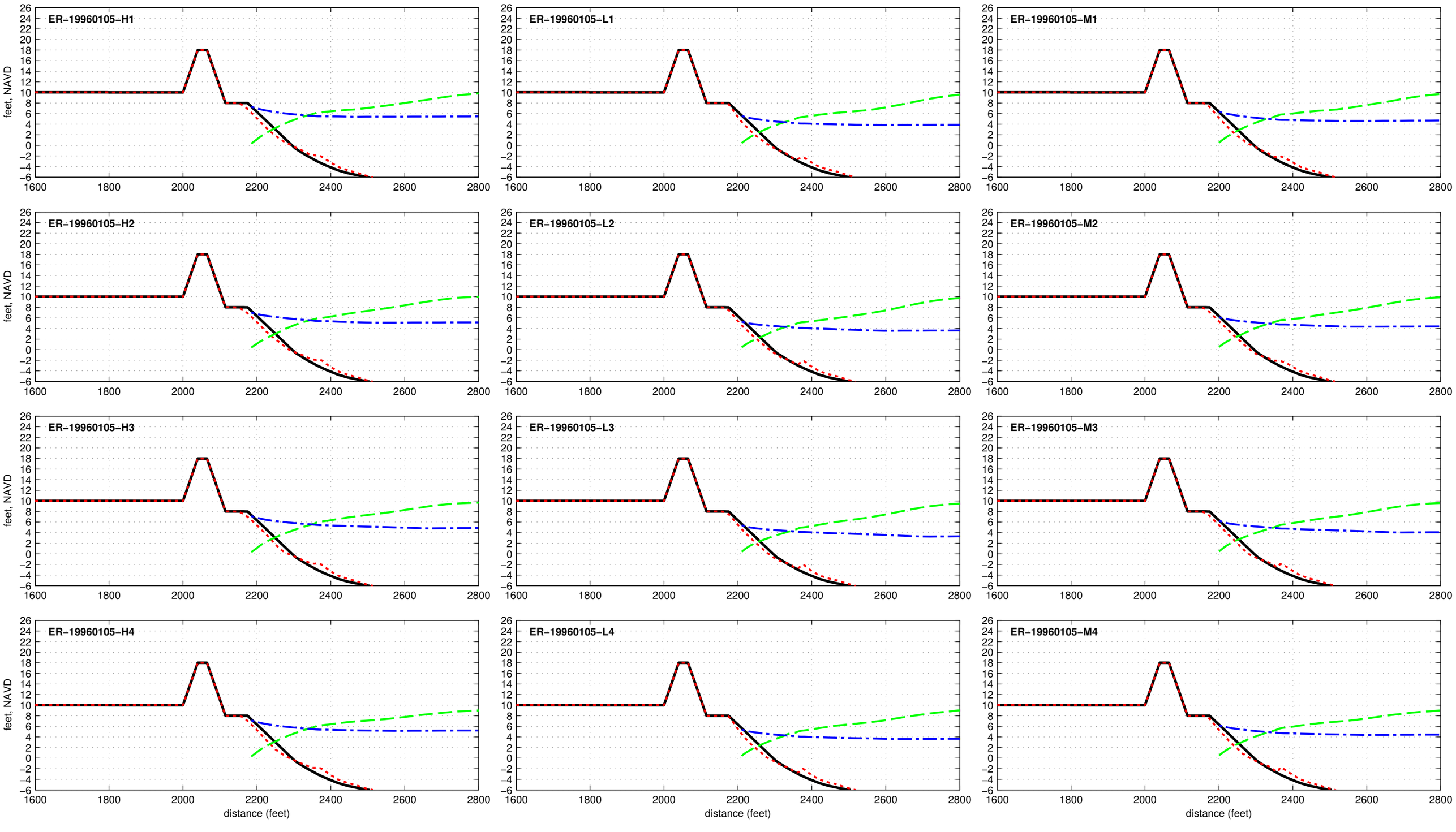
Composite Seawall R2T1-18.0-025-060 - ER-19940228



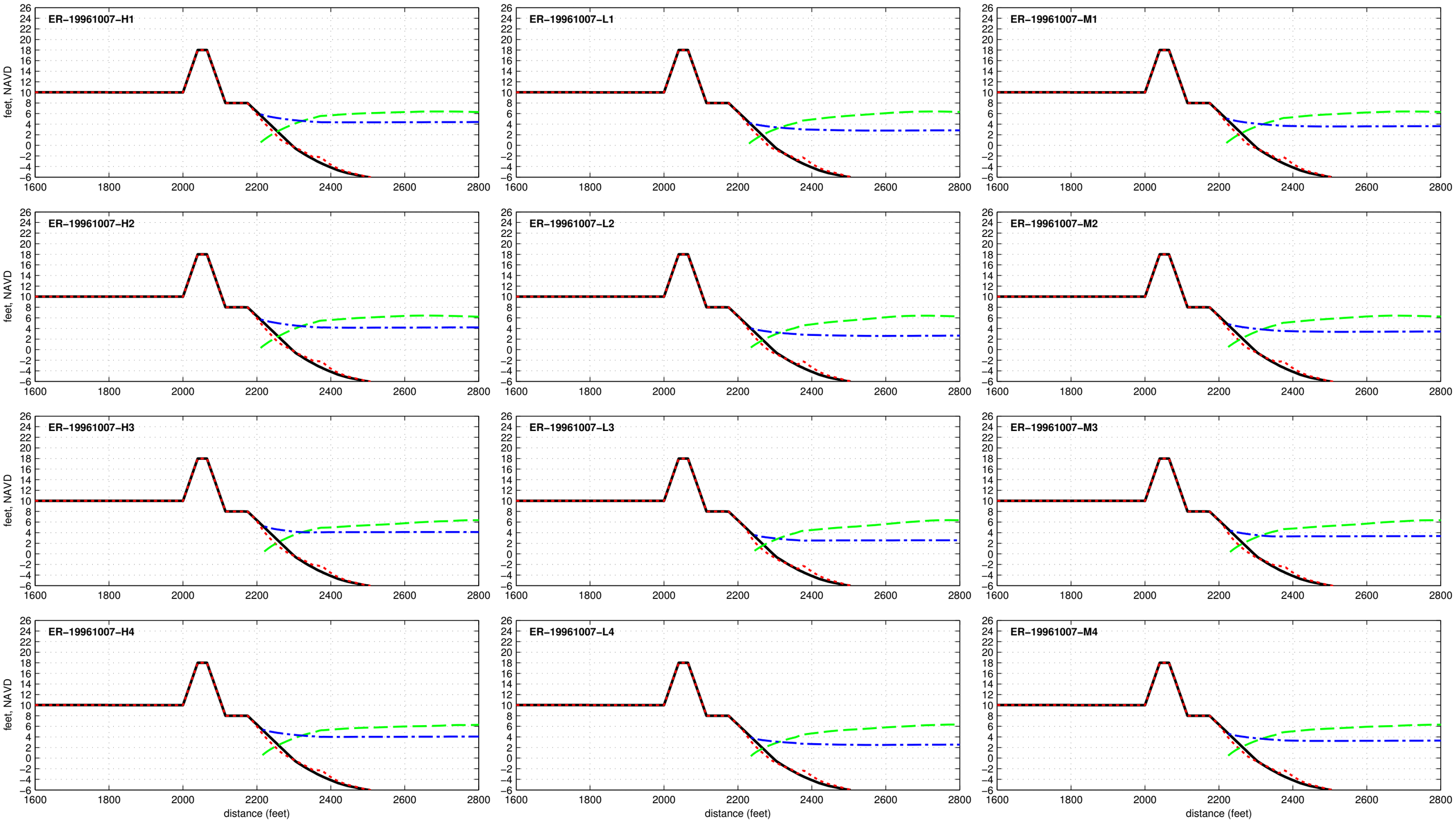
Composite Seawall R2T1-18.0-025-060 - ER-19941221



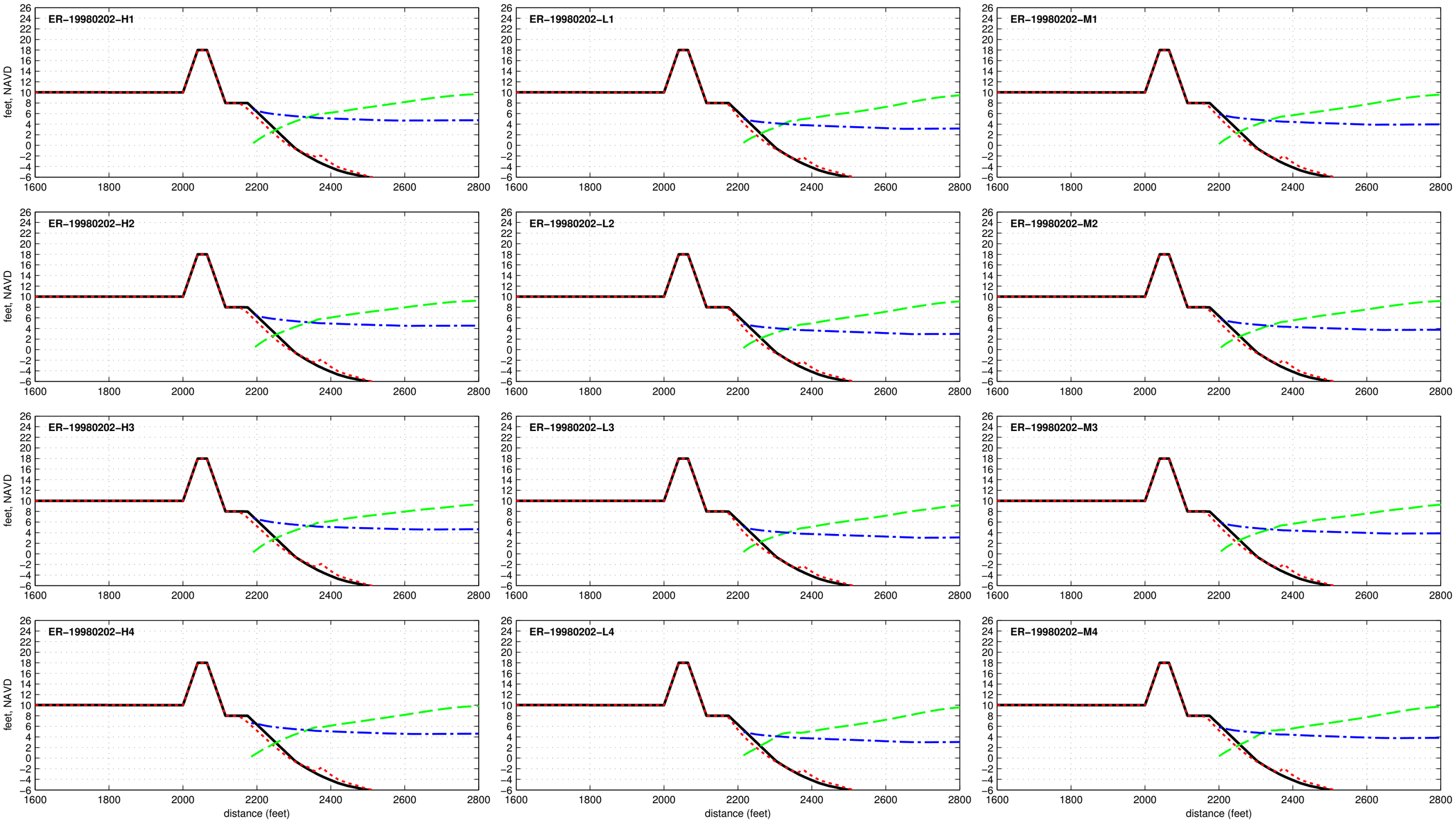
Composite Seawall R2T1-18.0-025-060 - ER-19960105



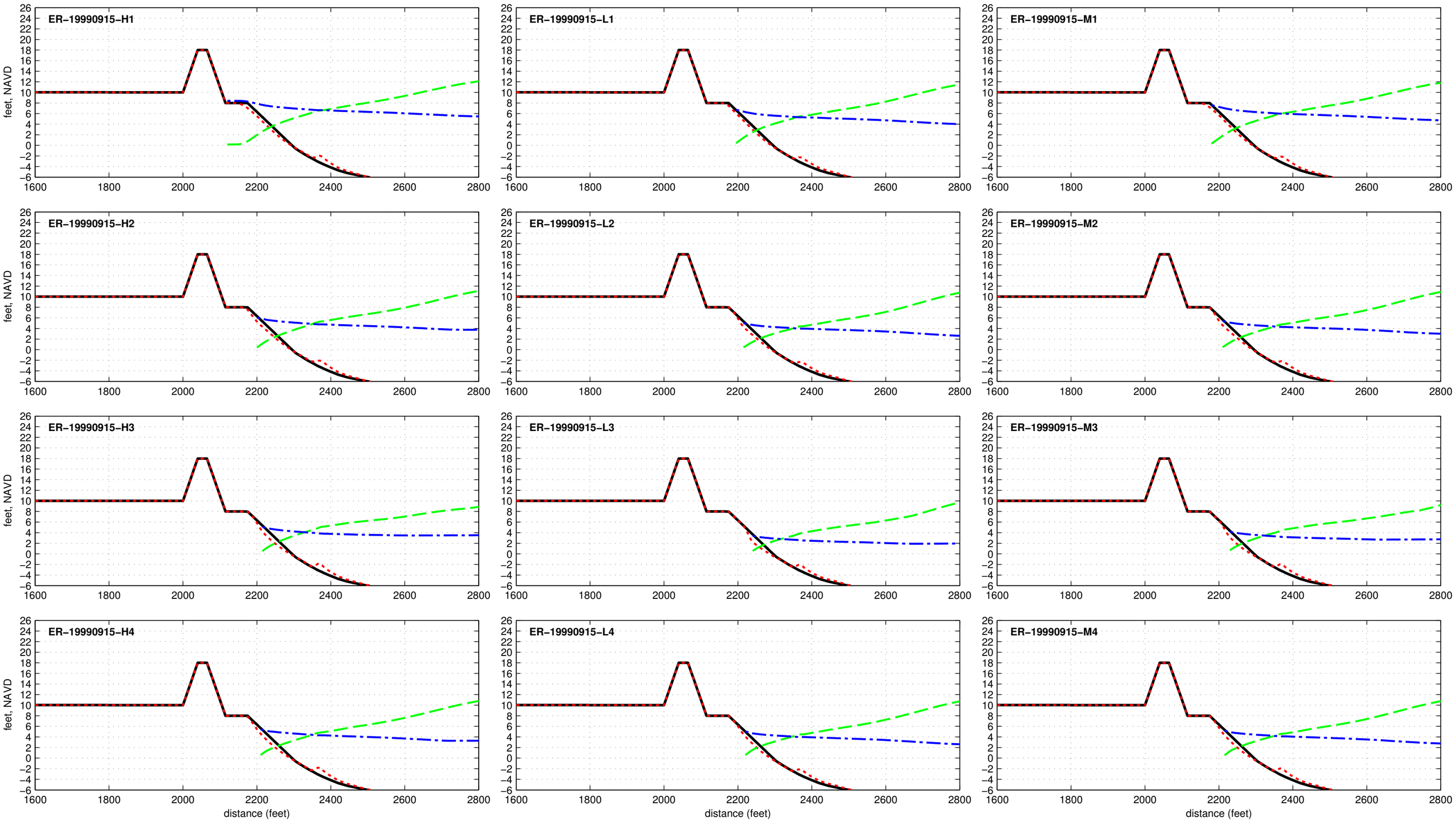
Composite Seawall R2T1-18.0-025-060 - ER-19961007



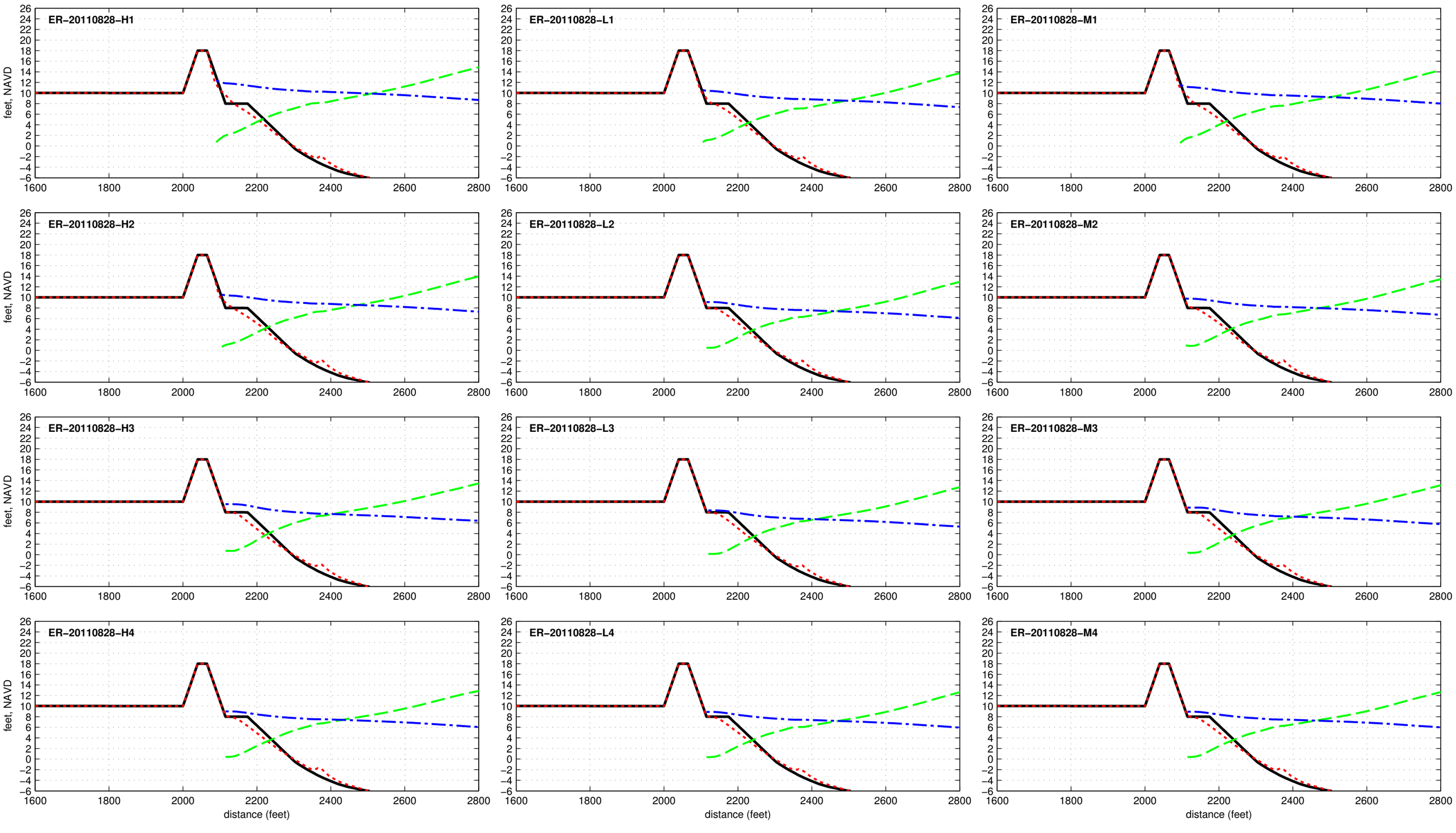
Composite Seawall R2T1-18.0-025-060 - ER-19980202



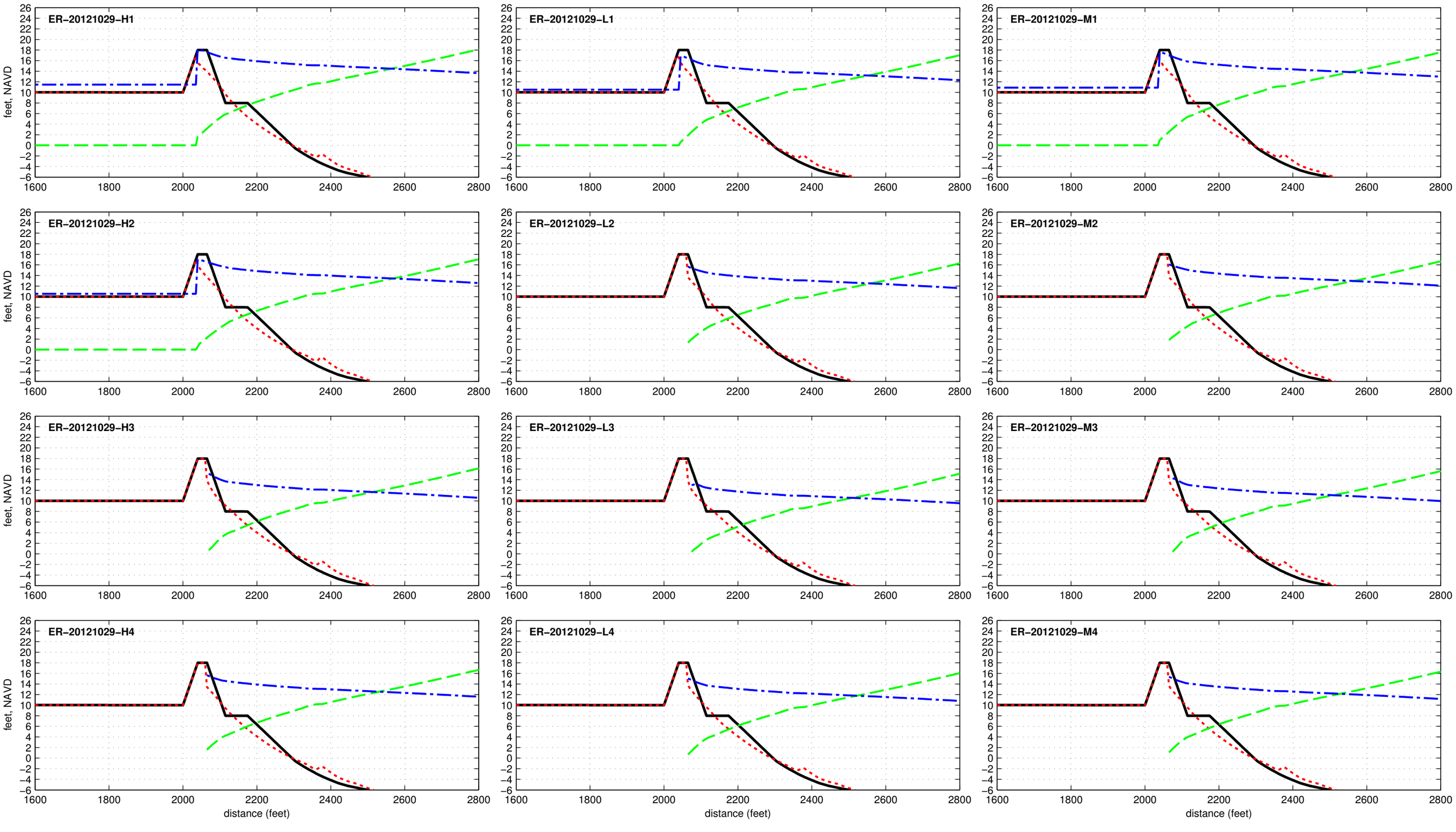
Composite Seawall R2T1-18.0-025-060 - ER-19990915



Composite Seawall R2T1-18.0-025-060 - ER-20110828



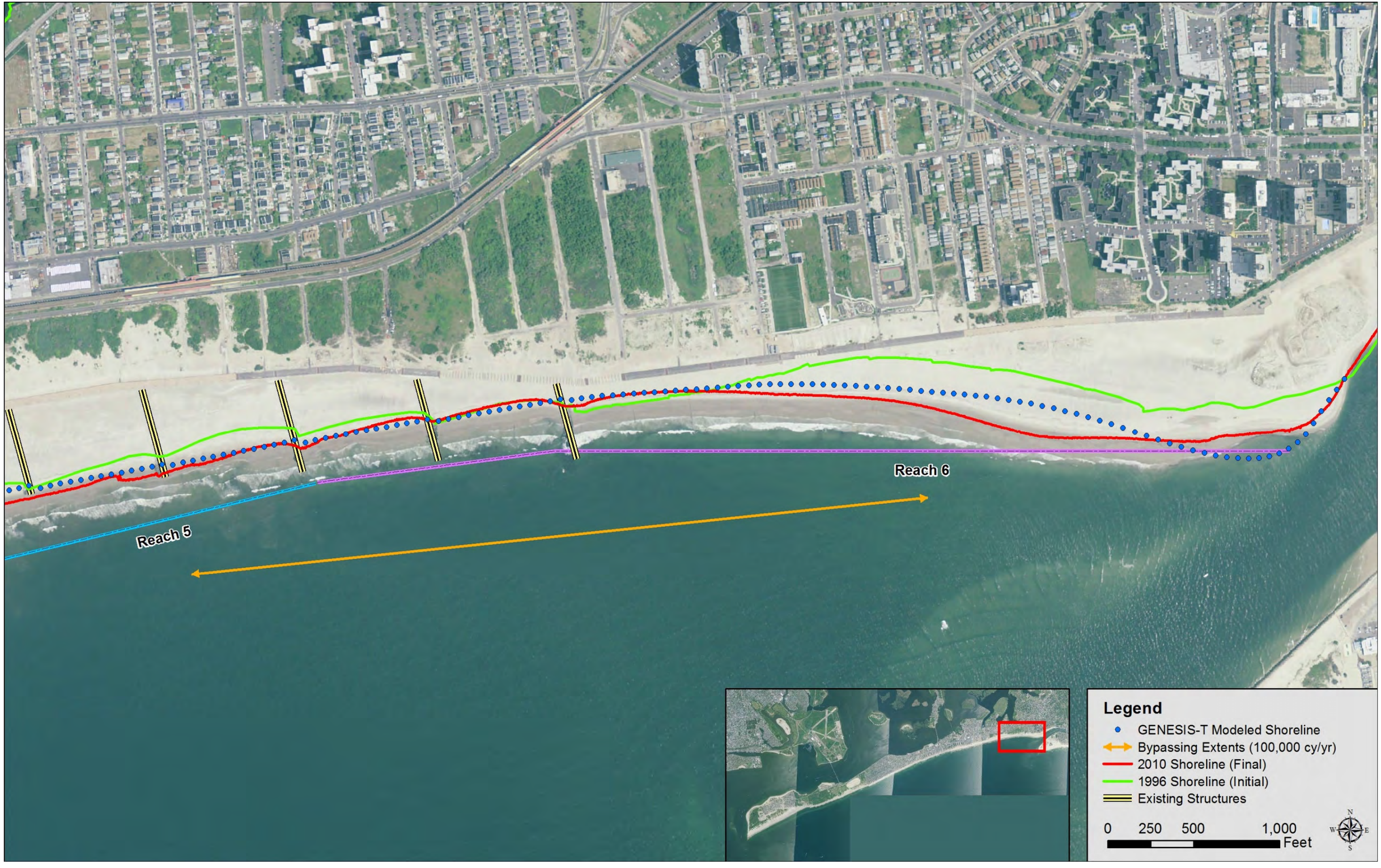
Composite Seawall R2T1-18.0-025-060 - ER-20121029

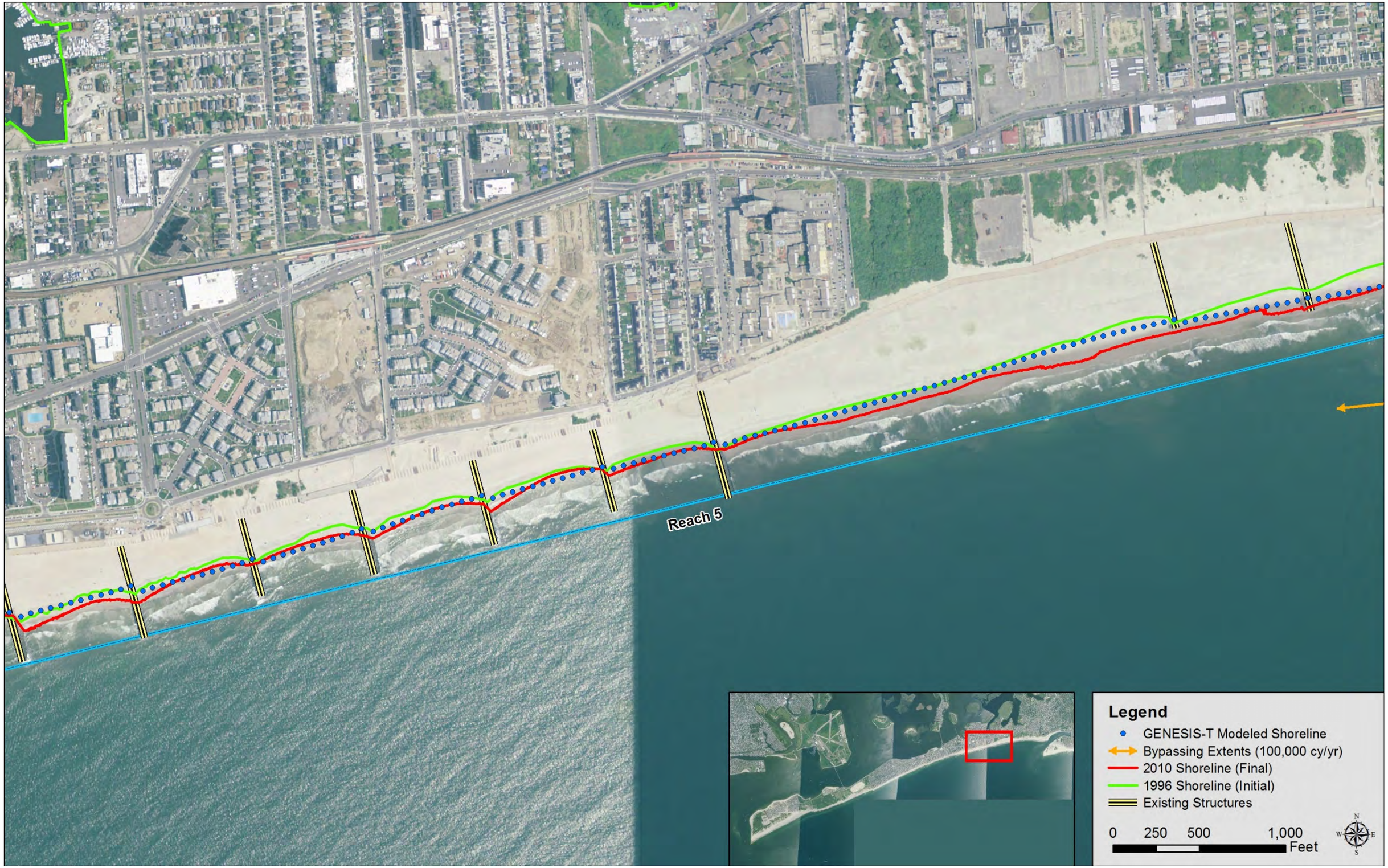


ENCLOSURE B

GENESIS-T MODEL RESULTS

GENESIS-T MODEL CALIBRATION

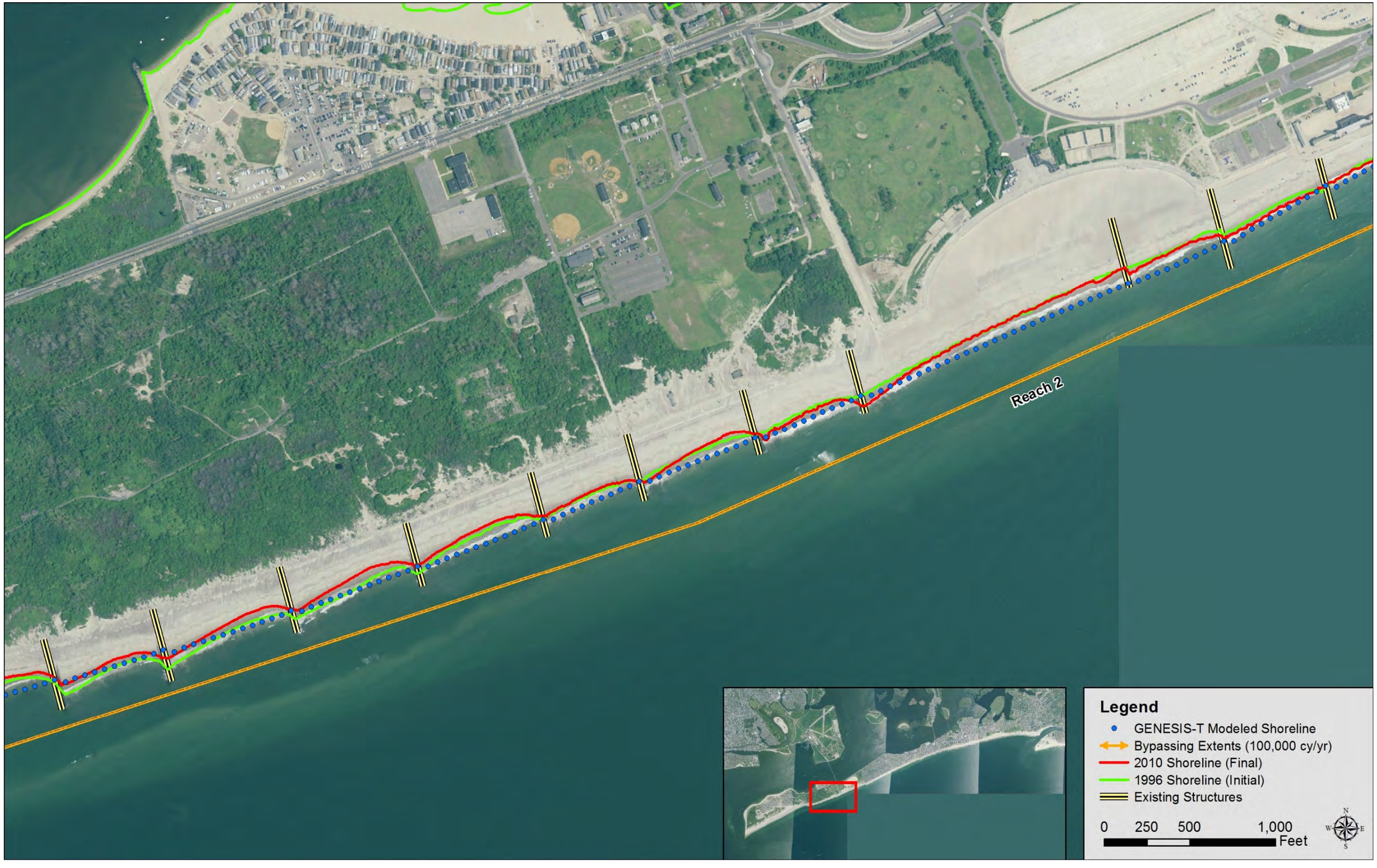

Reach 5
Reach 6
Legend
GENESIS-T Modeled Shoreline
Bypassing Extents (100,000 cy/yr)
2010 Shoreline (Final)
1996 Shoreline (Initial)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S


Reach 5
Legend
GENESIS-T Modeled Shoreline
Bypassing Extents (100,000 cy/yr)
2010 Shoreline (Final)
1996 Shoreline (Initial)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S

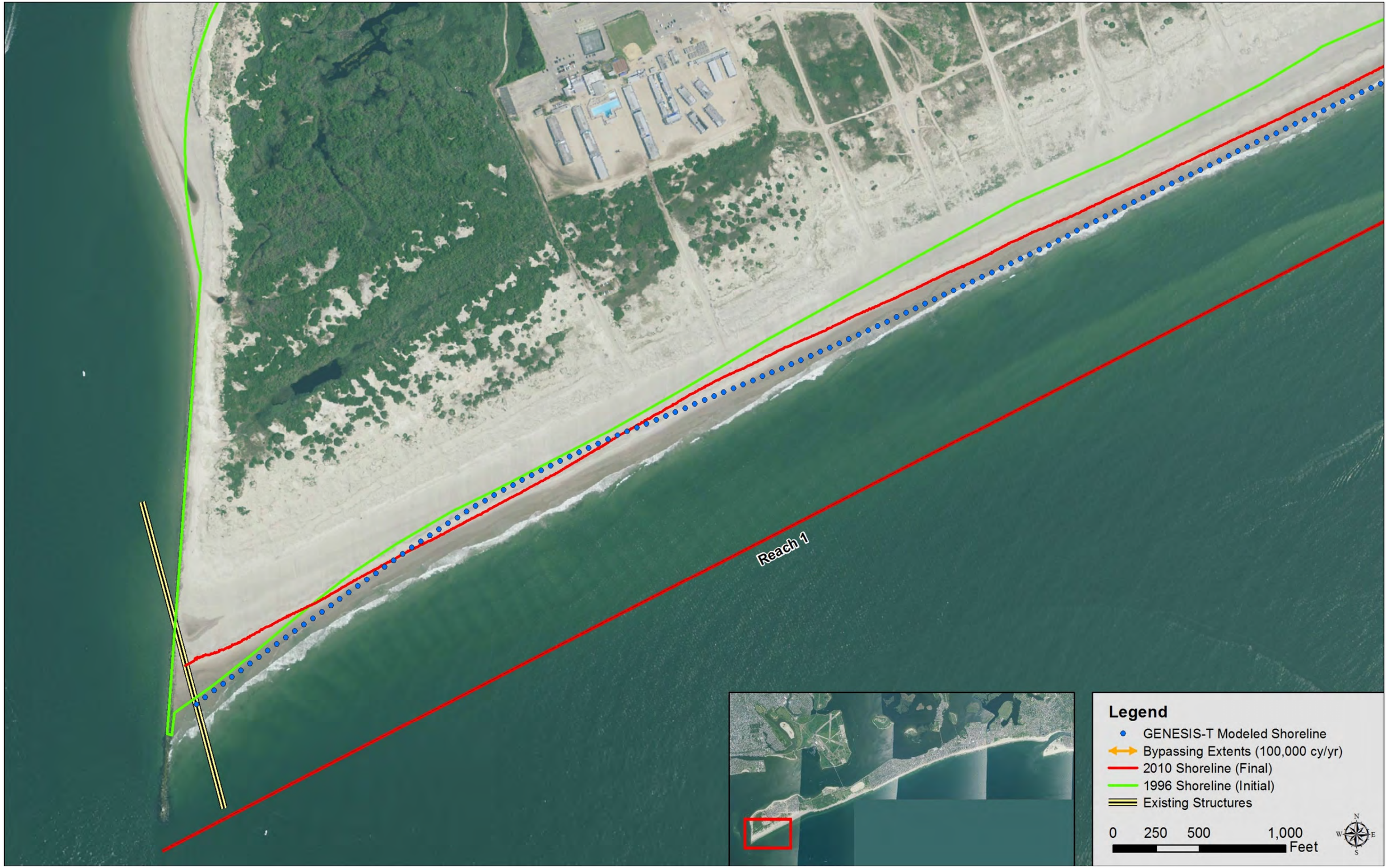
Reach 5
Reach 4
Legend
GENESIS-T Modeled Shoreline
Bypassing Extents (100,000 cy/yr)
2010 Shoreline (Final)
1996 Shoreline (Initial)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S

Reach 4
Reach 3
Legend
GENESIS-T Modeled Shoreline
Bypassing Extents (100,000 cy/yr)
2010 Shoreline (Final)
1996 Shoreline (Initial)
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

Reach 3
Reach 2
Legend
GENESIS-T Modeled Shoreline
Bypassing Extents (100,000 cy/yr)
2010 Shoreline (Final)
1996 Shoreline (Initial)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S


Reach 2
Legend
GENESIS-T Modeled Shoreline
Bypassing Extents (100,000 cy/yr)
2010 Shoreline (Final)
1996 Shoreline (Initial)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S

Reach 2
Reach 1
Legend
GENESIS-T Modeled Shoreline
Bypassing Extents (100,000 cy/yr)
2010 Shoreline (Final)
1996 Shoreline (Initial)
Existing Structures
0
250
500
1,000
Feet
N
W
E
S


Reach 1
Legend
GENESIS-T Modeled Shoreline
Bypassing Extents (100,000 cy/yr)
2010 Shoreline (Final)
1996 Shoreline (Initial)
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

GENESIS-T WOPFC

Reach 5

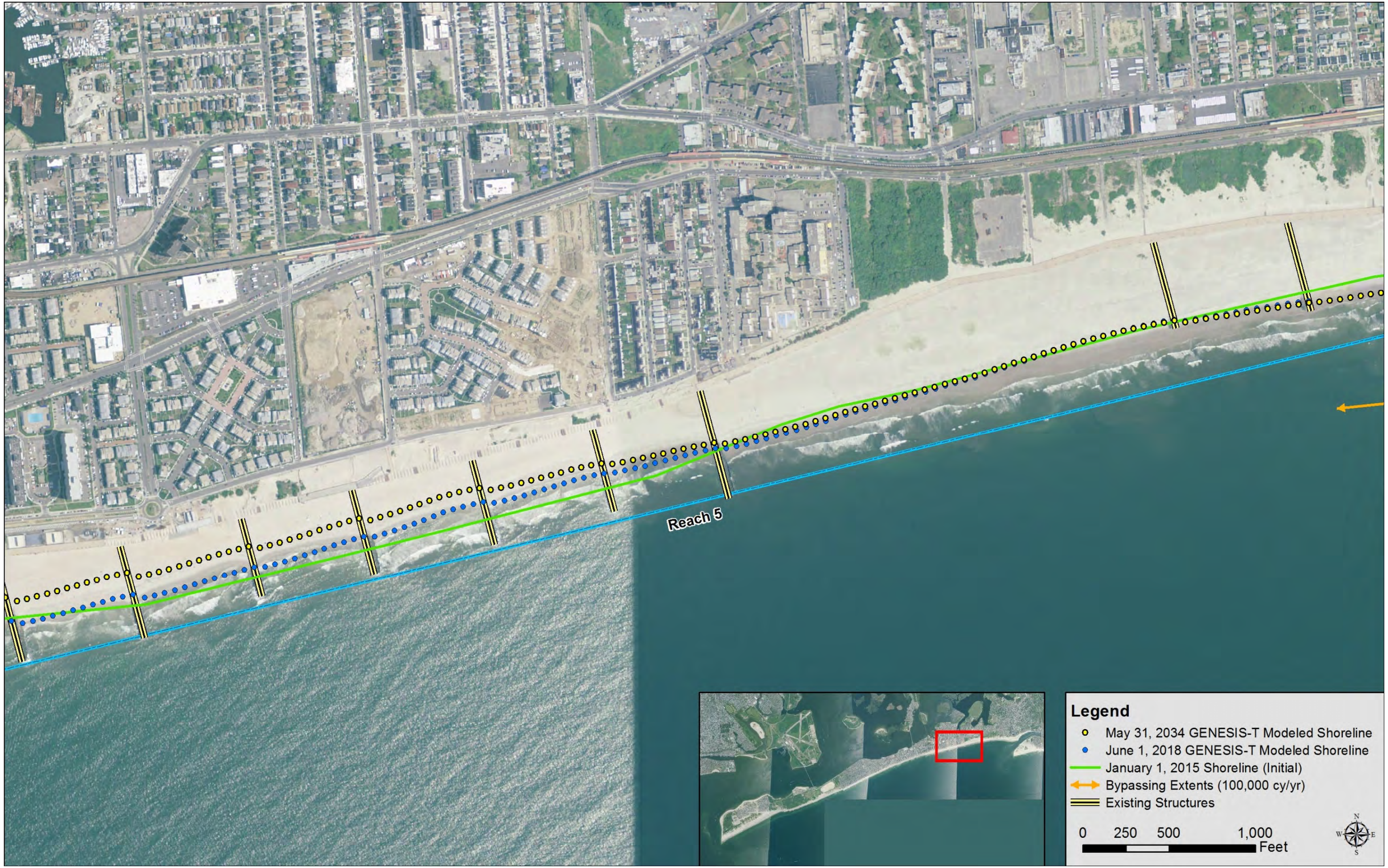
Reach 6

Legend

- May 31, 2034 GENESIS-T Modeled Shoreline
- June 1, 2018 GENESIS-T Modeled Shoreline
- January 1, 2015 Shoreline (Initial)
- Bypassing Extents (100,000 cy/yr)
- Existing Structures

0 250 500 1,000 Feet

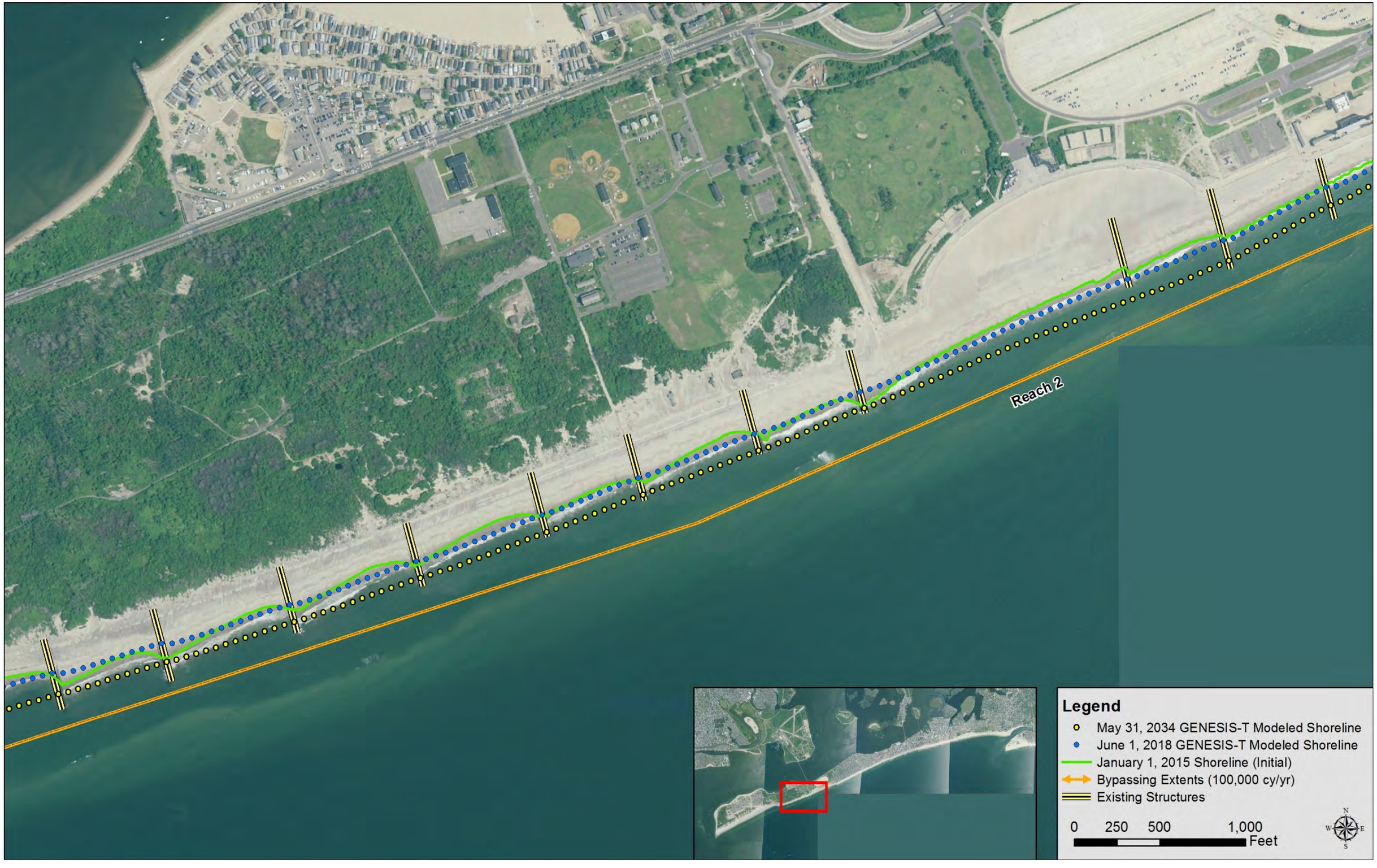
N W E S

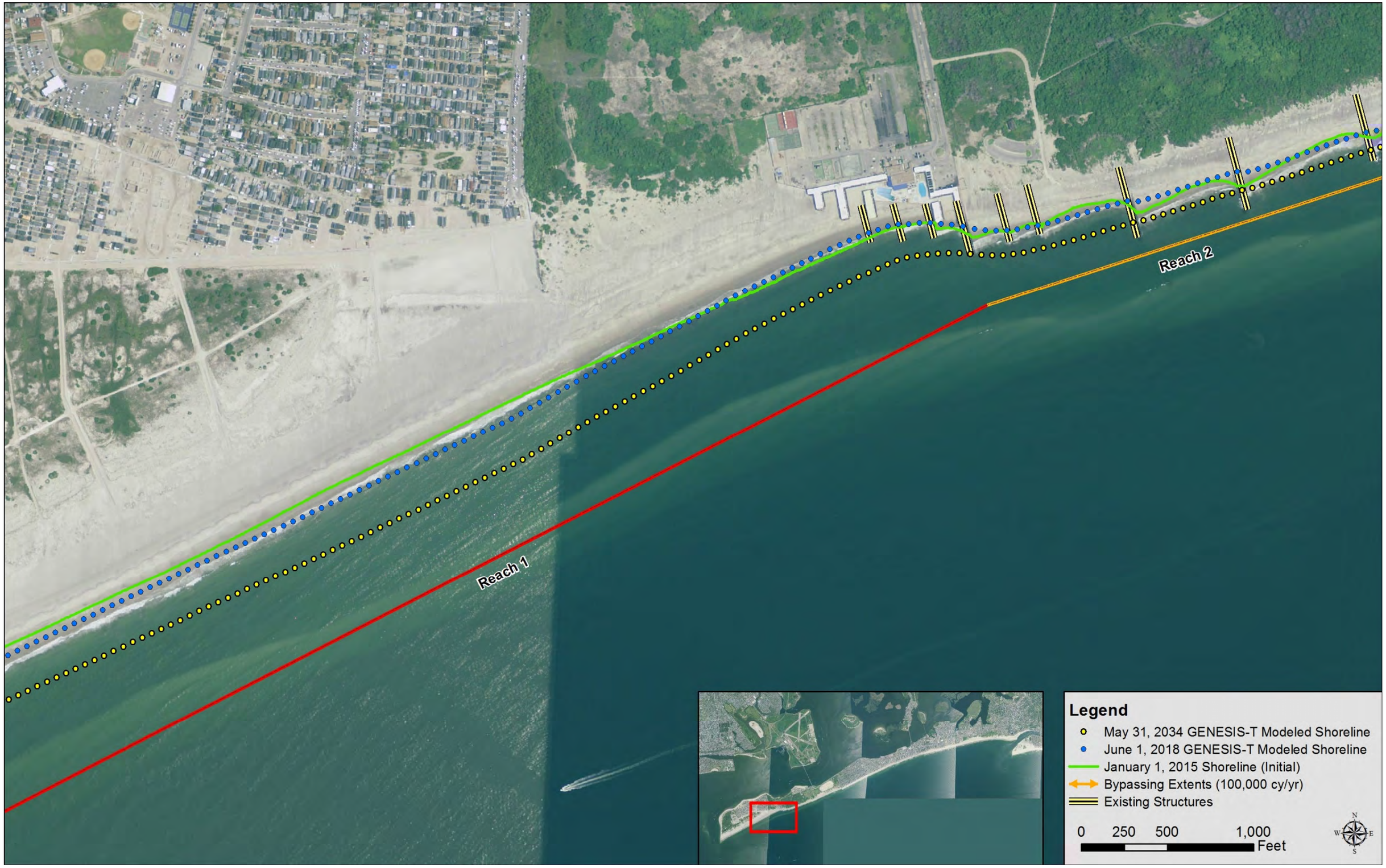

Reach 5
Legend
May 31, 2034 GENESIS-T Modeled Shoreline
June 1, 2018 GENESIS-T Modeled Shoreline
January 1, 2015 Shoreline (Initial)
Bypassing Extents (100,000 cy/yr)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S

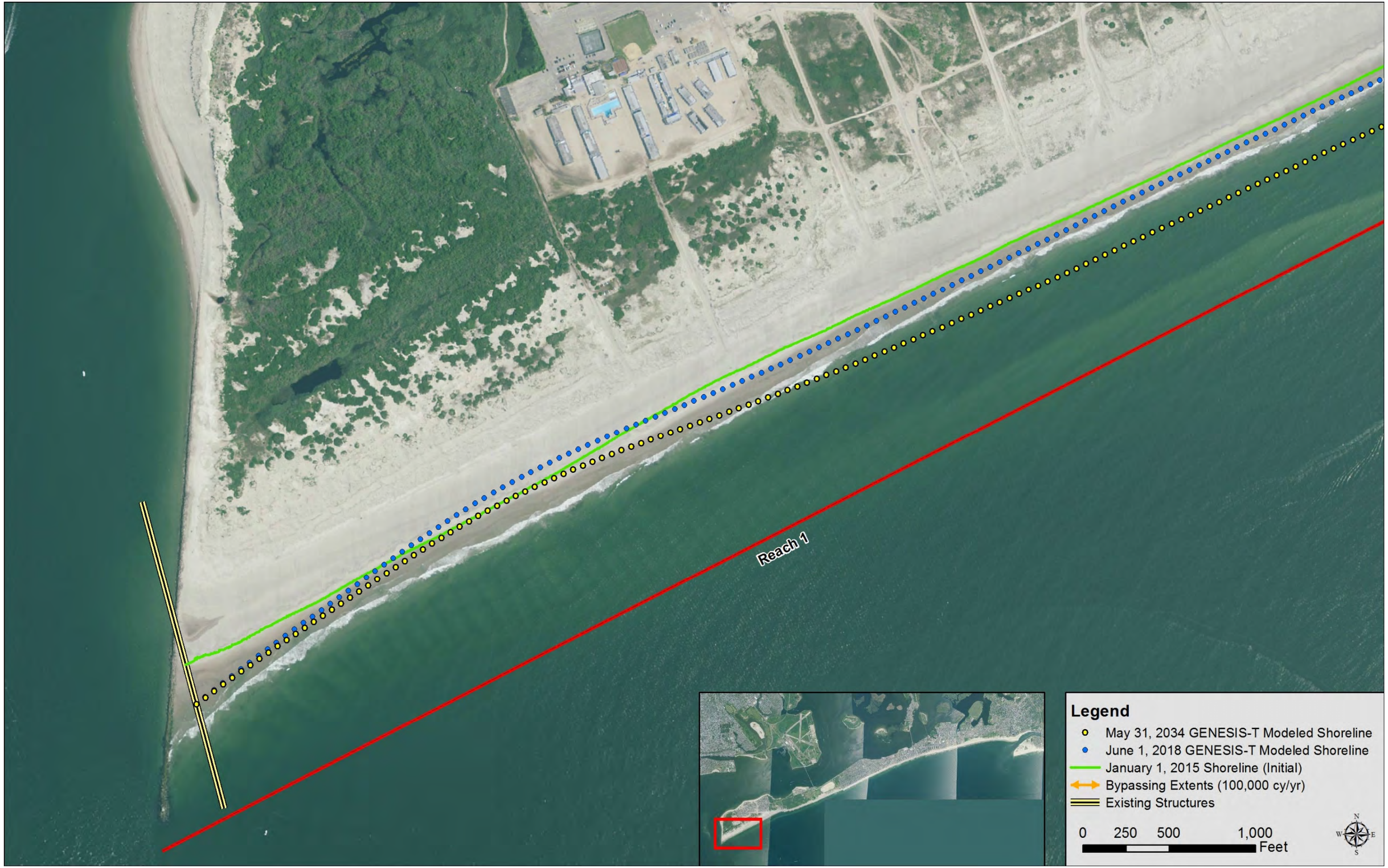
Reach 5
Reach 4
Legend
May 31, 2034 GENESIS-T Modeled Shoreline
June 1, 2018 GENESIS-T Modeled Shoreline
January 1, 2015 Shoreline (Initial)
Bypassing Extents (100,000 cy/yr)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S

Reach 4
Reach 3
Legend
May 31, 2034 GENESIS-T Modeled Shoreline
June 1, 2018 GENESIS-T Modeled Shoreline
January 1, 2015 Shoreline (Initial)
Bypassing Extents (100,000 cy/yr)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S

Reach 3
Reach 2
Legend
May 31, 2034 GENESIS-T Modeled Shoreline
June 1, 2018 GENESIS-T Modeled Shoreline
January 1, 2015 Shoreline (Initial)
Bypassing Extents (100,000 cy/yr)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S

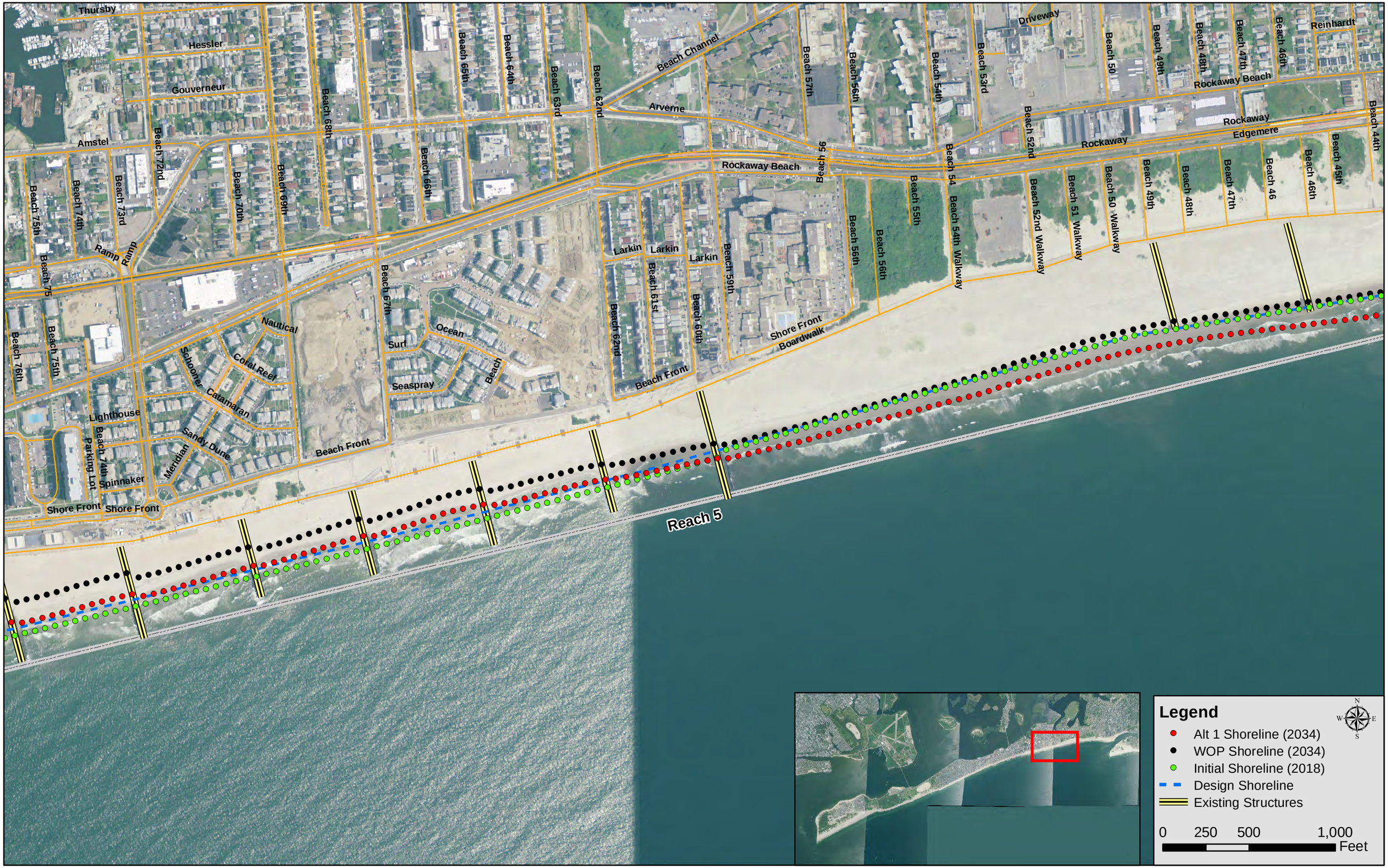

Reach 2
Legend
May 31, 2034 GENESIS-T Modeled Shoreline
June 1, 2018 GENESIS-T Modeled Shoreline
January 1, 2015 Shoreline (Initial)
Bypassing Extents (100,000 cy/yr)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S


Reach 2
Reach 1
Legend
May 31, 2034 GENESIS-T Modeled Shoreline
June 1, 2018 GENESIS-T Modeled Shoreline
January 1, 2015 Shoreline (Initial)
Bypassing Extents (100,000 cy/yr)
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

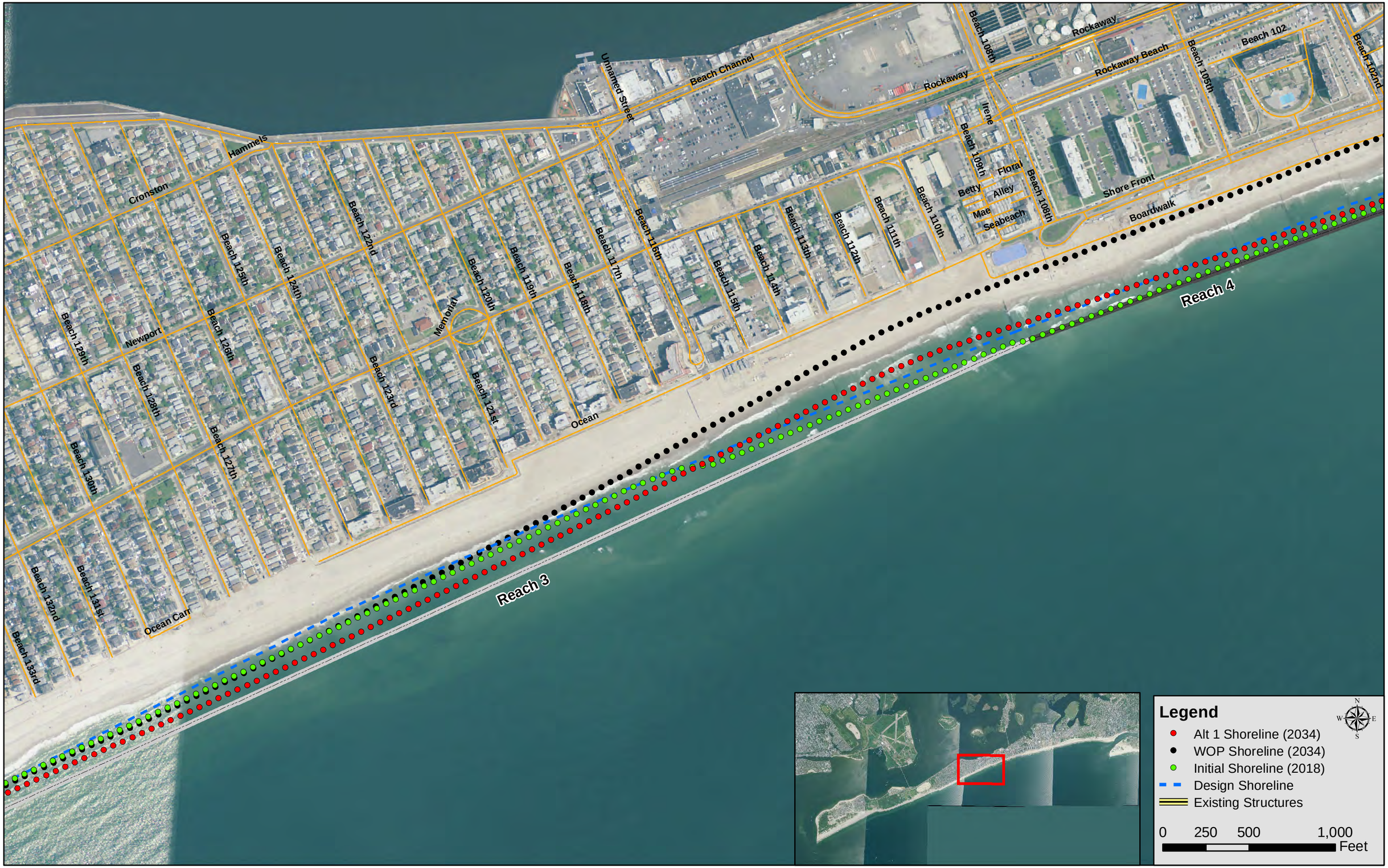

Reach 1
Legend
May 31, 2034 GENESIS-T Modeled Shoreline
June 1, 2018 GENESIS-T Modeled Shoreline
January 1, 2015 Shoreline (Initial)
Bypassing Extents (100,000 cy/yr)
Existing Structures
0 250 500 1,000
Feet
N
W
E
S

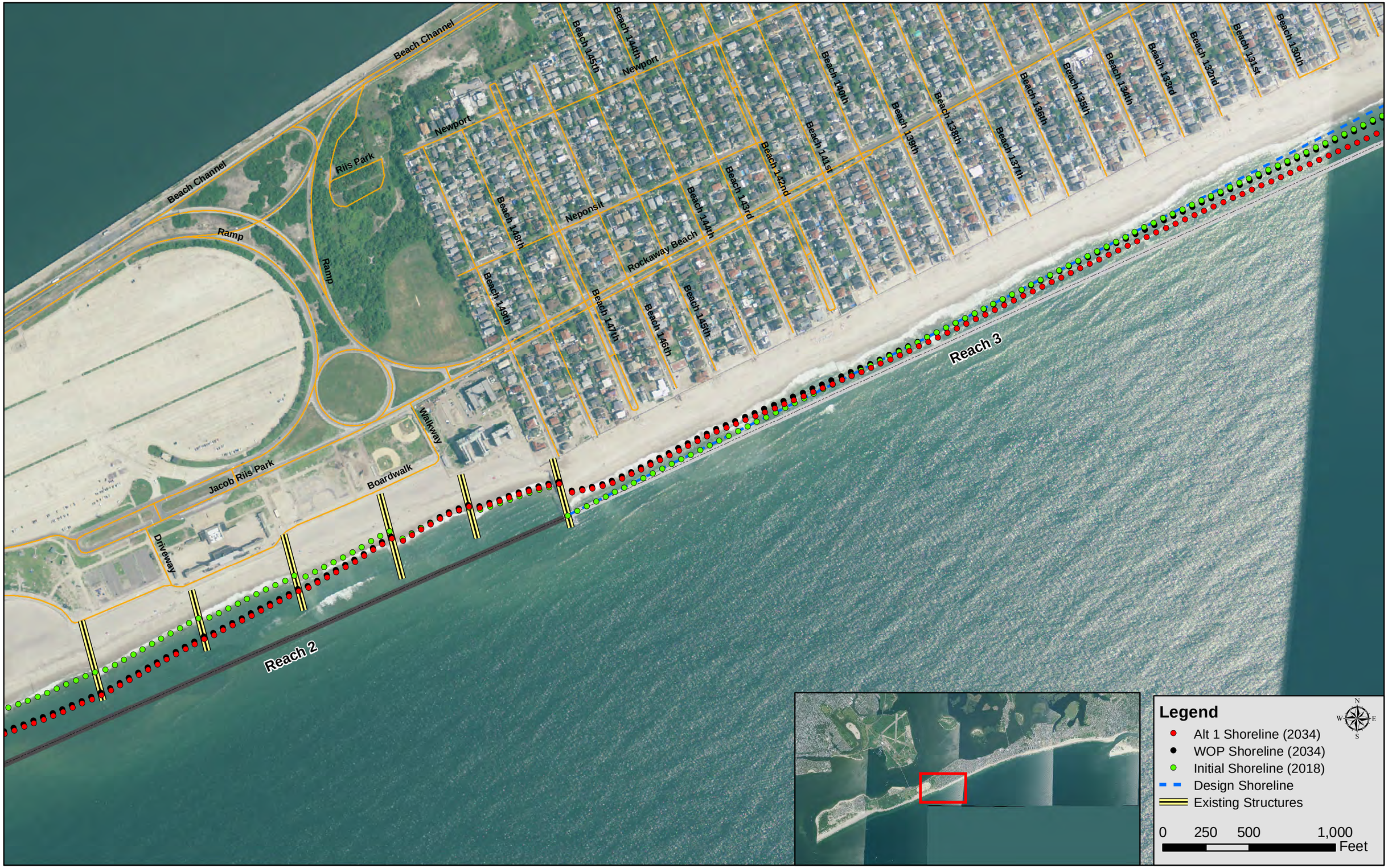
GENESIS-T ALTERNATIVE 1 – BEACH RESTORATION

Norton
Hantz
Beach Channel
Beach 48th
Beach 47th
Beach 46th
Beach 45th
Beach 44th
Beach 43rd
Beach 42nd
Beach 41st
Beach 40th
Beach 39th
Beach 38th
Beach 37th
Beach 36th
Beach Channel
Ramp
Rockaway
Edgemere
Deerfield
Beach 31st
Beach 30th
Beach 29th
Beach 28th
Beach 27th
Beach 26th
Camp
Wavlean
Highland
Edgemere
Fernside
Ramp
Beach 20th
Beach 19th
Beach 17th
Seagirt
Beach 49th
Rockaway Beach
Rockaway
Beach 48th
Beach 47th
Beach 46
Beach 46th
Beach 45thWalkway
Beach 44th
Beach 43rd
Beach 42nd
Beach 40th
Beach 37th
Beach 36
Beach 35th
Beach 34
Beach 33
Spray View
Spray View
Spray View
Beach 32nd
Surf
Lewmay
Beach 31st
Beach 30th
Beach 29th
Beach 28th
Beach 28th
Beach 27th
Beach 26th
Alley
Beach 25th
Beach 24th
Parking Lot
Parking Lot
Parking Lot
Parking Lot
Parking Lot
Driveway
Walkway
Boardwalk
Reach 5
Reach 6
Legend
Alt 1 Shoreline (2034)
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet


Thursby
Hessler
Gouverneur
Amstel
Beach 72nd
Beach 73rd
Beach 74th
Beach 75th
Beach 75
Beach 76th
Beach 75th
Beach 70th
Beach 69th
Beach 68th
Beach 66th
Beach 65th
Beach 64th
Beach 63rd
Beach 62nd
Beach Channel
Arverne
Rockaway Beach
Beach 57th
Beach 56th
Beach 54th
Beach 53rd
Driveway
Beach 52nd
Beach 50
Beach 49th
Beach 48th
Beach 47th
Beach 46th
Reinhardt
Rockaway Beach
Rockaway
Edgemere
Beach 44th
Beach 45th
Beach 46th
Beach 46
Beach 47th
Beach 48th
Beach 49th
Beach 50 Walkway
Beach 51 Walkway
Beach 52nd Walkway
Beach 54th Walkway
Beach 54
Beach 55th
Beach 56th
Beach 56th
Beach 56th
Beach 59th
Beach 60th
Beach 61st
Beach 62nd
Larkin
Larkin
Larkin
Shore Front
Boardwalk
Beach Front
Ramp
Ramp
Beach 67th
Surf
Ocean
Beach
Seaspray
Nautical
Schooner
Catamaran
Coral Reef
Lighthouse
Beach 74th
Parking Lot
Spinnaker
Sandy Dune
Meridian
Beach Front
Shore Front
Shore Front
Reach 5
Legend
Alt 1 Shoreline (2034)
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

Ramp
Cross Bay Bridge
Beach Channel
Old Beach 86th
Beach 88th
Beach 87th
Beach 86th
Beach 85th
Java
Ramp
Beach 84th
Beach 83rd
Beach 82nd
Beach Channel
Rockaway
Rockaway
Beach 81st
Beach 80th
Beach 79th
Beach 76th
Beach 75th
Beach 73rd
Schooner
Coral Reef
Catamaran
Meridian
Beach 90th
Beach 89th
Gull
Beach 92nd
Alley
Beach 91st
Unnamed Street
Ruland
Beach 88th
Beach 86th
Rockaway Beach
Parking Lot
Beach 77th
Parking Lot
Beach 74th
Spinnaker
Water
Beach Front
Shore Front
De Sota
Beach 96th
Beach 97th
Beach 98th
Cross Bay
Beach 95th
Beach 94th
Holland
Beach 92nd
Beach 91st
Beach 90th
Holland
Beach 86th
Beach 84th
Unnamed Street
Shore Front
Beach Channel
Seaside
Constance
Ida
Marie
Beach 104th
Rockaway
Steeplechase
Dalys
Alley
Beach 99th
Beach 101st
Louise
Beach 100th
Beach 96th
Beach 97th
Cross Bay
Beach 93rd
Shore Front
Ramp
Rockaway Beach
Beach 102
Beach 105th
Beach 102nd
Boardwalk
Reach 4
Reach 5
Legend
Alt 1 Shoreline (2034)
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S


Unnamed Street
Beach Channel
Rockaway
Beach 108th
Rockaway
Rockaway Beach
Beach 105th
Beach 102
Beach 102nd
Irene
Beach 109th
Floral
Alley
Betty
Mae
Seabeach
Beach 108th
Shore Front
Boardwalk
Beach 110th
Beach 111th
Beach 112th
Beach 113th
Beach 114th
Beach 115th
Beach 116th
Beach 117th
Beach 118th
Beach 119th
Beach 120th
Memorial
Beach 121st
Beach 123rd
Ocean
Hammels
Cronston
Beach 122nd
Beach 125th
Beach 124th
Beach 129th
Newport
Beach 126th
Beach 128th
Beach 127th
Beach 130th
Beach 132nd
Beach 131st
Beach 133rd
Ocean Cam
Reach 4
Reach 3
Legend
Alt 1 Shoreline (2034)
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S


Beach Channel
Beach Channel
Riis Park
Ramp
Ramp
Newport
Newport
Beach 145th
Beach 144th
Beach 148th
Beach 149th
Neponsit
Beach 147th
Beach 146th
Rockaway Beach
Beach 144th
Beach 143rd
Beach 142nd
Beach 141st
Beach 140th
Beach 139th
Beach 138th
Beach 137th
Beach 136th
Beach 135th
Beach 134th
Beach 133rd
Beach 132nd
Beach 131st
Beach 130th
Reach 3
Walkway
Jacob Riis Park
Boardwalk
Driveway
Reach 2
Legend
Alt 1 Shoreline (2034)
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet

Bayside
Seabreeze
Seabreeze
Roxbury
Bayside
Alley
Park End
Alley
Unnamed Street
Ramp
Beach Channel
Walkway
Jacob Riis Park
Driveway
Boardwalk
Browns
Creekside
Alley
Roxbury
Alley
Alley
Alley
Harmony
Oceanview
Alley
Beach 178
Hillside
Alley
Church
Parking Lot
Beach 184th
Rockaway Point
Rockaway Point
Unnamed Street
Hero
Steele
Steele
Unnamed Street
Barret
Ramp
Heinzelman
Murray
Davis
Unnamed Street
Unnamed Street
Beach 169th
Unnamed Street
East
Unnamed Street
Marshall
Center
Range
Hero
Unnamed Street
Unnamed Street
Shore
Reach 2
Legend
Alt 1 Shoreline (2034)
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

Point Breeze
Hillcrest
8th
Beach 208th
Ocean
Beach 207th
10th
Alley
9th
Arcadia
Bedford
Beach 203
Courtney
Manville
Neptune
Thetford
Doris
Reid
Beach 201st
Janet
Graham
Oceanside
Walkway
Essex
7th
Lincoln
Kildare
Jamaica
Irving
Hudson
Gotham
Fulton
Beach 207
Atlantic
Devon
Brant
Breezy Point
Beach 193rd
Beach 193
West
Range
Shore
Reach 2
Reach 1
Legend
Alt 1 Shoreline (2034)
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

Reach 1

Legend

- Alt 1 Shoreline (2034)
- WOP Shoreline (2034)
- Initial Shoreline (2018)
- Design Shoreline
- Existing Structures

N
W E
S

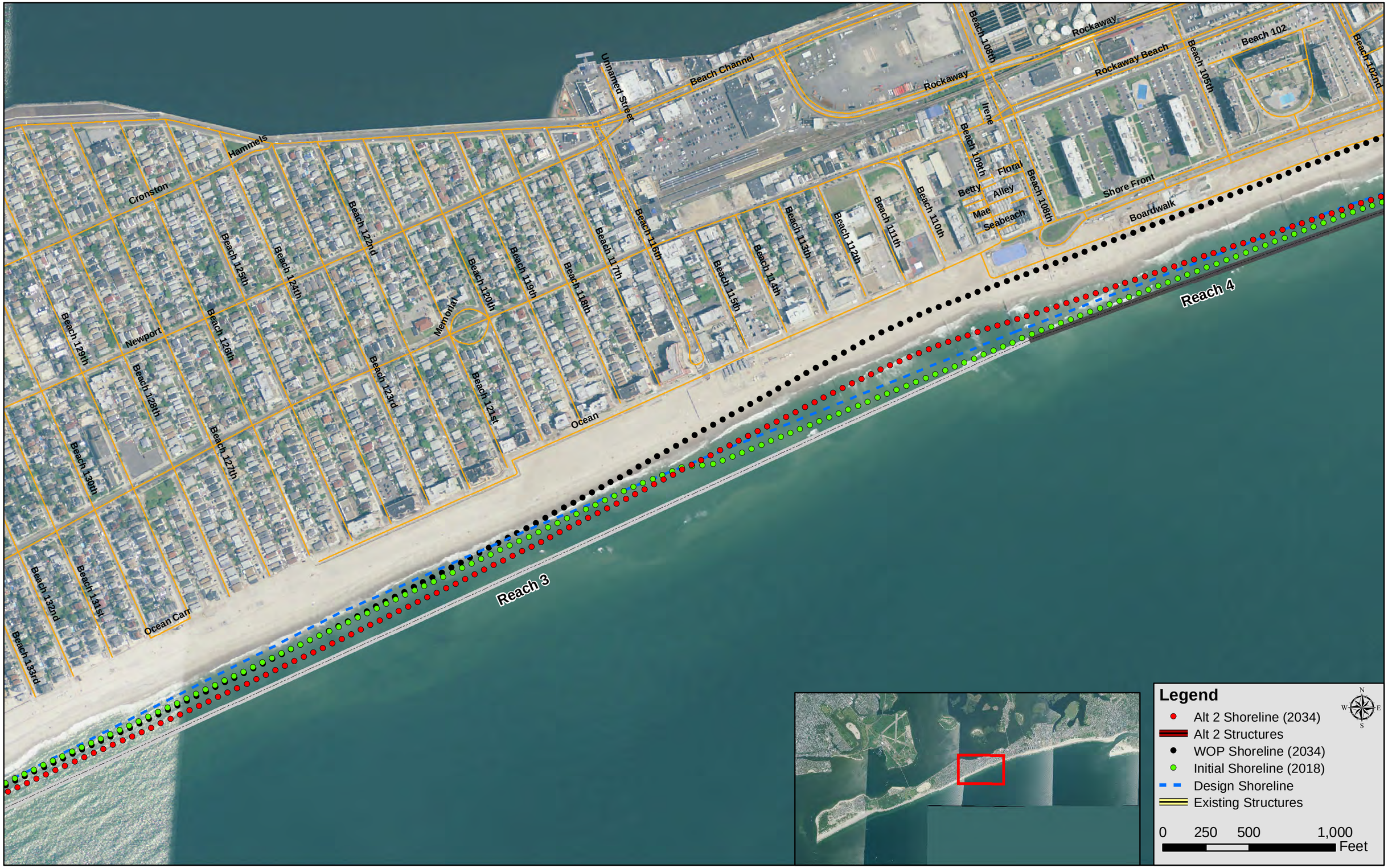
0 250 500 1,000
Feet

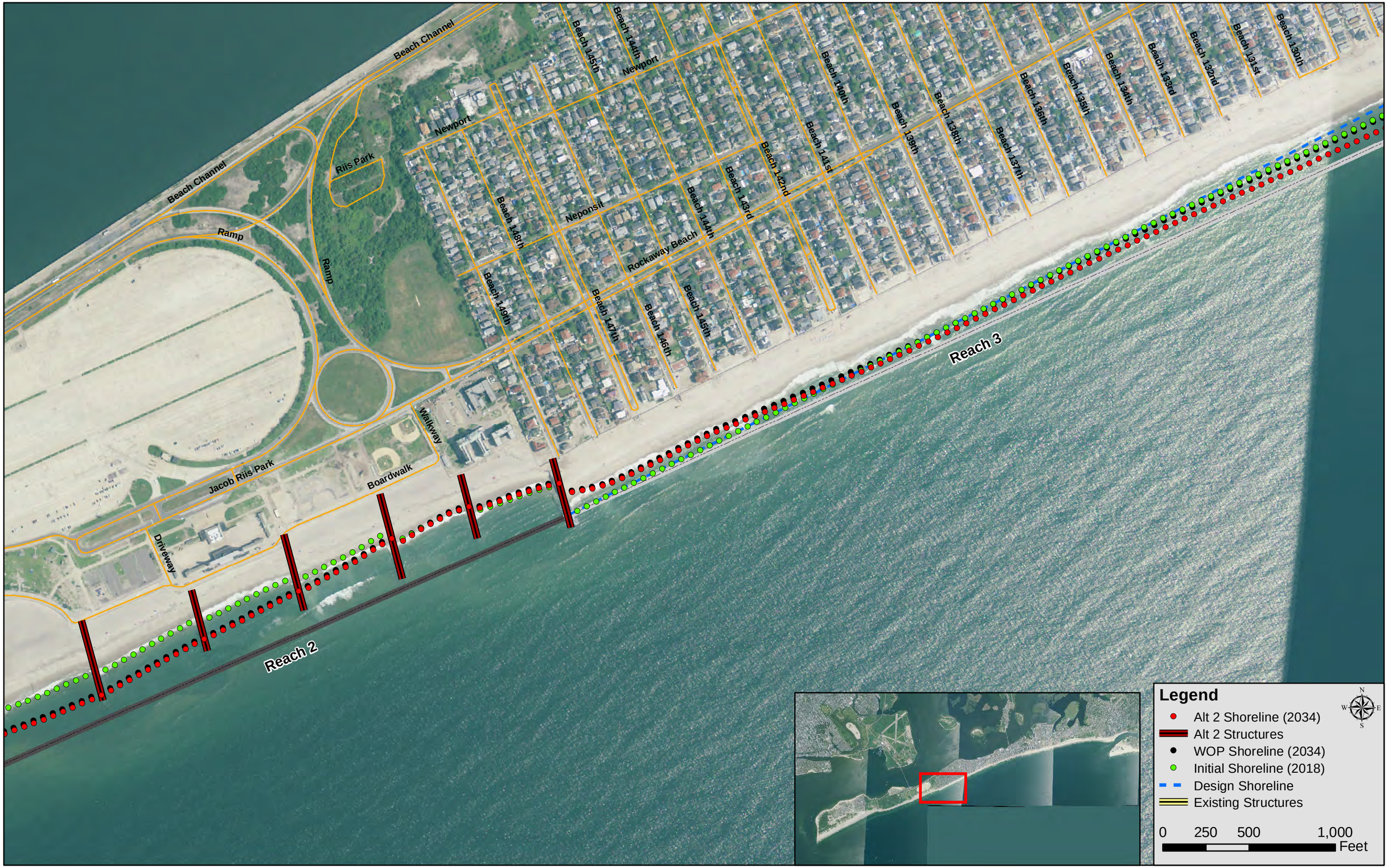
GENESIS-T ALTERNATIVE 2 – BEACH RESTORATION + REDUCED EROSION CONTROL

Norton
Hantz
Beach Channel
Beach 48th
Beach 47th
Beach 46th
Beach 45th
Beach 44th
Beach 43rd
Beach 42nd
Beach 41st
Beach 40th
Beach 39th
Beach 38th
Beach 37th
Beach 36th
Beach Channel
Ramp
Rockaway
Edgemere
Deerfield
Beach 31st
Beach 30th
Beach 29th
Beach 28th
Beach 27th
Beach 26th
Camp
Wavecrest
Edgemere
Highland
Fernside
Ramp
Beach 20th
Beach 19th
Beach 17th
Seagirt
Beach 49th
Rockaway Beach
Rockaway
Beach 48th
Beach 47th
Beach 46
Beach 46th
Beach 45thWalkway
Beach 44th
Beach 43rd
Beach 42nd
Beach 40th
Beach 37th
Beach 36
Beach 35th
Beach 34
Beach 33
Beach 32nd
Beach 31st
Beach 30th
Beach 29th
Beach 28th
Beach 27th
Beach 26th
Beach 25th
Beach 24th
Alley
Lewmay
Surf
Spray View
Spray View
Spray View
Boardwalk
Parking Lot
Parking Lot
Parking Lot
Parking Lot
Parking Lot
Driveway
Walkway
Reach 5
Reach 6
Legend
Alt 2 Shoreline (2034)
Alt 2 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet

Thursby
Hessler
Gouverneur
Amstel
Beach 72nd
Beach 73rd
Beach 74th
Beach 75th
Beach 75
Beach 76th
Beach 75th
Ramp
Ramp
Beach 70th
Beach 69th
Beach 68th
Beach 67th
Beach 66th
Beach 65th
Beach 64th
Beach 63rd
Beach 62nd
Beach Channel
Arverne
Rockaway Beach
Beach 57th
Beach 56th
Beach 54th
Beach 53rd
Driveway
Beach 52nd
Beach 50
Beach 49th
Beach 48th
Beach 47th
Beach 46th
Reinhardt
Rockaway Beach
Rockaway
Edgemere
Beach 44th
Beach 54
Beach 55th
Beach 56th
Beach 56th
Beach 56th
Beach 54th Walkway
Beach 52nd Walkway
Beach 51 Walkway
Beach 50 Walkway
Beach 49th
Beach 48th
Beach 47th
Beach 46
Beach 46th
Beach 45th
Larkin
Larkin
Larkin
Beach 62nd
Beach 61st
Beach 60th
Beach 59th
Beach Front
Shore Front
Boardwalk
Nautical
Coral Reef
Schooner
Catamaran
Lighthouse
Beach 74th
Parking Lot
Spinnaker
Sandy Dune
Meridian
Shore Front
Shore Front
Surf
Ocean
Seaspray
Beach
Beach Front
Reach 5
Legend
Alt 2 Shoreline (2034)
Alt 2 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

Ramp
Cross Bay Bridge
Beach Channel
Old Beach 86th
Beach 88th
Beach 87th
Beach 86th
Beach 85th
Java
Ramp
Beach 84th
Beach 83rd
Beach 82nd
Beach Channel
Rockaway
Rockaway
Beach 81st
Beach 80th
Beach 79th
Beach 76th
Beach 75th
Beach 73rd
Schooner
Coral Reef
Catamaran
Meridian
Beach 90th
Beach 89th
Gull
Alley
Beach 91st
Beach 92nd
Unnamed Street
Ruland
Beach 88th
Beach 86th
Rockaway Beach
Parking Lot
Beach 77th
Parking Lot
Beach 74th
Spinnaker
Water
Beach Front
Shore Front
De Sota
Beach 96th
Beach 97th
Beach 98th
Cross Bay Beach 95th
Holland
Beach 90th
Beach 84th
Unnamed Street
Beach 86th
Beach 94th
Beach 92nd
Beach 91st
Holland
Cross Bay
Beach 93rd
Shore Front
Beach Channel
Seaside
Constance
Ida
Marie
Beach 104th
Rockaway
Dalys
Steeplechase
Alley
Beach 99th
Beach 101st
Louise
Beach 100th
Ramp
Rockaway Beach
Beach 102
Beach 105th
Beach 102nd
Boardwalk
Reach 4
Reach 5
Legend
Alt 2 Shoreline (2034)
Alt 2 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S


Beach Channel
Unnamed Street
Hammels
Cronston
Newport
Rockaway
Rockaway Beach
Beach 102
Beach 102nd
Beach 105th
Beach 108th
Irene
Beach 109th
Floral
Alley
Betty
Mae
Seabeach
Beach 110th
Beach 111th
Beach 112th
Beach 113th
Beach 114th
Beach 115th
Beach 116th
Beach 117th
Beach 118th
Beach 119th
Beach 120th
Memorial
Beach 121st
Beach 122nd
Beach 123rd
Beach 124th
Beach 125th
Beach 126th
Beach 127th
Beach 128th
Beach 129th
Beach 130th
Beach 131st
Beach 132nd
Beach 133rd
Shore Front
Boardwalk
Ocean
Ocean Cam
Reach 4
Reach 3
Legend
Alt 2 Shoreline (2034)
Alt 2 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0 250 500 1,000
Feet
N
W
E
S


Beach Channel
Beach Channel
Riis Park
Ramp
Ramp
Beach 145th
Beach 144th
Newport
Newport
Beach 140th
Beach 139th
Beach 138th
Beach 137th
Beach 136th
Beach 135th
Beach 134th
Beach 133rd
Beach 132nd
Beach 131st
Beach 130th
Beach 148th
Neponsit
Beach 143rd
Beach 142nd
Beach 141st
Beach 144th
Rockaway Beach
Beach 149th
Beach 147th
Beach 146th
Beach 145th
Walkway
Jacob Riis Park
Boardwalk
Driveway
Reach 3
Reach 2
Legend
Alt 2 Shoreline (2034)
Alt 2 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet

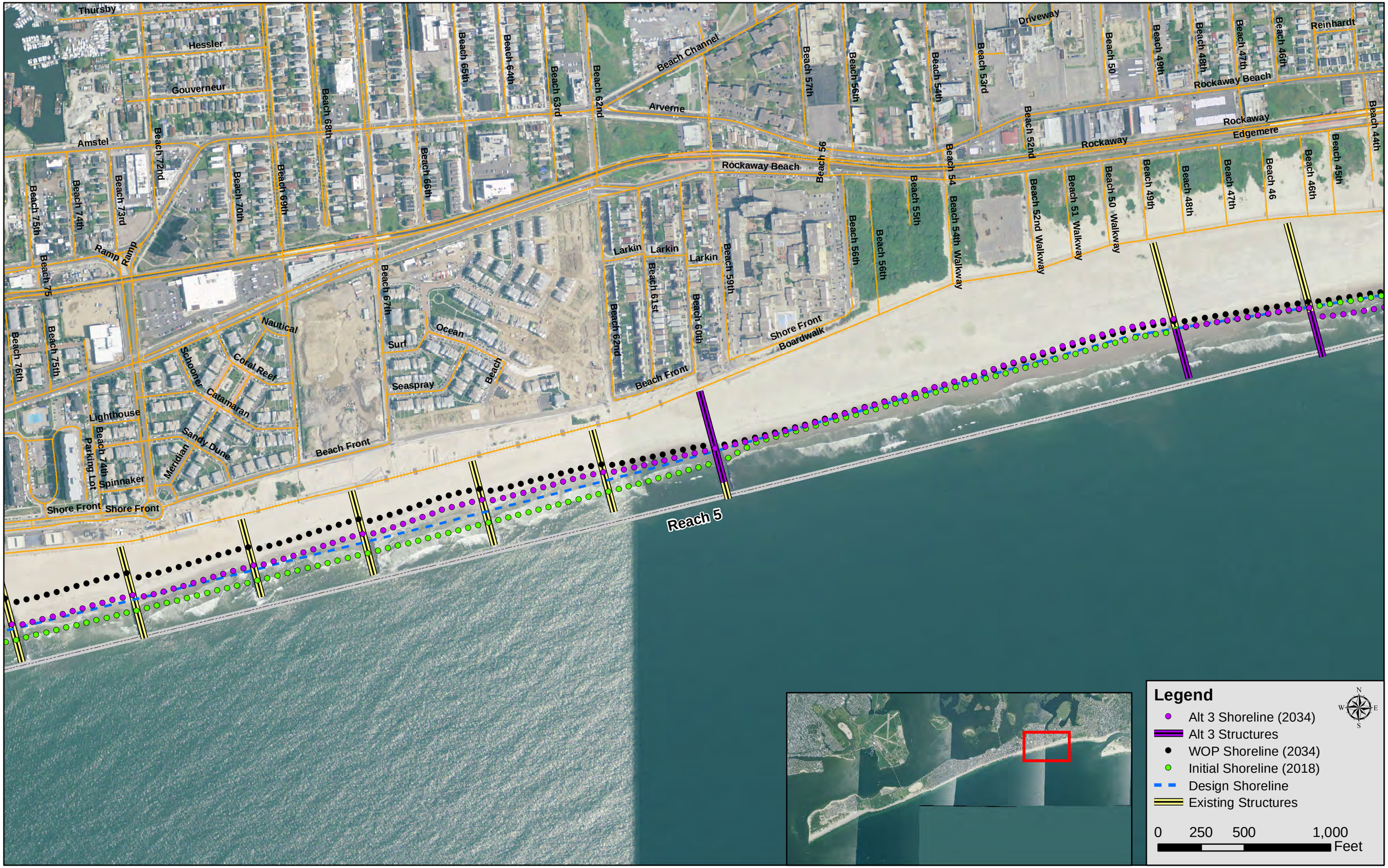
Bayside
Seabreeze
Seabreeze
Roxbury
Bayside
Alley
Park End
Alley
Unnamed Street
Ramp
Beach Channel
Walkway
Jacob Riis Park
Driveway
Boardwalk
Browns
Creekside
Alley
Roxbury
Alley
Alley
Alley
Harmony
Oceanview
Alley
Beach 178
Hillside
Alley
Church
Parking Lot
Beach 184th
Rockaway Point
Rockaway Point
Unnamed Street
Hero
Steele
Steele
Unnamed Street
Barret
Ramp
Heinzelman
Murray
Davis
Unnamed Street
Unnamed Street
Beach 169th
Unnamed Street
East
Unnamed Street
Marshall
Center
Hero
Unnamed Street
Unnamed Street
Unnamed Street
Shore
Range
Reach 2
Legend
Alt 2 Shoreline (2034)
Alt 2 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet

Point Breeze
Hillcrest
8th
Beach 208th
Ocean
Beach 207th
Alley
10th
9th
Arcadia
Bedford
Beach 203
Courtney
Manville
Neptune
Thetford
Doris
Janet
Reid
Beach 201st
Beach 193rd
West
Range
Shore
Oceanside
7th
Essex
Walkway
Graham
Lincoln
Kildare
Jamaica
Irving
Hudson
Gotham
Fulton
Beach 207
Atlantic
Devon
Brant
Breezy Point
Reach 2
Reach 1
Legend
Alt 2 Shoreline (2034)
Alt 2 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

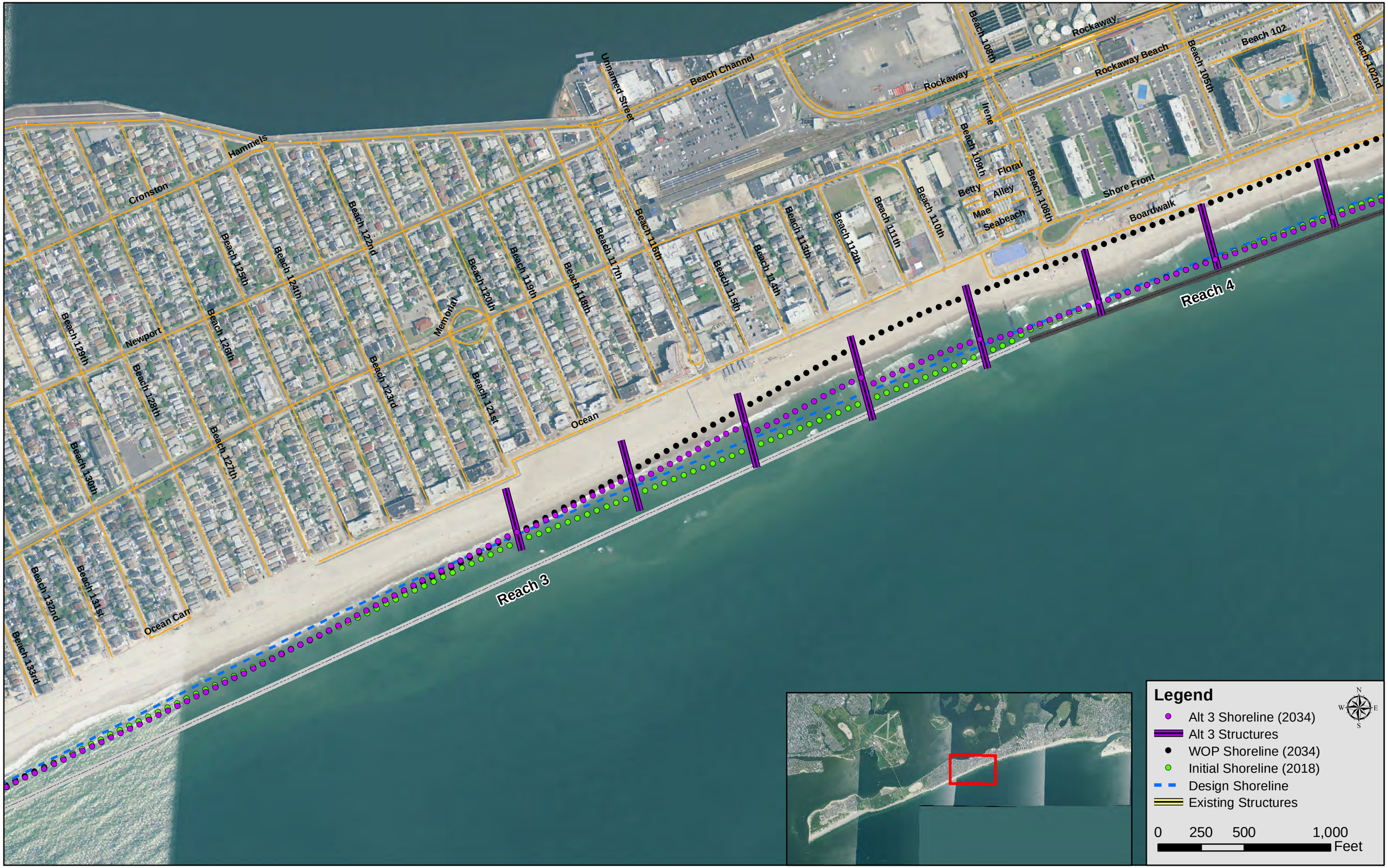
Reach 1
Legend
Alt 2 Shoreline (2034)
Alt 2 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet

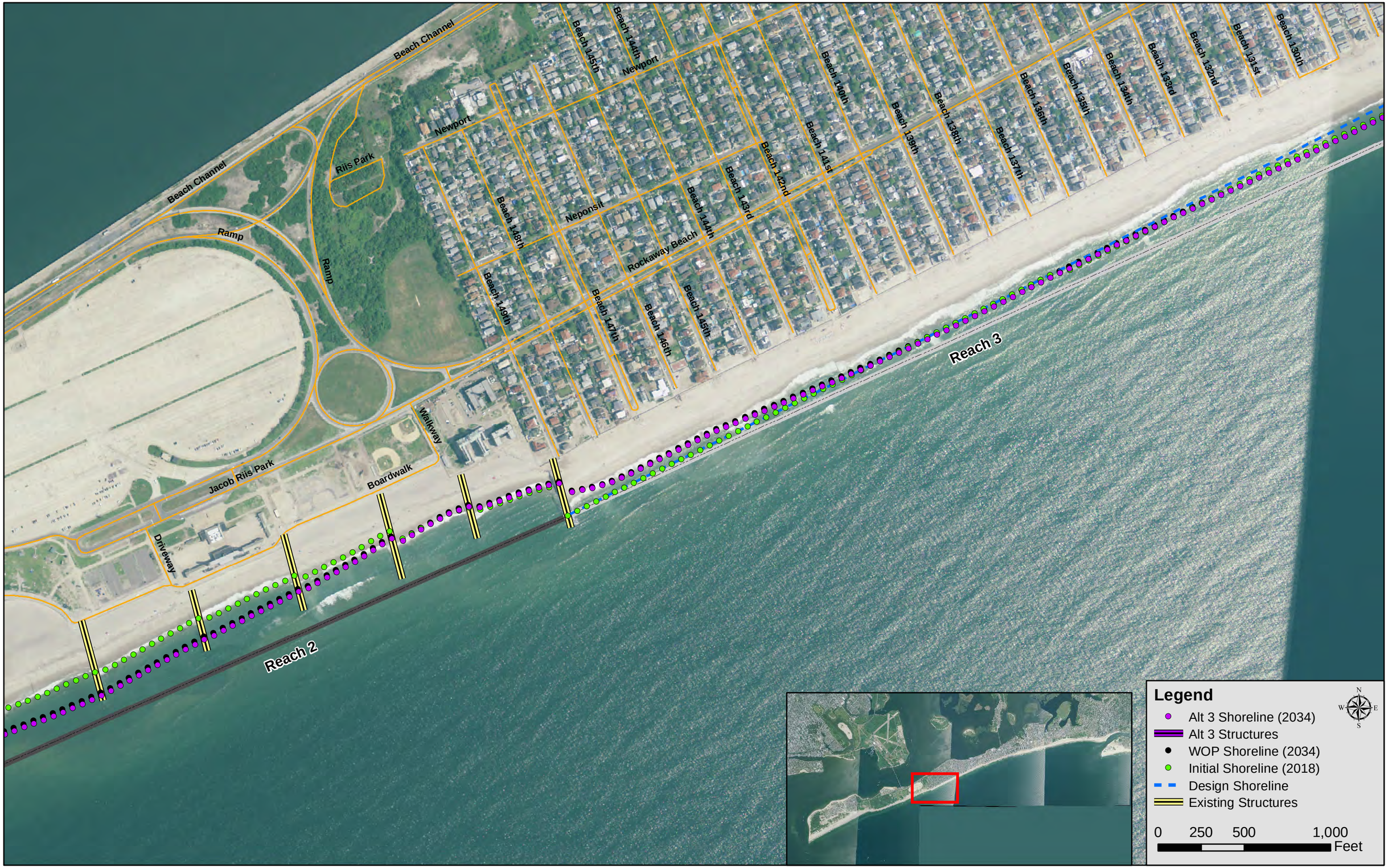
GENESIS-T ALTERNATIVE 3 – BEACH RESTORATION + INCREASED EROSION CONTROL

Norton
Hantz
Beach 48th
Beach 47th
Beach Channel
Beach 46th
Beach 45th
Beach 44th
Beach 43rd
Beach 42nd
Beach 41st
Beach 40th
Beach 39th
Beach 38th
Beach 37th
Beach 36th
Beach Channel
Ramp
Rockaway
Edgemere
Deerfield
Beach 31st
Beach 30th
Beach 29th
Beach 28th
Beach 27th
Beach 26th
Camp
Wavlean
Edgemere
Highland
Fernside
Ramp
Crest
Beach 20th
Beach 19th
Beach 17th
Seagirt
Beach 49th
Rockaway Beach
Rockaway
Beach 48th
Beach 47th
Beach 46
Beach 46th
Beach 45thWalkway
Beach 44th
Beach 43rd
Beach 42nd
Beach 40th
Beach 37th
Beach 36
Beach 35th
Beach 34
Beach 33
Beach 32nd
Beach 31st
Lewmay
Beach 31st
Beach 30th
Beach 29th
Beach 28th
Beach 28th
Beach 27th
Beach 26th
Alley
Beach 25th
Beach 24th
Parking Lot
Parking Lot
Parking Lot
Parking Lot
Parking Lot
Driveway
Walkway
Surf
Spray View
Spray View
Spray View
Boardwalk
Reach 5
Reach 6
Legend
Alt 3 Shoreline (2034)
Alt 3 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet


Thursby
Hessler
Gouverneur
Amstel
Beach 72nd
Beach 68th
Beach 65th
Beach 64th
Beach 63rd
Beach 62nd
Beach Channel
Arverne
Beach 57th
Beach 56th
Beach 54th
Beach 53rd
Driveway
Beach 50
Beach 49th
Beach 48th
Beach 47th
Beach 46th
Reinhardt
Rockaway Beach
Rockaway
Edgemere
Beach 44th
Beach 52nd
Beach 54
Beach 75th
Beach 74th
Beach 73rd
Beach 70th
Beach 69th
Beach 66th
Rockaway Beach
Beach 55th
Beach 54th Walkway
Beach 52nd Walkway
Beach 51 Walkway
Beach 50 Walkway
Beach 49th
Beach 48th
Beach 47th
Beach 46
Beach 46th
Beach 45th
Ramp
Ramp
Beach 75
Beach 76th
Beach 75th
Nautical
Schooner
Catamaran
Coral Reef
Lighthouse
Beach 74th
Parking Lot
Spinnaker
Meridian
Sandy Dune
Shore Front
Shore Front
Beach 67th
Surf
Ocean
Seaspray
Beach
Beach Front
Larkin
Larkin
Larkin
Beach 62nd
Beach 61st
Beach 60th
Beach 59th
Beach 56th
Beach 56th
Shore Front
Boardwalk
Beach Front
Reach 5
Legend
Alt 3 Shoreline (2034)
Alt 3 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet

Ramp
Cross Bay Bridge
Beach Channel
Old Beach 86th
Beach 88th
Beach 87th
Beach 86th
Java
Beach 85th
Ramp
Beach 84th
Beach 83rd
Beach 82nd
Beach 81st
Beach 80th
Beach 79th
Beach 76th
Beach 75th
Rockaway
Rockaway
Coral Reef
Schooner
Catamaran
Beach 73rd
Beach 73rd
Meridian
Beach 74th
Spinnaker
Water
Beach Front
Parking Lot
Parking Lot
Beach 77th
Unnamed Street
Rockaway Beach
Shore Front
Ruland
Beach 88th
Beach 86th
Beach 90th
Gull
Beach 91st
Alley
Beach 92nd
Unnamed Street
De Sota
Beach 96th
Beach 97th
Beach 98th
Cross Bay
Beach 95th
Beach 94th
Holland
Beach 92nd
Beach 91st
Beach 90th
Holland
Beach 86th
Beach 84th
Shore Front
Beach 93rd
Cross Bay
Beach Channel
Seaside
Constance
Ida
Marie
Beach 104th
Rockaway
Steeplechase
Dalys
Alley
Beach 99th
Beach 101st
Louise
Beach 100th
Beach 102nd
Rockaway Beach
Beach 102
Beach 105th
Ramp
Boardwalk
Reach 4
Reach 5
Legend
Alt 3 Shoreline (2034)
Alt 3 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S


Unnamed Street
Beach Channel
Rockaway
Beach 108th
Rockaway
Rockaway Beach
Beach 105th
Beach 102
Beach 102nd
Irene
Beach 109th
Floral
Alley
Betty
Mae
Seabeach
Beach 108th
Shore Front
Boardwalk
Beach 110th
Beach 111th
Beach 112th
Beach 113th
Beach 114th
Beach 115th
Beach 116th
Beach 117th
Beach 118th
Beach 119th
Beach 120th
Memorial
Beach 121st
Beach 123rd
Beach 122nd
Beach 124th
Beach 125th
Beach 126th
Beach 127th
Beach 128th
Beach 129th
Beach 130th
Beach 131st
Beach 132nd
Beach 133rd
Hammels
Cronston
Newport
Ocean
Ocean Cam
Reach 4
Reach 3
Legend
Alt 3 Shoreline (2034)
Alt 3 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet


Beach Channel
Beach Channel
Riis Park
Ramp
Ramp
Beach 145th
Beach 144th
Newport
Newport
Beach 148th
Neponsit
Beach 149th
Beach 147th
Beach 146th
Beach 144th
Beach 143rd
Beach 142nd
Rockaway Beach
Beach 145th
Beach 141st
Beach 140th
Beach 139th
Beach 138th
Beach 137th
Beach 136th
Beach 135th
Beach 134th
Beach 133rd
Beach 132nd
Beach 131st
Beach 130th
Walkway
Jacob Riis Park
Boardwalk
Driveway
Reach 3
Reach 2
Legend
Alt 3 Shoreline (2034)
Alt 3 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
N
W
E
S
0
250
500
1,000
Feet

Bayside
Seabreeze
Seabreeze
Roxbury
Bayside
Alley
Alley
Alley
Alley
Park End
Alley
Hillside
Alley
Church
Beach 178
Alley
Oceanview
Harmony
Roxbury
Alley
Browns
Creekside
Parking Lot
Beach 184th
Rockaway Point
Rockaway Point
Unnamed Street
Hero
Steele
Murray
Steele
Unnamed Street
Heinzelman
Unnamed Street
Ramp
Barret
Ramp
Beach Channel
Walkway
Jacob Riis Park
Driveway
Boardwalk
Davis
Unnamed Street
Unnamed Street
Beach 169th
Unnamed Street
East
Unnamed Street
Marshall
Center
Unnamed Street
Range
Hero
Unnamed Street
Unnamed Street
Shore
Reach 2
Legend
Alt 3 Shoreline (2034)
Alt 3 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

Point Breeze
Hillcrest
8th
Beach 208th
Ocean
Beach 207th
10th
Alley
9th
Arcadia
Bedford
Beach 203
Courtney
Alley
Manville
Neptune
Thetford
Doris
Reid
Beach 201st
Janet
Graham
Oceanside
Walkway
Essex
7th
Lincoln
Kildare
Jamaica
Irving
Hudson
Gotham
Fulton
Beach 207
Atlantic
Devon
Brant
Breezy Point
Beach 193rd
Beach 193
West
Range
Shore
Reach 2
Reach 1
Legend
Alt 3 Shoreline (2034)
Alt 3 Structures
WOP Shoreline (2034)
Initial Shoreline (2018)
Design Shoreline
Existing Structures
0
250
500
1,000
Feet
N
W
E
S

Reach 1

Legend

- Alt 3 Shoreline (2034)
- Alt 3 Structures
- WOP Shoreline (2034)
- Initial Shoreline (2018)
- Design Shoreline
- Existing Structures

N
W E
S

0 250 500 1,000
Feet

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Sub Appendix A1-B:

SCREENING LEVEL COST ESTIMATES SUPPORTING DATA

US Army Corps of Engineers

B. SUB-APPENDIX A1.B: SCREENING LEVEL COST ESTIMATES SUPPORTING DATA

TABLE OF CONTENTS

B.1 INTRODUCTION....4
B.2 PROJECT DESCRIPTION....5
B.3 ROCKAWAY SHOREFRONT SCREENING....6

Attachment A: Erosion Control

Attachment B: Low Alternatives

Attachment C: Intermediate Alternatives

Attachment D: High Alternatives

B.1 INTRODUCTION

This Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet Hurricane Sandy General Revaluation Report Cost Engineering Screening Appendix summarizes the cost engineering and analyses applied to evaluate and compare alternative features for each planning reach within the study area. There are two reaches within the study area: 1) the Atlantic Shorefront, 2) Jamaica Bay. Since each planning reach is exposed to different risk mechanisms two engineering appendices are included within this GRR/EIS: Appendix A1 - Shorefront Engineering and Design Appendix, and Appendix A2 - Jamaica Bay High Frequency Flood Risk Reduction Features Engineering and Design Appendix.

This Cost Engineering Screening Appendix provides an overview of the cost analyses supporting both the screening process for the High Frequency Flood Risk Reduction Features (HFFRRF) for Jamaica Bay and the shorefront alternatives.

The initial study was initially limited to the Atlantic Ocean Shoreline Planning Reach and was conducted as a legacy study. The engineering analyses were conducted to satisfy a more rigorous design level and the Atlantic Ocean shorefront summary engineering documents were written to satisfy those study requirements (USACE-NAN, 2016). The Jamaica Bay Planning Reach analysis was added following Hurricane Sandy and was conducted to broaden the recommended plan to the entire authorized study area and was conducted under SMART planning guidelines.

As a result of the Agency Decision Milestone, the storm surge barrier component of the Tentatively Selected Plan was moved into the New York and New Jersey Harbor and Tributaries Study for further study and possible recommendation. Without the barrier, the communities surrounding Jamaica Bay still experience substantial risk for coastal flooding. Therefore, the study team sought to identify stand-alone features that could complement a potential future storm surge barrier, but also be economically justified on their own. Residents in many parts of the Jamaica Bay area experience regular flooding due to rainfall events and high tides that occur frequently. Since the proposed barrier would not be closed at every high tide or rainfall event, there is an opportunity to recommend features to mitigate flood risk for high frequency flooding events where the proposed storm surge barrier would remain open yet inundation still occurs.

B.2 PROJECT DESCRIPTION

Location

Please refer to Figure 1-1 of the Shorefront Engineering Appendix A1 and Figure 2-4 in the HFFRRF Engineering Appendix A2 for details relating to the project location.

Feature Descriptions

The alternative development options for the shorefront are detailed in Section 7 of the Shorefront Engineering Appendix (A1).

B.3 ROCKAWAY SHOREFRONT SCREENING

The Rockaway shorefront E&D Appendix presents and discusses Erosion Control alternatives and Coastal Storm Risk Management (CSRM) alternatives for the Atlantic Ocean Shorefront Planning Reach. Although previously presented and screened (USACE-NAN, 2016)[1], the cost estimates and benefits were updated to current price levels.

This screening process was updated for this report, with the composite seawall still providing the most benefits (see Appendix A1). Cost estimates for all shorefront reach alternatives (both Erosion Control Alternatives and CSRM alternatives) are provided in Attachment A - D.

[1] USACE-NAN. (2016). Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay - Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement.

ATTACHMENT A
EROSION CONTROL ALTERNATIVES
SCREENING LEVEL COST ESTIMATES

EROSION CONTROL
ALTERNATIVE 1N

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 1n
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 5
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 1,225,000.00	$ 1,225,000	
2	Renourishment	1	LS	$ 7,975,000.00	$ 7,975,000	
3	Major Rehab	1	LS	$332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ -	$ -	
5	Monitoring	1	LS	$403,000.00	$ 403,000	
	SUBTOTAL				**$ 9,935,000**	

Total Annual Cost $ 9,935,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 1n
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 5
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: R. Hampson

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 19,548,000.00	$ 19,548,000	
	SUBTOTAL				**$ 22,848,000**	
	CONTINGENCY 18.60%				$ 4,250,000	
	SUBTOTAL				**$ 27,098,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 2,285,000	
	CONTINGENCY 15.25%				$ 348,000	
	SUBTOTAL				**$ 2,633,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.85%	$ 1,794,000	
	CONTINGENCY 15.25%				$ 274,000	
	SUBTOTAL				**$ 2,068,000**	

First Cost		$	31,799,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,051,000
Interest During Construction		$	215,000
Total Investment Cost		**$**	**33,065,000**
Annualized Total Investment Cost		**$**	**1,225,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	6.70
IDC Factor	0.006559521

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 1n
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 5
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 12,867,000.00	$ 12,867,000	
	SUBTOTAL				**$ 16,167,000**	
	CONTINGENCY 30.47%				$ 4,926,000	
	SUBTOTAL				**$ 21,093,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,617,000	
	CONTINGENCY 15.25%				$ 247,000	
	SUBTOTAL				**$ 1,864,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.16%	$ 1,319,000	
	CONTINGENCY 15.25%				$ 201,000	
	SUBTOTAL				**$ 1,520,000**	

First Cost		$	24,477,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	809,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**25,286,000**

Annualized TotalRenourishment Cost **$ 7,975,261** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	7.609319

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 1n
Feasibility Estimate

Discipline: Beachfill-Initial | Sheet: 4 OF 5
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	304,000	CY	$ 12.88	$ 3,915,520	design + advance fill
4	Beachfill-Reach 4	456,000	CY	$ 12.88	$ 5,873,280	design + advance fill
5	Beachfill-Reach 5	252,000	CY	$ 12.88	$ 3,245,760	design + advance fill
6	Beachfill-Reach 6a	391,000	CY	$ 12.88	$ 5,036,080	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	61	AC	$ 20,000.00	$ 1,220,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 19,548,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	22,848,000
CONTINGENCY 18.6%		$	4,249,728
Escalation 2Q 2016 to 2Q 2018	3.31%	$	896,000
GRAND TOTAL CONSTRUCTION COST		**$**	**27,993,728**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 1n
Feasibility Estimate

Discipline: Beachfill-Ren. Sheet: 5 OF 5
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	133,000	CY	$ 12.88	$ 1,713,040	advance fill - 3-year cycle
4	Beachfill-Reach 4	416,000	CY	$ 12.88	$ 5,358,080	advance fill - 3-year cycle
5	Beachfill-Reach 5	250,000	CY	$ 12.88	$ 3,220,000	advance fill - 3-year cycle
6	Beachfill-Reach 6a	200,000	CY	$ 12.88	$ 2,576,000	advance fill - 3-year cycle
	SUBTOTAL	**999,000**	**CY**		**$ 12,867,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	16,167,000
CONTINGENCY 30.47%		$	4,926,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	697,000
GRAND TOTAL CONSTRUCTION COST		**$**	**21,093,000**

EROSION CONTROL
ALTERNATIVE 2N

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 2n
Feasibility Estimate

Discipline: Annualized Cost Sheet: 1 OF 7
Prepared by: R. Hampson Date: 4/20/2015
Updated: M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 5,314,000.00	$ 5,314,000	
2	Renourishment	1	LS	$ 6,153,000.00	$ 6,153,000	
3	Major Rehab	1	LS	$332,000	$ 332,000	
4	Groin Maintenance	1	LS	$ 62,000	$ 62,000	
5	Monitoring	1	LS	$403,000	$ 403,000	
	SUBTOTAL				**$ 12,264,000**	

Total Annual Cost $ 12,264,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 2n
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
Updated: M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 15,890,000.00	$ 15,890,000	
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	Groin Shortening in Reach 5	1	LS	$ 8,998,000.00	$ 8,998,000	
02	Boardwalk Relocation	1	LS	$ 19,677,000.00	$ 19,677,000	
	SUBTOTAL				**$ 50,365,000**	
	CONTINGENCY 33.46%				$ 16,852,000	
	SUBTOTAL				**$ 67,217,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ 40,000,000.00	$ 40,000,000	
	CONTINGENCY 48.97%				$ 19,588,000	
	SUBTOTAL				**$ 59,588,000**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 5,037,000	
	CONTINGENCY 15.25%				$ 768,000	
	SUBTOTAL				**$ 5,805,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.13%	$ 3,591,000	
	CONTINGENCY 15.25%				$ 548,000	
	SUBTOTAL				**$ 4,139,000**	

First Cost		$ 136,749,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 4,520,000
Interest During Construction		$ 2,207,000
Total Investment Cost		**$ 143,476,000**

Annualized Total Investment Cost **$ 5,314,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	14.51
IDC Factor	0.015623805

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 2n
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
Updated: M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 13,717,000.00	$ 13,717,000	
	SUBTOTAL				**$ 17,017,000**	
	CONTINGENCY 30.47%				$ 5,185,000	
	SUBTOTAL				**$ 22,202,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,702,000	
	CONTINGENCY 15.25%				$ 260,000	
	SUBTOTAL				**$ 1,962,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.12%	$ 1,382,000	
	CONTINGENCY 15.25%				$ 211,000	
	SUBTOTAL				**$ 1,593,000**	

First Cost		$	25,757,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	851,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**26,608,000**

Annualized TotalRenourishment Cost **$ 6,152,870** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 2n
Feasibility Estimate

Discipline: Beachfill-Initial Sheet: 4 OF 7
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
Updated: M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	315,000	CY	$ 12.88	$ 4,057,200	design + advance fill
4	Beachfill-Reach 4	378,000	CY	$ 12.88	$ 4,868,640	design + advance fill
5	Beachfill-Reach 5	341,000	CY	$ 12.88	$ 4,392,080	design + advance fill
6	Beachfill-Reach 6a	85,000	CY	$ 12.88	$ 1,094,800	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	61	AC	$ 20,000.00	$ 1,220,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 15,890,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	19,190,000
CONTINGENCY 33.46%		$	6,421,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	847,000
GRAND TOTAL CONSTRUCTION COST		**$**	**26,458,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 2n
Feasibility Estimate

Discipline: Groins | Sheet: 5 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
Updated: M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Groin Shortening in Reach 5 - Excavation						
	Items					
1	Excavation - Armor Stone (8 TON)	27,900	TON	$ 59.74	$ 1,666,746	Excavate 150 feet of groin (OS & Head)
2	Excavation - Underlayer Stone (500-1500 lbs)	5,850	TON	$ 43.38	$ 253,773	
3	Excavation - Core Stone (30-130 lbs)	3,300	TON	$ 34.70	$ 114,510	
4	Excavation - Bedding Stone (30-130 lbs)	13,650	TON	$ 34.70	$ 473,655	
5	Excavation - Geotextile Filter Layer	12,750	SY	$ 9.18	$ 117,045	
6	Excavation - Sand	21,900	CY	$ 7.24	$ 158,556	
	SUBTOTAL				**$ 2,784,000**	*$1,856* per LF
Groin Shortening in Reach 5 - Reset Stone						
	Items					
1	Reset - Armor Stone (8 TON)	16,300	TON	$ 66.38	$ 1,081,994	
2	Reset - Bedding Stone (30-130 lbs)	8,350	TON	$ 27.54	$ 229,959	
3	Replace - Geotextile Filter Layer	5,200	SY	$ 23.68	$ 123,136	
	SUBTOTAL				**$ 1,435,000**	*$2,870* per LF
Groin Shortening in Reach 5 - Disposal						
	Items					
1	Dispose - Armor Stone (8 TON)	11,600	TON	$ 118.00	$ 1,368,800	
2	Dispose - Underlayer Stone (500-1500 lbs)	5,900	TON	$ 66.00	$ 389,400	
3	Dispose - Core Stone (30-130 lbs)	3,300	TON	$ 52.00	$ 171,600	
4	Dispose - Bedding Stone (30-130 lbs)	5,400	TON	$ 52.00	$ 280,800	
5	Dispose - Filter Fabric	7,600	SY	$ 9.00	$ 68,400	
	SUBTOTAL				**$ 2,279,000**	*$2,279* per LF
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	8,998,000
CONTINGENCY 33.46%		$	3,011,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	397,000
GRAND TOTAL CONSTRUCTION COST		**$**	**12,406,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 2n
Feasibility Estimate

Discipline: Beachfill-Ren | Sheet: 6 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
Updated: M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	133,000	CY	$ 12.88	$ 1,713,040	advance fill - 4-year cycle
4	Beachfill-Reach 4	333,000	CY	$ 12.88	$ 4,289,040	advance fill - 4-year cycle
5	Beachfill-Reach 5	599,000	CY	$ 12.88	$ 7,715,120	advance fill - 4-year cycle
6	Beachfill-Reach 6a	-	CY	$ 12.88	$ -	advance fill - 4-year cycle
	SUBTOTAL	**1,065,000**	**CY**		**$ 13,717,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	17,017,000
CONTINGENCY 30.47%		$	5,185,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	734,000
GRAND TOTAL CONSTRUCTION COST		**$**	**22,202,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 2n
Feasibility Estimate

Discipline: Structural | Sheet: 7 OF 7
Prepared by: R. Hampson | Date: 12/2/2014
Updated: S. Jessup | Date: 7/11/2018
Updated: M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Boardwalk						
	Items					
1	Precast Concrete Pile Cap	1,232	CY	$ 1,500.00	$ 1,848,000	77 caps @ 16 cy each
2	Precast Concrete Pile Cap with Light Post	360	CY	$ 1,500.00	$ 540,000	20 caps @ 18 cy each
3	Precast Concrete Deck Plank	4,296	CY	$ 1,000.00	$ 4,296,000	2,900' x 40' x 1'
4	24" Steel Pipe Pile	19,400	LF	$ 135.00	$ 2,619,000	194 piles @ 24x1/2" WT (100 ft long)
5	Cast in Place Concrete Plug	135	CY	$ 500.00	$ 67,500	194 plugs
6	Handrail	5,800	LF	$ 150.00	$ 870,000	Furnish and Install
7	Benches	52	EA	$ 4,000.00	$ 208,000	Furnish and Install
8	Sand Fill	34,370	CY	$ 10.00	$ 343,700	Move, Stockpile, Rehandle
	Other Items					
	Electrical Utilities	1	EA	$ 431,688.00	$ 431,688	4% of total cost
	Pedestrian Access Stairs/Ramps	1	EA	$ 431,688.00	$ 431,688	4% of total cost
	Mechanical Utilities	1	EA	$ 215,844.00	$ 215,844	2% of total cost
	Misc. Boardwalk Furnature/Utilities	1	EA	$ 215,844.00	$ 215,844	2% of total cost
	SUBTOTAL				$ 12,087,000	
Sand Retaining Wall						
	Items					
1	HP14x89 Pile	10,150	LF	$ 110.00	$ 1,116,500	290 HP @ 35 ft each
2	Precast Concrete Panel	859	CY	$ 850.00	$ 730,150	2900'x10'x0.8'
	SUBTOTAL				$ 1,847,000	
Demolition						
	Items					
1	Boardwalk	116,000	SF	$ 35.00	$ 4,060,000	Demo and Dispose of Boardwalk
2	Sand Retaining Wall	2,900	LF	$ 150.00	$ 435,000	Demo and Dispose of Boardwalk
3	Credit for reuse of 24" Steel Pipe Piles	19,400	LF	$ (95.00)	$ (1,843,000)	Reuse 24" Piles and Splice 5' of Pile
4	Credit for reuse of HP14x89 Piles	10,150	LF	$ (50.00)	$ (507,500)	Reuse HP Piles and Splice 5' of Pile
5	Credit for reuse Precast Concrete Panel	859	CY	$ 400.00	$ 343,600	Reuse Precast Concrete Panels
6	Credit on disposal of reused Items	116,000	SF	$ (10.00)	$ (1,160,000)	Disposal not required for reused Items
	SUBTOTAL				$ 1,328,000	
General						
	Items					
1	Mob/Demob	1	EA	$ 1,000,000.00	$ 1,000,000	
	SUBTOTAL				$ 1,000,000	

SUBTOTAL		$	16,262,000
GENERAL CONDITIONS 10%		$	1,626,000
SUBTOTAL (ALL ITEMS)		$	17,888,000
G. C. OVERHEAD & PROFIT 10%		$	1,789,000
TOTAL		$	19,677,000
CONTINGENCY 33.46%		$	6,584,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	868,000
GRAND TOTAL CONSTRUCTION COST		**$**	**27,129,000**

26,261,000
59,588,000

EROSION CONTROL
ALTERNATIVE 3N

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 2,679,000.00	$ 2,679,000	
2	Renourishment	1	LS	$ 5,950,000.00	$ 5,950,000	
3	Major Rehab	1	LS	$332,000	$ 332,000	
4	Groin Maintenance	1	LS	$ 176,000.00	$ 176,000	
5	Monitoring	1	LS	$403,000	$ 403,000	
	SUBTOTAL				**$ 9,540,000**	

Total Annual Cost $ 9,540,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,204,000.00	$ 17,204,000	
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
	SUBTOTAL				**$ 48,348,000**	
	CONTINGENCY 22.41%				$ 10,835,000	
	SUBTOTAL				**$ 59,183,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 4,835,000	
	CONTINGENCY 15.25%				$ 737,000	
	SUBTOTAL				**$ 5,572,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.16%	$ 3,462,000	
	CONTINGENCY 15.25%				$ 528,000	
	SUBTOTAL				**$ 3,990,000**	

First Cost		$ 68,745,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 2,272,000
Interest During Construction		$ 1,307,000
Total Investment Cost		**$ 72,324,000**
Annualized Total Investment Cost		**$ 2,679,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	16.88
IDC Factor	0.018406369

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 13,150,000.00	$ 13,150,000	
	SUBTOTAL				**$ 16,450,000**	
	CONTINGENCY 30.47%				$ 5,012,000	
	SUBTOTAL				**$ 21,462,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,645,000	
	CONTINGENCY 15.25%				$ 251,000	
	SUBTOTAL				**$ 1,896,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.15%	$ 1,341,000	
	CONTINGENCY 15.25%				$ 205,000	
	SUBTOTAL				**$ 1,546,000**	

First Cost		$	24,904,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	823,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**25,727,000**

Annualized TotalRenourishment Cost **$ 5,950,011** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n
Feasibility Estimate

Discipline: Beachfill-Initial | Sheet: 4 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	61	AC	$ 20,000.00	$ 1,220,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,204,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,504,000
CONTINGENCY 22.41%		$	4,594,946
Escalation 2Q 2016 to 2Q 2018	3.31%	$	830,000
GRAND TOTAL CONSTRUCTION COST		**$**	**25,928,946**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n
Feasibility Estimate

Discipline: Groins | Sheet: 5 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	27,844,000
CONTINGENCY 22.41%		$	6,239,840
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,127,000
GRAND TOTAL CONSTRUCTION COST		**$**	**35,210,840**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n
Feasibility Estimate

Discipline: Beachfill-Ren | Sheet: 6 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	444,000	CY	$ 12.88	$ 5,718,720	advance fill - 4-year cycle
4	Beachfill-Reach 4	133,000	CY	$ 12.88	$ 1,713,040	advance fill - 4-year cycle
5	Beachfill-Reach 5	444,000	CY	$ 12.88	$ 5,718,720	advance fill - 4-year cycle
6	Beachfill-Reach 6a	-	CY	$ 12.88	$ -	advance fill - 4-year cycle
	SUBTOTAL	**1,021,000**	**CY**		**$ 13,150,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	16,450,000
CONTINGENCY 30.47%		$	5,012,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	709,000
GRAND TOTAL CONSTRUCTION COST		**$**	**21,462,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Summary
Feasibility Estimate

Discipline: Annualized Cost Sheet: 1 OF 1
Prepared by: R. Hampson Date: 4/20/2015
Updated: M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Alt 1n	Alt 2n	Alt 3n			
Annualized Costs - 4 year Cycle							
	Items						
1	Total Investment	$1,225,000	$5,314,000	$2,679,000			
2	Renourishment	$7,975,000	$6,153,000	$5,950,000			
3	Major Rehab	$332,000	$332,000	$332,000			
4	Groin Maintenance	$0	$62,000	$176,000			
5	Monitoring	$403,000	$403,000	$403,000			
	Total	**$9,935,000**	**$12,264,000**	**$9,540,000**			

Contract No.: W912DS-09-0009
Task Order No.: 26

Summary
Feasibility Estimate

Discipline: Initial Costs Sheet: 1 OF 1
Prepared by: R. Hampson Date: 4/20/2015
Updated: M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Alt 1n	Alt 2n	Alt 3n			
Initial Costs							
	Items						
1	Beachfill	$22,848,000	$19,190,000	$20,504,000			
2	Groin Construction/Modification	$0	$11,498,000	$27,844,000			
3	Boardwalk Relocation	$0	$59,677,000	$0			
4	PED	$2,285,000	$5,037,000	$4,835,000			
5	Construction Mangement	$1,794,000	$3,591,000	$3,462,000			
6	Contingency	$5,923,000	$42,276,000	$14,372,000			
	Total	**$32,850,000**	**$141,269,000**	**$71,017,000**			
	IDC	$215,000	$2,207,000	$1,307,000			
		$33,065,000	$143,476,000	$72,324,000			

Contract No.: W912DS-09-0009
Task Order No.: 26

Summary
Feasibility Estimate

Discipline: Ren Cost | Sheet: 1 OF 1
Prepared by: R. Hampson | Date: 4/20/2015
Updated: M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Alt 1n	Alt 2n	Alt 3n			
Renourishment Costs - Per Operation							
	Items						
1	Beachfill	$16,167,000	$17,017,000	$16,450,000			
2	PED	$1,617,000	$1,702,000	$1,645,000			
3	Construction Mangement	$1,319,000	$1,382,000	$1,341,000			
4	Contingencies	$6,183,000	$6,507,000	$6,291,000			
	Total	**$25,286,000**	**$26,608,000**	**$25,727,000**			
	Total over project life	**$215,309,467**	**$166,110,072**	**$160,633,447**			

ATTACHMENT
CSRM ALTERNATIVES
LOW SEA LEVEL CHANGE
SCREENING LEVEL COST
ESTIMATES

CSRM ALTERNATIVES
LOW SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N MEDIUM DUNE

Discipline: Annualized Cost | Sheet: 1 OF 6

Contract No.: W912DS-09-0009 | **Alternative 3n - Medium** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 2,679,000.00	$ 2,679,000	
2	Renourishment	1	LS	$ 5,950,000.00	$ 5,950,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ 176,000.00	$ 176,000	
5	Monitoring	1	LS	$403,000	$ 403,000	
	SUBTOTAL				**$ 9,540,000**	

Total Annual Cost $ 9,540,000

Discipline: First Costs | Sheet: 2 OF 6

Contract No.: W912DS-09-0009 | **Alternative 3n - Medium** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,204,000.00	$ 17,204,000	
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
	SUBTOTAL				**$ 48,348,000**	
	CONTINGENCY 22.41%				$ 10,835,000	
	SUBTOTAL				**$ 59,183,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 4,835,000	
	CONTINGENCY 15.25%				$ 737,000	
	SUBTOTAL				**$ 5,572,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.16%	$ 3,462,000	
	CONTINGENCY 15.25%				$ 528,000	
	SUBTOTAL				**$ 3,990,000**	

First Cost		$ 68,745,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 2,272,000
Interest During Construction		$ 1,307,000
Total Investment Cost		**$ 72,324,000**
Annualized Total Investment Cost		**$ 2,679,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	16.88
IDC Factor	0.018406454

Discipline: Ren. Costs | Sheet: 3 OF 6

Contract No.: W912DS-09-0009 | **Alternative 3n - Medium** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 13,150,000.00	$ 13,150,000	
	SUBTOTAL				**$ 16,450,000**	
	CONTINGENCY 30.47%				$ 5,012,000	
	SUBTOTAL				**$ 21,462,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,645,000	
	CONTINGENCY 15.25%				$ 251,000	
	SUBTOTAL				**$ 1,896,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.15%	$ 1,341,000	
	CONTINGENCY 15.25%				$ 205,000	
	SUBTOTAL				**$ 1,546,000**	

First Cost		$	24,904,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	823,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**25,727,000**

Annualized TotalRenourishment Cost **$ 5,950,000** from ammoritization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Discipline: Beachfill-Initial | Sheet: 4 OF 6

Contract No.: W912DS-09-0009 | **Alternative 3n - Medium** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	61	AC	$ 20,000.00	$ 1,220,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,204,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,504,000
CONTINGENCY 22.41%		$	4,594,946
Escalation 2Q 2016 to 2Q 2018	3.31%	$	830,000
GRAND TOTAL CONSTRUCTION COST		**$**	**25,928,946**

Contract No.: W912DS-09-0009 | **Alternative 3n - Medium** | Discipline: Groins | Sheet: 5 OF 6
Task Order No.: 26 | **Feasibility Estimate** | Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018
Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	27,844,000
CONTINGENCY 22.41%		$	6,239,840
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,127,000
GRAND TOTAL CONSTRUCTION COST		**$**	**35,210,840**

Discipline: Beachfill-Ren | Sheet: 6 OF 6

Contract No.: W912DS-09-0009 | **Alternative 3n - Medium** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	444,000	CY	$ 12.88	$ 5,718,720	advance fill - 4-year cycle
4	Beachfill-Reach 4	133,000	CY	$ 12.88	$ 1,713,040	advance fill - 4-year cycle
5	Beachfill-Reach 5	444,000	CY	$ 12.88	$ 5,718,720	advance fill - 4-year cycle
6	Beachfill-Reach 6a	-	CY	$ 12.88	$ -	advance fill - 4-year cycle
	SUBTOTAL	**1,021,000**	**CY**		**$ 13,150,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	16,450,000
CONTINGENCY 30.47%		$	5,012,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	709,000
GRAND TOTAL CONSTRUCTION COST		**$**	**22,171,000**

CSRM ALTERNATIVES
LOW SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N LARGE DUNE

Discipline: Annualized Cost | Sheet: 1 OF 6

Contract No.: W912DS-09-0009 | **Alternative 3n - Large** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 3,616,000.00	$ 3,616,000	
2	Renourishment	1	LS	$ 6,392,000.00	$ 6,392,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ 195,000.00	$ 195,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
	SUBTOTAL				**$ 10,938,000**	

Total Annual Cost $ 10,938,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: First Costs Sheet:
Prepared by: R. Hampson Date:
Updated: S. Jessup Date:

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Updated: M. Kluijver Date:

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 31,110,000.00	$ 31,110,000	
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 19,483,000.00	$ 19,483,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,333,000.00	$ 2,333,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 6,786,000.00	$ 6,786,000	extend 5 groins
	SUBTOTAL				**$ 65,512,000**	
	CONTINGENCY 21.64%				$ 14,177,000	
	SUBTOTAL				**$ 79,689,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 6,551,000	
	CONTINGENCY 15.25%				$ 999,000	
	SUBTOTAL				**$ 7,550,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.89%	$ 4,514,000	
	CONTINGENCY 15.25%				$ 688,000	
	SUBTOTAL				**$ 5,202,000**	

First Cost		$	92,441,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	3,056,000
Interest During Construction		$	2,129,000
Total Investment Cost		**$**	**97,626,000**
Annualized Total Investment Cost		**$**	**3,616,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	20.19
IDC Factor	0.022297379

4/20/2015

7/11/2018

7/13/2018

/ Basis

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 14,387,000.00	$ 14,387,000	
	SUBTOTAL				**$ 17,687,000**	
	CONTINGENCY 30.47%				$ 5,389,000	
	SUBTOTAL				**$ 23,076,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,769,000	
	CONTINGENCY 15.25%				$ 270,000	
	SUBTOTAL				**$ 2,039,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.08%	$ 1,429,000	
	CONTINGENCY 15.25%				$ 218,000	
	SUBTOTAL				**$ 1,647,000**	

First Cost		$ 26,762,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 885,000
Interest During Construction		$ -
Total Renourishment Cost		**$ 27,647,000**
Annualized TotalRenourishment Cost		**$ 6,392,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Discipline: Beachfill-Initial Sheet: 4 OF 6

Contract No.: W912DS-09-0009 **Alternative 3n - Large** Prepared by: R. Hampson Date: 4/20/2015

Task Order No.: 26 **Feasibility Estimate** Updated: S. Jessup Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Updated: M. Kluijver Date: 7/13/2018

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	611,000	CY	$ 12.88	$ 7,869,680	design + advance fill
4	Beachfill-Reach 4	478,000	CY	$ 12.88	$ 6,156,640	design + advance fill
5	Beachfill-Reach 5	758,000	CY	$ 12.88	$ 9,763,040	design + advance fill
6	Beachfill-Reach 6a	417,000	CY	$ 12.88	$ 5,370,960	design + advance fill
7	Beachfill-Reach 6b	38,000	CY	$ 12.88	$ 489,440	design + advance fill
8	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 31,110,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	34,410,000
CONTINGENCY 21.64%		$	7,446,324
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,384,000
GRAND TOTAL CONSTRUCTION COST		**$**	**43,240,324**

Contract No.: W912DS-09-0009
Task Order No.: 26
Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Alternative 3n - Large Feasibility Estimate

Discipline: Groins | Sheet: 5 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
Updated: M. Kluijver | Date: 7/13/2018
Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	61,007	TON	$ 193.30	$ 11,792,556	12 groins @ a total of 4519 ft
2	Underlayer Stone (500-1500 lbs)	19,884	TON	$ 104.68	$ 2,081,415	
3	Core Stone (30-130 lbs)	12,201	TON	$ 92.87	$ 1,133,135	
4	Bedding Stone (30-130 lbs)	31,181	CY	$ 92.87	$ 2,895,789	
5	Geotextile Filter Fabric	34,796	SY	$ 23.68	$ 823,976	
6	Excavation - Sand	104,389	CY	$ 7.24	$ 755,776	
	SUBTOTAL				**$ 19,483,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	7,306	TON	$ 193.30	$ 1,412,250	1 groin @ 562 ft
2	Underlayer Stone (500-1500 lbs)	2,585	TON	$ 104.68	$ 270,619	
3	Core Stone (30-130 lbs)	1,574	TON	$ 92.87	$ 146,140	
4	Bedding Stone (30-130 lbs)	3,541	CY	$ 92.87	$ 328,816	
5	Geotextile Filter Fabric	4,215	SY	$ 23.68	$ 99,811	
6	Excavation - Sand	10,453	CY	$ 7.24	$ 75,681	
	SUBTOTAL				**$ 2,333,000**	*$4,151* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	24,206	TON	$ 193.30	$ 4,679,020	5 groin extensions @ a total of 980'
2	Underlayer & Core Stone (500-1500 lbs)	5,096	TON	$ 104.68	$ 533,449	
3	Core Stone (30-130 lbs)	3,234	TON	$ 92.87	$ 300,342	
4	Bedding Stone (30-130 lbs)	10,192	CY	$ 92.87	$ 946,531	
5	Geotextile Filter Fabric	9,212	SY	$ 23.68	$ 218,140	
6	Excavation - Sand	14,994	CY	$ 7.24	$ 108,557	
	SUBTOTAL				**$ 6,786,000**	*$6,924* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	31,102,000
CONTINGENCY 21.64%		$	6,730,473
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,251,000
GRAND TOTAL CONSTRUCTION COST		**$**	**39,083,473**

Contract No.: W912DS-09-0009
Task Order No.: 26
Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Alternative 3n - Large Feasibility Estimate

Discipline: Beachfill-Ren | Sheet: 6 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
Updated: M. Kluijver | Date: 7/13/2018
Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	511,000	CY	$ 12.88	$ 6,581,680	advance fill - 4-year cycle
4	Beachfill-Reach 4	133,000	CY	$ 12.88	$ 1,713,040	advance fill - 4-year cycle
5	Beachfill-Reach 5	473,000	CY	$ 12.88	$ 6,092,240	advance fill - 4-year cycle
6	Beachfill-Reach 6a	-	CY	$ 12.88	$ -	advance fill - 4-year cycle
	SUBTOTAL	**1,117,000**	**CY**		**$ 14,387,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	17,687,000
CONTINGENCY 30.47%		$	5,389,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	763,000
GRAND TOTAL CONSTRUCTION COST		**$**	**23,839,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 5,581,000.00	$ 5,581,000	
2	Renourishment	1	LS	$ 6,829,000.00	$ 6,829,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ 218,000.00	$ 218,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
	SUBTOTAL				**$ 13,363,000**	

Total Annual Cost $ 13,363,000

CSRM ALTERNATIVES
LOW SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N BURRIED SEAWALL

Discipline: First Costs | Sheet: 2 OF 7

Contract No.: W912DS-09-0009 | **Alternative 3n - XL** | Prepared by: R. Hampson | Date: 5/1/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 6,600,000.00	$ 6,600,000	
17	Beachfill	1	LS	$ 52,885,000.00	$ 52,885,000	
2	Access Ramps	8	LS	$ 825,000.00	$ 6,600,000	Demo & Rebuild 8 Concrete Access Ramps
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 21,345,000.00	$ 21,345,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,483,000.00	$ 2,483,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 8,032,000.00	$ 8,032,000	extend 5 groins
	SUBTOTAL				**$ 100,445,000**	
	CONTINGENCY 22.84%				$ 22,942,000	
	SUBTOTAL				**$ 123,387,000**	

Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	

Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 10,045,000	
	CONTINGENCY 15.25%				$ 1,532,000	
	SUBTOTAL				**$ 11,577,000**	

Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.50%	$ 6,529,000	
	CONTINGENCY 15.25%				$ 996,000	
	SUBTOTAL				**$ 7,525,000**	

First Cost			$ 142,489,000
Escalation 2Q 2016 to 2Q 2018		3.31%	$ 4,710,000
Interest During Construction			$ 3,462,000
Total Investment Cost			**$ 150,661,000**
Annualized Total Investment Cost			**$ 5,581,000**
Interest Rate	2.750%		
Life	50		
Capital Recovery Factor	0.03704		
Construction Period in months	21.22		
IDC Factor	0.023517518		

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 15,611,000.00	$ 15,611,000	
	SUBTOTAL				**$ 18,911,000**	
	CONTINGENCY 30.47%				$ 5,762,000	
	SUBTOTAL				**$ 24,673,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,891,000	
	CONTINGENCY 15.25%				$ 288,000	
	SUBTOTAL				**$ 2,179,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.02%	$ 1,517,000	
	CONTINGENCY 15.25%				$ 231,000	
	SUBTOTAL				**$ 1,748,000**	

First Cost		$	28,600,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	945,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**29,545,000**

Annualized TotalRenourishment Cost **$ 6,829,000** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009 | **Alternative 3n - XL** | Discipline: Beachfill-Initial | Sheet: 4 OF 7

Task Order No.: 26 | **Feasibility Estimate** | Prepared by: R. Hampson | Date: 5/1/2015

Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	1,044,000	CY	$ 12.88	$ 13,446,720	design + advance fill
4	Beachfill-Reach 4	827,000	CY	$ 12.88	$ 10,651,760	design + advance fill
5	Beachfill-Reach 5	1,424,000	CY	$ 12.88	$ 18,341,120	design + advance fill
6	Beachfill-Reach 6a	621,000	CY	$ 12.88	$ 7,998,480	design + advance fill
7	Beachfill-Reach 6b	58,000	CY	$ 12.88	$ 747,040	design + advance fill
8	Dune Grass Planting	85	AC	$ 20,000.00	$ 1,700,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 52,885,000**	
General						
	Items					
1	Mob/Demob	2	EA	$ 3,300,000.00	$ 6,600,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 6,600,000**	

TOTAL		$	59,485,000
CONTINGENCY 22.84%		$	13,586,374
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,415,000
GRAND TOTAL CONSTRUCTION COST		**$**	**75,486,374**

Discipline: Groins | Sheet: 5 OF 7

Contract No.: W912DS-09-0009 | **Alternative 3n - XL** | Prepared by: R. Hampson | Date: 5/1/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	66,839	TON	$ 193.30	$ 12,919,882	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	21,784	TON	$ 104.68	$ 2,280,391	
3	Core Stone (30-130 lbs)	13,368	TON	$ 92.87	$ 1,241,458	
4	Bedding Stone (30-130 lbs)	34,162	CY	$ 92.87	$ 3,172,616	
5	Geotextile Filter Fabric	38,123	SY	$ 23.68	$ 902,746	
6	Excavation - Sand	114,368	CY	$ 7.24	$ 828,025	
	SUBTOTAL				**$ 21,345,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	7,774	TON	$ 193.30	$ 1,502,714	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,751	TON	$ 104.68	$ 287,954	
3	Core Stone (30-130 lbs)	1,674	TON	$ 92.87	$ 155,502	
4	Bedding Stone (30-130 lbs)	3,767	CY	$ 92.87	$ 349,878	
5	Geotextile Filter Fabric	4,485	SY	$ 23.68	$ 106,205	
6	Excavation - Sand	11,123	CY	$ 7.24	$ 80,529	
	SUBTOTAL				**$ 2,483,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	28,652	TON	$ 193.30	$ 5,538,432	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	6,032	TON	$ 104.68	$ 631,430	
3	Core Stone (30-130 lbs)	3,828	TON	$ 92.87	$ 355,506	
4	Bedding Stone (30-130 lbs)	12,064	CY	$ 92.87	$ 1,120,384	
5	Geotextile Filter Fabric	10,904	SY	$ 23.68	$ 258,207	
6	Excavation - Sand	17,748	CY	$ 7.24	$ 128,496	
	SUBTOTAL				**$ 8,032,000**	*$6,924* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	34,360,000
CONTINGENCY 22.84%		$	7,847,824
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,395,000
GRAND TOTAL CONSTRUCTION COST		**$**	**43,602,824**

Discipline: Beachfill-Ren | Sheet: 6 OF 7

Contract No.: W912DS-09-0009 | **Alternative 3n - XL** | Prepared by: R. Hampson | Date: 5/1/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	577,000	CY	$ 12.88	$ 7,431,760	advance fill - 4-year cycle
4	Beachfill-Reach 4	133,000	CY	$ 12.88	$ 1,713,040	advance fill - 4-year cycle
5	Beachfill-Reach 5	502,000	CY	$ 12.88	$ 6,465,760	advance fill - 4-year cycle
6	Beachfill-Reach 6a	-	CY	$ 12.88	$ -	advance fill - 4-year cycle
	SUBTOTAL	**1,212,000**	**CY**		**$ 15,611,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	18,911,000
CONTINGENCY 30.47%		$	5,762,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	816,000
GRAND TOTAL CONSTRUCTION COST		**$**	**25,489,000**

Discipline: Structural | Sheet: 7 OF 7

Contract No.: W912DS-09-0009 | **Alternative 3n - XL** | Prepared by: R. Hampson | Date: 5/1/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Boardwalk Access Ramps						
	Items					
1	24" Steel Pipe Pile	342	LF	$ 135.00	$ 46,170	9 piles @ 24x1/2" WT (38 ft long)
2	Precast Concrete Pile Cap	46	CY	$ 1,500.00	$ 69,000	9 caps @ 5.1 cy each
3	Cast in Place Concrete Plug	6	CY	$ 500.00	$ 3,000	9 plugs
4	Cast in Place Concrete Deck	18	CY	$ 1,000.00	$ 17,500	9 @ 4'6" x 10' x 14"
5	Precast Concrete Deck	102	CY	$ 1,000.00	$ 102,000	278' x 10' x 14"
6	RPL Decking	2,780	SF	$ 50.00	$ 139,000	Furnish and Install
7	Handrail	556	LF	$ 150.00	$ 83,400	Furnish and Install
	SUBTOTAL				$ 460,000	
Demolition						
	Items					
1	Access Ramps	2,780	SF	$ 35.00	$ 97,300	Demo and Dispose of Access Ramp
	SUBTOTAL				$ 97,000	
General						
	Items					
1	Mob/Demob	0.125	EA	$ 1,000,000.00	$ 125,000	
	SUBTOTAL				$ 125,000	

SUBTOTAL		$	682,000
GENERAL CONDITIONS 10%		$	68,000
SUBTOTAL (ALL ITEMS)		$	750,000
G. C. OVERHEAD & PROFIT 10%		$	75,000
TOTAL		$	825,000
CONTINGENCY 22.84%		$	188,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	33,000
GRAND TOTAL CONSTRUCTION COST		**$**	**1,046,000**

Discipline: Annualized Cost | Sheet: 1 OF 7

Contract No.: W912DS-09-0009 | **Alternative 3n - Buried Seawall** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 5,898,000.00	$ 5,898,000	
2	Renourishment	1	LS	$ 5,950,000.00	$ 5,950,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin & Seawall Maintenance	1	LS	$ 324,000.00	$ 324,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
	SUBTOTAL				**$ 12,907,000**	

Total Annual Cost $ 12,907,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,444,000.00	$ 17,444,000	
10	Mob/Demob - Groins	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
10	Mob/Demob - Seawall	1	LS	$ 2,600,000.00	$ 2,600,000	
10	Buried Seawall	1	LS	$ 53,674,000.00	$ 53,674,000	32,000 lf of buried seawall
	SUBTOTAL				**$ 104,862,000**	
	CONTINGENCY 24.56%				$ 25,754,000	
	SUBTOTAL				**$ 130,616,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 10,486,000	
	CONTINGENCY 15.25%				$ 1,599,000	
	SUBTOTAL				**$ 12,085,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.46%	$ 6,774,000	
	CONTINGENCY 15.25%				$ 1,033,000	
	SUBTOTAL				**$ 7,807,000**	

First Cost		$	150,508,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	4,975,000
Interest During Construction		$	3,752,000
Total Investment Cost		**$**	**159,235,000**
Annualized Total Investment Cost		**$**	**5,898,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	21.75
IDC Factor	0.024133159

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 13,150,000.00	$ 13,150,000	
	SUBTOTAL				**$ 16,450,000**	
	CONTINGENCY 30.47%				$ 5,012,000	
	SUBTOTAL				**$ 21,462,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,645,000	
	CONTINGENCY 15.25%				$ 251,000	
	SUBTOTAL				**$ 1,896,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.15%	$ 1,341,000	
	CONTINGENCY 15.25%				$ 205,000	
	SUBTOTAL				**$ 1,546,000**	

First Cost		$	24,904,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	823,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**25,727,000**

Annualized TotalRenourishment Cost **$ 5,950,000** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Discipline: Beachfill-Initial Sheet: 4 OF 7

Contract No.: W912DS-09-0009 **Alternative 3n - Buried Seawall** Prepared by: R. Hampson Date: 4/20/2015

Task Order No.: 26 **Feasibility Estimate** Updated: S. Jessup Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Updated: M. Kluijver Date: 7/13/2018

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,444,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,744,000
CONTINGENCY 24.56%		$	5,094,726
Escalation 2Q 2016 to 2Q 2018	3.31%	$	854,000
GRAND TOTAL CONSTRUCTION COST		**$**	**26,692,726**

Discipline: Buried Seawall | Sheet: 5 OF 7

Contract No.: W912DS-09-0009 | Prepared by: R. Hampson | Date: 3/24/2015

Task Order No.: 26 | Updated: S. Jessup | Date: 7/11/2018

Buried Seawall
Feasibility Estimate

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Buried Seawall						
	Items					
1	Armor Stone (1.5 TON)	272,960	TON	$ 124.71	$ 34,040,842	
2	Core Stone	202,560	TON	$ 87.47	$ 17,717,923	
3	Geotextile	155,520	SY	$ 7.72	$ 1,200,614	
4	Excavation - Sand	186,560	CY	$ 3.83	$ 714,525	
	SUBTOTAL				**$ 53,674,000**	
General						
	Items					
1	Mob/Demob	2	EA	$ 1,300,000.00	$ 2,600,000	
	SUBTOTAL				**$ 2,600,000**	

TOTAL		$	56,274,000
CONTINGENCY 24.56%		$	13,820,894
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,317,000
GRAND TOTAL CONSTRUCTION COST		**$**	**72,411,894**

Contract No.: W912DS-09-0009
Task Order No.: 26
Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Groins | Sheet: 6 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
Updated: M. Kluijver | Date: 7/13/2018
Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	27,844,000
CONTINGENCY 24.56%		$	6,838,486
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,146,000
GRAND TOTAL CONSTRUCTION COST		**$**	**35,828,486**

Discipline: Beachfill-Ren | Sheet: 7 OF 7

Contract No.: W912DS-09-0009 | **Alternative 3n - Buried Seawall** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	444,000	CY	$ 12.88	$ 5,718,720	advance fill - 4-year cycle
4	Beachfill-Reach 4	133,000	CY	$ 12.88	$ 1,713,040	advance fill - 4-year cycle
5	Beachfill-Reach 5	444,000	CY	$ 12.88	$ 5,718,720	advance fill - 4-year cycle
6	Beachfill-Reach 6a	-	CY	$ 12.88	$ -	advance fill - 4-year cycle
	SUBTOTAL	**1,021,000**	**CY**		**$ 13,150,000**	

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	16,450,000
CONTINGENCY 24.56%		$	4,040,120
Escalation 2Q 2016 to 2Q 2018	3.31%	$	677,000
GRAND TOTAL CONSTRUCTION COST		**$**	**21,167,120**

CSRM ALTERNATIVES
LOW SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N COMPOSITE SEAWALL

Discipline: Annualized Cost | Sheet: 1 OF 8

Contract No.: W912DS-09-0009 | **Alternative 3n - Composite Seawall** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 8,436,000.00	$ 8,436,000	
2	Renourishment	1	LS	$ 5,950,000.00	$ 5,950,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin & Seawall Maintenance	1	LS	$ 433,000.00	$ 433,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
	SUBTOTAL				**$ 15,554,000**	

Total Annual Cost $ 15,554,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,444,000.00	$ 17,444,000	
2	Boardwalk Access Ramps	8	LS	$ 333,000.00	$ 2,664,000	
10	Mob/Demob - Groin	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
10	Mob/Demob - Composite Wall	1	LS	$ 3,400,000.00	$ 3,400,000	
10	Composite Seawall	1	LS	$ 93,786,000.00	$ 93,786,000	32,000 lf of composite seawall
	SUBTOTAL				**$ 148,438,000**	
	CONTINGENCY 25.51%				$ 37,867,000	
	SUBTOTAL				**$ 186,305,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 14,844,000	
	CONTINGENCY 15.25%				$ 2,264,000	
	SUBTOTAL				**$ 17,108,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.14%	$ 9,114,000	
	CONTINGENCY 15.25%				$ 1,390,000	
	SUBTOTAL				**$ 10,504,000**	

First Cost		$ 213,917,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 7,071,000
Interest During Construction		$ 6,760,000
Total Investment Cost		**$ 227,748,000**
Annualized Total Investment Cost		**$ 8,436,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	27.19
IDC Factor	0.030589177

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 13,150,000.00	$ 13,150,000	
	SUBTOTAL				**$ 16,450,000**	
	CONTINGENCY 30.47%				$ 5,012,000	
	SUBTOTAL				**$ 21,462,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,645,000	
	CONTINGENCY 15.25%				$ 251,000	
	SUBTOTAL				**$ 1,896,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.15%	$ 1,341,000	
	CONTINGENCY 15.25%				$ 205,000	
	SUBTOTAL				**$ 1,546,000**	

First Cost		$ 24,904,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 823,000
Interest During Construction		$ 144,361,000
Total Renourishment Cost		**$ 170,088,000**

Annualized TotalRenourishment Cost **$ 5,950,000** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Discipline: Beachfill-Initial Sheet: 4 OF 8

Contract No.: W912DS-09-0009 **Alternative 3n - Composite Seawall** Prepared by: R. Hampson Date: 4/20/2015

Task Order No.: 26 **Feasibility Estimate** Updated: S. Jessup Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Updated: M. Kluijver Date: 7/13/2018

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,444,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,744,000
CONTINGENCY 25.51%		$	5,291,794
Escalation 2Q 2016 to 2Q 2018	3.31%	$	861,000
GRAND TOTAL CONSTRUCTION COST		**$**	**26,896,794**

Discipline: Composite Seawall | Sheet: 5 OF 8

Contract No.: W912DS-09-0009 | **Composite Seawall** | Prepared by: R. Hampson | Date: 3/24/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Composite Seawall						
	Items					
1	Armor Stone (3 TON)	348,160	TON	$ 124.29	$ 43,272,806	
2	Core Stone	135,360	TON	$ 86.15	$ 11,661,264	
3	Geotextile	151,040	SY	$ 9.18	$ 1,386,547	
4	Excavation - Sand	312,960	CY	$ 3.73	$ 1,167,341	
5	Concrete Cap	11,520	CY	$ 820.91	$ 9,456,883	
6	AZ 12-770	7,040	TON	$ 3,462.40	$ 24,375,296	
7	Splash - Armor Stone	14,940	TON	$ 110.00	$ 1,643,400	
8	Splash - Bedding Stone	6,360	TON	$ 80.00	$ 508,800	
9	Splash - Geotextile	10,020	SY	$ 9.18	$ 91,984	
10	Splash - Fill	4,440	CY	$ 50.00	$ 222,000	
	SUBTOTAL				**$ 93,786,000**	

General			
	Items		
1	Mob/Demob	2 EA	$ 1,700,000.00	$ 3,400,000	
	SUBTOTAL			**$ 3,400,000**	

TOTAL		$	97,186,000
	CONTINGENCY 25.51%	$	24,792,149
	Escalation 2Q 2016 to 2Q 2018	3.31% $	4,032,000
GRAND TOTAL CONSTRUCTION COST		**$**	**126,010,149**

Discipline: Composite Seawall | Sheet: 5 OF 8

Contract No.: W912DS-09-0009 | **Composite Seawall** | Prepared by: R. Hampson | Date: 3/24/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay | Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Composite Seawall						
	Items					
1	Armor Stone (3 TON)	10.880	TON	$ 124.29	$ 1,352	
2	Core Stone	4.230	TON	$ 86.15	$ 364	
3	Geotextile	4.720	SY	$ 9.18	$ 43	
4	Excavation - Sand	9.780	CY	$ 3.73	$ 36	
5	Concrete Cap	0.360	CY	$ 820.91	$ 296	
6	AZ 12-770	0.220	TON	$ 3,462.40	$ 762	
7	Splash - Armor Stone	2.490	TON	$ 110.00	$ 274	
8	Splash - Bedding Stone	1.060	TON	$ 80.00	$ 85	
9	Splash - Geotextile	1.670	SY	$ 9.18	$ 15	
10	Splash - Fill	0.740	CY	$ 50.00	$ 37	
11	Beach Fill (Dune)	18.500	CY	$ 40.00	$ 740	
12	Dune Grass Planting	0.001722	AC	$ 20,000.00	$ 34	
	SUBTOTAL				**$ 4,040**	
General						
	Items					
1	Mob/Demob	1	EA	$ 1,700,000.00	$ 1,700,000	
	SUBTOTAL				**$ 1,700,000**	

TOTAL	$	1,704,040
CONTINGENCY 25.51%	$	434,701
Escalation 2Q 2016 to 2Q 2018 3.31%	$	71,000
GRAND TOTAL CONSTRUCTION COST	**$**	**2,209,741**

					Discipline:	Groins	Sheet: 6 OF 8
Contract No.:	W912DS-09-0009	**Alternative 3n - Composite Seawall**			Prepared by:	R. Hampson	Date: 4/20/2015
Task Order No.:	26	**Feasibility Estimate**			Updated:	S. Jessup	Date: 7/11/2018
Project Title:	East Rockaway to Rockaway Inlet Reformulation Study				Updated:	M. Kluijver	Date: 7/13/2018
	Consultant Name:	Moffatt & Nichol			Consultant Contact:	M. Kluijver	

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	27,844,000
CONTINGENCY 25.51%		$	7,103,004
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,155,000
GRAND TOTAL CONSTRUCTION COST		**$**	**36,102,004**

				Discipline:	Beachfill-Ren	Sheet:	7 OF 8
Contract No.:	W912DS-09-0009	**Alternative 3n - Composite Seawall**		Prepared by:	R. Hampson	Date:	4/20/2015
Task Order No.:	26	**Feasibility Estimate**		Updated:	S. Jessup	Date:	7/11/2018
Project Title:	Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay			Updated:	M. Kluijver	Date:	7/13/2018
	Consultant Name:	Moffatt & Nichol		Consultant Contact:	M. Kluijver		

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	444,000	CY	$ 12.88	$ 5,718,720	advance fill - 4-year cycle
4	Beachfill-Reach 4	133,000	CY	$ 12.88	$ 1,713,040	advance fill - 4-year cycle
5	Beachfill-Reach 5	444,000	CY	$ 12.88	$ 5,718,720	advance fill - 4-year cycle
6	Beachfill-Reach 6a	-	CY	$ 12.88	$ -	advance fill - 4-year cycle
	SUBTOTAL	**1,021,000**	**CY**		**$ 13,150,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	16,450,000
CONTINGENCY 30.47%		$	5,012,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	709,000
GRAND TOTAL CONSTRUCTION COST		**$**	**22,171,000**

Contract No.: W912DS-09-0009
Task Order No.: 26
Project Title: East Rockaway to Rockaway Inlet Reformulation Study

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Structural | Sheet: 8 OF 8
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: R. Hampson

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Boardwalk Access Ramps						
	Items					
1	24" Steel Pipe Pile	114	LF	$ 135.00	$ 15,390	3 piles @ 24x1/2" WT (38 ft long)
2	Precast Concrete Pile Cap	15	CY	$ 1,500.00	$ 22,500	3 caps @ 5.1 cy each
3	Cast in Place Concrete Plug	2	CY	$ 500.00	$ 1,000	3 plugs
4	Cast in Place Concrete Deck	6	CY	$ 1,000.00	$ 6,000	3 @ 4'6" x 10' x 14"
5	Precast Concrete Deck	25	CY	$ 1,000.00	$ 25,000	70' x 10' x 14"
6	RPL Decking	695	SF	$ 50.00	$ 34,750	Furnish and Install
7	Handrail	139	LF	$ 150.00	$ 20,850	Furnish and Install
	SUBTOTAL				$ 125,000	
Demolition						
	Items					
1	Access Ramps	700	SF	$ 35.00	$ 24,500	Demo and Dispose of Access Ramp
	SUBTOTAL				$ 25,000	
General						
	Items					
1	Mob/Demob	0.125	EA	$ 1,000,000.00	$ 125,000	
	SUBTOTAL				$ 125,000	

SUBTOTAL		$	275,000
GENERAL CONDITIONS 10%		$	28,000
SUBTOTAL (ALL ITEMS)		$	303,000
G. C. OVERHEAD & PROFIT 10%		$	30,000
TOTAL		$	333,000
CONTINGENCY 25.51%		$	85,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	14,000
GRAND TOTAL CONSTRUCTION COST		**$**	**432,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Summary - Annualized Costs - Low SLR
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 1
Prepared by: R. Hampson | Date: 6/17/2015

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Medium +16'	Large +18'	XL +20'	Buried Seawall	Composite Seawall	
Annualized Costs - 4 year Cycle							
	Items						
1	Total Investment	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000	
2	Renourishment	$5,950,000	$6,392,000	$6,829,000	$5,950,000	$5,950,000	
3	Major Rehab	$332,000	$332,000	$332,000	$332,000	$332,000	
4	Groin & Seawall Maintenance	$176,000	$195,000	$218,000	$324,000	$433,000	
5	Monitoring	$403,000	$403,000	$403,000	$403,000	$403,000	
	Total	**$9,540,000**	**$10,938,000**	**$13,363,000**	**$12,907,000**	**$15,554,000**	

Contract No.: W912DS-09-0009
Task Order No.: 26

Summary - Initial Costs - Low SLR
Feasibility Estimate

Discipline: Initial Cost | Sheet: 1 OF 1
Prepared by: R. Hampson | Date: 6/17/2015

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Medium	Large	XL	Buried Seawall	Composite Seawall	
Initial Construction Costs							
	Items						
1	Beachfill	$20,504,000	$34,410,000	$59,485,000	$20,744,000	$20,744,000	
2	Groin Construction/Modification	$27,844,000	$31,102,000	$34,360,000	$27,844,000	$27,844,000	
3	Reinforced Dune	$0	$0	$0	$56,274,000	$97,186,000	
4	Boardwalk Access Ramps	$0	$0	$6,600,000	$0	$2,664,000	
5	PED	$4,835,000	$6,551,000	$10,045,000	$10,486,000	$14,844,000	
6	Construction Mangement	$3,462,000	$4,514,000	$6,529,000	$6,774,000	$9,114,000	
7	Contingency	$12,100,000	$15,864,000	$25,470,000	$28,386,000	$41,521,000	
8	Escalation to Q2 2018	$2,272,000	$3,056,000	$4,710,000	$4,975,000	$7,071,000	
	Total	**$71,017,000**	**$95,497,000**	**$147,199,000**	**$155,483,000**	**$220,988,000**	
	IDC	**$1,307,000**	**$2,129,000**	**$3,462,000**	**$3,752,000**	**$6,760,000**	
	check	$72,324,000	$97,626,000	$150,661,000	$159,235,000	$227,748,000	

Contract No.: W912DS-09-0009
Task Order No.: 26

Summary - Renourishment Costs - Low SLR
Feasibility Estimate

Discipline: Renourishment Cost | Sheet: 1 OF 1
Prepared by: R. Hampson | Date: 6/17/2015

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Updated: M. Kluijver | Date: 7/13/2018

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Medium	Large	XL	Buried Seawall	Composite Seawall	
Renourishment Costs Per Operation							
	Items						
1	Beachfill	$21,462,000	$23,076,000	$24,673,000	$21,462,000	$21,462,000	
2	PED	$1,896,000	$2,039,000	$2,179,000	$1,896,000	$1,896,000	
3	Construction Mangement	$1,546,000	$1,647,000	$1,748,000	$1,546,000	$1,546,000	
4	Escalation to Q2 2018	$823,000	$885,000	$945,000	$823,000	$823,000	
	Total	**$25,727,000**	**$27,647,000**	**$29,545,000**	**$25,727,000**	**$25,727,000**	

ATTACHMENT C
CSRM ALTERNATIVES
INTERMEDIATE SEA LEVEL CHANGE
SCREENING LEVEL COST ESTIMATES

CSRM ALTERNATIVES
INTERMEDIATE SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N MEDIUM DUNE

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 2,679,000.00	$ 2,679,000	
2	Renourishment	1	LS	$ 6,364,000.00	$ 6,364,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ 176,000.00	$ 176,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
6	SLR Adaption	1	LS	$ 210,000.00	$ 210,000	
	SUBTOTAL				**$ 10,164,000**	

Total Annual Cost $ 10,164,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,204,000.00	$ 17,204,000	
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
	SUBTOTAL				**$ 48,348,000**	
	CONTINGENCY 22.41%				$ 10,835,000	
	SUBTOTAL				**$ 59,183,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 4,835,000	
	CONTINGENCY 15.25%				$ 737,000	
	SUBTOTAL				**$ 5,572,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.16%	$ 3,462,000	
	CONTINGENCY 15.25%				$ 528,000	
	SUBTOTAL				**$ 3,990,000**	

First Cost		$	68,745,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,272,000
Interest During Construction		$	1,307,000
Total Investment Cost		**$**	**72,324,000**
Annualized Total Investment Cost		**$**	**2,679,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	16.88
IDC Factor	0.018404314

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 14,310,000.00	$ 14,310,000	
	SUBTOTAL				**$ 17,610,000**	
	CONTINGENCY 30.47%				$ 5,366,000	
	SUBTOTAL				**$ 22,976,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,761,000	
	CONTINGENCY 15.25%				$ 269,000	
	SUBTOTAL				**$ 2,030,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.08%	$ 1,423,000	
	CONTINGENCY 15.25%				$ 217,000	
	SUBTOTAL				**$ 1,640,000**	

First Cost		$	26,646,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	881,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**27,527,000**

Annualized TotalRenourishment Cost **$ 6,364,000** from ammoritization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	-	EA	$ 3,300,000.00	$ -	
17	Beachfill	553,000	CY	$ 12.88	$ 7,123,000	
17	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
17	Access Ramps	-	EA	$ 825,000.00	$ -	
	SUBTOTAL				**$ 8,583,000**	
	CONTINGENCY 30.47%				$ 2,615,000	
	SUBTOTAL				**$ 11,198,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 858,000	
	CONTINGENCY 15.25%				$ 131,000	
	SUBTOTAL				**$ 989,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.74%	$ 750,000	
	CONTINGENCY 15.25%				$ 114,000	
	SUBTOTAL				**$ 864,000**	

First Cost		$	13,051,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	431,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**13,482,000**

Annualized TotalRenourishment Cost **$ 210,000** from ammortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Beachfill-Initial Sheet: 4 OF 6
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	61	AC	$ 20,000.00	$ 1,220,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,204,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,504,000
CONTINGENCY 22.41%		$	4,594,946
Escalation 2Q 2016 to 2Q 2018	3.31%	$	830,000
GRAND TOTAL CONSTRUCTION COST		**$**	**25,928,946**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Groins | Sheet: 5 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	27,844,000
CONTINGENCY 22.41%		$	6,239,840
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,127,000
GRAND TOTAL CONSTRUCTION COST		**$**	**35,210,840**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Beachfill-Ren Sheet: 6 OF 6
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	475,000	CY	$ 12.88	$ 6,118,000	advance fill - 4-year cycle
4	Beachfill-Reach 4	149,000	CY	$ 12.88	$ 1,919,120	advance fill - 4-year cycle
5	Beachfill-Reach 5	476,000	CY	$ 12.88	$ 6,130,880	advance fill - 4-year cycle
6	Beachfill-Reach 6a	11,000	CY	$ 12.88	$ 141,680	advance fill - 4-year cycle
	SUBTOTAL	**1,111,000**	**CY**		**$ 14,310,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	17,610,000
CONTINGENCY 30.47%		$	5,366,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	760,000
GRAND TOTAL CONSTRUCTION COST		**$**	**23,736,000**

CSRM ALTERNATIVES
INTERMEDIATE SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N LARGE DUNE

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 3,616,000.00	$ 3,616,000	
2	Renourishment	1	LS	$ 6,801,000.00	$ 6,801,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ 195,000.00	$ 195,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
6	SLR Adaption	1	LS	$ 373,000.00	$ 373,000	
	SUBTOTAL				**$ 11,720,000**	

Total Annual Cost $ 11,720,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 31,110,000.00	$ 31,110,000	
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 19,483,000.00	$ 19,483,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,333,000.00	$ 2,333,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 6,786,000.00	$ 6,786,000	extend 5 groins
	SUBTOTAL				**$ 65,512,000**	
	CONTINGENCY 21.64%				$ 14,177,000	
	SUBTOTAL				**$ 79,689,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 6,551,000	
	CONTINGENCY 15.25%				$ 999,000	
	SUBTOTAL				**$ 7,550,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.89%	$ 4,514,000	
	CONTINGENCY 15.25%				$ 688,000	
	SUBTOTAL				**$ 5,202,000**	

First Cost		$ 92,441,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 3,056,000
Interest During Construction		$ 2,129,000
Total Investment Cost		**$ 97,626,000**
Annualized Total Investment Cost		**$ 3,616,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	20.19
IDC Factor	0.022297107

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 15,533,000.00	$ 15,533,000	
	SUBTOTAL				**$ 18,833,000**	
	CONTINGENCY 30.47%				$ 5,738,000	
	SUBTOTAL				**$ 24,571,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,883,000	
	CONTINGENCY 15.25%				$ 287,000	
	SUBTOTAL				**$ 2,170,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.02%	$ 1,510,000	
	CONTINGENCY 15.25%				$ 230,000	
	SUBTOTAL				**$ 1,740,000**	

First Cost		$	28,481,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	941,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**29,422,000**

Annualized TotalRenourishment Cost **$ 6,801,000** from ammoritization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: Adaption Costs Sheet: 3 OF 6
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	-	EA	$ 3,300,000.00	$ -	
17	Beachfill	566,000	CY	$ 12.88	$ 7,290,000	
17	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
17	Access Ramps	8	EA	$ 825,000.00	$ 6,600,000	Demo & Rebuild 8 Concrete Access Ramps
	SUBTOTAL				**$ 15,350,000**	
	CONTINGENCY 30.47%				$ 4,677,000	
	SUBTOTAL				**$ 20,027,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,535,000	
	CONTINGENCY 15.25%				$ 234,000	
	SUBTOTAL				**$ 1,769,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.21%	$ 1,260,000	
	CONTINGENCY 15.25%				$ 192,000	
	SUBTOTAL				**$ 1,452,000**	

First Cost		$	23,248,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	768,000
Interest During Construction		$	-
Total Adaption Cost		**$**	**24,016,000**

Annualized Adaption Cost **$ 373,000** from amortization

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large Feasibility Estimate

Discipline: Beachfill-Initial | Sheet: 4 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	611,000	CY	$ 12.88	$ 7,869,680	design + advance fill
4	Beachfill-Reach 4	478,000	CY	$ 12.88	$ 6,156,640	design + advance fill
5	Beachfill-Reach 5	758,000	CY	$ 12.88	$ 9,763,040	design + advance fill
6	Beachfill-Reach 6a	417,000	CY	$ 12.88	$ 5,370,960	design + advance fill
7	Beachfill-Reach 6b	38,000	CY	$ 12.88	$ 489,440	design + advance fill
8	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 31,110,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	34,410,000
CONTINGENCY 21.64%		$	7,446,324
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,384,000
GRAND TOTAL CONSTRUCTION COST		**$**	**43,240,324**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large Feasibility Estimate

Discipline: Groins | Sheet: 5 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	61,007	TON	$ 193.30	$ 11,792,556	12 groins @ a total of 4519 ft
2	Underlayer Stone (500-1500 lbs)	19,884	TON	$ 104.68	$ 2,081,415	
3	Core Stone (30-130 lbs)	12,201	TON	$ 92.87	$ 1,133,135	
4	Bedding Stone (30-130 lbs)	31,181	CY	$ 92.87	$ 2,895,789	
5	Geotextile Filter Fabric	34,796	SY	$ 23.68	$ 823,976	
6	Excavation - Sand	104,389	CY	$ 7.24	$ 755,776	
	SUBTOTAL				**$ 19,483,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	7,306	TON	$ 193.30	$ 1,412,250	1 groin @ 562 ft
2	Underlayer Stone (500-1500 lbs)	2,585	TON	$ 104.68	$ 270,619	
3	Core Stone (30-130 lbs)	1,574	TON	$ 92.87	$ 146,140	
4	Bedding Stone (30-130 lbs)	3,541	CY	$ 92.87	$ 328,816	
5	Geotextile Filter Fabric	4,215	SY	$ 23.68	$ 99,811	
6	Excavation - Sand	10,453	CY	$ 7.24	$ 75,681	
	SUBTOTAL				**$ 2,333,000**	*$4,151* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	24,206	TON	$ 193.30	$ 4,679,020	5 groin extensions @ a total of 980'
2	Underlayer & Core Stone (500-1500 lbs)	5,096	TON	$ 104.68	$ 533,449	
3	Core Stone (30-130 lbs)	3,234	TON	$ 92.87	$ 300,342	
4	Bedding Stone (30-130 lbs)	10,192	CY	$ 92.87	$ 946,531	
5	Geotextile Filter Fabric	9,212	SY	$ 23.68	$ 218,140	
6	Excavation - Sand	14,994	CY	$ 7.24	$ 108,557	
	SUBTOTAL				**$ 6,786,000**	*$6,924* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	31,102,000
CONTINGENCY 21.64%		$	6,730,473
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,251,000
GRAND TOTAL CONSTRUCTION COST		**$**	**39,083,473**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large Feasibility Estimate

Discipline: Beachfill-Ren | Sheet: 6 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	541,000	CY	$ 12.88	$ 6,968,080	advance fill - 4-year cycle
4	Beachfill-Reach 4	149,000	CY	$ 12.88	$ 1,919,120	advance fill - 4-year cycle
5	Beachfill-Reach 5	505,000	CY	$ 12.88	$ 6,504,400	advance fill - 4-year cycle
6	Beachfill-Reach 6a	11,000	CY	$ 12.88	$ 141,680	advance fill - 4-year cycle
	SUBTOTAL	**1,206,000**	**CY**		**$ 15,533,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	18,833,000
CONTINGENCY 30.47%		$	5,738,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	812,000
GRAND TOTAL CONSTRUCTION COST		**$**	**25,383,000**

CSRM ALTERNATIVES
INTERMEDIATE SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N XL DUNE

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 5,581,000.00	$ 5,581,000	
2	Renourishment	1	LS	$ 7,243,000.00	$ 7,243,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ 218,000.00	$ 218,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
6	SLR Adaption	1	LS	$ 377,000.00	$ 377,000	
	SUBTOTAL				**$ 14,154,000**	

Total Annual Cost $ 14,154,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 6,600,000.00	$ 6,600,000	
17	Beachfill	1	LS	$ 52,885,000.00	$ 52,885,000	
2	Access Ramps	8	EA	$ 825,000.00	$ 6,600,000	Demo & Rebuild 8 Concrete Access Ramps
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 21,345,000.00	$ 21,345,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,483,000.00	$ 2,483,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 8,032,000.00	$ 8,032,000	extend 5 groins
	SUBTOTAL				**$ 100,445,000**	
	CONTINGENCY 22.84%				$ 22,942,000	
	SUBTOTAL				**$ 123,387,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 10,045,000	
	CONTINGENCY 15.25%				$ 1,532,000	
	SUBTOTAL				**$ 11,577,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.50%	$ 6,529,000	
	CONTINGENCY 15.25%				$ 996,000	
	SUBTOTAL				**$ 7,525,000**	

First Cost		$ 142,489,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 4,710,000
Interest During Construction		$ 3,461,000
Total Investment Cost		**$ 150,660,000**
Annualized Total Investment Cost		**$ 5,581,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	21.22
IDC Factor	0.023512491

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 16,770,000.00	$ 16,770,000	
	SUBTOTAL				**$ 20,070,000**	
	CONTINGENCY 30.47%				$ 6,115,000	
	SUBTOTAL				**$ 26,185,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 2,007,000	
	CONTINGENCY 15.25%				$ 306,000	
	SUBTOTAL				**$ 2,313,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.96%	$ 1,598,000	
	CONTINGENCY 15.25%				$ 244,000	
	SUBTOTAL				**$ 1,842,000**	

First Cost		$	30,340,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,003,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**31,343,000**

Annualized TotalRenourishment Cost **$ 7,243,000** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	-	EA	$ 3,300,000.00	$ -	
17	Beachfill	578,000	CY	$ 12.88	$ 7,445,000	
17	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
17	Access Ramps	8	EA	$ 825,000.00	$ 6,600,000	Demo & Rebuild 8 Concrete Access Ramps
	SUBTOTAL				**$ 15,505,000**	
	CONTINGENCY 30.47%				$ 4,724,000	
	SUBTOTAL				**$ 20,229,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,551,000	
	CONTINGENCY 15.25%				$ 237,000	
	SUBTOTAL				**$ 1,788,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.20%	$ 1,271,000	
	CONTINGENCY 15.25%				$ 194,000	
	SUBTOTAL				**$ 1,465,000**	

First Cost		$	23,482,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	776,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**24,258,000**
Annualized TotalRenourishment Cost		**$**	**377,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Beachfill-Initial | Sheet: 4 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	1,044,000	CY	$ 12.88	$ 13,446,720	design + advance fill
4	Beachfill-Reach 4	827,000	CY	$ 12.88	$ 10,651,760	design + advance fill
5	Beachfill-Reach 5	1,424,000	CY	$ 12.88	$ 18,341,120	design + advance fill
6	Beachfill-Reach 6a	621,000	CY	$ 12.88	$ 7,998,480	design + advance fill
7	Beachfill-Reach 6b	58,000	CY	$ 12.88	$ 747,040	design + advance fill
8	Dune Grass Planting	85	AC	$ 20,000.00	$ 1,700,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 52,885,000**	
General						
	Items					
1	Mob/Demob	2	EA	$ 3,300,000.00	$ 6,600,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 6,600,000**	

TOTAL		$	59,485,000
CONTINGENCY 22.84%		$	13,586,374
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,415,000
GRAND TOTAL CONSTRUCTION COST		**$**	**75,486,374**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Groins | Sheet: 5 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	66,839	TON	$ 193.30	$ 12,919,882	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	21,784	TON	$ 104.68	$ 2,280,391	
3	Core Stone (30-130 lbs)	13,368	TON	$ 92.87	$ 1,241,458	
4	Bedding Stone (30-130 lbs)	34,162	CY	$ 92.87	$ 3,172,616	
5	Geotextile Filter Fabric	38,123	SY	$ 23.68	$ 902,746	
6	Excavation - Sand	114,368	CY	$ 7.24	$ 828,025	
	SUBTOTAL				**$ 21,345,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	7,774	TON	$ 193.30	$ 1,502,714	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,751	TON	$ 104.68	$ 287,954	
3	Core Stone (30-130 lbs)	1,674	TON	$ 92.87	$ 155,502	
4	Bedding Stone (30-130 lbs)	3,767	CY	$ 92.87	$ 349,878	
5	Geotextile Filter Fabric	4,485	SY	$ 23.68	$ 106,205	
6	Excavation - Sand	11,123	CY	$ 7.24	$ 80,529	
	SUBTOTAL				**$ 2,483,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	28,652	TON	$ 193.30	$ 5,538,432	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	6,032	TON	$ 104.68	$ 631,430	
3	Core Stone (30-130 lbs)	3,828	TON	$ 92.87	$ 355,506	
4	Bedding Stone (30-130 lbs)	12,064	CY	$ 92.87	$ 1,120,384	
5	Geotextile Filter Fabric	10,904	SY	$ 23.68	$ 258,207	
6	Excavation - Sand	17,748	CY	$ 7.24	$ 128,496	
	SUBTOTAL				**$ 8,032,000**	*$6,924* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	34,360,000
CONTINGENCY 22.84%		$	7,847,824
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,395,000
GRAND TOTAL CONSTRUCTION COST		**$**	**43,602,824**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Beachfill-Ren | Sheet: 6 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	608,000	CY	$ 12.88	$ 7,831,040	advance fill - 4-year cycle
4	Beachfill-Reach 4	149,000	CY	$ 12.88	$ 1,919,120	advance fill - 4-year cycle
5	Beachfill-Reach 5	534,000	CY	$ 12.88	$ 6,877,920	advance fill - 4-year cycle
6	Beachfill-Reach 6a	11,000	CY	$ 12.88	$ 141,680	advance fill - 4-year cycle
	SUBTOTAL	**1,302,000**	**CY**		**$ 16,770,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,070,000
CONTINGENCY 30.47%		$	6,115,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	866,000
GRAND TOTAL CONSTRUCTION COST		**$**	**27,051,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Structural | Sheet: 7 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Boardwalk Access Ramps						
	Items					
1	24" Steel Pipe Pile	342	LF	$ 135.00	$ 46,170	9 piles @ 24x1/2" WT (38 ft long)
2	Precast Concrete Pile Cap	46	CY	$ 1,500.00	$ 69,000	9 caps @ 5.1 cy each
3	Cast in Place Concrete Plug	6	CY	$ 500.00	$ 3,000	9 plugs
4	Cast in Place Concrete Deck	18	CY	$ 1,000.00	$ 17,500	9 @ 4'6" x 10' x 14"
5	Precast Concrete Deck	102	CY	$ 1,000.00	$ 102,000	278' x 10' x 14"
6	RPL Decking	2,780	SF	$ 50.00	$ 139,000	Furnish and Install
7	Handrail	556	LF	$ 150.00	$ 83,400	Furnish and Install
	SUBTOTAL				$ 460,000	
Demolition						
	Items					
1	Access Ramps	2,780	SF	$ 35.00	$ 97,300	Demo and Dispose of Access Ramp
	SUBTOTAL				$ 97,000	
General						
	Items					
1	Mob/Demob	0.125	EA	$ 1,000,000.00	$ 125,000	
	SUBTOTAL				$ 125,000	

SUBTOTAL		$	682,000
GENERAL CONDITIONS 10%		$	68,000
SUBTOTAL (ALL ITEMS)		$	750,000
G. C. OVERHEAD & PROFIT 10%		$	75,000
TOTAL		$	825,000
CONTINGENCY 22.84%		$	188,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	33,000
GRAND TOTAL CONSTRUCTION COST		**$**	**1,046,000**

CSRM ALTERNATIVES
INTERMEDIATE SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N BURRIED SEAWALL

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 5,898,000.00	$ 5,898,000	
2	Renourishment	1	LS	$ 6,364,000.00	$ 6,364,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin & Seawall Maintenance	1	LS	$ 325,000.00	$ 325,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
6	SLR Adaption	1	LS	$ 1,020,000.00	$ 1,020,000	
	SUBTOTAL				**$ 14,342,000**	

Total Annual Cost $ 14,342,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,444,000.00	$ 17,444,000	
10	Mob/Demob - Groins	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
10	Mob/Demob - Seawall	1	LS	$ 2,600,000.00	$ 2,600,000	
10	Buried Seawall	1	LS	$ 53,674,000.00	$ 53,674,000	32,000 lf of buried seawall
	SUBTOTAL				**$ 104,862,000**	
	CONTINGENCY 24.56%				$ 25,754,000	
	SUBTOTAL				**$ 130,616,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 10,486,000	
	CONTINGENCY 15.25%				$ 1,599,000	
	SUBTOTAL				**$ 12,085,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.46%	$ 6,774,000	
	CONTINGENCY 15.25%				$ 1,033,000	
	SUBTOTAL				**$ 7,807,000**	

First Cost		$ 150,508,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 4,975,000
Interest During Construction		$ 3,753,000
Total Investment Cost		**$ 159,236,000**
Annualized Total Investment Cost		**$ 5,898,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	21.75
IDC Factor	0.024138631

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 14,310,000.00	$ 14,310,000	
	SUBTOTAL				**$ 17,610,000**	
	CONTINGENCY 30.47%				$ 5,366,000	
	SUBTOTAL				**$ 22,976,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,761,000	
	CONTINGENCY 15.25%				$ 269,000	
	SUBTOTAL				**$ 2,030,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.08%	$ 1,423,000	
	CONTINGENCY 15.25%				$ 217,000	
	SUBTOTAL				**$ 1,640,000**	

First Cost		$	26,646,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	881,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**27,527,000**

Annualized TotalRenourishment Cost **$ 6,364,000** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
10	Mob/Demob	1	EA	$ 1,700,000.00	$ 1,700,000	
10	Armor Stone (1.5 TON)	125,760	TON	$ 124.71	$ 15,683,530	
10	Core Stone	19,200	TON	$ 87.47	$ 1,679,424	
10	Geotextile	35,520	SY	$ 7.72	$ 274,214	
10	Excavation/Placement - Sand	301,760	CY	$ 7.66	$ 2,311,482	
17	Beachfill - Dune	1,106,000	CY	$ 12.88	$ 14,245,280	
17	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
10	Access Ramps	8	EA	$ 825,000.00	$ 6,600,000	
	SUBTOTAL				**$ 43,954,000**	
	CONTINGENCY 24.56%				$ 10,795,000	
	SUBTOTAL				**$ 54,749,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 4,395,000	
	CONTINGENCY 15.25%				$ 670,000	
	SUBTOTAL				**$ 5,065,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.25%	$ 3,187,000	
	CONTINGENCY 15.25%				$ 486,000	
	SUBTOTAL				**$ 3,673,000**	

First Cost		$	63,487,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,099,000
Interest During Construction		$	-
Total Adaption Cost		**$**	**65,586,000**
Annualized Total Investment Cost		**$**	**1,020,000** Construction in Year 32

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	3.7
IDC Factor	0.003097769

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Beachfill-Initial Sheet: 4 OF 7
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,444,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,744,000
CONTINGENCY 24.56%		$	5,094,726
Escalation 2Q 2016 to 2Q 2018	3.31%	$	854,000
GRAND TOTAL CONSTRUCTION COST		**$**	**26,692,726**

Contract No.: W912DS-09-0009
Task Order No.: 26

Buried Seawall
Feasibility Estimate

Discipline: Buried Seawall | Sheet: 5 OF 7
Prepared by: R. Hampson | Date: 3/24/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Buried Seawall						
	Items					
1	Armor Stone (1.5 TON)	272,960	TON	$ 124.71	$ 34,040,842	
2	Core Stone	202,560	TON	$ 87.47	$ 17,717,923	
3	Geotextile	155,520	SY	$ 7.72	$ 1,200,614	
4	Excavation - Sand	186,560	CY	$ 3.83	$ 714,525	
	SUBTOTAL				**$ 53,674,000**	
General						
	Items					
1	Mob/Demob	2	EA	$ 1,300,000.00	$ 2,600,000	
	SUBTOTAL				**$ 2,600,000**	

TOTAL		$	56,274,000
CONTINGENCY 24.56%		$	13,820,894
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,317,000
GRAND TOTAL CONSTRUCTION COST		**$**	**72,411,894**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Groins Sheet: 6 OF 7
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	27,844,000
CONTINGENCY 24.56%		$	7,089,082
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,155,000
GRAND TOTAL CONSTRUCTION COST		**$**	**36,088,082**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Beachfill-Ren Sheet: 7 OF 7
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	475,000	CY	$ 12.88	$ 6,118,000	advance fill - 4-year cycle
4	Beachfill-Reach 4	149,000	CY	$ 12.88	$ 1,919,120	advance fill - 4-year cycle
5	Beachfill-Reach 5	476,000	CY	$ 12.88	$ 6,130,880	advance fill - 4-year cycle
6	Beachfill-Reach 6a	11,000	CY	$ 12.88	$ 141,680	advance fill - 4-year cycle
	SUBTOTAL	**1,111,000**	**CY**		**$ 14,310,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	17,610,000
CONTINGENCY 30.47%		$	5,366,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	760,000
GRAND TOTAL CONSTRUCTION COST		**$**	**23,736,000**

Discipline: Annualized Cost | Sheet: 1 OF 8

Contract No.: W912DS-09-0009 | **Alternative 3n - Composite Seawall** | Prepared by: R. Hampson | Date: 4/20/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

Project Title: East Rockaway to Rockaway Inlet Reformulation Study

Consultant Name: Moffatt & Nichol | Consultant Contact: R. Hampson

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 8,436,000.00	$ 8,436,000	
2	Renourishment	1	LS	$ 6,364,000.00	$ 6,364,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin & Seawall Maintenance	1	LS	$ 433,000.00	$ 433,000	
5	Monitoring	1	LS	$ 408,000.00	$ 403,000	
6	SLR Adaption	1	LS	$ 1,453,000.00	$ 1,453,000	
	SUBTOTAL				**$ 17,421,000**	

Total Annual Cost $ 17,421,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,444,000.00	$ 17,444,000	
2	Boardwalk Access Ramps	8	LS	$ 333,000.00	$ 2,664,000	
10	Mob/Demob - Groin	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
10	Mob/Demob - Composite Wall	1	LS	$ 3,400,000.00	$ 3,400,000	
10	Composite Seawall	1	LS	$ 93,786,000.00	$ 93,786,000	32,000 lf of composite seawall
	SUBTOTAL				**$ 148,438,000**	
	CONTINGENCY 25.51%				$ 37,867,000	
	SUBTOTAL				**$ 186,305,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 14,844,000	
	CONTINGENCY 15.25%				$ 2,264,000	
	SUBTOTAL				**$ 17,108,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.14%	$ 9,114,000	
	CONTINGENCY 15.25%				$ 1,390,000	
	SUBTOTAL				**$ 10,504,000**	

First Cost		$ 213,917,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 7,071,000
Interest During Construction		$ 6,761,000
Total Investment Cost		**$ 227,749,000**
Annualized Total Investment Cost		**$ 8,436,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	27.19
IDC Factor	0.030594915

CSRM ALTERNATIVES
INTERMEDIATE SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N COMPOSITE SEAWALL

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 14,310,000.00	$ 14,310,000	
	SUBTOTAL				**$ 17,610,000**	
	CONTINGENCY 30.47%				$ 5,366,000	
	SUBTOTAL				**$ 22,976,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,761,000	
	CONTINGENCY 15.25%				$ 269,000	
	SUBTOTAL				**$ 2,030,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.08%	$ 1,423,000	
	CONTINGENCY 15.25%				$ 217,000	
	SUBTOTAL				**$ 1,640,000**	

First Cost		$	26,646,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	881,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**27,527,000**

Annualized TotalRenourishment Cost **$ 6,364,000** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
10	Mob/Demob - Composite Wall	1	EA	$ 1,700,000.00	$ 1,700,000	
10	Armor Stone (3 TON)	189,760	TON	$ 124.29	$ 23,585,270	
10	Core Stone	28,800	TON	$ 86.15	$ 2,481,120	
10	Geotextile	35,520	SY	$ 9.18	$ 326,074	
10	Excavation - Sand	445,760	CY	$ 7.46	$ 3,325,370	
10	Concrete Cap	7,680	CY	$ 820.91	$ 6,304,589	
17	Beachfill-Dune	1,288,490	CY	$ 12.88	$ 16,595,751	
17	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
10	Access Ramps	8	EA	$ 825,000.00	$ 6,600,000	
	SUBTOTAL				**$ 62,378,000**	
	CONTINGENCY 25.51%				$ 15,913,000	
	SUBTOTAL				**$ 78,291,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 6,238,000	
	CONTINGENCY 15.25%				$ 951,000	
	SUBTOTAL				**$ 7,189,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.93%	$ 4,323,000	
	CONTINGENCY 15.25%				$ 659,000	
	SUBTOTAL				**$ 4,982,000**	

First Cost		$	90,462,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,990,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**93,452,000**
Annualized Total Investment Cost		**$**	**1,453,000** Construction in Year 32

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	12
IDC Factor	0.012700947

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Beachfill-Initial Sheet: 4 OF 8
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,444,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,744,000
CONTINGENCY 25.51%		$	5,291,794
Escalation 2Q 2016 to 2Q 2018	3.31%	$	861,000
GRAND TOTAL CONSTRUCTION COST		**$**	**26,896,794**

Contract No.: W912DS-09-0009
Task Order No.: 26

Composite Seawall
Feasibility Estimate

Discipline: Composite Seawall Sheet: 5 OF 8
Prepared by: R. Hampson Date: 3/24/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Composite Seawall						
	Items					
1	Armor Stone (3 TON)	348,160	TON	$ 124.29	$ 43,272,806	
2	Core Stone	135,360	TON	$ 86.15	$ 11,661,264	
3	Geotextile	151,040	SY	$ 9.18	$ 1,386,547	
4	Excavation - Sand	312,960	CY	$ 3.73	$ 1,167,341	
5	Concrete Cap	11,520	CY	$ 820.91	$ 9,456,883	
6	AZ 12-770	7,040	TON	$ 3,462.40	$ 24,375,296	
7	Splash - Armor Stone	14,940	TON	$ 110.00	$ 1,643,400	
8	Splash - Bedding Stone	6,360	TON	$ 80.00	$ 508,800	
9	Splash - Geotextile	10,020	SY	$ 9.18	$ 91,984	
10	Splash - Fill	4,440	CY	$ 50.00	$ 222,000	
	SUBTOTAL				**$ 93,786,000**	

General				
	Items			
1	Mob/Demob	2	EA	$ 1,700,000.00	$ 3,400,000	
	SUBTOTAL			**$ 3,400,000**	

TOTAL		$	97,186,000
CONTINGENCY 25.51%		$	24,792,149
Escalation 2Q 2016 to 2Q 2018	3.31%	$	4,032,000
GRAND TOTAL CONSTRUCTION COST		**$**	**126,010,149**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Groins | Sheet: 6 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	27,844,000
CONTINGENCY 25.51%		$	7,103,004
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,155,000
GRAND TOTAL CONSTRUCTION COST		**$**	**36,102,004**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Beachfill-Ren Sheet: 7 OF 8
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	475,000	CY	$ 12.88	$ 6,118,000	advance fill - 4-year cycle
4	Beachfill-Reach 4	149,000	CY	$ 12.88	$ 1,919,120	advance fill - 4-year cycle
5	Beachfill-Reach 5	476,000	CY	$ 12.88	$ 6,130,880	advance fill - 4-year cycle
6	Beachfill-Reach 6a	11,000	CY	$ 12.88	$ 141,680	advance fill - 4-year cycle
	SUBTOTAL	**1,111,000**	**CY**		**$ 14,310,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	17,610,000
CONTINGENCY 30.47%		$	5,366,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	760,000
GRAND TOTAL CONSTRUCTION COST		**$**	**23,736,000**

Discipline: Structural | Sheet: 8 OF 8

Contract No.: W912DS-09-0009 | **Alternative 3n - Composite Seawall** | Prepared by: R. Hampson | Date: 5/1/2015

Task Order No.: 26 | **Feasibility Estimate** | Updated: S. Jessup | Date: 7/11/2018

M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Boardwalk Access Ramps						
	Items					
1	24" Steel Pipe Pile	114	LF	$ 135.00	$ 15,390	3 piles @ 24x1/2" WT (38 ft long)
2	Precast Concrete Pile Cap	15	CY	$ 1,500.00	$ 22,500	3 caps @ 5.1 cy each
3	Cast in Place Concrete Plug	2	CY	$ 500.00	$ 1,000	3 plugs
4	Cast in Place Concrete Deck	6	CY	$ 1,000.00	$ 6,000	3 @ 4'6" x 10' x 14"
5	Precast Concrete Deck	25	CY	$ 1,000.00	$ 25,000	70' x 10' x 14"
6	RPL Decking	695	SF	$ 50.00	$ 34,750	Furnish and Install
7	Handrail	139	LF	$ 150.00	$ 20,850	Furnish and Install
	SUBTOTAL				$ 125,000	
Demolition						
	Items					
1	Access Ramps	700	SF	$ 35.00	$ 24,500	Demo and Dispose of Access Ramp
	SUBTOTAL				$ 25,000	
General						
	Items					
1	Mob/Demob	0.125	EA	$ 1,000,000.00	$ 125,000	
	SUBTOTAL				$ 125,000	

SUBTOTAL		$	275,000
GENERAL CONDITIONS 10%		$	28,000
SUBTOTAL (ALL ITEMS)		$	303,000
G. C. OVERHEAD & PROFIT 10%		$	30,000
TOTAL		$	333,000
CONTINGENCY 25.51%		$	85,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	14,000
GRAND TOTAL CONSTRUCTION COST		**$**	**432,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Summary - Annualized Costs - Int SLR
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 1
Prepared by: R. Hampson | Date: 6/17/2015
Updated: M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: **Moffatt & Nichol** Consultant Contact: M. Kluijver

Item #	Description	Medium +16'	Large +18'	XL +20'	Buried Seawall	Composite Seawall	
Annualized Costs - 4 year Cycle							
	Items						
1	Total Investment	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000	
2	Renourishment	$6,364,000	$6,801,000	$7,243,000	$6,364,000	$6,364,000	
3	Major Rehab	$332,000	$332,000	$332,000	$332,000	$332,000	
4	Groin & Seawall Maintenance	$176,000	$195,000	$218,000	$325,000	$433,000	
5	Monitoring	$403,000	$403,000	$403,000	$403,000	$403,000	
6	SLR Adaption	$210,000	$373,000	$377,000	$1,020,000	$1,453,000	
	Total	**$10,164,000**	**$11,720,000**	**$14,154,000**	**$14,342,000**	**$17,421,000**	
	IDC	**$1,307,000**	**$2,129,000**	**$3,461,000**	**$3,753,000**	**$6,761,000**	

ATTACHMENT D
CSRM ALTERNATIVES
HIGH SEA LEVEL
CHANGE SCREENING
LEVEL COST ESTIMATES

CSRM ALTERNATIVES
HIGH SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N MEDIUM DUNE

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 2,679,000.00	$ 2,679,000	
2	Renourishment	1	LS	$ 7,666,000.00	$ 7,666,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ 176,000.00	$ 176,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
6	SLR Adaption Costs	1	LS	$ 564,000.00	$ 564,000	
	SUBTOTAL				**$ 11,820,000**	

Total Annual Cost $ 11,820,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,204,000.00	$ 17,204,000	
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
	SUBTOTAL				**$ 48,348,000**	
	CONTINGENCY 22.41%				$ 10,835,000	
	SUBTOTAL				**$ 59,183,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 4,835,000	
	CONTINGENCY 15.25%				$ 737,000	
	SUBTOTAL				**$ 5,572,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.16%	$ 3,462,000	
	CONTINGENCY 15.25%				$ 528,000	
	SUBTOTAL				**$ 3,990,000**	

First Cost		$ 68,745,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 2,272,000
Interest During Construction		$ 1,307,000
Total Investment Cost		**$ 72,324,000**
Annualized Total Investment Cost		**$ 2,679,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	16.88
IDC Factor	0.018404314

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,955,000.00	$ 17,955,000	
	SUBTOTAL				**$ 21,255,000**	
	CONTINGENCY 30.47%				$ 6,476,000	
	SUBTOTAL				**$ 27,731,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 2,126,000	
	CONTINGENCY 15.25%				$ 324,000	
	SUBTOTAL				**$ 2,450,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.91%	$ 1,681,000	
	CONTINGENCY 15.25%				$ 256,000	
	SUBTOTAL				**$ 1,937,000**	

First Cost		$	32,118,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,062,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**33,180,000**

Annualized TotalRenourishment Cost **$ 7,666,000** from ammoritization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: Adaption Costs | Sheet: 3 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	-	EA	$ 3,300,000.00	$ -	
17	Beachfill	553,000	CY	$ 12.88	$ 7,123,000	
17	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
17	Access Ramps	-	EA	$ 825,000.00	$ -	Demo & Rebuild 8 Concrete Access Ramps
	SUBTOTAL				**$ 8,583,000**	
	CONTINGENCY 30.47%				$ 2,615,000	
	SUBTOTAL				**$ 11,198,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 858,000	
	CONTINGENCY 15.25%				$ 131,000	
	SUBTOTAL				**$ 989,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.74%	$ 750,000	
	CONTINGENCY 15.25%				$ 114,000	
	SUBTOTAL				**$ 864,000**	

First Cost		$	13,051,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	431,000
Interest During Construction		$	-
Total Adaption Cost		**$**	**13,482,000**

Annualized Adaption Cost **$ 564,000** from amortization

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Beachfill-Initial Sheet: 4 OF 6
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	61	AC	$ 20,000.00	$ 1,220,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,204,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,504,000
CONTINGENCY 22.41%		$	4,594,946
Escalation 2Q 2016 to 2Q 2018	3.31%	$	830,000
GRAND TOTAL CONSTRUCTION COST		**$**	**25,928,946**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Groins | Sheet: 5 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	27,844,000
CONTINGENCY 22.41%		$	6,239,840
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,127,000
GRAND TOTAL CONSTRUCTION COST		**$**	**35,210,840**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Medium
Feasibility Estimate

Discipline: Beachfill-Ren | Sheet: 6 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	572,000	CY	$ 12.88	$ 7,367,360	advance fill - 4-year cycle
4	Beachfill-Reach 4	200,000	CY	$ 12.88	$ 2,576,000	advance fill - 4-year cycle
5	Beachfill-Reach 5	576,000	CY	$ 12.88	$ 7,418,880	advance fill - 4-year cycle
6	Beachfill-Reach 6a	46,000	CY	$ 12.88	$ 592,480	advance fill - 4-year cycle
	SUBTOTAL	**1,394,000**	**CY**		**$ 17,955,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	21,255,000
CONTINGENCY 30.47%		$	6,476,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	917,000
GRAND TOTAL CONSTRUCTION COST		**$**	**28,648,000**

CSRM ALTERNATIVES
HIGH SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N LARGE DUNE

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 3,616,000.00	$ 3,616,000	
2	Renourishment	1	LS	$ 8,108,000.00	$ 8,108,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ 195,000.00	$ 195,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
6	SLR Adaption - Access	1	LS	$ 849,000.00	$ 849,000	
	SUBTOTAL				**$ 13,503,000**	

Total Annual Cost $ 13,503,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 31,110,000.00	$ 31,110,000	
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 19,483,000.00	$ 19,483,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,333,000.00	$ 2,333,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 6,786,000.00	$ 6,786,000	extend 5 groins
	SUBTOTAL				**$ 65,512,000**	
	CONTINGENCY 21.64%				$ 14,177,000	
	SUBTOTAL				**$ 79,689,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 6,551,000	
	CONTINGENCY 15.25%				$ 999,000	
	SUBTOTAL				**$ 7,550,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.89%	$ 4,514,000	
	CONTINGENCY 15.25%				$ 688,000	
	SUBTOTAL				**$ 5,202,000**	

First Cost		$	92,441,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	3,056,000
Interest During Construction		$	2,129,000
Total Investment Cost		**$**	**97,626,000**
Annualized Total Investment Cost		**$**	**3,616,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	20.19
IDC Factor	0.022297107

$	34,410,000
$	31,102,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 19,191,000.00	$ 19,191,000	
	SUBTOTAL				**$ 22,491,000**	
	CONTINGENCY 30.47%				$ 6,853,000	
	SUBTOTAL				**$ 29,344,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 2,249,000	
	CONTINGENCY 15.25%				$ 343,000	
	SUBTOTAL				**$ 2,592,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.86%	$ 1,768,000	
	CONTINGENCY 15.25%				$ 270,000	
	SUBTOTAL				**$ 2,038,000**	

First Cost		$ 33,974,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 1,123,000
Interest During Construction		$ -
Total Renourishment Cost		**$ 35,097,000**

Annualized TotalRenourishment Cost **$ 8,108,000** from ammoritization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: Adaption Costs Sheet: 3 OF 6
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	-	EA	$ 3,300,000.00	$ -	
17	Beachfill	566,000	CY	$ 12.88	$ 7,290,000	
17	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
17	Access Ramps	8	EA	$ 825,000.00	$ 6,600,000	Demo & Rebuild 8 Concrete Access Ramps
	SUBTOTAL				**$ 15,350,000**	
	CONTINGENCY 30.47%				$ 4,677,000	
	SUBTOTAL				**$ 20,027,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 1,535,000	
	CONTINGENCY 15.25%				$ 234,000	
	SUBTOTAL				**$ 1,769,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	8.21%	$ 1,260,000	
	CONTINGENCY 15.25%				$ 192,000	
	SUBTOTAL				**$ 1,452,000**	

First Cost		$	23,248,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	768,000
Interest During Construction		$	-
Total Adaption Cost		**$**	**24,016,000**

Annualized Adaption Cost **$ 849,000** from amortization

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large
Feasibility Estimate

Discipline: Beachfill-Initial Sheet: 4 OF 6
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	611,000	CY	$ 12.88	$ 7,869,680	design + advance fill
4	Beachfill-Reach 4	478,000	CY	$ 12.88	$ 6,156,640	design + advance fill
5	Beachfill-Reach 5	758,000	CY	$ 12.88	$ 9,763,040	design + advance fill
6	Beachfill-Reach 6a	417,000	CY	$ 12.88	$ 5,370,960	design + advance fill
7	Beachfill-Reach 6b	38,000	CY	$ 12.88	$ 489,440	design + advance fill
8	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 31,110,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	34,410,000
CONTINGENCY 21.64%		$	7,446,324
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,384,000
GRAND TOTAL CONSTRUCTION COST		**$**	**43,240,324**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large Feasibility Estimate

Discipline: Groins | Sheet: 5 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	61,007	TON	$ 193.30	$ 11,792,556	12 groins @ a total of 4519 ft
2	Underlayer Stone (500-1500 lbs)	19,884	TON	$ 104.68	$ 2,081,415	
3	Core Stone (30-130 lbs)	12,201	TON	$ 92.87	$ 1,133,135	
4	Bedding Stone (30-130 lbs)	31,181	CY	$ 92.87	$ 2,895,789	
5	Geotextile Filter Fabric	34,796	SY	$ 23.68	$ 823,976	
6	Excavation - Sand	104,389	CY	$ 7.24	$ 755,776	
	SUBTOTAL				**$ 19,483,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	7,306	TON	$ 193.30	$ 1,412,250	1 groin @ 562 ft
2	Underlayer Stone (500-1500 lbs)	2,585	TON	$ 104.68	$ 270,619	
3	Core Stone (30-130 lbs)	1,574	TON	$ 92.87	$ 146,140	
4	Bedding Stone (30-130 lbs)	3,541	CY	$ 92.87	$ 328,816	
5	Geotextile Filter Fabric	4,215	SY	$ 23.68	$ 99,811	
6	Excavation - Sand	10,453	CY	$ 7.24	$ 75,681	
	SUBTOTAL				**$ 2,333,000**	*$4,151* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	24,206	TON	$ 193.30	$ 4,679,020	5 groin extensions @ a total of 980'
2	Underlayer & Core Stone (500-1500 lbs)	5,096	TON	$ 104.68	$ 533,449	
3	Core Stone (30-130 lbs)	3,234	TON	$ 92.87	$ 300,342	
4	Bedding Stone (30-130 lbs)	10,192	CY	$ 92.87	$ 946,531	
5	Geotextile Filter Fabric	9,212	SY	$ 23.68	$ 218,140	
6	Excavation - Sand	14,994	CY	$ 7.24	$ 108,557	
	SUBTOTAL				**$ 6,786,000**	*$6,924* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	31,102,000
CONTINGENCY 21.64%		$	6,730,473
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,251,000
GRAND TOTAL CONSTRUCTION COST		**$**	**39,083,473**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Large Feasibility Estimate

Discipline: Beachfill-Ren | Sheet: 6 OF 6
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	639,000	CY	$ 12.88	$ 8,230,320	advance fill - 4-year cycle
4	Beachfill-Reach 4	200,000	CY	$ 12.88	$ 2,576,000	advance fill - 4-year cycle
5	Beachfill-Reach 5	605,000	CY	$ 12.88	$ 7,792,400	advance fill - 4-year cycle
6	Beachfill-Reach 6a	46,000	CY	$ 12.88	$ 592,480	advance fill - 4-year cycle
	SUBTOTAL	**1,490,000**	**CY**		**$ 19,191,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	22,491,000
CONTINGENCY 30.47%		$	6,853,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	970,000
GRAND TOTAL CONSTRUCTION COST		**$**	**30,314,000**

CSRM ALTERNATIVES
HIGH SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N XL DUNE

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 5,581,000.00	$ 5,581,000	
2	Renourishment	1	LS	$ 8,544,000.00	$ 8,544,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin Maintenance	1	LS	$ 218,000.00	$ 218,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
6	SLR Adaption	1	LS	$ 859,000.00	$ 859,000	
	SUBTOTAL				**$ 15,937,000**	

Total Annual Cost $ 15,937,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 6,600,000.00	$ 6,600,000	
17	Beachfill	1	LS	$ 52,885,000.00	$ 52,885,000	
2	Access Ramps	8	LS	$ 825,000.00	$ 6,600,000	Demo & Rebuild 8 Concrete Access Ramps
10	Mob/Demob	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 21,345,000.00	$ 21,345,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,483,000.00	$ 2,483,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 8,032,000.00	$ 8,032,000	extend 5 groins
	SUBTOTAL				**$ 100,445,000**	
	CONTINGENCY 22.84%				$ 22,942,000	
	SUBTOTAL				**$ 123,387,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 10,045,000	
	CONTINGENCY 15.25%				$ 1,532,000	
	SUBTOTAL				**$ 11,577,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.50%	$ 6,529,000	
	CONTINGENCY 15.25%				$ 996,000	
	SUBTOTAL				**$ 7,525,000**	

First Cost		$ 142,489,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 4,710,000
Interest During Construction		$ 3,461,000
Total Investment Cost		**$ 150,660,000**
Annualized Total Investment Cost		**$ 5,581,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	21.22
IDC Factor	0.023512491

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 20,415,000.00	$ 20,415,000	
	SUBTOTAL				**$ 23,715,000**	
	CONTINGENCY 30.47%				$ 7,226,000	
	SUBTOTAL				**$ 30,941,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 2,372,000	
	CONTINGENCY 15.25%				$ 362,000	
	SUBTOTAL				**$ 2,734,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.81%	$ 1,852,000	
	CONTINGENCY 15.25%				$ 282,000	
	SUBTOTAL				**$ 2,134,000**	

First Cost		$	35,809,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,184,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**36,993,000**

Annualized TotalRenourishment Cost **$ 8,544,000** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Beachfill-Initial Sheet: 4 OF 7
Prepared by: R. Hampson Date: 5/1/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	1,044,000	CY	$ 12.88	$ 13,446,720	design + advance fill
4	Beachfill-Reach 4	827,000	CY	$ 12.88	$ 10,651,760	design + advance fill
5	Beachfill-Reach 5	1,424,000	CY	$ 12.88	$ 18,341,120	design + advance fill
6	Beachfill-Reach 6a	621,000	CY	$ 12.88	$ 7,998,480	design + advance fill
7	Beachfill-Reach 6b	58,000	CY	$ 12.88	$ 747,040	design + advance fill
8	Dune Grass Planting	85	AC	$ 20,000.00	$ 1,700,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 52,885,000**	

General						
	Items					
1	Mob/Demob	2	EA	$ 3,300,000.00	$ 6,600,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 6,600,000**	

TOTAL		$	59,485,000
CONTINGENCY 22.84%		$	13,586,374
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,415,000
GRAND TOTAL CONSTRUCTION COST		**$**	**75,486,374**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Groins | Sheet: 5 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	66,839	TON	$ 193.30	$ 12,919,882	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	21,784	TON	$ 104.68	$ 2,280,391	
3	Core Stone (30-130 lbs)	13,368	TON	$ 92.87	$ 1,241,458	
4	Bedding Stone (30-130 lbs)	34,162	CY	$ 92.87	$ 3,172,616	
5	Geotextile Filter Fabric	38,123	SY	$ 23.68	$ 902,746	
6	Excavation - Sand	114,368	CY	$ 7.24	$ 828,025	
	SUBTOTAL				**$ 21,345,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	7,774	TON	$ 193.30	$ 1,502,714	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,751	TON	$ 104.68	$ 287,954	
3	Core Stone (30-130 lbs)	1,674	TON	$ 92.87	$ 155,502	
4	Bedding Stone (30-130 lbs)	3,767	CY	$ 92.87	$ 349,878	
5	Geotextile Filter Fabric	4,485	SY	$ 23.68	$ 106,205	
6	Excavation - Sand	11,123	CY	$ 7.24	$ 80,529	
	SUBTOTAL				**$ 2,483,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	28,652	TON	$ 193.30	$ 5,538,432	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	6,032	TON	$ 104.68	$ 631,430	
3	Core Stone (30-130 lbs)	3,828	TON	$ 92.87	$ 355,506	
4	Bedding Stone (30-130 lbs)	12,064	CY	$ 92.87	$ 1,120,384	
5	Geotextile Filter Fabric	10,904	SY	$ 23.68	$ 258,207	
6	Excavation - Sand	17,748	CY	$ 7.24	$ 128,496	
	SUBTOTAL				**$ 8,032,000**	*$6,924* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	34,360,000
CONTINGENCY 22.84%		$	7,847,824
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,395,000
GRAND TOTAL CONSTRUCTION COST		**$**	**43,602,824**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Beachfill-Ren | Sheet: 6 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	705,000	CY	$ 12.88	$ 9,080,400	advance fill - 4-year cycle
4	Beachfill-Reach 4	200,000	CY	$ 12.88	$ 2,576,000	advance fill - 4-year cycle
5	Beachfill-Reach 5	634,000	CY	$ 12.88	$ 8,165,920	advance fill - 4-year cycle
6	Beachfill-Reach 6a	46,000	CY	$ 12.88	$ 592,480	advance fill - 4-year cycle
	SUBTOTAL	**1,585,000**	**CY**		**$ 20,415,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL	$	23,715,000
CONTINGENCY 30.47%	$	7,226,000
Escalation 2Q 2016 to 2Q 2018 3.31%	$	1,023,000
GRAND TOTAL CONSTRUCTION COST	**$**	**31,964,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - XL
Feasibility Estimate

Discipline: Structural | Sheet: 7 OF 7
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Boardwalk Access Ramps						
	Items					
1	24" Steel Pipe Pile	342	LF	$ 135.00	$ 46,170	9 piles @ 24x1/2" WT (38 ft long)
2	Precast Concrete Pile Cap	46	CY	$ 1,500.00	$ 69,000	9 caps @ 5.1 cy each
3	Cast in Place Concrete Plug	6	CY	$ 500.00	$ 3,000	9 plugs
4	Cast in Place Concrete Deck	18	CY	$ 1,000.00	$ 17,500	9 @ 4'6" x 10' x 14"
5	Precast Concrete Deck	102	CY	$ 1,000.00	$ 102,000	278' x 10' x 14"
6	RPL Decking	2,780	SF	$ 50.00	$ 139,000	Furnish and Install
7	Handrail	556	LF	$ 150.00	$ 83,400	Furnish and Install
	SUBTOTAL				$ 460,000	
Demolition						
	Items					
1	Access Ramps	2,780	SF	$ 35.00	$ 97,300	Demo and Dispose of Access Ramp
	SUBTOTAL				$ 97,000	
General						
	Items					
1	Mob/Demob	0.125	EA	$ 1,000,000.00	$ 125,000	
	SUBTOTAL				$ 125,000	

SUBTOTAL		$	682,000
GENERAL CONDITIONS 10%		$	68,000
SUBTOTAL (ALL ITEMS)		$	750,000
G. C. OVERHEAD & PROFIT 10%		$	75,000
TOTAL		$	825,000
CONTINGENCY 22.84%		$	188,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	33,000
GRAND TOTAL CONSTRUCTION COST		**$**	**1,046,000**

ATTACHMENT C
CSRM ALTERNATIVES
HIGH SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N BURIED SEAWALL

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 5,898,000.00	$ 5,898,000	
2	Renourishment	1	LS	$ 7,666,000.00	$ 7,666,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin & Seawall Maintenance	1	LS	$ 151,000.00	$ 151,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
6	SLR Adaption	1	LS	$ 2,197,000.00	$ 2,197,000	
	SUBTOTAL				**$ 16,647,000**	

Total Annual Cost $ 16,647,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,444,000.00	$ 17,444,000	
10	Mob/Demob - Groins	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
10	Mob/Demob - Seawall	1	LS	$ 2,600,000.00	$ 2,600,000	
10	Buried Seawall	1	LS	$ 53,674,000.00	$ 53,674,000	32,000 lf of buried seawall
	SUBTOTAL				**$ 104,862,000**	
	CONTINGENCY 24.56%				$ 25,754,000	
	SUBTOTAL				**$ 130,616,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 10,486,000	
	CONTINGENCY 15.25%				$ 1,599,000	
	SUBTOTAL				**$ 12,085,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.46%	$ 6,774,000	
	CONTINGENCY 15.25%				$ 1,033,000	
	SUBTOTAL				**$ 7,807,000**	

First Cost		$	150,508,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	4,975,000
Interest During Construction		$	3,753,000
Total Investment Cost		**$**	**159,236,000**
Annualized Total Investment Cost		**$**	**5,898,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	21.75
IDC Factor	0.024138631

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,955,000.00	$ 17,955,000	
	SUBTOTAL				**$ 21,255,000**	
	CONTINGENCY 30.47%				$ 6,476,000	
	SUBTOTAL				**$ 27,731,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 2,126,000	
	CONTINGENCY 15.25%				$ 324,000	
	SUBTOTAL				**$ 2,450,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.91%	$ 1,681,000	
	CONTINGENCY 15.25%				$ 256,000	
	SUBTOTAL				**$ 1,937,000**	

First Cost		$	32,118,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,062,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**33,180,000**

Annualized TotalRenourishment Cost **$ 7,666,000** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
10	Mob/Demob	1	EA	$ 1,700,000.00	$ 1,700,000	
10	Armor Stone (1.5 TON)	211,520	TON	$ 124.71	$ 26,378,659	
10	Core Stone	31,680	TON	$ 87.47	$ 2,771,050	
10	Geotextile	35,520	SY	$ 7.72	$ 274,214	
10	Excavation - Sand	444,480	CY	$ 3.83	$ 1,702,358	
17	Beachfill-Dune	1,106,000	CY	$ 12.88	$ 14,245,280	
17	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
10	Access Ramps	8	EA	$ 825,000.00	$ 6,600,000	
	SUBTOTAL				**$ 55,132,000**	
	CONTINGENCY 24.56%				$ 13,540,000	
	SUBTOTAL				**$ 68,672,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 5,513,000	
	CONTINGENCY 15.25%				$ 841,000	
	SUBTOTAL				**$ 6,354,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.04%	$ 3,881,000	
	CONTINGENCY 15.25%				$ 592,000	
	SUBTOTAL				**$ 4,473,000**	

First Cost		$	79,499,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,628,000
Interest During Construction		$	-
Total Adaption Cost		**$**	**82,127,000**
Annualized Total Investment Cost		**$**	**2,197,000** Construction in Year 12

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	3.7
IDC Factor	0.003097769

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Beachfill-Initial Sheet: 4 OF 7
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,444,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,744,000
CONTINGENCY 24.56%		$	5,094,726
Escalation 2Q 2016 to 2Q 2018	3.31%	$	854,000
GRAND TOTAL CONSTRUCTION COST		**$**	**26,692,726**

Contract No.: W912DS-09-0009
Task Order No.: 26

Buried Seawall
Feasibility Estimate

Discipline: Buried Seawall | Sheet: 5 OF 7
Prepared by: R. Hampson | Date: 3/24/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Buried Seawall						
	Items					
1	Armor Stone (1.5 TON)	272,960	TON	$ 124.71	$ 34,040,842	
2	Core Stone	202,560	TON	$ 87.47	$ 17,717,923	
3	Geotextile	155,520	SY	$ 7.72	$ 1,200,614	
4	Excavation - Sand	186,560	CY	$ 3.83	$ 714,525	
	SUBTOTAL				**$ 53,674,000**	
General						
	Items					
1	Mob/Demob	2	EA	$ 1,300,000.00	$ 2,600,000	
	SUBTOTAL				**$ 2,600,000**	

TOTAL		$	56,274,000
CONTINGENCY 24.56%		$	13,820,894
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,317,000
GRAND TOTAL CONSTRUCTION COST		**$**	**72,411,894**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Groins | Sheet: 6 OF 7
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL			$ 27,844,000
CONTINGENCY 24.56%			$ 7,089,082
Escalation 2Q 2016 to 2Q 2018		3.31%	$ 1,155,000
GRAND TOTAL CONSTRUCTION COST			**$ 36,088,082**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Buried Seawall
Feasibility Estimate

Discipline: Beachfill-Ren Sheet: 7 OF 7
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	572,000	CY	$ 12.88	$ 7,367,360	advance fill - 4-year cycle
4	Beachfill-Reach 4	200,000	CY	$ 12.88	$ 2,576,000	advance fill - 4-year cycle
5	Beachfill-Reach 5	576,000	CY	$ 12.88	$ 7,418,880	advance fill - 4-year cycle
6	Beachfill-Reach 6a	46,000	CY	$ 12.88	$ 592,480	advance fill - 4-year cycle
	SUBTOTAL	**1,394,000**	**CY**		**$ 17,955,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	21,255,000
CONTINGENCY 30.47%		$	6,476,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	917,000
GRAND TOTAL CONSTRUCTION COST		**$**	**28,648,000**

ATTACHMENT D
CSRM ALTERNATIVES
HIGH SEA LEVEL CHANGE SCENARIO
ALTERNATIVE 3N COMPOSITE SEAWALL

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Annualized Costs						
	Items					
1	Total Investment	1	LS	$ 8,436,000.00	$ 8,436,000	
2	Renourishment	1	LS	$ 7,666,000.00	$ 7,666,000	
3	Major Rehab	1	LS	$ 332,000.00	$ 332,000	
4	Groin & Seawall Maintenance	1	LS	$ 14,000.00	$ 14,000	
5	Monitoring	1	LS	$ 403,000.00	$ 403,000	
6	Seawall Adaption	1	LS	$ 2,288,000.00	$ 2,288,000	
	SUBTOTAL				**$ 19,139,000**	

Total Annual Cost $ 19,139,000

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,444,000.00	$ 17,444,000	
2	Boardwalk Access Ramps	8	LS	$ 333,000.00	$ 2,664,000	
10	Mob/Demob - Groin	1	LS	$ 2,500,000.00	$ 2,500,000	
10	New Groins in Reach 3 & 4	1	LS	$ 17,620,000.00	$ 17,620,000	build 12 new groins
10	New Groin in Reach 6	1	LS	$ 2,184,000.00	$ 2,184,000	build 1 new groin
10	Groin Extensions in Reach 6	1	LS	$ 5,540,000.00	$ 5,540,000	extend 5 groins
10	Mob/Demob - Composite Wall	1	LS	$ 3,400,000.00	$ 3,400,000	
10	Composite Seawall	1	LS	$ 93,786,000.00	$ 93,786,000	32,000 lf of composite seawall
	SUBTOTAL				**$ 148,438,000**	
	CONTINGENCY 25.51%				$ 37,867,000	
	SUBTOTAL				**$ 186,305,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 14,844,000	
	CONTINGENCY 15.25%				$ 2,264,000	
	SUBTOTAL				**$ 17,108,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	6.14%	$ 9,114,000	
	CONTINGENCY 15.25%				$ 1,390,000	
	SUBTOTAL				**$ 10,504,000**	

First Cost		$ 213,917,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$ 7,071,000
Interest During Construction		$ 6,761,000
Total Investment Cost		**$ 227,749,000**
Annualized Total Investment Cost		**$ 8,436,000**

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	27.19
IDC Factor	0.030594915

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Ren. Costs | Sheet: 3 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
17	Mob/Demob	1	LS	$ 3,300,000.00	$ 3,300,000	
17	Beachfill	1	LS	$ 17,955,000.00	$ 17,955,000	
	SUBTOTAL				**$ 21,255,000**	
	CONTINGENCY 30.47%				$ 6,476,000	
	SUBTOTAL				**$ 27,731,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 2,126,000	
	CONTINGENCY 15.25%				$ 324,000	
	SUBTOTAL				**$ 2,450,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.91%	$ 1,681,000	
	CONTINGENCY 15.25%				$ 256,000	
	SUBTOTAL				**$ 1,937,000**	

First Cost		$	32,118,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,062,000
Interest During Construction		$	-
Total Renourishment Cost		**$**	**33,180,000**

Annualized TotalRenourishment Cost **$ 7,666,000** from amortization file

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Present Value Factor	5.61125

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: First Costs | Sheet: 2 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Construction Costs						
WBS	**Items**					
10	Mob/Demob - Composite Wall	2	EA	$ 1,700,000.00	$ 3,400,000	
10	Armor Stone (3 TON)	168,960	TON	$ 124.29	$ 21,000,038	
10	Core Stone	24,000	TON	$ 86.15	$ 2,067,600	
10	Geotextile	35,520	SY	$ 9.18	$ 326,074	
10	Excavation - Sand	444,480	CY	$ 3.73	$ 1,657,910	
10	Concrete Cap	4,800	CY	$ 820.91	$ 3,940,368	
17	Beachfill-Dune	1,288,490	CY	$ 12.88	$ 16,595,751	
17	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
10	Access Ramps	8	EA	$ 825,000.00	$ 6,600,000	
	SUBTOTAL				**$ 57,048,000**	
	CONTINGENCY 25.51%				$ 14,553,000	
	SUBTOTAL				**$ 71,601,000**	
Lands & Damages						
WBS	**Items**					
01	Lands & Damages	1	LS	$ -	$ -	
	CONTINGENCY 20%				$ -	
	SUBTOTAL				**$ -**	
Planning, Engineering & Design						
WBS	**Items**					
30	Planning, Engineering & Design	1	LS	10.00%	$ 5,705,000	
	CONTINGENCY 15.25%				$ 870,000	
	SUBTOTAL				**$ 6,575,000**	
Construction Management						
WBS	**Items**					
30	Consruction Management	1	LS	7.01%	$ 3,999,000	
	CONTINGENCY 15.25%				$ 610,000	
	SUBTOTAL				**$ 4,609,000**	

First Cost		$	82,785,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	2,737,000
Interest During Construction		$	-
Total Adaption Cost		**$**	**85,522,000**
Annualized Total Investment Cost		**$**	**2,288,000** Construction in Year 12

Interest Rate	2.750%
Life	50
Capital Recovery Factor	0.03704
Construction Period in months	12
IDC Factor	0.012700947

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Beachfill-Initial Sheet: 4 OF 8
Prepared by: R. Hampson Date: 4/20/2015
Updated: S. Jessup Date: 7/11/2018
M. Kluijver Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill - Initial Construction						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	
3	Beachfill-Reach 3	356,000	CY	$ 12.88	$ 4,585,280	design + advance fill
4	Beachfill-Reach 4	294,000	CY	$ 12.88	$ 3,786,720	design + advance fill
5	Beachfill-Reach 5	321,000	CY	$ 12.88	$ 4,134,480	design + advance fill
6	Beachfill-Reach 6a	250,000	CY	$ 12.88	$ 3,220,000	design + advance fill
7	Beachfill-Reach 6b	20,000	CY	$ 12.88	$ 257,600	design + advance fill
8	Dune Grass Planting	73	AC	$ 20,000.00	$ 1,460,000	32,000 LF of dune grass planting
	SUBTOTAL		**CY**		**$ 17,444,000**	

General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	30" Cutter Head Dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	20,744,000
CONTINGENCY 25.51%		$	5,291,794
Escalation 2Q 2016 to 2Q 2018	3.31%	$	861,000
GRAND TOTAL CONSTRUCTION COST		**$**	**26,896,794**

Contract No.: W912DS-09-0009
Task Order No.: 26

Composite Seawall
Feasibility Estimate

Discipline: Composite Seawall | Sheet: 5 OF 8
Prepared by: R. Hampson | Date: 3/24/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Composite Seawall						
	Items					
1	Armor Stone (3 TON)	348,160	TON	$ 124.29	$ 43,272,806	
2	Core Stone	135,360	TON	$ 86.15	$ 11,661,264	
3	Geotextile	151,040	SY	$ 9.18	$ 1,386,547	
4	Excavation - Sand	312,960	CY	$ 3.73	$ 1,167,341	
5	Concrete Cap	11,520	CY	$ 820.91	$ 9,456,883	
6	AZ 12-770	7,040	TON	$ 3,462.40	$ 24,375,296	
7	Splash - Armor Stone	14,940	TON	$ 110.00	$ 1,643,400	
8	Splash - Bedding Stone	6,360	TON	$ 80.00	$ 508,800	
9	Splash - Geotextile	10,020	SY	$ 9.18	$ 91,984	
10	Splash - Fill	4,440	CY	$ 50.00	$ 222,000	
	SUBTOTAL				**$ 93,786,000**	

General			
	Items		
1	Mob/Demob	2 EA	$ 1,700,000.00	$ 3,400,000	
	SUBTOTAL			**$ 3,400,000**	

TOTAL		$	97,186,000
CONTINGENCY 25.51%		$	24,792,149
Escalation 2Q 2016 to 2Q 2018	3.31%	$	4,032,000
GRAND TOTAL CONSTRUCTION COST		**$**	**126,010,149**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Groins | Sheet: 6 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
New Groins in Reach 3 & 4						
	Items					
1	Armor Stone (4-8 TON)	55,175	TON	$ 193.30	$ 10,665,231	12 groins @ a total of 4087 ft
2	Underlayer Stone (500-1500 lbs)	17,983	TON	$ 104.68	$ 1,882,440	
3	Core Stone (30-130 lbs)	11,035	TON	$ 92.87	$ 1,024,811	
4	Bedding Stone (30-130 lbs)	28,200	CY	$ 92.87	$ 2,618,962	
5	Geotextile Filter Fabric	31,470	SY	$ 23.68	$ 745,207	
6	Excavation - Sand	94,410	CY	$ 7.24	$ 683,526	
	SUBTOTAL				**$ 17,620,000**	*$4,311* per LF of groin
New Groin in Reach 6a						
	Items					
1	Armor Stone (3-10 TON)	6,838	TON	$ 193.30	$ 1,321,785	1 groin @ 526 ft
2	Underlayer Stone (500-1500 lbs)	2,420	TON	$ 104.68	$ 253,284	
3	Core Stone (30-130 lbs)	1,473	TON	$ 92.87	$ 136,779	
4	Bedding Stone (30-130 lbs)	3,314	CY	$ 92.87	$ 307,753	
5	Geotextile Filter Fabric	3,945	SY	$ 23.68	$ 93,418	
6	Excavation - Sand	9,784	CY	$ 7.24	$ 70,833	
	SUBTOTAL				**$ 2,184,000**	*$4,152* per LF of groin
Groin Extensions in Reach 6a						
	Items					
1	Armor Stone (10 TON)	19,760	TON	$ 193.30	$ 3,819,608	5 groin extensions @ a total of 800'
2	Underlayer & Core Stone (500-1500 lbs)	4,160	TON	$ 104.68	$ 435,469	
3	Core Stone (30-130 lbs)	2,640	TON	$ 92.87	$ 245,177	
4	Bedding Stone (30-130 lbs)	8,320	CY	$ 92.87	$ 772,678	
5	Geotextile Filter Fabric	7,520	SY	$ 23.68	$ 178,074	
6	Excavation - Sand	12,240	CY	$ 7.24	$ 88,618	
	SUBTOTAL				**$ 5,540,000**	*$6,925* per LF of groin
General						
	Items					
1	Mob/Demob	1	EA	$ 2,500,000.00	$ 2,500,000	
	SUBTOTAL				**$ 2,500,000**	

TOTAL		$	27,844,000
CONTINGENCY 25.51%		$	7,103,004
Escalation 2Q 2016 to 2Q 2018	3.31%	$	1,155,000
GRAND TOTAL CONSTRUCTION COST		**$**	**36,102,004**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Beachfill-Ren | Sheet: 7 OF 8
Prepared by: R. Hampson | Date: 4/20/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Beachfill-Renourishment Operation						
	Items					
1	Beachfill-Reach 1	-	CY	$ 12.88	$ -	estimate for a single renourishment operation
2	Beachfill-Reach 2	-	CY	$ 12.88	$ -	renourishment operations occur in 4-year cycles
3	Beachfill-Reach 3	572,000	CY	$ 12.88	$ 7,367,360	advance fill - 4-year cycle
4	Beachfill-Reach 4	200,000	CY	$ 12.88	$ 2,576,000	advance fill - 4-year cycle
5	Beachfill-Reach 5	576,000	CY	$ 12.88	$ 7,418,880	advance fill - 4-year cycle
6	Beachfill-Reach 6a	46,000	CY	$ 12.88	$ 592,480	advance fill - 4-year cycle
	SUBTOTAL	**1,394,000**	**CY**		**$ 17,955,000**	
General						
	Items					
1	Mob/Demob	1	EA	$ 3,300,000.00	$ 3,300,000	large hopper dredge
	SUBTOTAL				**$ 3,300,000**	

TOTAL		$	21,255,000
CONTINGENCY 30.47%		$	6,476,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	917,000
GRAND TOTAL CONSTRUCTION COST		**$**	**28,648,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

Alternative 3n - Composite Seawall
Feasibility Estimate

Discipline: Structural | Sheet: 8 OF 8
Prepared by: R. Hampson | Date: 5/1/2015
Updated: S. Jessup | Date: 7/11/2018
M. Kluijver | Date: 7/12/2018

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Quantity	Unit	Unit Price $	Total $	Assumption / Basis
Boardwalk Access Ramps						
	Items					
1	24" Steel Pipe Pile	114	LF	$ 135.00	$ 15,390	3 piles @ 24x1/2" WT (38 ft long)
2	Precast Concrete Pile Cap	15	CY	$ 1,500.00	$ 22,500	3 caps @ 5.1 cy each
3	Cast in Place Concrete Plug	2	CY	$ 500.00	$ 1,000	3 plugs
4	Cast in Place Concrete Deck	6	CY	$ 1,000.00	$ 6,000	3 @ 4'6" x 10' x 14"
5	Precast Concrete Deck	25	CY	$ 1,000.00	$ 25,000	70' x 10' x 14"
6	RPL Decking	695	SF	$ 50.00	$ 34,750	Furnish and Install
7	Handrail	139	LF	$ 150.00	$ 20,850	Furnish and Install
	SUBTOTAL				$ 125,000	
Demolition						
	Items					
1	Access Ramps	700	SF	$ 35.00	$ 24,500	Demo and Dispose of Access Ramp
	SUBTOTAL				$ 25,000	
General						
	Items					
1	Mob/Demob	0.125	EA	$ 1,000,000.00	$ 125,000	
	SUBTOTAL				$ 125,000	

SUBTOTAL		$	275,000
GENERAL CONDITIONS 10%		$	28,000
SUBTOTAL (ALL ITEMS)		$	303,000
G. C. OVERHEAD & PROFIT 10%		$	30,000
TOTAL		$	333,000
CONTINGENCY 25.51%		$	85,000
Escalation 2Q 2016 to 2Q 2018	3.31%	$	14,000
GRAND TOTAL CONSTRUCTION COST		**$**	**432,000**

Contract No.: W912DS-09-0009
Task Order No.: 26

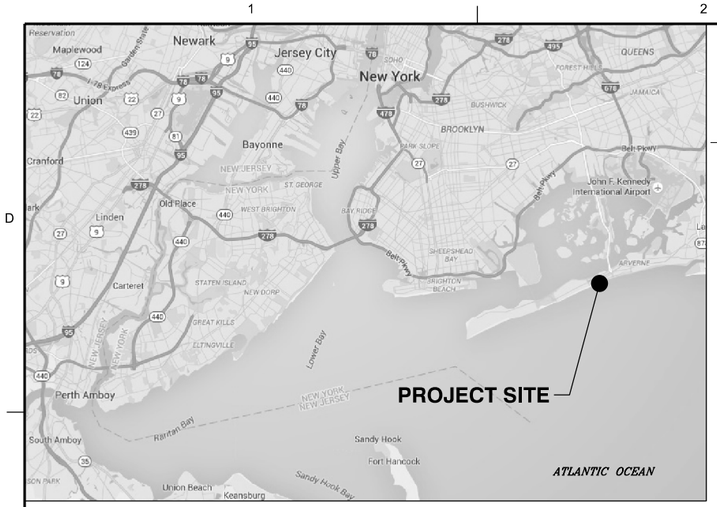
Summary - Annualized Cost - High SLR
Feasibility Estimate

Discipline: Annualized Cost | Sheet: 1 OF 1
Prepared by: R. Hampson | Date: 6/17/2015

Project Title: Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement - Atlantic Coast of New York - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Consultant Name: Moffatt & Nichol | Consultant Contact: M. Kluijver

Item #	Description	Medium +16'	Large +18'	XL +20'	Buried Seawall	Composite Seawall	
Annualized Costs - 4 year Cycle							
	Items						
1	Total Investment	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000	
2	Renourishment	$7,666,000	$8,108,000	$8,544,000	$7,666,000	$7,666,000	
3	Major Rehab	$332,000	$332,000	$332,000	$332,000	$332,000	
4	Groin & Seawall Maintenance	$176,000	$195,000	$218,000	$151,000	$14,000	
5	Monitoring	$403,000	$403,000	$403,000	$403,000	$403,000	
6	SLR Adaption	$564,000	$849,000	$859,000	$2,197,000	$2,288,000	
	Total	**$11,820,000**	**$13,503,000**	**$15,937,000**	**$16,647,000**	**$19,139,000**	
	IDC	**$1,307,000**	**$2,129,000**	**$3,461,000**	**$3,753,000**	**$6,761,000**	

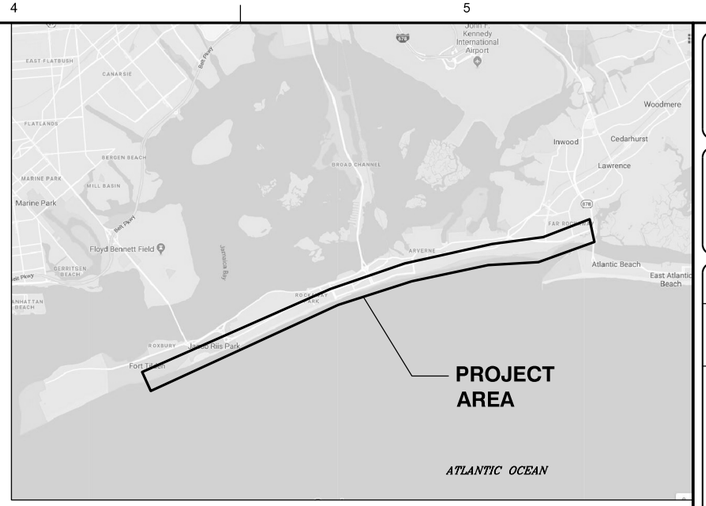


VICINITY MAP
NTS

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

ATLANTIC COAST OF NEW YORK

EAST ROCKAWAY INLET TO ROCKAWAY INLET



LOCATION PLAN
NTS

INDEX TO DRAWINGS

INDEX NO.	SHEET NO.	SHEET TITLE
1	G-001	COVER SHEET
2	G-002	SHEET KEY PLAN
3	CS-101	SITE PLAN (1 OF 17)
4	CS-102	SITE PLAN (2 OF 17)
5	CS-103	SITE PLAN (3 OF 17)
6	CS-104	SITE PLAN (4 OF 17)
7	CS-105	SITE PLAN (5 OF 17)
8	CS-106	SITE PLAN (6 OF 17)
9	CS-107	SITE PLAN (7 OF 17)
10	CS-108	SITE PLAN (8 OF 17)
11	CS-109	SITE PLAN (9 OF 17)
12	CS-110	SITE PLAN (10 OF 17)
13	CS-111	SITE PLAN (11 OF 17)
14	CS-112	SITE PLAN (12 OF 17)
15	CS-113	SITE PLAN (13 OF 17)
16	CS-114	SITE PLAN (14 OF 17)
17	CS-115	SITE PLAN (15 OF 17)
18	CS-116	SITE PLAN (16 OF 17)
19	CS-117	SITE PLAN (17 OF 17)
20	CS-301	BEACH FILL TYPICAL SECTIONS
21	CS-302	COMPOSITE SEAWALL TYPICAL SECTIONS
22	CS-303	CROSS SECTIONS (SHEET 1 OF 5)
23	CS-304	CROSS SECTIONS (SHEET 2 OF 5)
24	CS-305	CROSS SECTIONS (SHEET 3 OF 5)
25	CS-306	CROSS SECTIONS (SHEET 4 OF 5)
26	CS-307	CROSS SECTIONS (SHEET 5 OF 5)
27	CS-401	TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 2
28	CS-402	TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 2 & 3
29	CS-403	TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 3
30	CS-404	TYPICAL SECTIONS GROIN CONSTRUCTION REACH 3
31	CS-405	TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 4
32	CS-406	TYPICAL SECTIONS GROIN CONSTRUCTION REACH 4
33	CS-407	TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 5
34	CS-408	TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 6A
35	CS-409	TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 6A
36	CS-410	TYPICAL SECTIONS GROIN CONSTRUCTION REACH 6A

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_G-001.dgn
LAST PLOTTED BY: mestimable 1:19:14 PM 12/3/2018

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

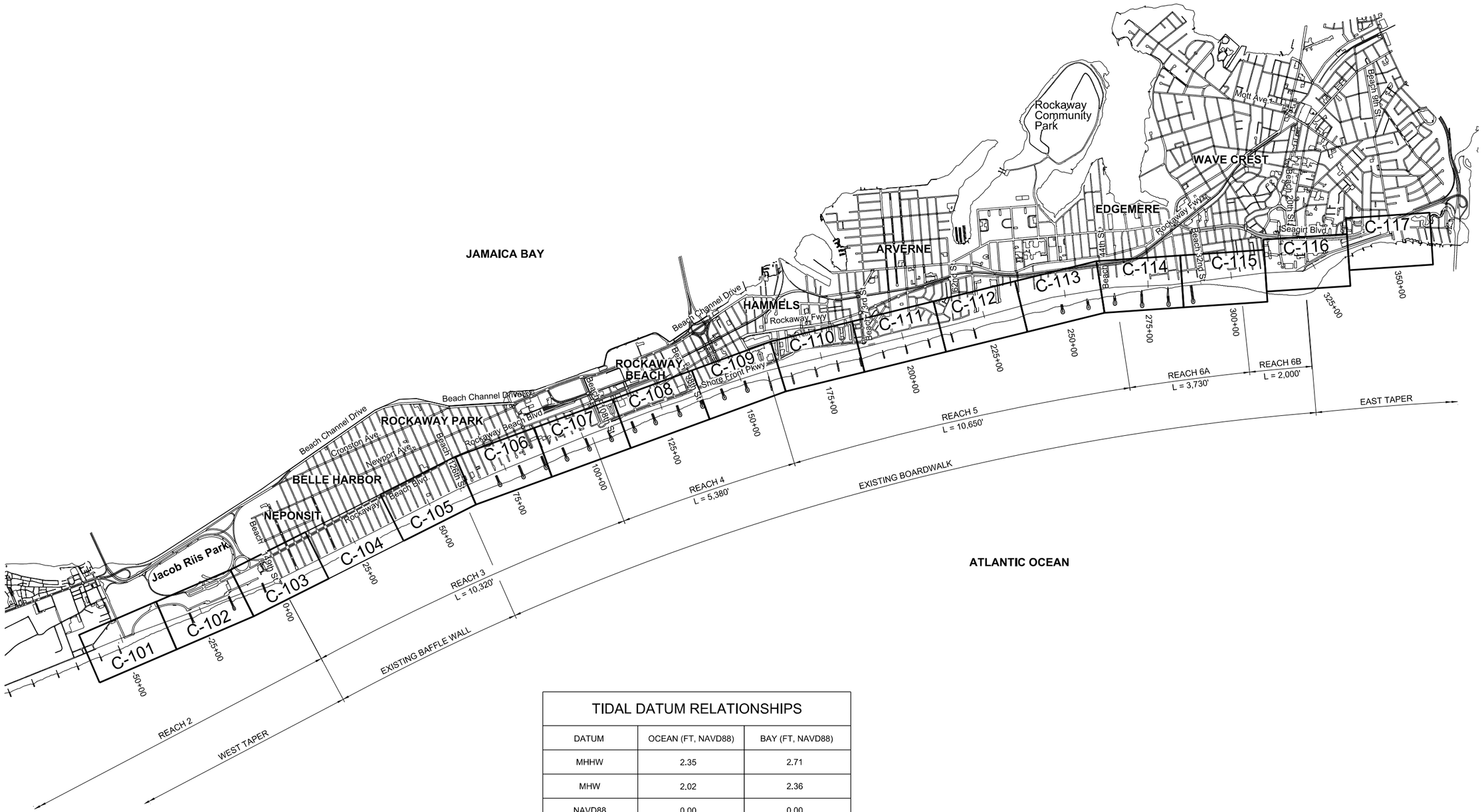
DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:1.0000'
PLOT DATE: 12/3/2018
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILE NAME: W912DS_A1_G-001.dgn

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

COVER SHEET

SHEET ID
G-001

SHEET 1 OF 36



TIDAL DATUM RELATIONSHIPS

DATUM	OCEAN (FT, NAVD88)	BAY (FT, NAVD88)
MHHW	2.35	2.71
MHW	2.02	2.36
NAVD88	0.00	0.00
MSL	-0.22	-0.23
NGVD29	-1.11	-1.11
MLW	-2.54	-2.84
MLLW	-2.73	-3.04

NOTE: TIDAL DATUMS BASED ON NOAA'S VDATUM 1983-2001 EPOCH

PRELIMINARY
NOT FOR CONSTRUCTION

0 1500' 3000'
SCALE:1"=1500'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRWN BY: ME
CHKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:2.000000
PLOT DATE: 12/3/2018
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILE NAME: W912DS_A1_G-002.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

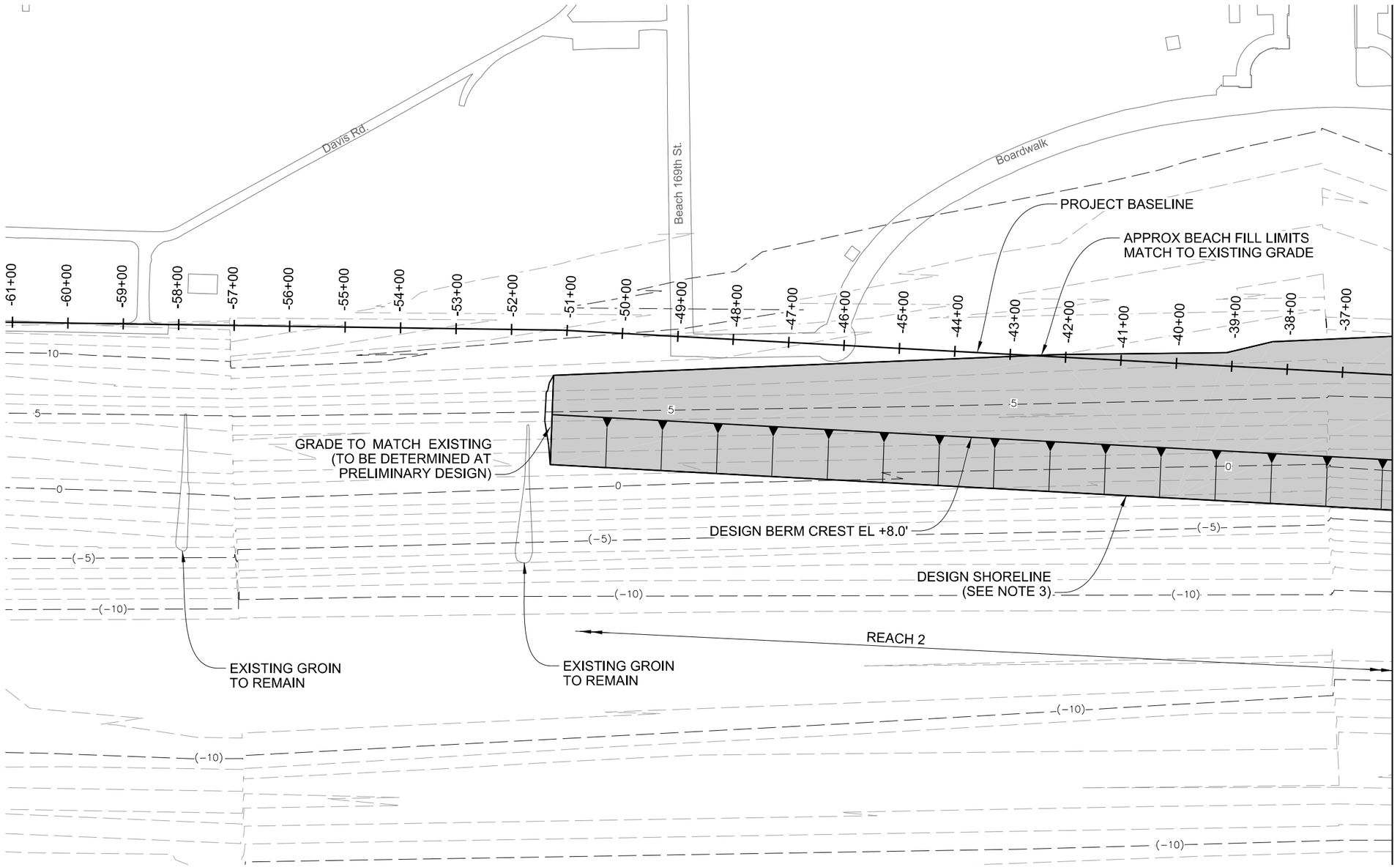
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SHEET KEY PLAN

SHEET ID
G-002
SHEET 2 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_G-002.dgn
12/3/2018
1:19:00 PM
LAST PLOTTED BY: mestimable

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-101.dgn
12/3/2018
1:12:30 PM
LAST PLOTTED BY: mestimable

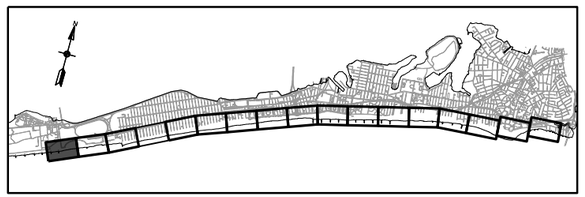


NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK

DESIGNED BY: RWH
DWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 1:1
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MK
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-101.dgn
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

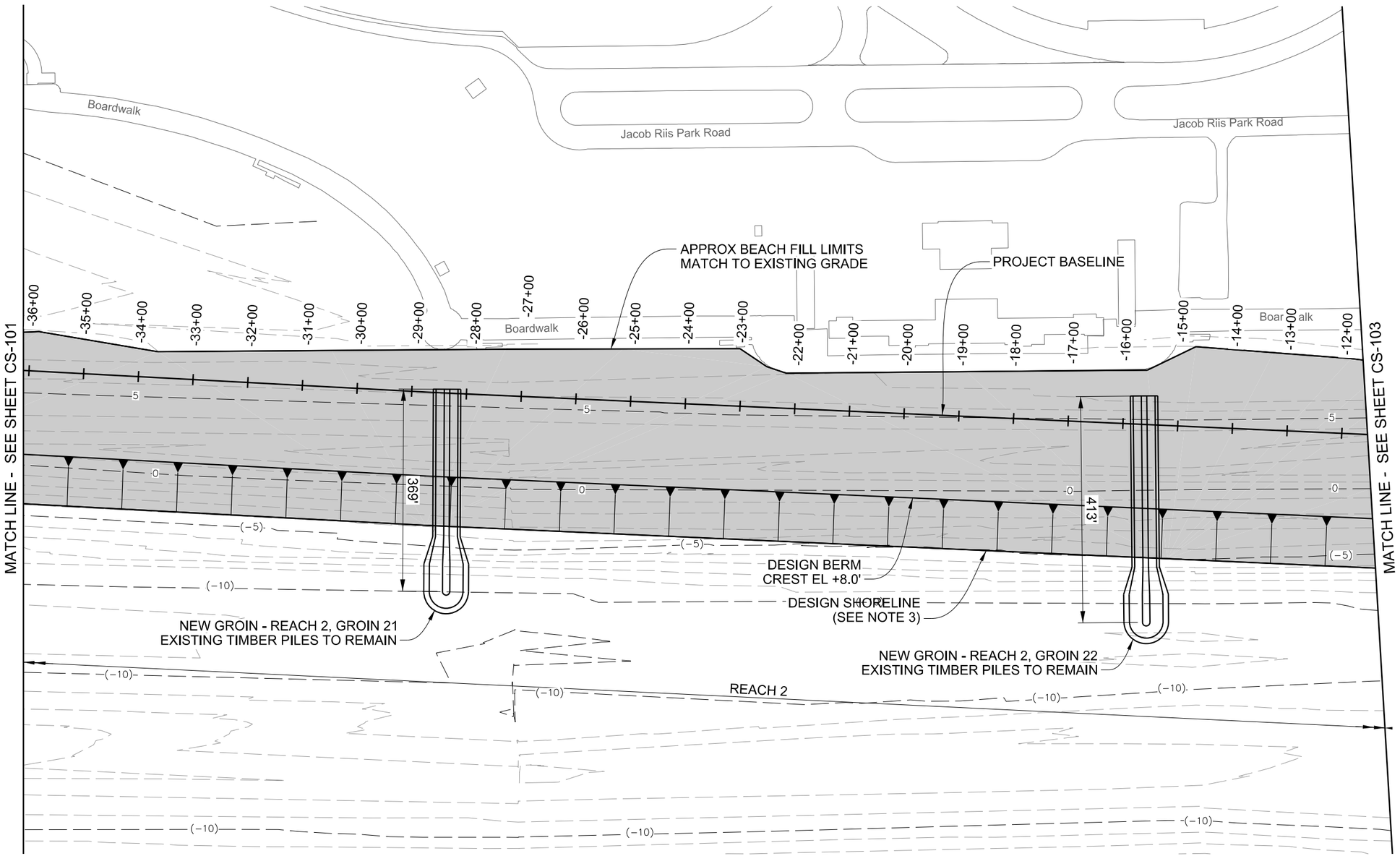
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (1 OF 17)

SHEET ID
CS-101
SHEET 3 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:12:45 PM 12/3/2018 FILE: W912DS_A1_CS-102.dgn



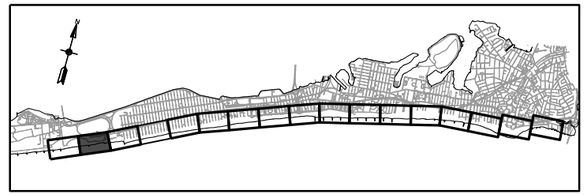
PRELIMINARY
NOT FOR CONSTRUCTION

NOTES

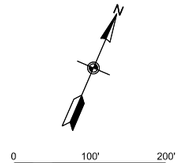
1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)



KEY PLAN



SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 100.0000'/IN
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-102.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

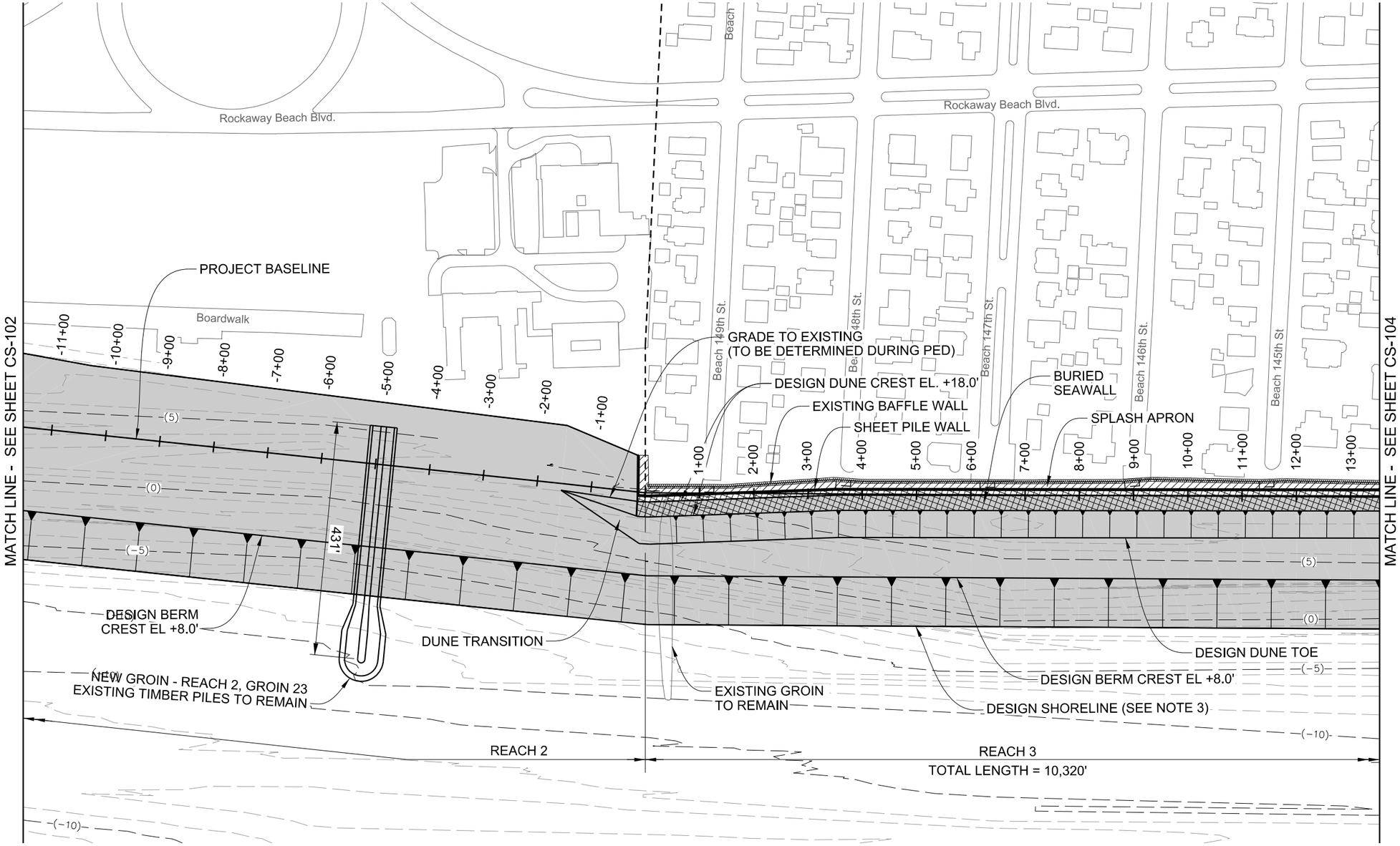
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (2 OF 17)

SHEET ID
CS-102
SHEET 4 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-103.dgn
12/3/2018
1:12:55 PM
LAST PLOTTED BY: mestimable



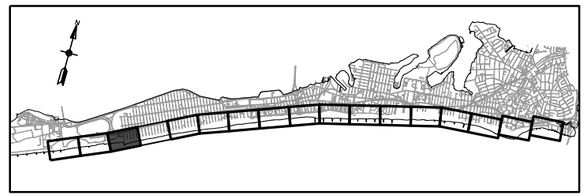
NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

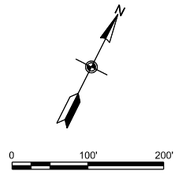
LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)

PRELIMINARY
NOT FOR CONSTRUCTION



KEY PLAN



SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK

DESIGNED BY: RWH
DRWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 100.000000
PLOT DATE: 12/05/18
SIZE: ANSI D
DATE: 12.05.18
CHKD BY: MK
FILE NAME: W912DS_A1_CS-103.dgn

SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

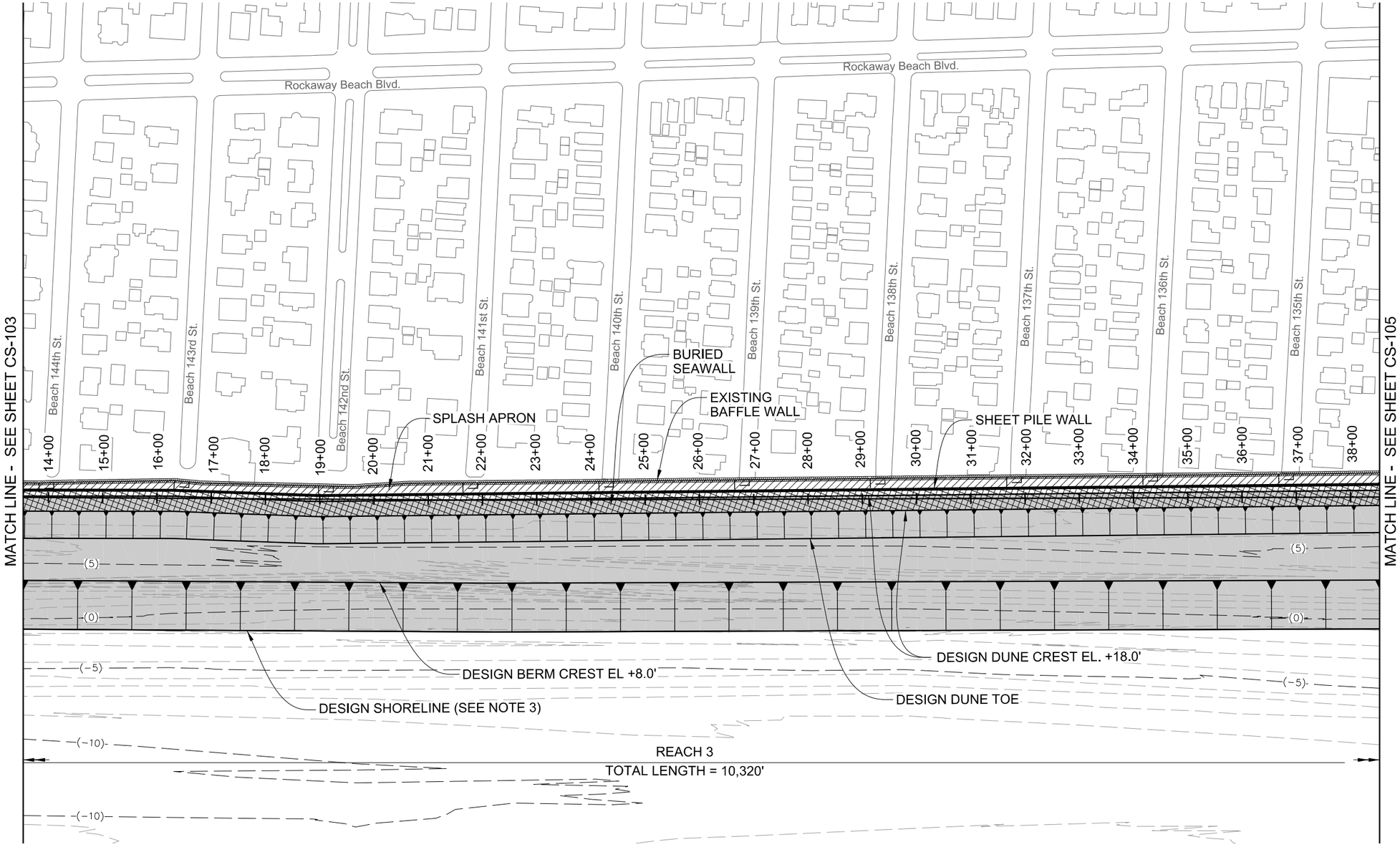
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (3 OF 17)

SHEET ID
CS-103
SHEET 5 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-104.dgn
12/3/2018
1:13:05 PM
LAST PLOTTED BY: mestimable



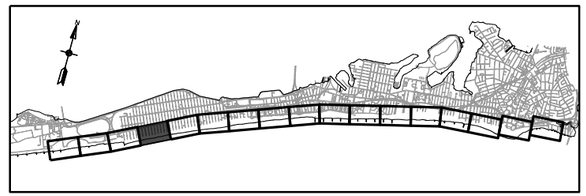
NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

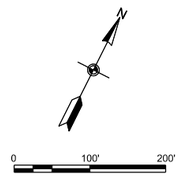
LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)

PRELIMINARY
NOT FOR CONSTRUCTION



KEY PLAN



SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 100.000000'
SIZE: ANSI D
CKD BY: MK
PLOT DATE: 12/5/2018
FILE NAME: W912DS_A1_CS-104.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

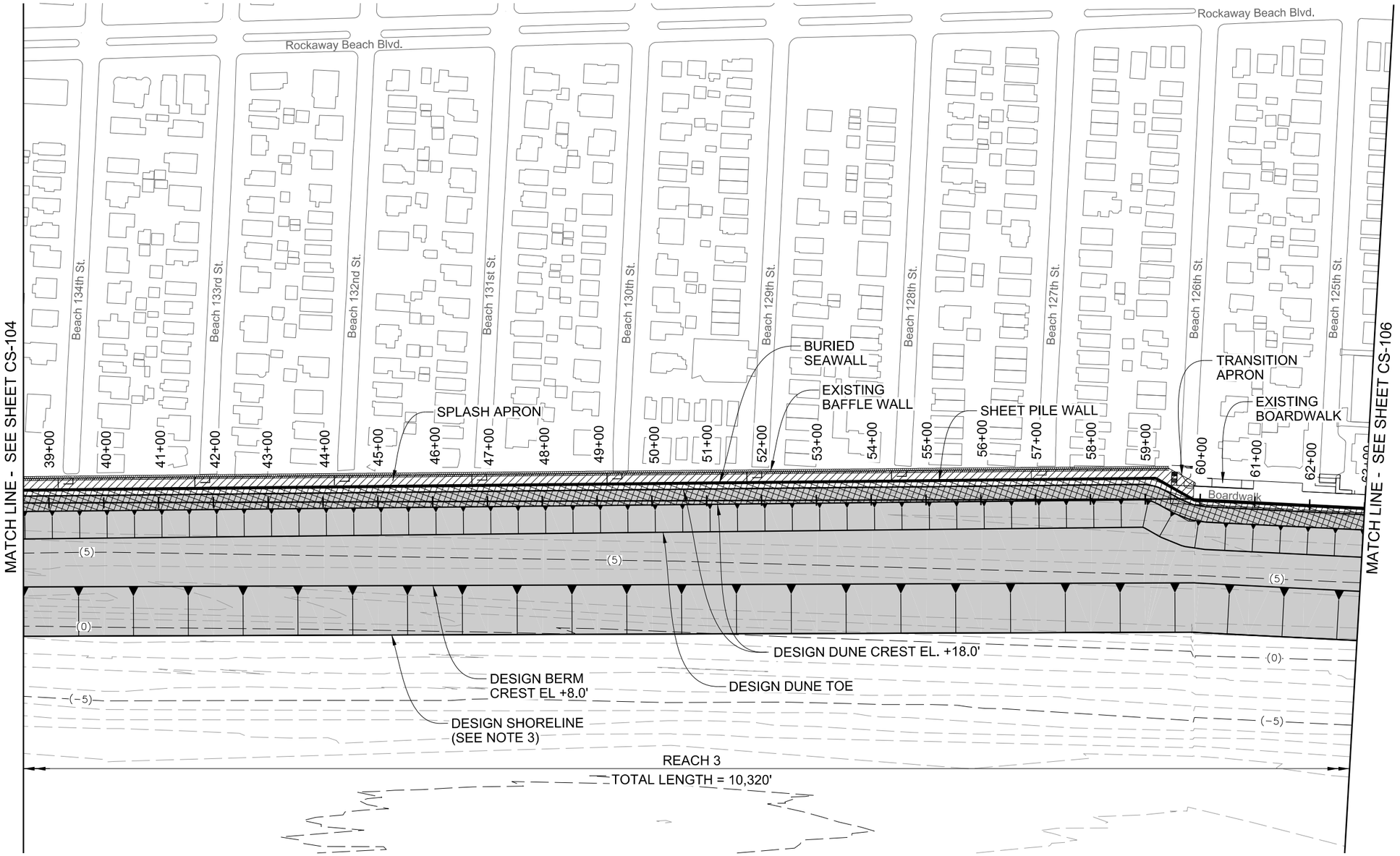
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (4 OF 17)

SHEET ID
CS-104
SHEET 6 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-105.dgn
12/3/2018
1:13:15 PM
LAST PLOTTED BY: mestimable



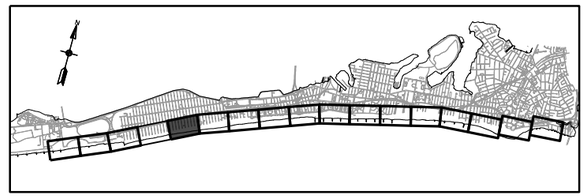
PRELIMINARY
NOT FOR CONSTRUCTION

NOTES

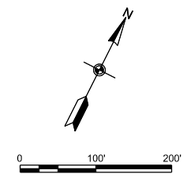
1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)



KEY PLAN



SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 100.000000'
PLOT DATE: 12/05/18
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILE NAME: W912DS_A1_CS-105.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (5 OF 17)

SHEET ID
CS-105
SHEET 7 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\

LAST PLOTTED BY: mestimable 1:13:25 PM 12/3/2018 FILE: W912DS_A1_CS-106.dgn

MATCH LINE - SEE SHEET CS-105

MATCH LINE - SEE SHEET CS-107

Beach 124th St. | Beach 123rd St. | Beach 122nd St. | Beach 121st St. | Beach 120th St. | Beach 119th St. | Beach 118th St. | Beach 117th St. | Beach 116th St. | Beach 115th St.

64+00 | 65+00 | 66+00 | 67+00 | 68+00 | 69+00 | 70+00 | 71+00 | 72+00 | 73+00 | 74+00 | 75+00 | 76+00 | 77+00 | 78+00 | 79+00 | 80+00 | 81+00 | 82+00 | 83+00 | 84+00 | 85+00 | 86+00 | 87+00

Boardwalk

Boardwalk

BURIED SEAWALL

SHEET PILE WALL

EXISTING BOARDWALK

START GROIN (TYP.)

(5)

(0)

(−5)

(−10)

299'

376'

376'

DESIGN DUNE CREST EL. +18.0'

DESIGN DUNE TOE

NEW GROIN - REACH 3 GROIN 31 -121st STREET

NEW GROIN - REACH 3 GROIN 32 -118th STREET

DESIGN BERM CREST EL +8.0'

DESIGN SHORELINE (SEE NOTE 3)

NEW GROIN - REACH 3 GROIN 33 -115th STREET

REACH 3
TOTAL LENGTH = 10,320'

NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)

PRELIMINARY
NOT FOR CONSTRUCTION

KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

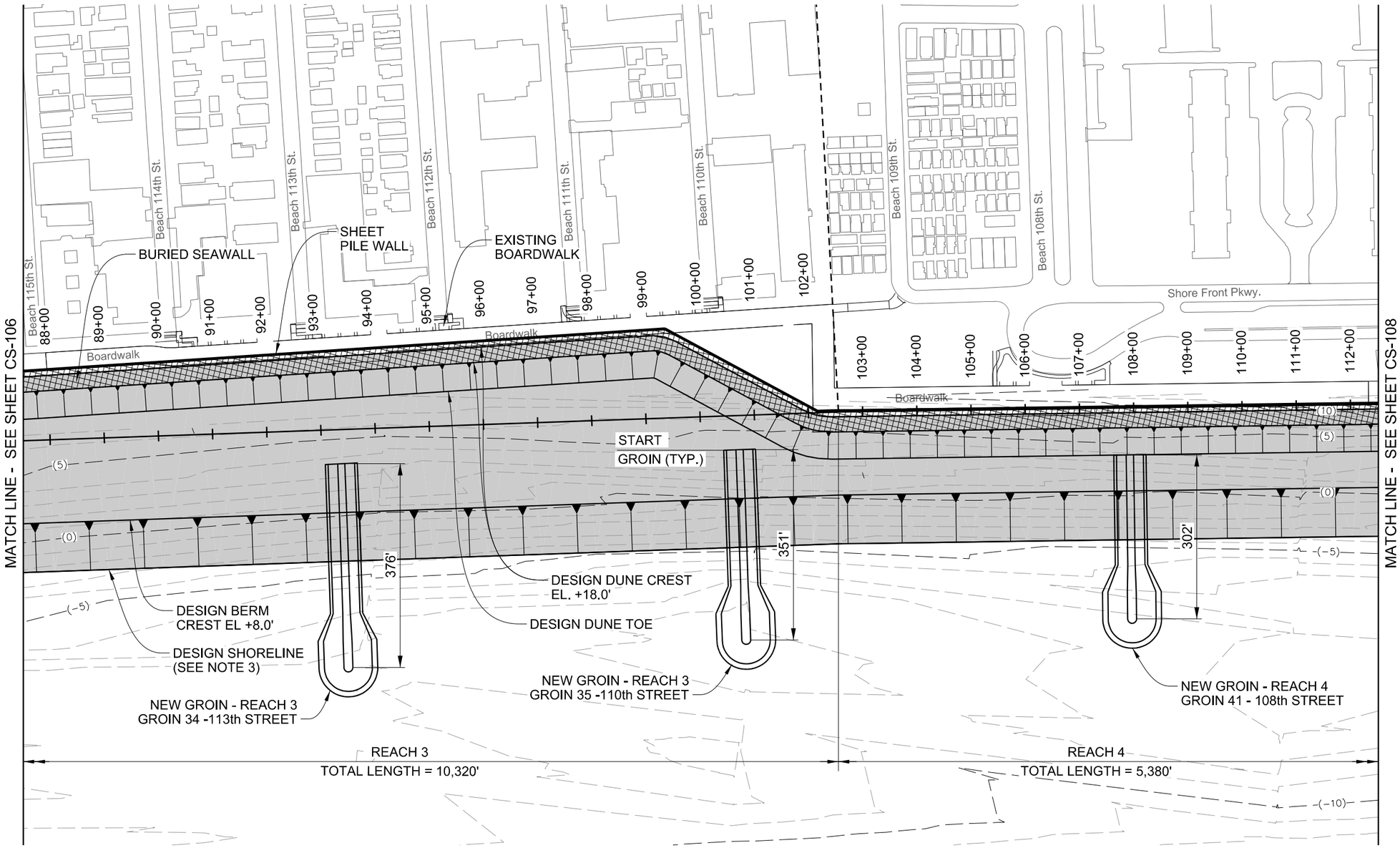
DESIGNED BY: RWH
DRWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 1:20.0667
PLOT DATE: 12/5/2018
FILE NAME: W912DS_A1_CS-106.dgn
DATE: 12/05/18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (6 OF 17)

SHEET ID
CS-106
SHEET 8 OF 36

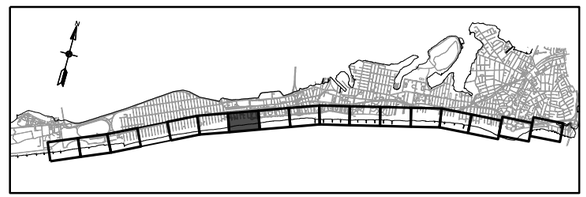


NOTES

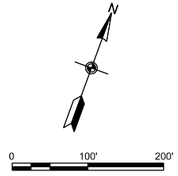
1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- --(4)-- EXISTING CONTOURS (BATHYMETRY)



KEY PLAN



SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-107.dgn
12/3/2018
1:13:36 PM
LAST PLOTTED BY: mestimable

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:20.00000
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-107.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

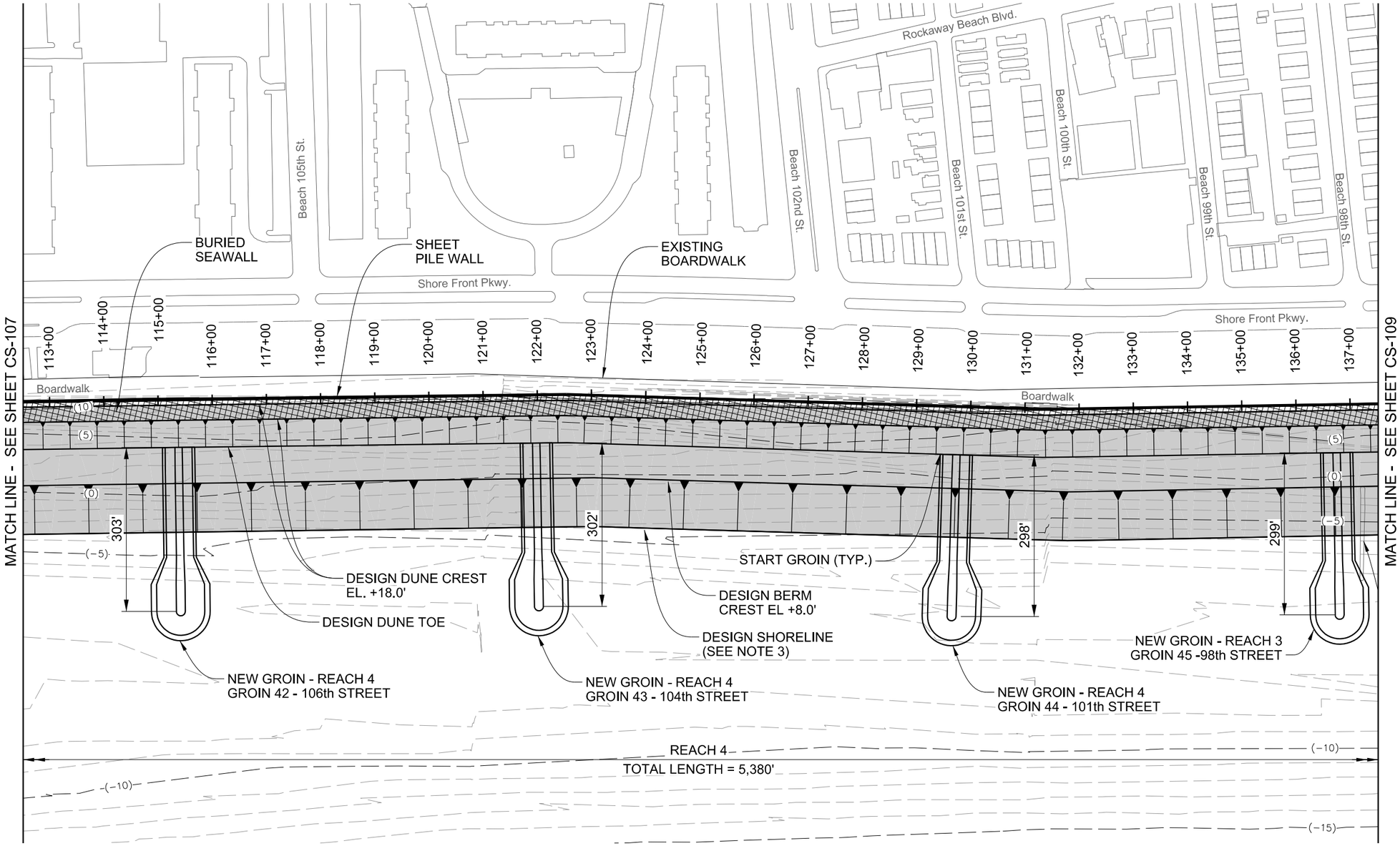
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (7 OF 17)

SHEET ID
CS-107

SHEET 9 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 12/3/2018 1:13:45 PM FILE: W912DS_A1_CS-108.dgn



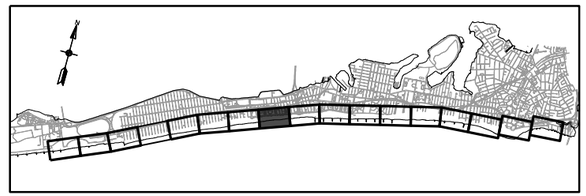
NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301, TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)

PRELIMINARY
NOT FOR CONSTRUCTION



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRWN BY: ME
SUBMITTED BY: SA
CKD BY: MK
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: 100.000000
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-108.dgn
FILE NUMBER:

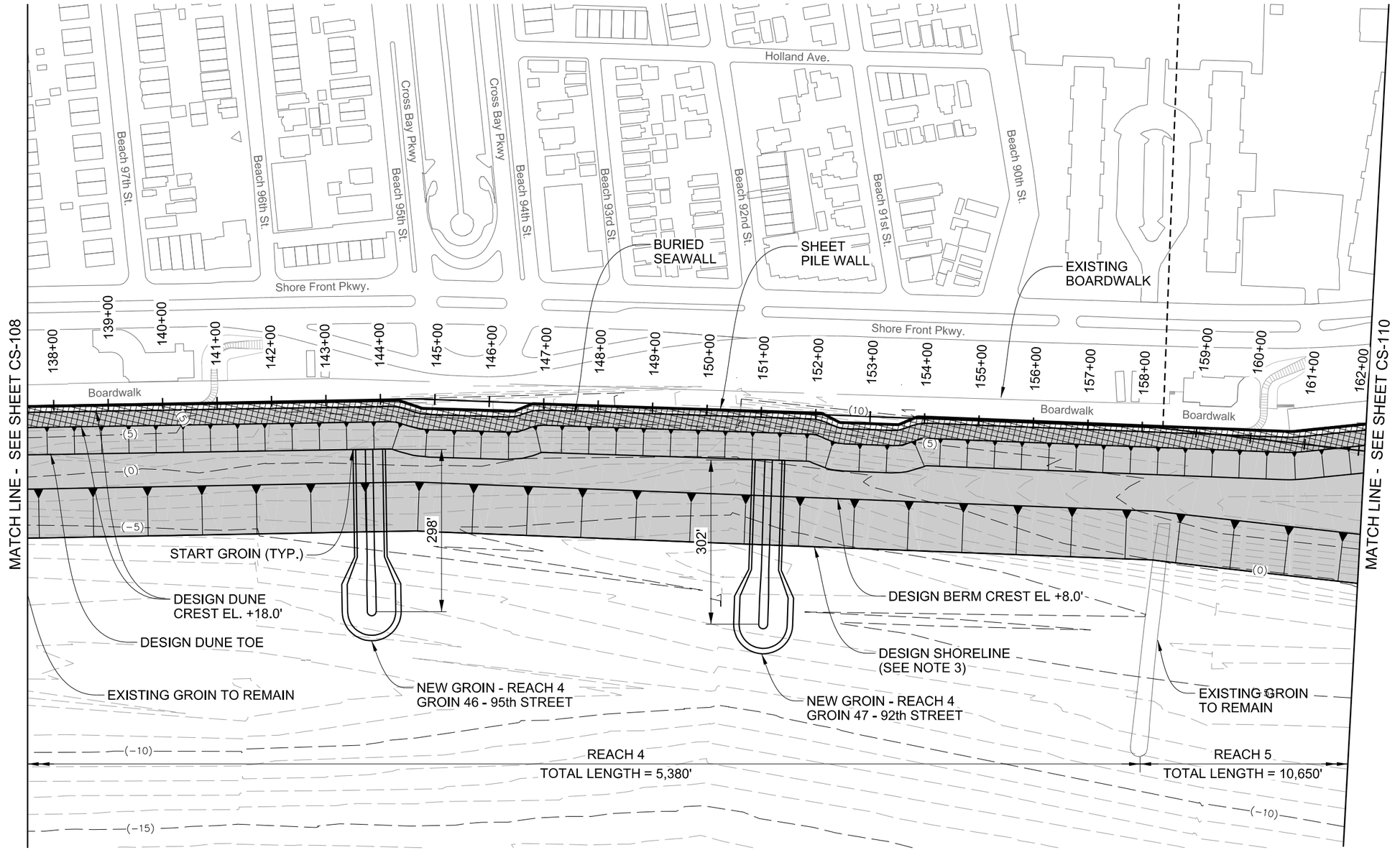
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (8 OF 17)

SHEET ID
CS-108
SHEET 10 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:13:54 PM 12/3/2018 FILE: W912DS_A1_CS-109.dgn

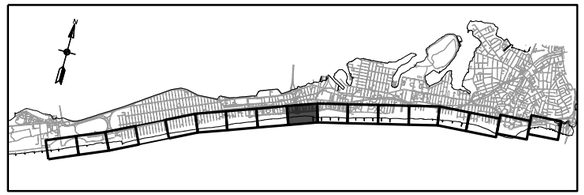


NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)



KEY PLAN

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

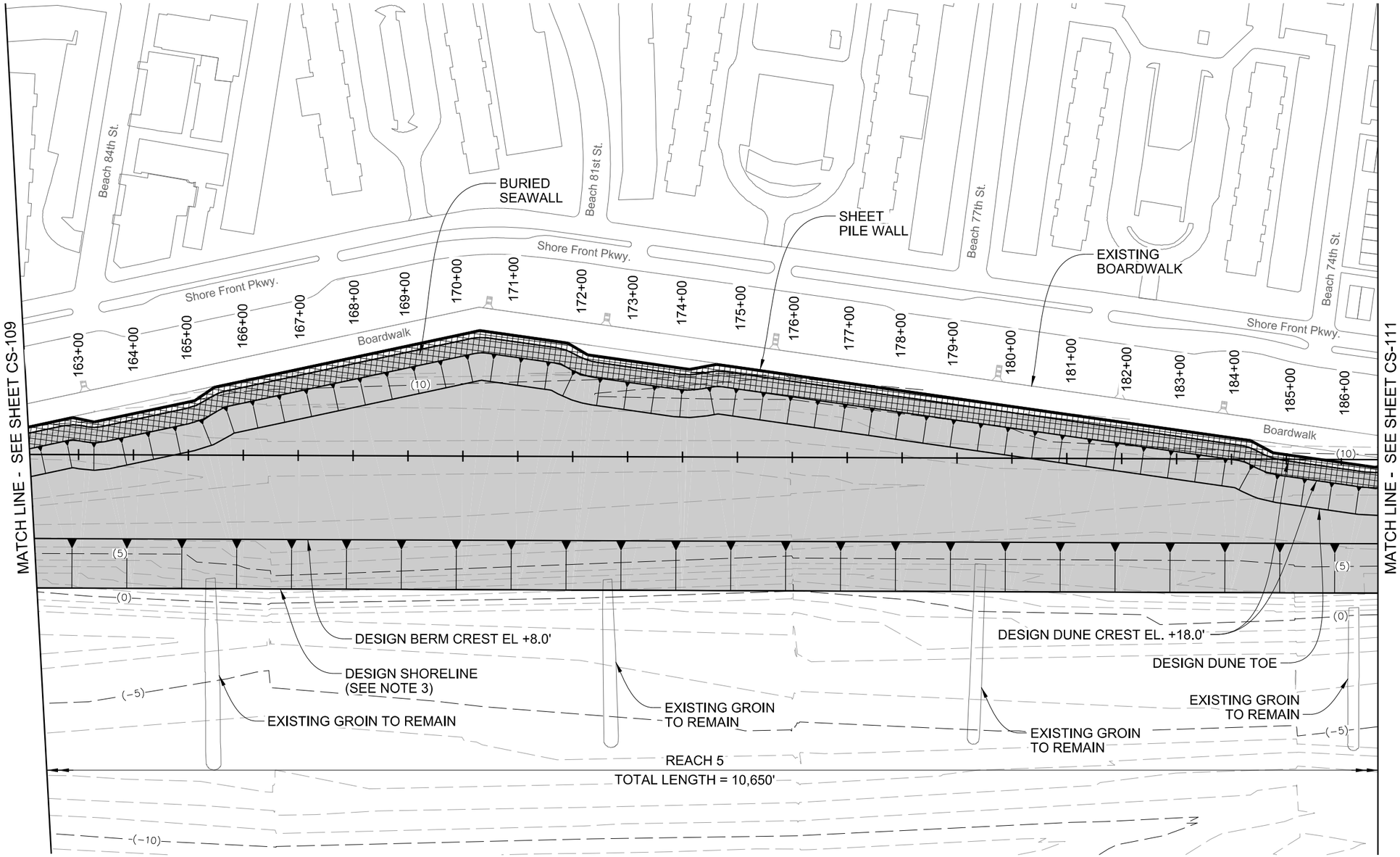
DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 100.000000'
PLOT DATE: 12/5/2018
DATE: 12/05/18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILE NAME: W912DS_A1_CS-109.dgn

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (9 OF 17)

SHEET ID
CS-109
SHEET 11 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:22:44 PM 12/3/2018 FILE: W912DS_A1_CS-110.dgn



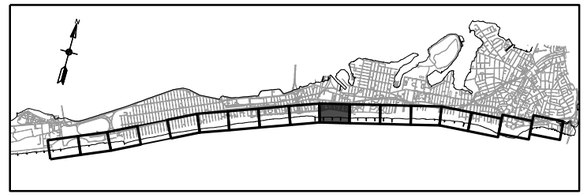
PRELIMINARY
NOT FOR CONSTRUCTION

NOTES

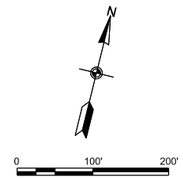
1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- −−(4)−− EXISTING CONTOURS (BATHYMETRY)



KEY PLAN



SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK

DESIGNED BY: RWH
DRWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: ANSI D
PLOT DATE: 12/5/2018
SIZE: ANSI D
FILE NAME: W912DS_A1_CS-110.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

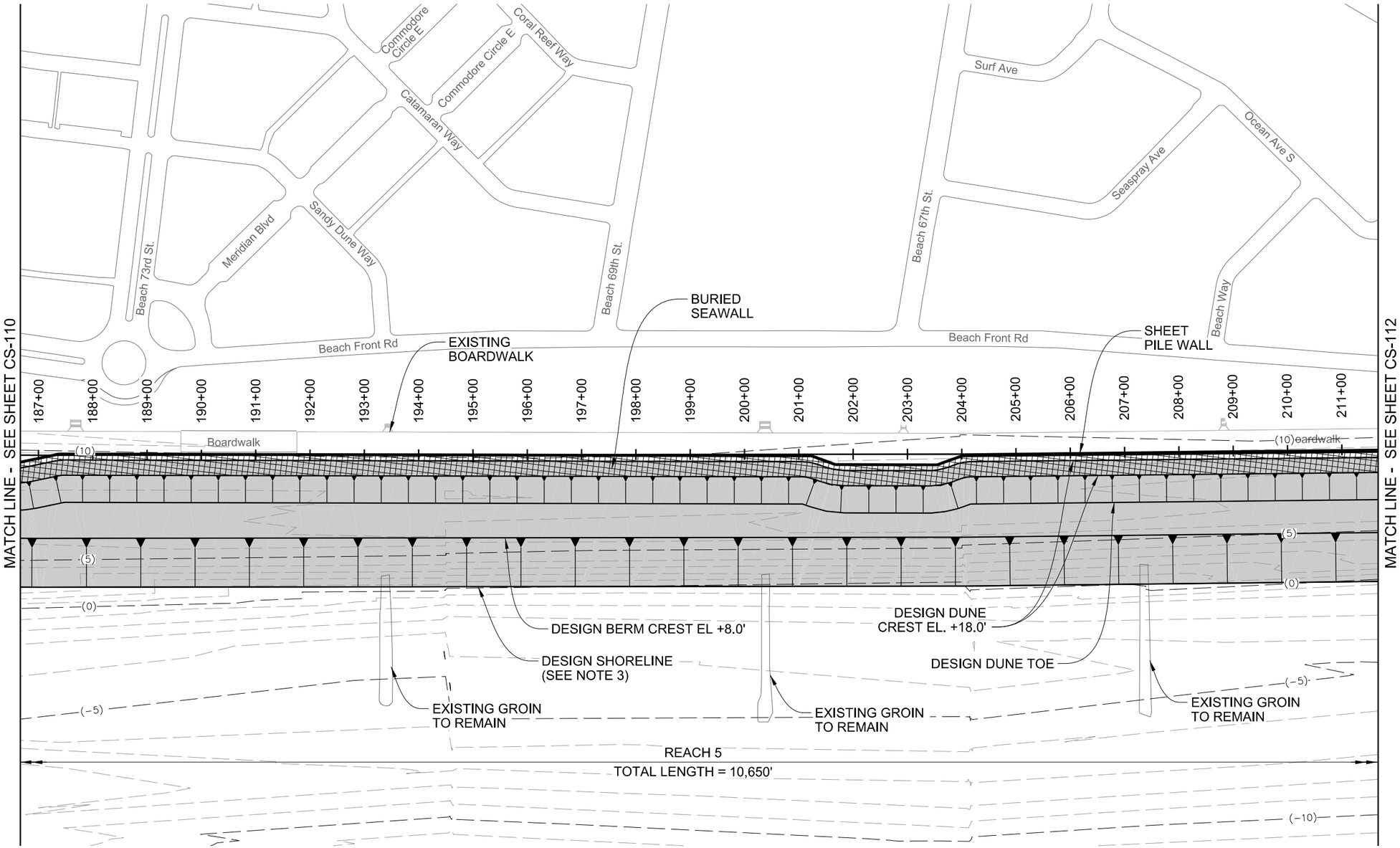
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (10 OF 17)

SHEET ID
CS-110
SHEET 12 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-111.dgn
12/3/2018
1:15:08 PM
LAST PLOTTED BY: mestimable

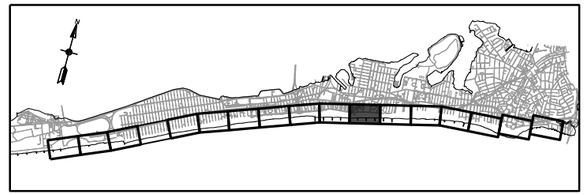


NOTES

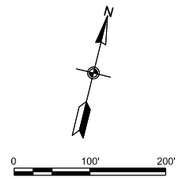
1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)



KEY PLAN



SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

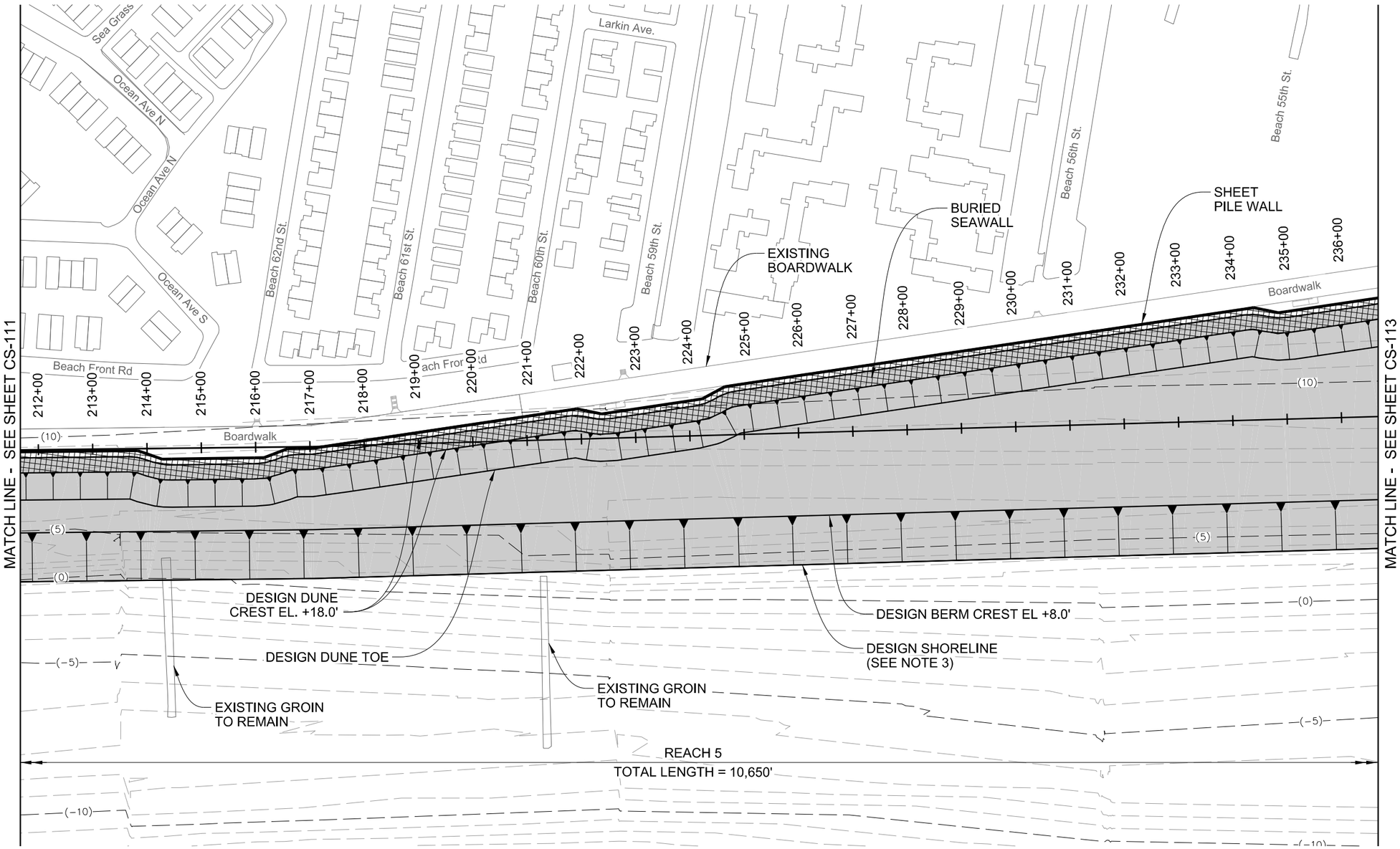
DESIGNED BY: RWH
DRWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:100.0000'
PLOT DATE: 12/5/2018
SIZE: ANSI D
FILE NAME: W912DS_A1_CS-111.dgn
DATE: 12/05/18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (11 OF 17)

SHEET ID
CS-111
SHEET 13 OF 36



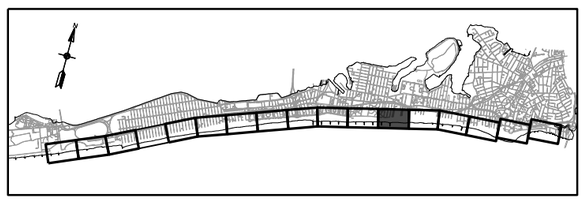
NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)

PRELIMINARY
NOT FOR CONSTRUCTION



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:50.666667
PLOT DATE: 12/3/2018
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
STYLE: ANSI D
FILE NAME: W912DS_A1_CS-112.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

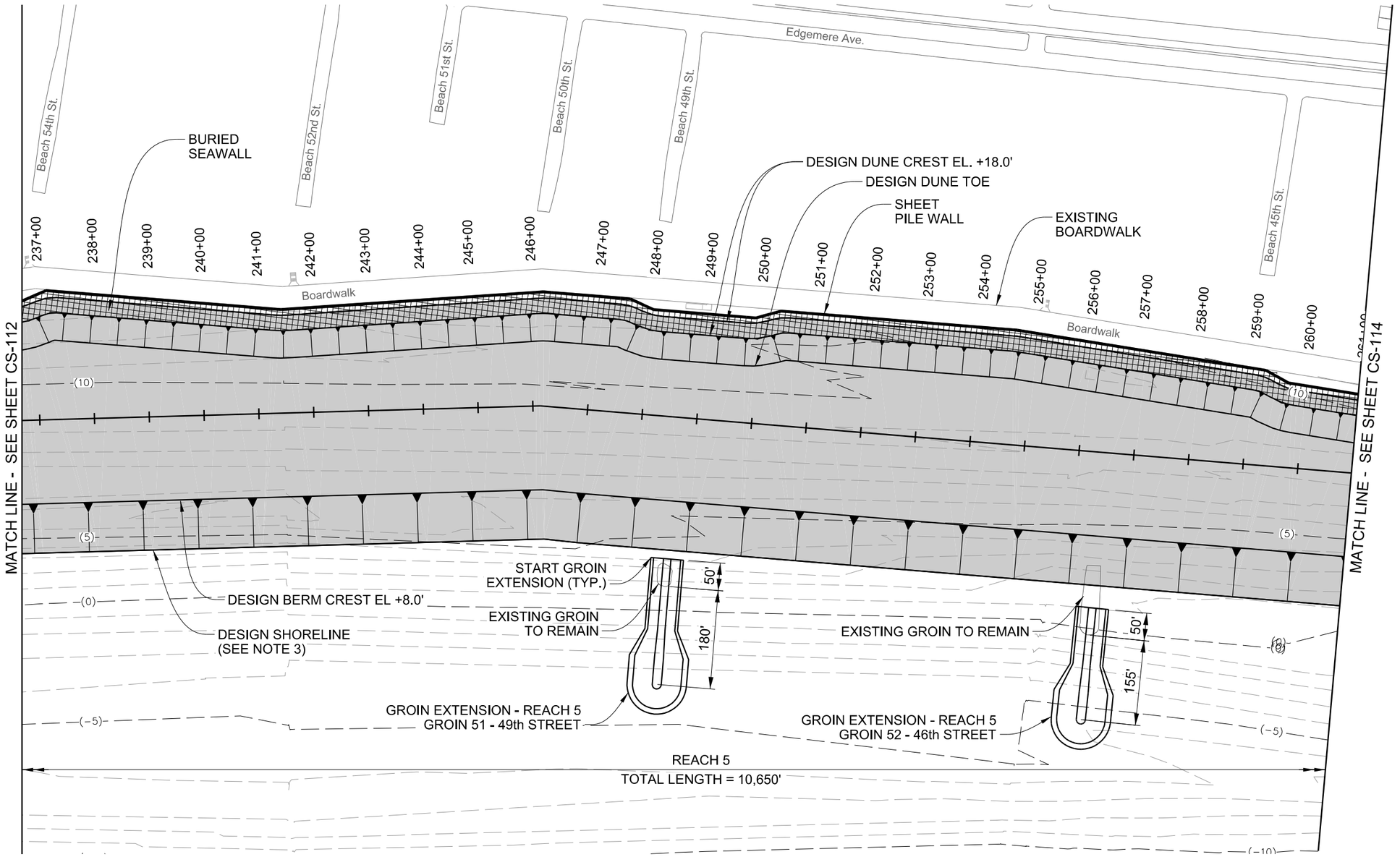
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (12 OF 17)

SHEET ID
CS-112
SHEET 14 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:15:17 PM 12/3/2018 FILE: W912DS_A1_CS-112.dgn

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:15:27 PM 12/3/2018 FILE: W912DS_A1_CS-113.dgn

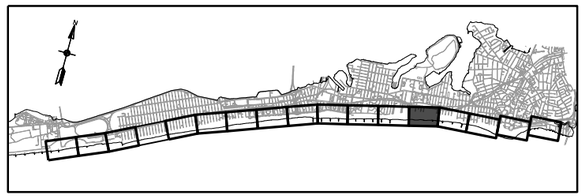


NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- – –(4)– – EXISTING CONTOURS (BATHYMETRY)



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: ROH
DRWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 1:1000
SIZE: ANSI D
DATE: 12/05/18
CKD BY: MK
PLOT DATE: 12/5/2018
FILE NAME: W912DS_A1_CS-113.dgn
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

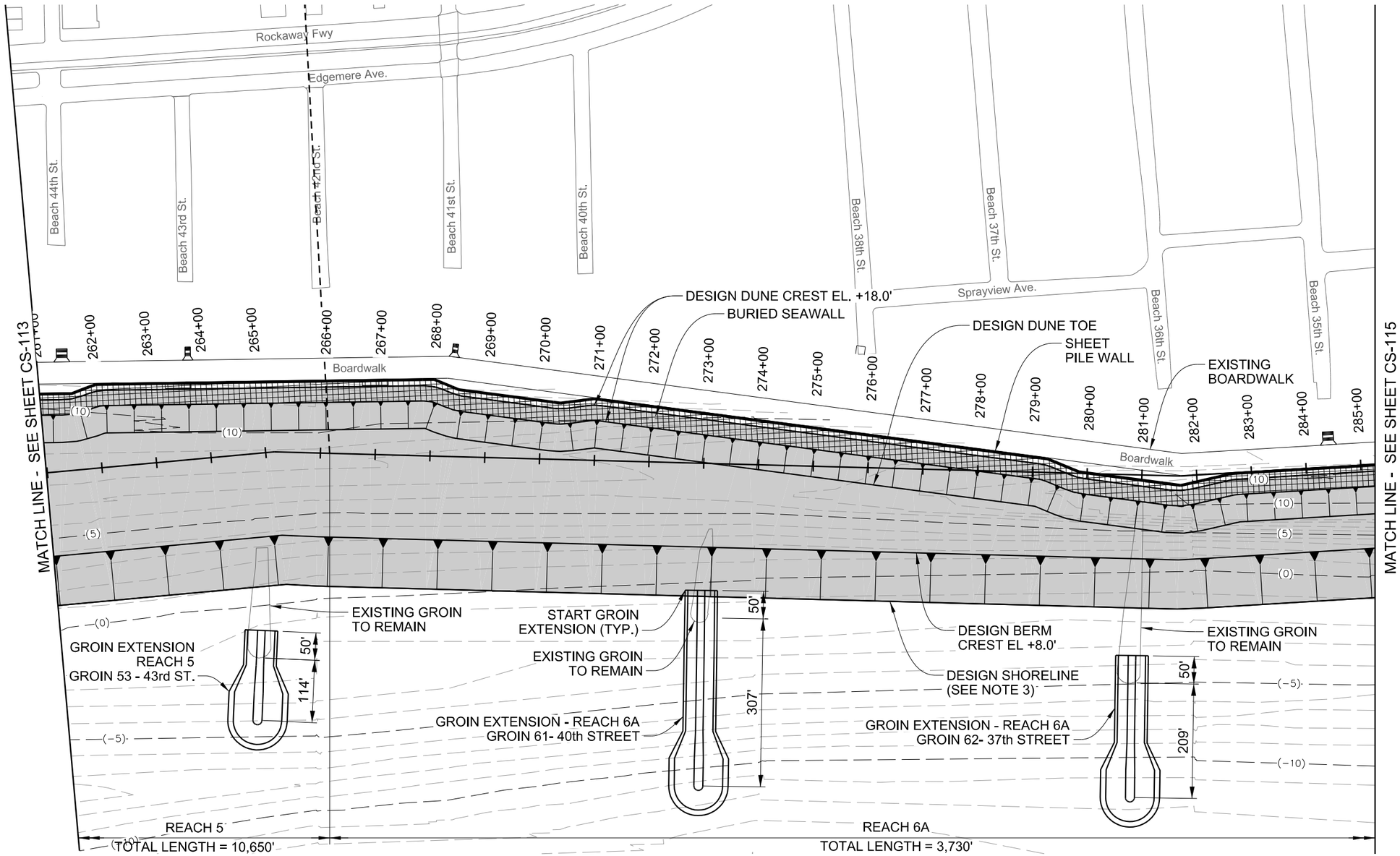
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (13 OF 17)

SHEET ID
CS-113
SHEET 15 OF 36

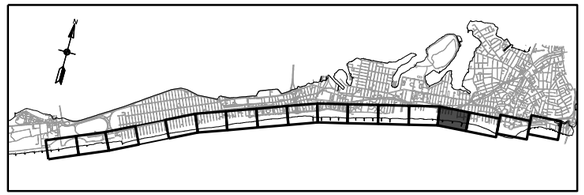


NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- EXISTING CONTOURS (BATHYMETRY) — —(4)— —



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:15:36 PM 12/3/2018 FILE: W912DS_A1_CS-114.dgn

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:1.0000
PLOT DATE: 12/3/2018
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILE NAME: W912DS_A1_CS-114.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

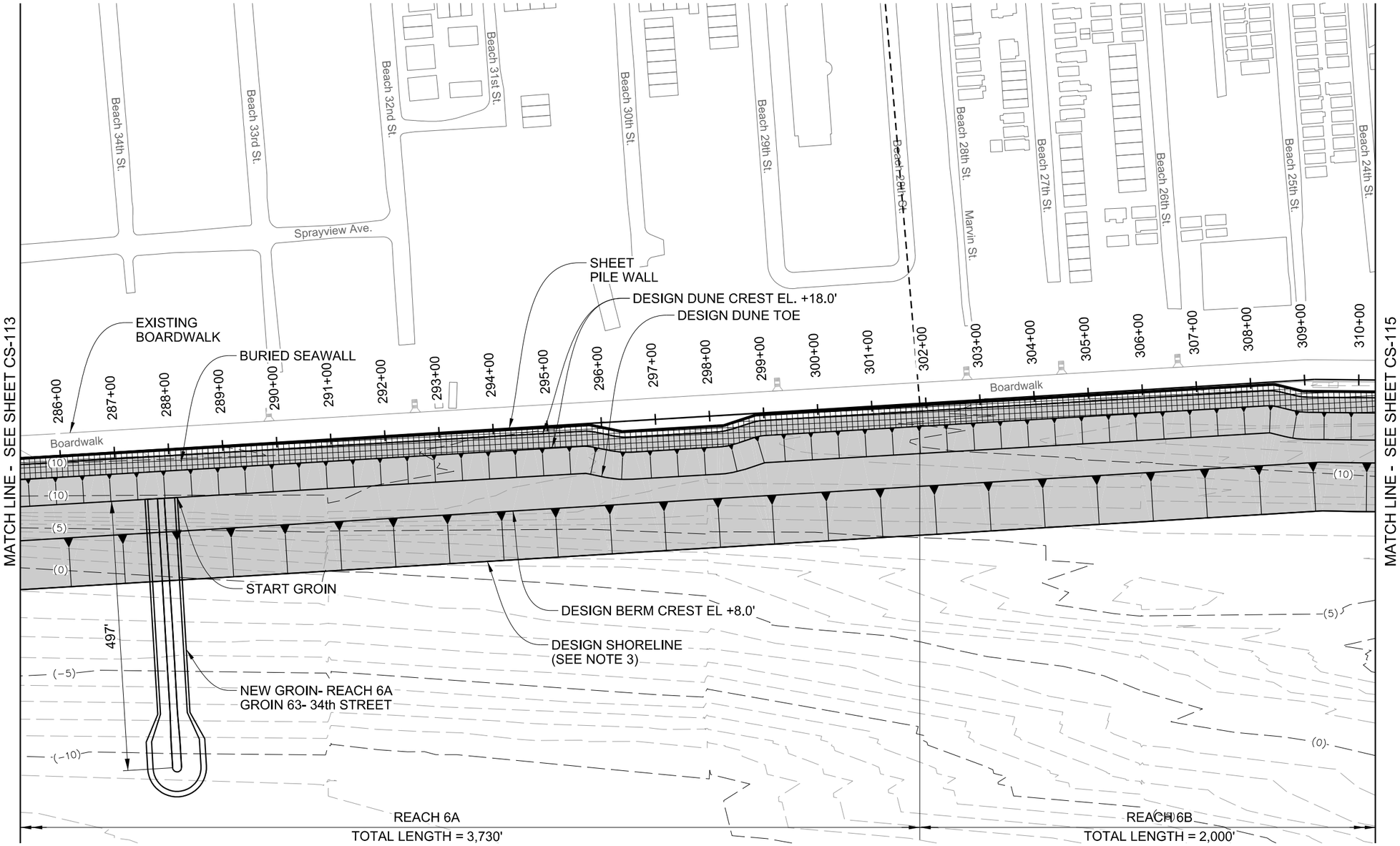
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (14 OF 17)

SHEET ID
CS-114
SHEET 16 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:15:45 PM 12/3/2018 FILE: W912DS_A1_CS-115.dgn

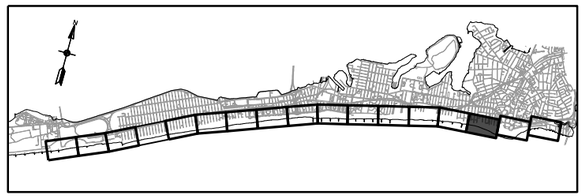


NOTES

1. EXISTING CONTOURS ARE BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
PLOT SCALE: 100.0000
PLOT DATE: 12/3/2018
STYLE: ANSI D
FILE NAME: W912DS_A1_CS-115.dgn

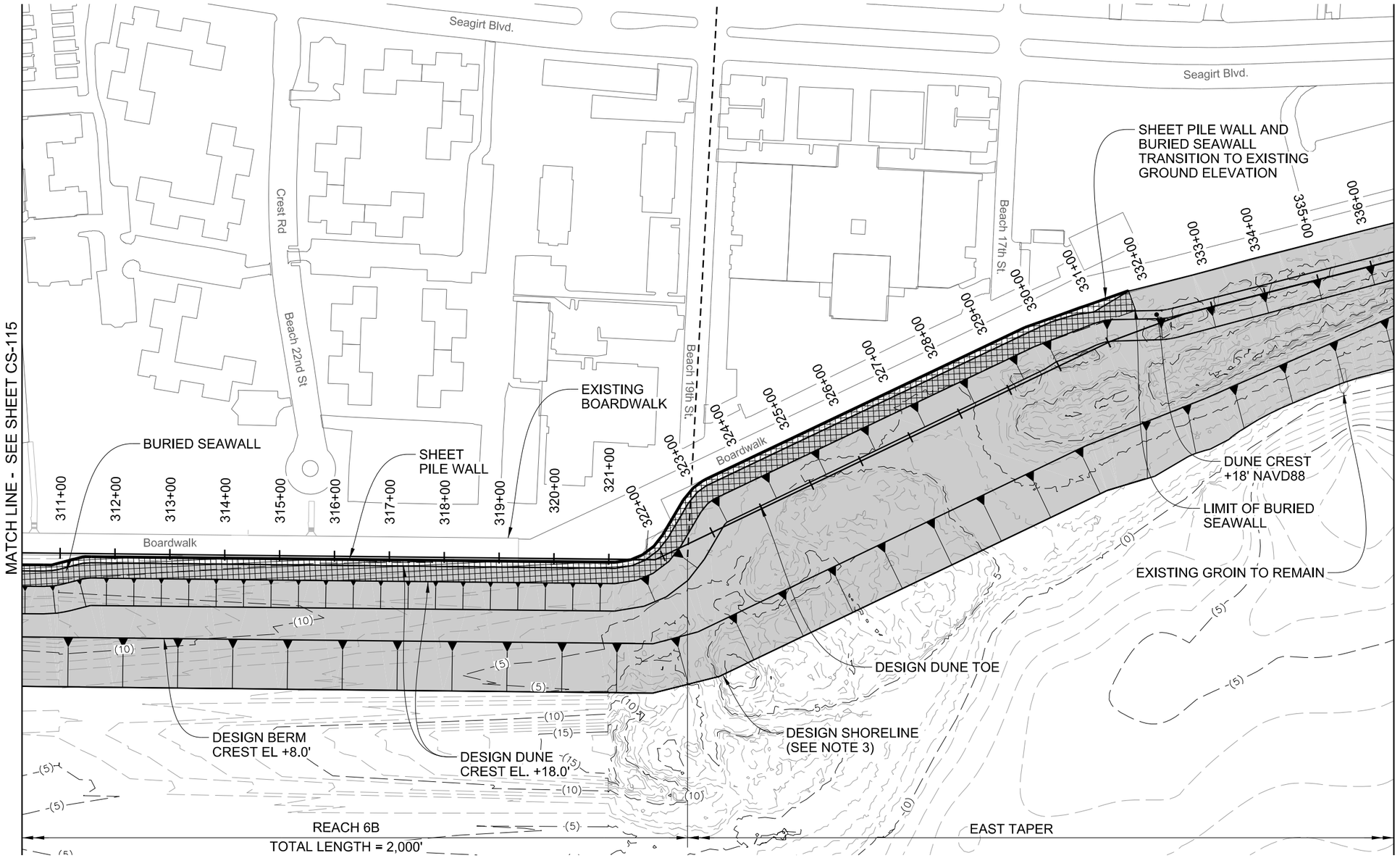
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (15 OF 17)

SHEET ID
CS-115
SHEET 17 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:15:54 PM 12/3/2018 FILE: W912DS_A1_CS-116.dgn



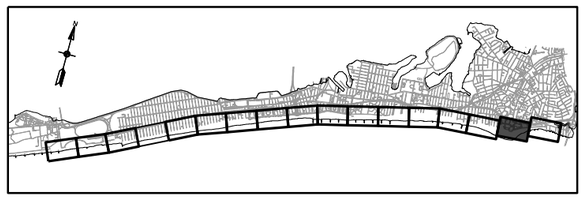
NOTES

1. EXISTING CONTOURS ARE BASED ON THE FOLLOWING SOURCES:
   - GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- EXISTING CONTOURS (BATHYMETRY)



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DATE	APPR.	DESCRIPTION
E	12.05.18	MK	FINAL GRR - APPENDIX A1.C
D	11.19.18	MK	DRAFT FINAL GRR-APPENDIX A1.C
C	08.30.18	MK	DRAFT FINAL GRR-APPENDIX A1.C
B	08.20.18	MK	DRAFT FINAL GRR-APPENDIX A1.C
A	07.19.18	MK	DRAFT FINAL GRR-APPENDIX A1.B

DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:100.0000
SIZE: ANSI D
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-116.dgn

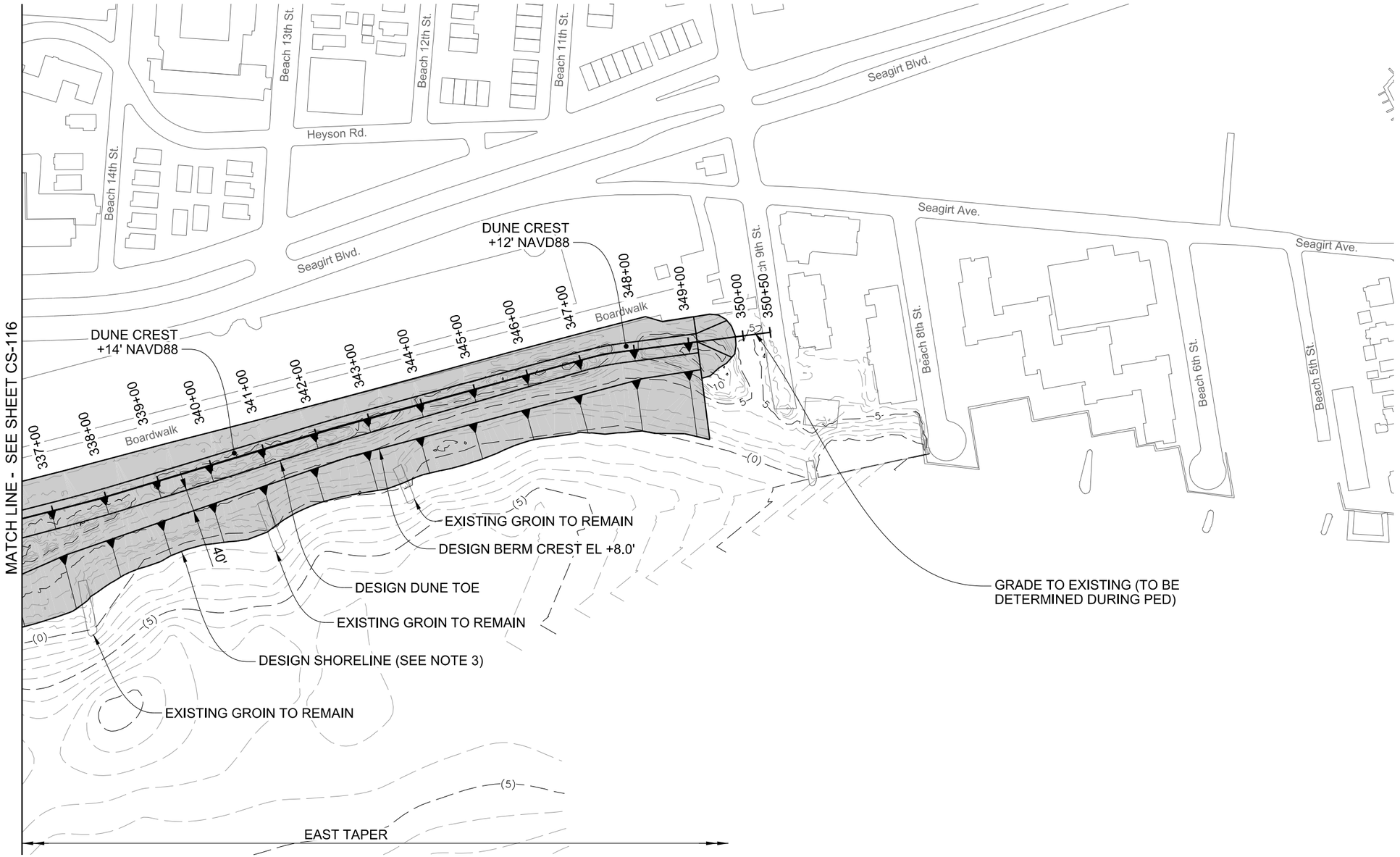
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (16 OF 17)

SHEET ID
CS-116
SHEET 18 OF 36



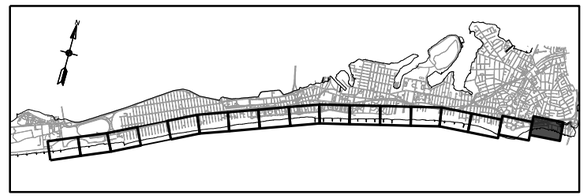
NOTES

1. EXISTING CONTOURS ARE BASED ON THE FOLLOWING SOURCES:
   - GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
2. ALL ELEVATIONS REFERENCED TO NAVD88.
3. DESIGN SHORELINE DEFINED ON SHEET CS-301. TYPICAL SECTIONS SHOWN ON SHEETS CS-301 TO CS-302.
4. SECTIONS SHOWN ON SHEETS CS-301 TO CS-307.
5. GROIN PLAN PROFILES AND SECTIONS SHOWN ON SHEETS CS-401 TO CS-410.
6. BEACH CONSTRUCTION TEMPLATE WILL EXTEND TO EXISTING GRADE AND IS NOT SHOWN FOR CLARITY.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- BASELINE
- SHEET PILE WALL
- BURIED SEAWALL
- BEACH FILL
- SPLASH APRON
- EXISTING BAFFLE WALL
- (4) EXISTING CONTOURS (BATHYMETRY)



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
LAST PLOTTED BY: mestimable 1:16:03 PM 12/3/2018 FILE: W912DS_A1_CS-117.dgn
PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\

DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT DATE: 12/5/2018
PLOT SCALE: 100.0000
STGS: ANSI D
FILE NAME: W912DS_A1_CS-117.dgn

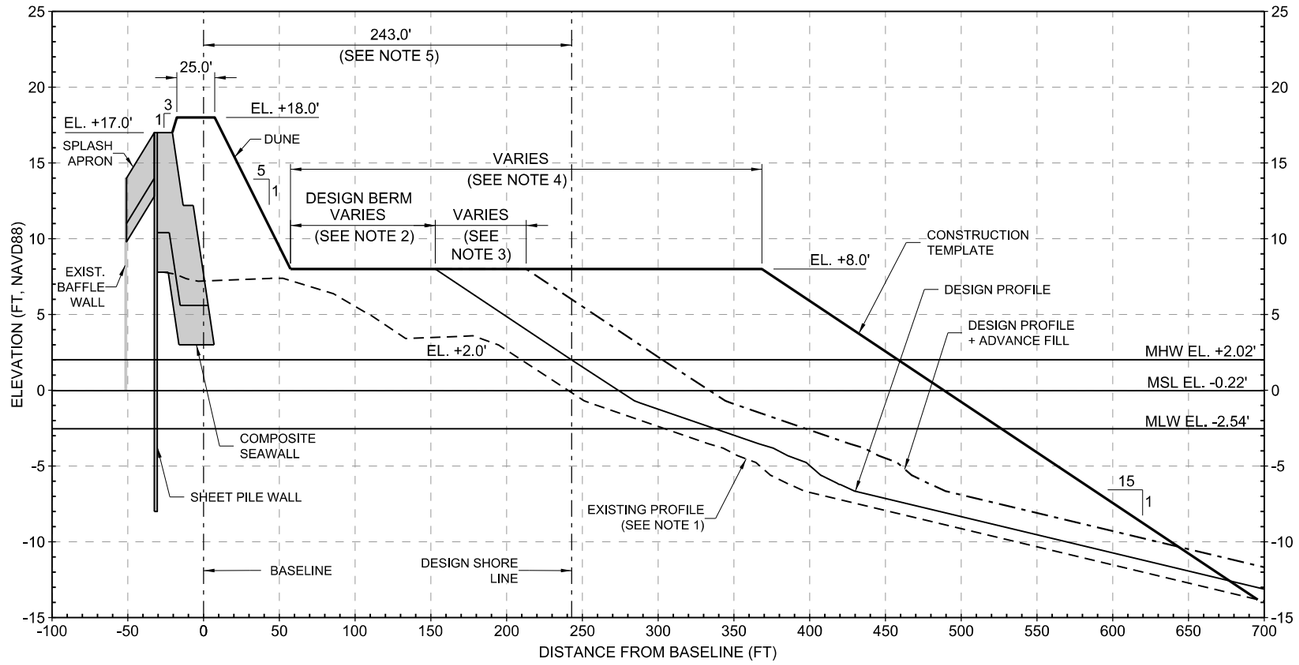
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

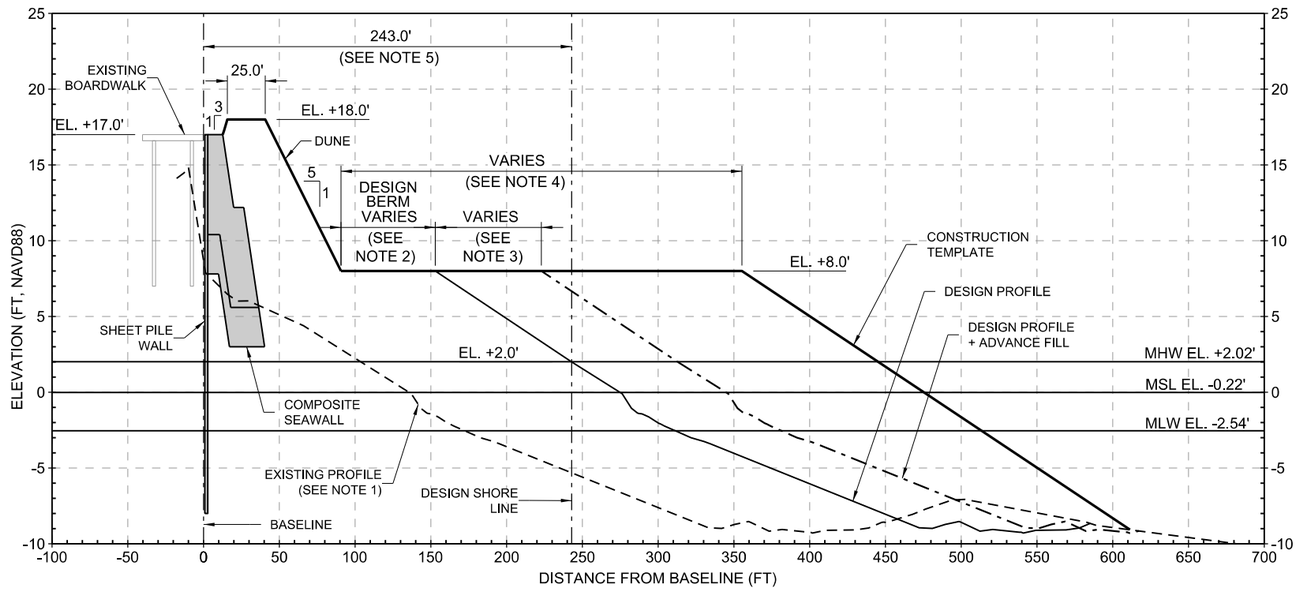
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (17 OF 17)

SHEET ID
CS-117
SHEET 19 OF 36



C2 TYPICAL BEACH FILL SECTION
BEACH 126TH ST. TO BEACH 149TH ST.
CS-101 TO CS-103
SCALE: 1"=50'-0"



A2 TYPICAL BEACH FILL SECTION
BEACH 19TH ST. TO BEACH 126TH ST.
CS-103 TO CS-114
SCALE: 1"=50'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

BEACH FILL NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. THE WIDTH OF THE DESIGN BERM IS GENERALLY 60 FEET OR MORE. THE SEAWARD CREST OF THE DESIGN BERM IS CONTROLLED BY THE ALIGNMENT OF THE BASELINE, WHICH DOES NOT ALWAYS FOLLOW THE BOARDWALK ALIGNMENT.
3. THE ADVANCE FILL WIDTH VARIES BASED UPON THE EROSION RATE.
4. THE WIDTH OF THE CONSTRUCTION TEMPLATE IS BASED UPON THE FILL VOLUME REQUIRED FOR THE DESIGN PROFILE + ADVANCE FILL AND VARIES FROM PROFILE TO PROFILE.
5. THE DISTANCE FROM THE BASELINE TO THE DESIGN SHORELINE IS ALWAYS 243.0 FEET. THE DESIGN SHORELINE IS ALIGNED WITH THE NATURAL SHORELINE. THE ALIGNMENT OF THE DUNE FOLLOWS THE UNNATURAL ALIGNMENT OF THE BOARDWALK.

0 5' 10'
VERT. SCALE: 1"=5'

0 50' 100'
HOR. SCALE: 1"=50'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:50.0000
SIZE: ANSI D
DATE: 12/05/18
PLOT DATE: 12/5/2018
FILE NAME: W912DS_A1_CS-301.dgn
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

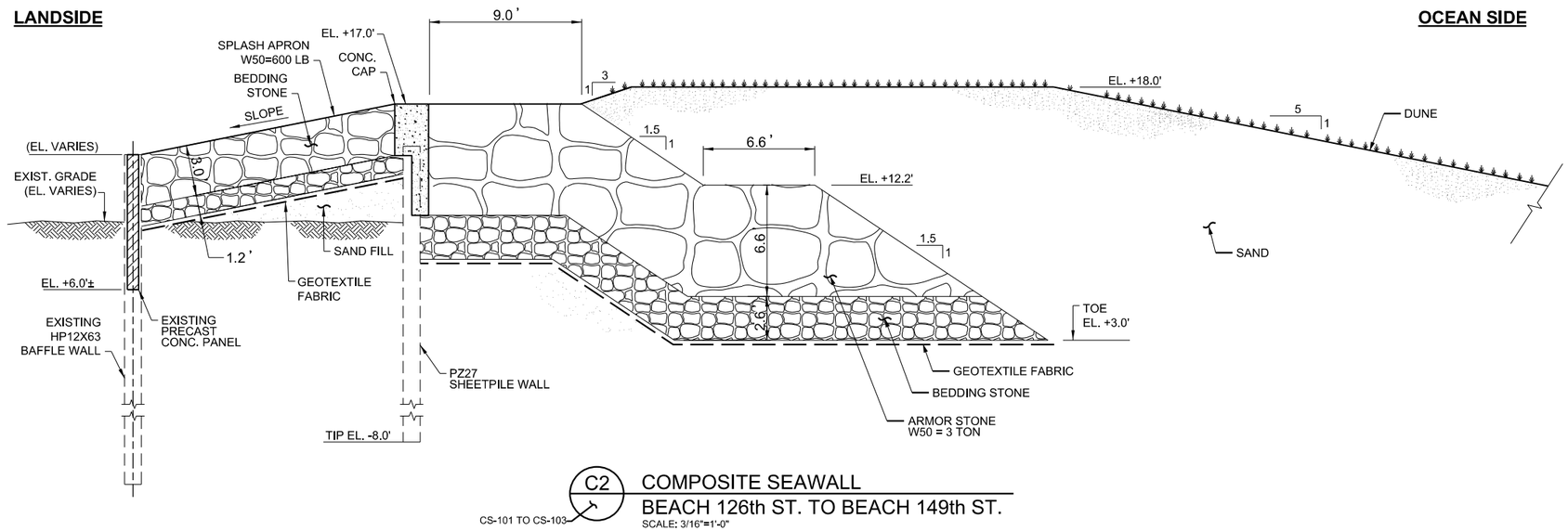
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

BEACH FILL TYPICAL SECTIONS

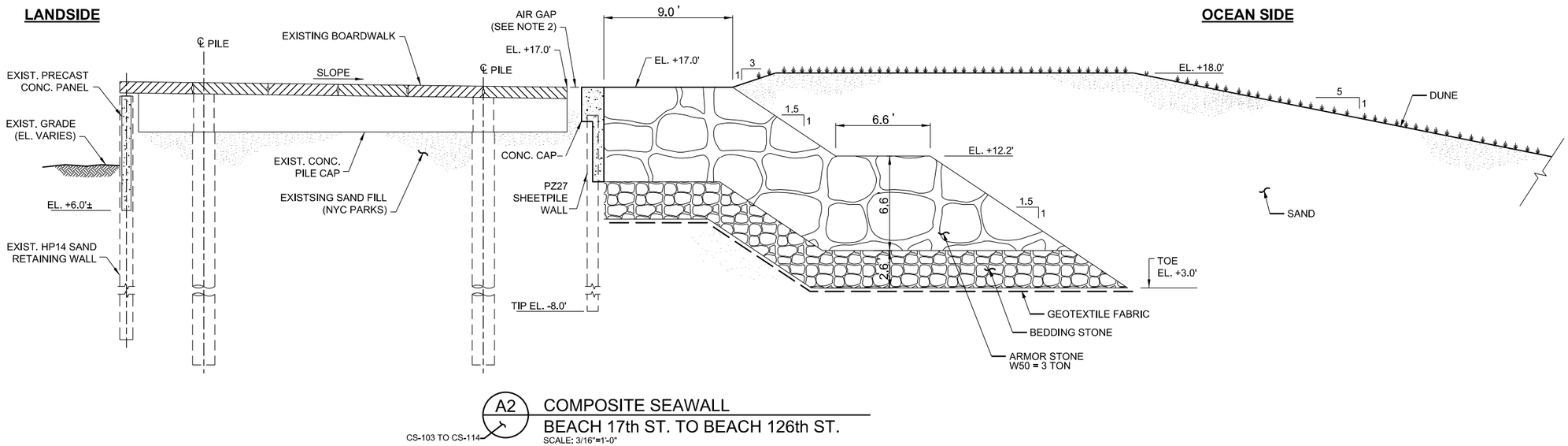
SHEET ID
CS-301
SHEET 20 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-301.dgn
12/3/2018
1:16:12 PM
LAST PLOTTED BY: mestimable

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:16:21 PM 12/3/2018 FILE: W912DS_A1_CS-302.dgn



C2 — COMPOSITE SEAWALL
BEACH 126th ST. TO BEACH 149th ST.
CS-101 TO CS-103
SCALE: 3/16"=1'-0"



A2 — COMPOSITE SEAWALL
BEACH 17th ST. TO BEACH 126th ST.
CS-103 TO CS-114
SCALE: 3/16"=1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

0 4' 8' 12'
VERT. SCALE: 3/16"=1'

0 4' 8' 12'
HOR. SCALE: 3/16"=1'

NOTES:

1. EXISTING GRADE SEAWARD OF BAFFLE WALL NOT SHOWN FOR CLARITY.
2. A 1-FT GAP IS INCLUDED FOR CONSTRUCTIBILITY AND TO ALLOW FOR HORIZONTAL DEFLECTIONS.
3. EXISTING APPURTENANCES, RAILINGS, ETC. FOR THE BOARDWALK ARE NOT SHOWN FOR CLARITY.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: 1.0000
PLOT DATE: 12/3/2018
FILE NUMBER:
SIZE: ANSI D
FILE NAME: W912DS_A1_CS-302.dgn

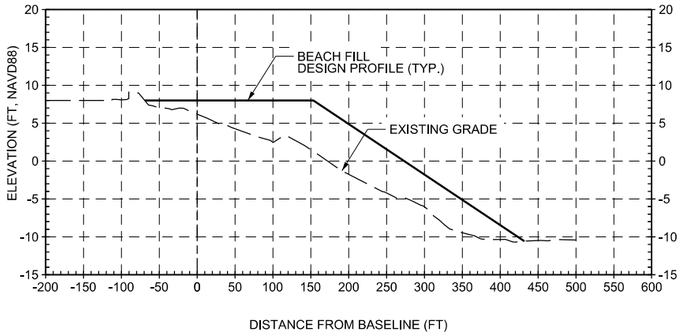
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

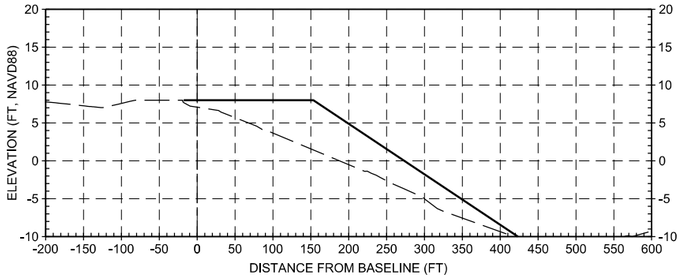
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

COMPOSITE SEAWALL TYPICAL SECTIONS

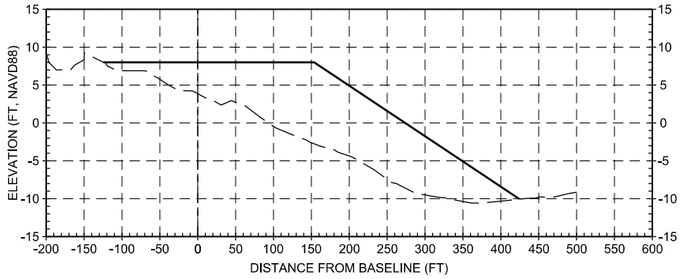
SHEET ID
CS-302
SHEET 21 OF 36



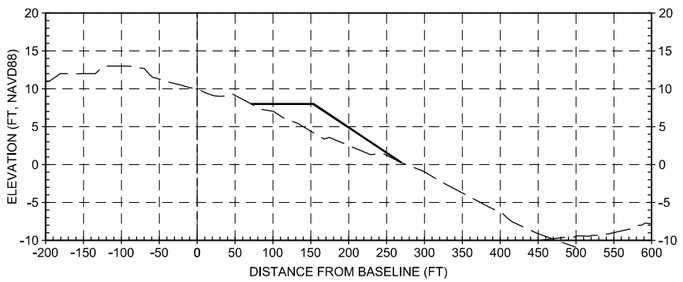
-30+00



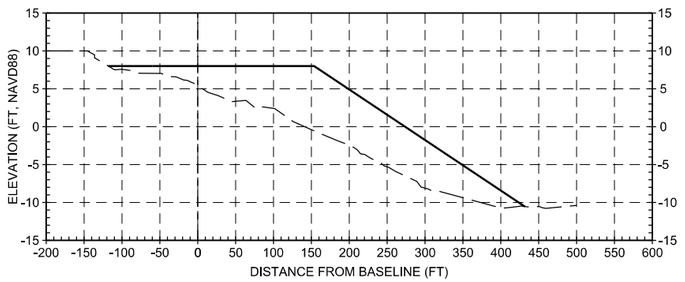
-40+00



-10+00



-50+00



-20+00

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. DESIGN PROFILE SHOWN IN SECTIONS.
3. REFER TO SHEETS CS-301 AND CS-302 FOR TYPICAL SECTIONS.

PRELIMINARY
NOT FOR CONSTRUCTION

0 10' 20'
VERT. SCALE: 1"=10'

0 100' 200'
HOR. SCALE: 1"=100'

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:16:30 PM 12/3/2018 FILE: W912DS_A1_CS-303.dgn

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

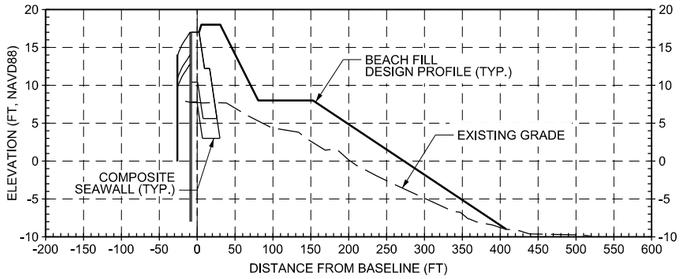
DESIGNED BY: RWH
DRWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 1:1.25000
SIZE: ANSI D
CKD BY: MK
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-303.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

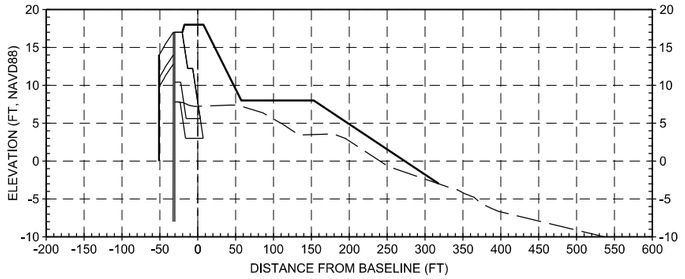
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

CROSS SECTIONS (SHEET 1 OF 5)

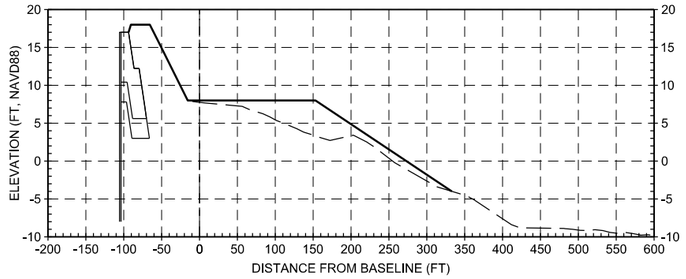
SHEET ID
CS-303
SHEET 22 OF 36



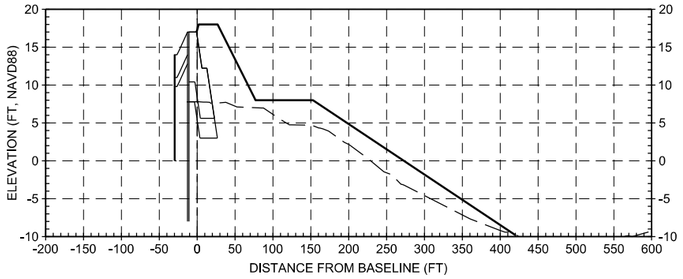
20+00



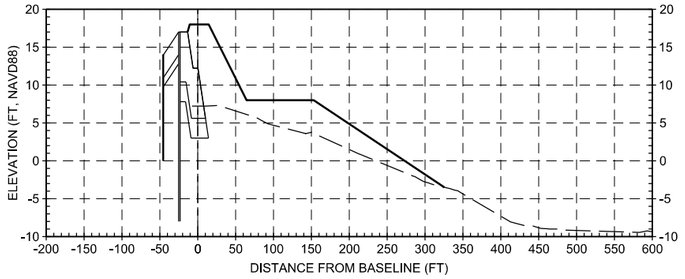
50+00



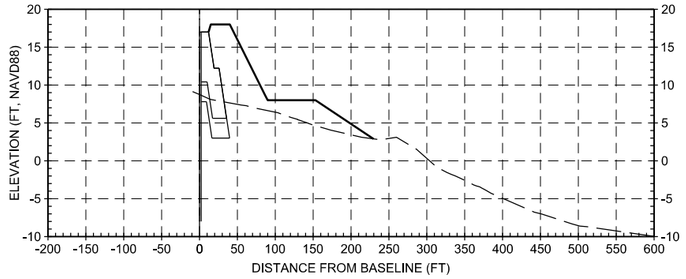
80+00



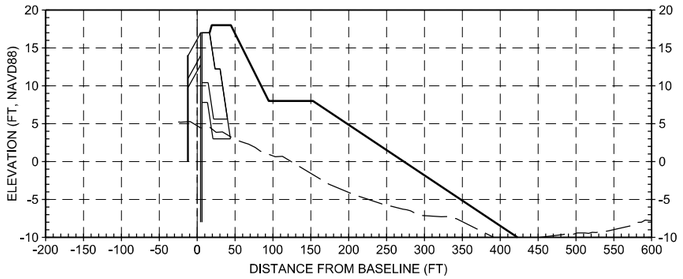
10+00



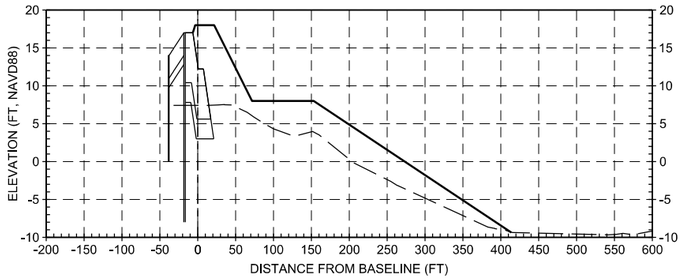
40+00



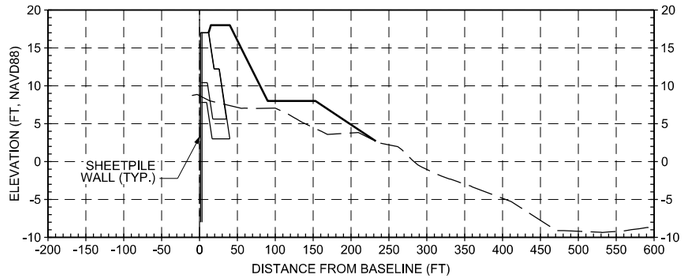
70+00



0+10



30+00



60+00

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. DESIGN PROFILE SHOWN IN SECTIONS.
3. REFER TO SHEETS CS-301 AND CS-302 FOR TYPICAL SECTIONS.

PRELIMINARY
NOT FOR CONSTRUCTION

VERT. SCALE: 1"=10'

HOR. SCALE: 1"=100'

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

US Army Corps of Engineers®

DESIGNED BY: RWH | DRAWN BY: ME | SUBMITTED BY: SA | CKD BY: MK | DATE: 12.05.18 | SOLICITATION NO.: | CONTRACT NO.: | PLOT SCALE: 1:1.0000 | PLOT DATE: 12/3/2018 | FILE NUMBER: | SIZE: ANSI D | FILE NAME: W912DS_A1_CS-304.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

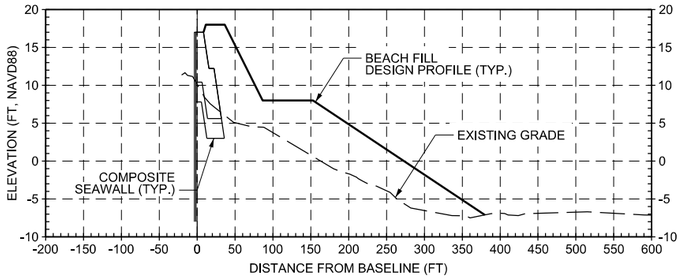
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

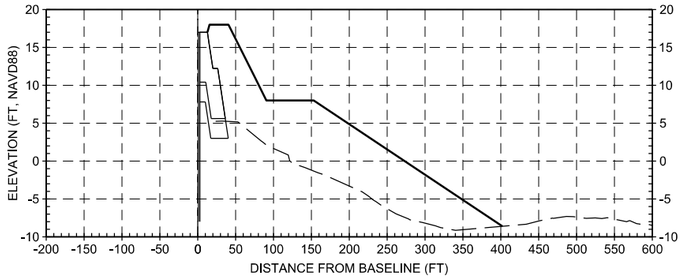
CROSS SECTIONS (SHEET 2 OF 5)

SHEET ID
CS-304
SHEET 23 OF 36

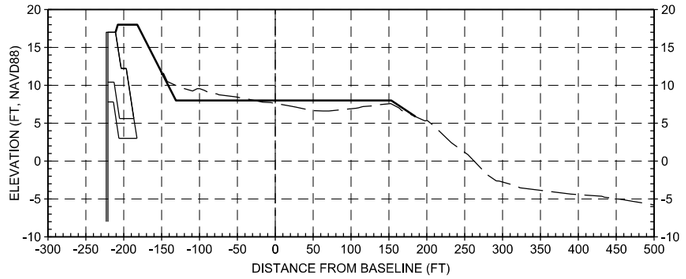
PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:16:59 PM 12/3/2018 FILE: W912DS_A1_CS-304.dgn



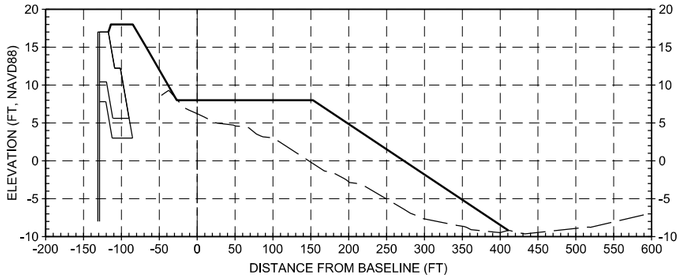
110+00



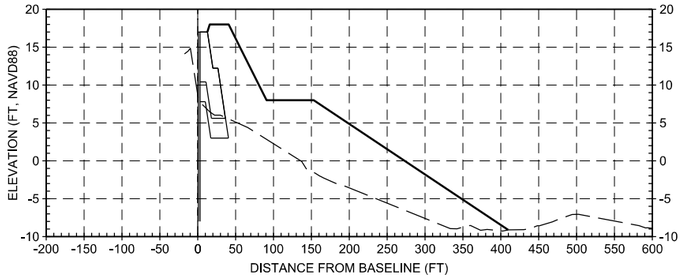
140+00



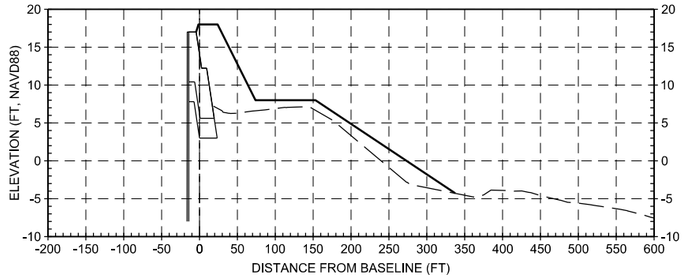
170+00



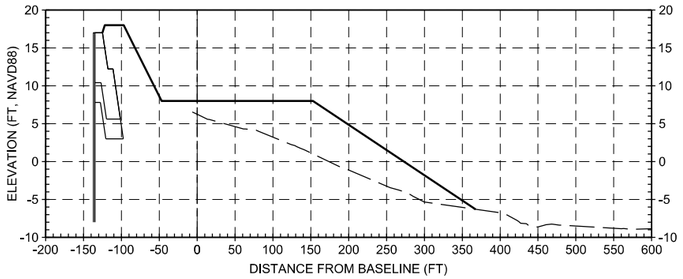
100+00



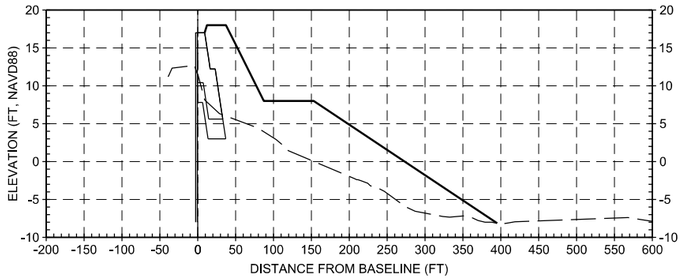
130+00



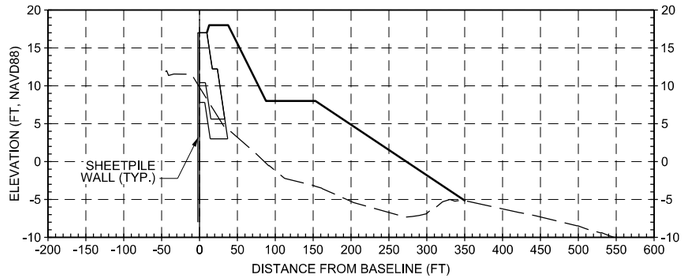
160+00



90+00



120+00



150+00

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. DESIGN PROFILE SHOWN IN SECTIONS.
3. REFER TO SHEETS CS-301 AND CS-302 FOR TYPICAL SECTIONS.

PRELIMINARY
NOT FOR CONSTRUCTION

VERT. SCALE: 1"=10'

HOR. SCALE: 1"=100'

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\

LAST PLOTTED BY: mestimable 1:17:08 PM 12/3/2018 FILE: W912DS_A1_CS-305.dgn

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

US Army Corps of Engineers®

DESIGNED BY: RWH | DRAWN BY: ME | SUBMITTED BY: SA | DRAWING STATUS: 100% | DATE: 12.05.18 | SOLICITATION NO.: | CONTRACT NO.: | FILE NUMBER: | PLOT SCALE: 1:1 | PLOT DATE: 12/3/2018 | SIZE: ANSI D | FILE NAME: W912DS_A1_CS-305.dgn

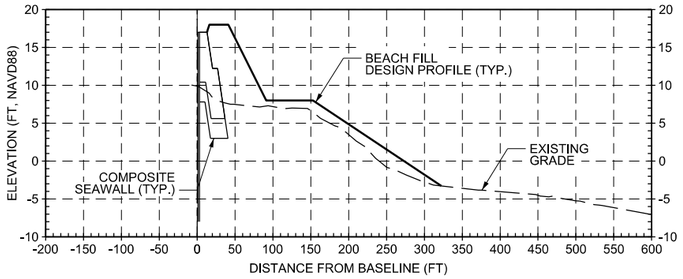
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

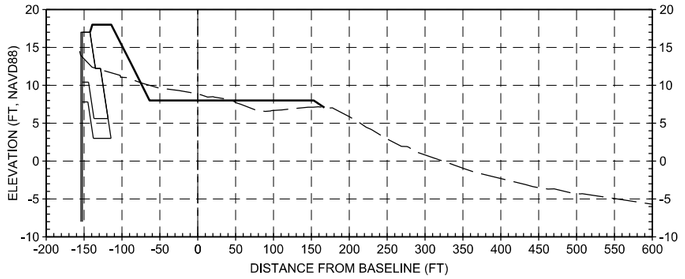
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

CROSS SECTIONS (SHEET 3 OF 5)

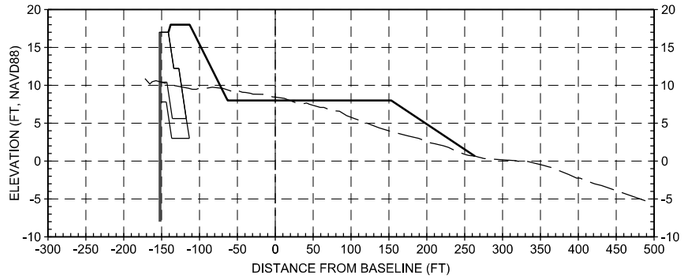
SHEET ID
CS-305
SHEET 24 OF 36



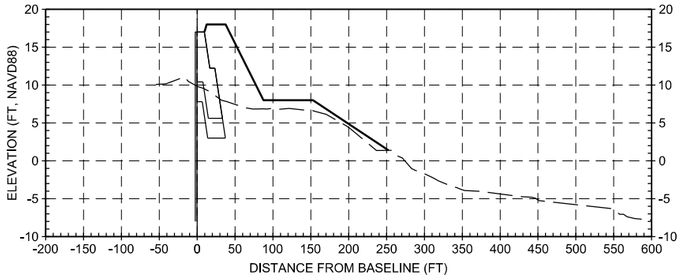
200+00



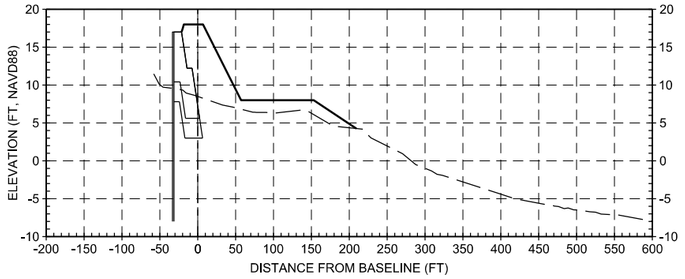
230+00



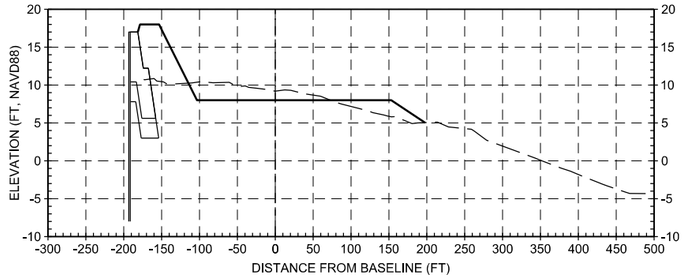
260+00



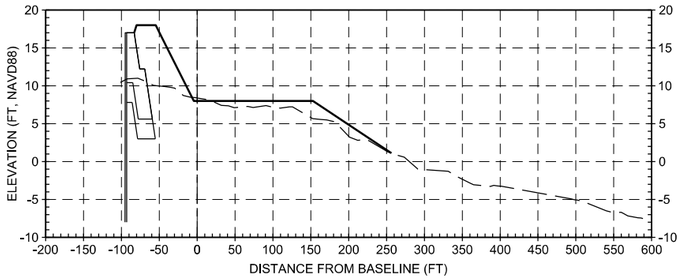
190+00



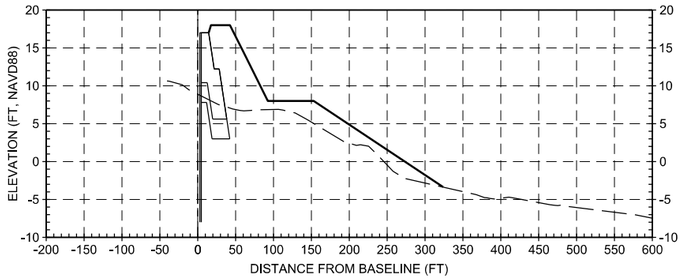
220+00



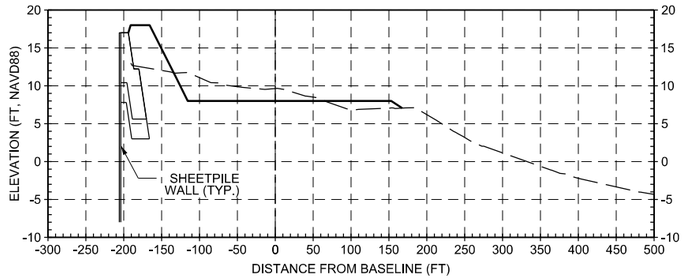
249+00



180+00



210+00



240+00

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. DESIGN PROFILE SHOWN IN SECTIONS.
3. REFER TO SHEETS CS-301 AND CS-302 FOR TYPICAL SECTIONS.

PRELIMINARY
NOT FOR CONSTRUCTION

VERT. SCALE: 1"=10'

HOR. SCALE: 1"=100'

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\

LAST PLOTTED BY: mestimable 1:17:19 PM 12/3/2018 FILE: W912DS_A1_CS-306.dgn

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRAWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 1:1.0000
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MK
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-306.dgn
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

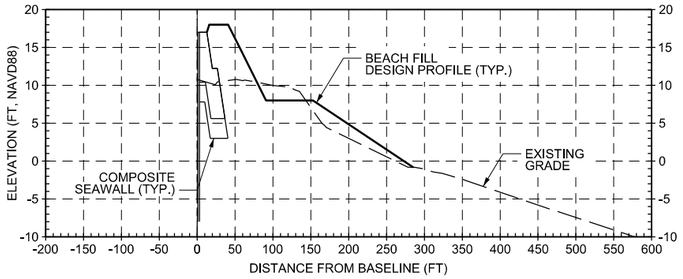
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

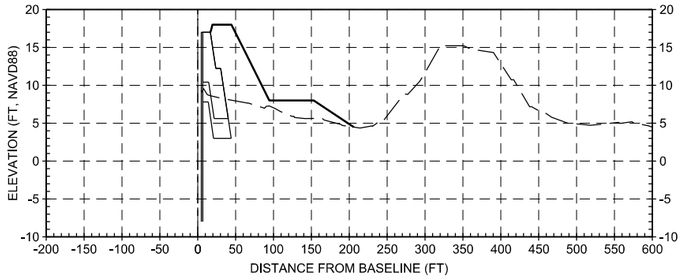
INTEGRATED HURRICANE SANDY GENERAL
RE-EVALUATION REPORT AND ENVIRONMENTAL
IMPACT STATEMENT

CROSS SECTIONS (SHEET 4 OF 5)

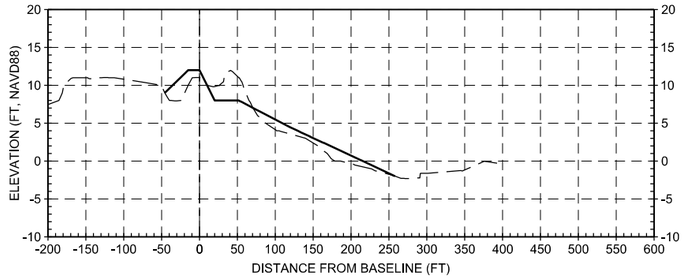
SHEET ID
CS-306
SHEET 25 OF 36



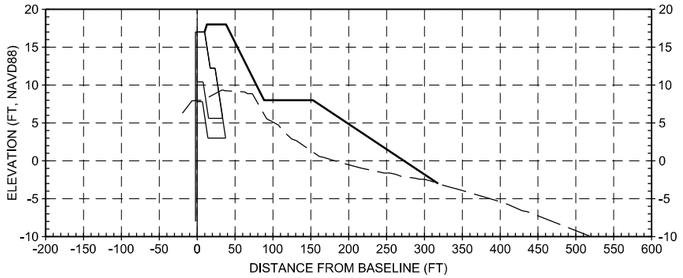
290+00



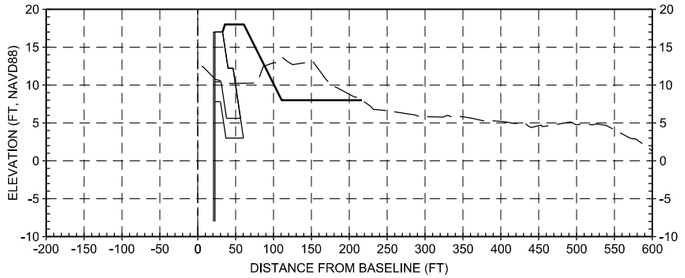
320+00



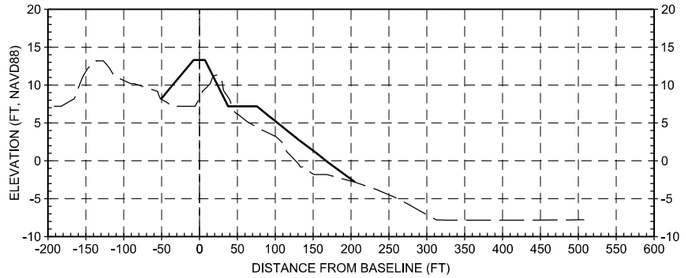
349+00



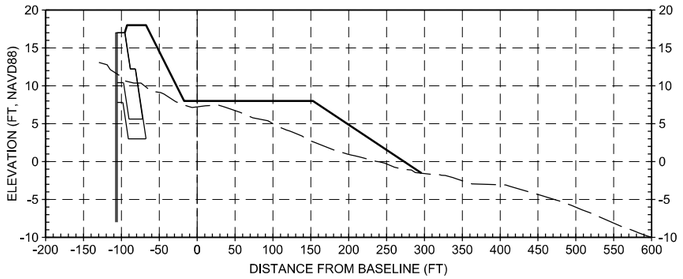
280+00



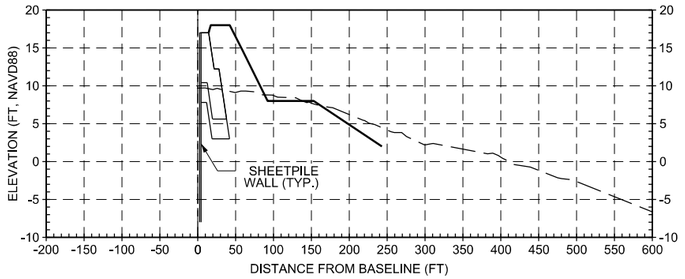
310+00



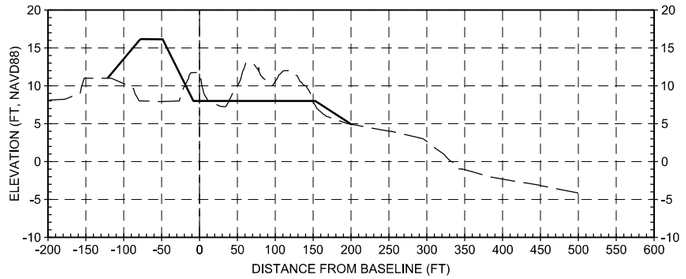
340+00



270+00



300+00



330+00

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. DESIGN PROFILE SHOWN IN SECTIONS.
3. REFER TO SHEETS CS-301 AND CS-302 FOR TYPICAL SECTIONS.

PRELIMINARY
NOT FOR CONSTRUCTION

VERT. SCALE: 1"=10'

HOR. SCALE: 1"=100'

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\

LAST PLOTTED BY: mestimable 1:17:29 PM 12/3/2018 FILE: W912DS_A1_CS-307.dgn

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

US Army Corps of Engineers®

DESIGNED BY: RWH | DRWN BY: ME | SUBMITTED BY: SA | CKD BY: MK | DATE: 12.05.18 | SOLICITATION NO.: | CONTRACT NO.: | FILE NUMBER: | PLOT SCALE: 1:1 | PLOT DATE: 12/3/2018 | SIZE: ANSI D | FILE NAME: W912DS_A1_CS-307.dgn

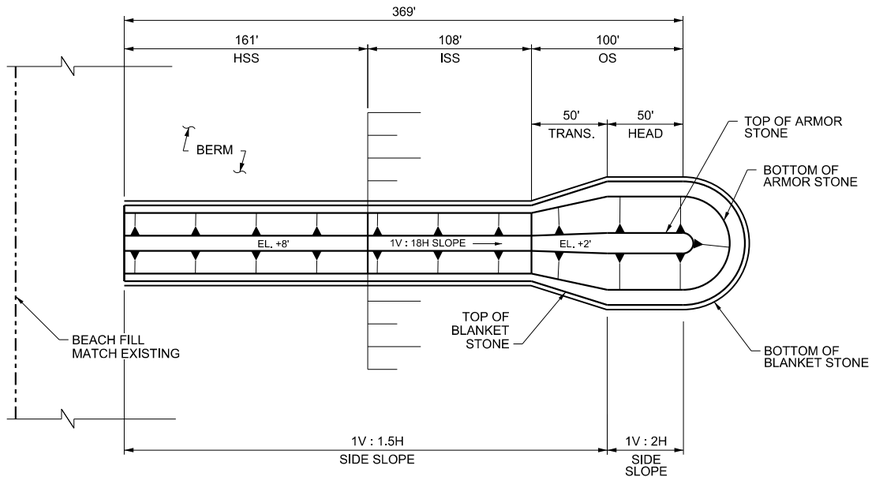
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

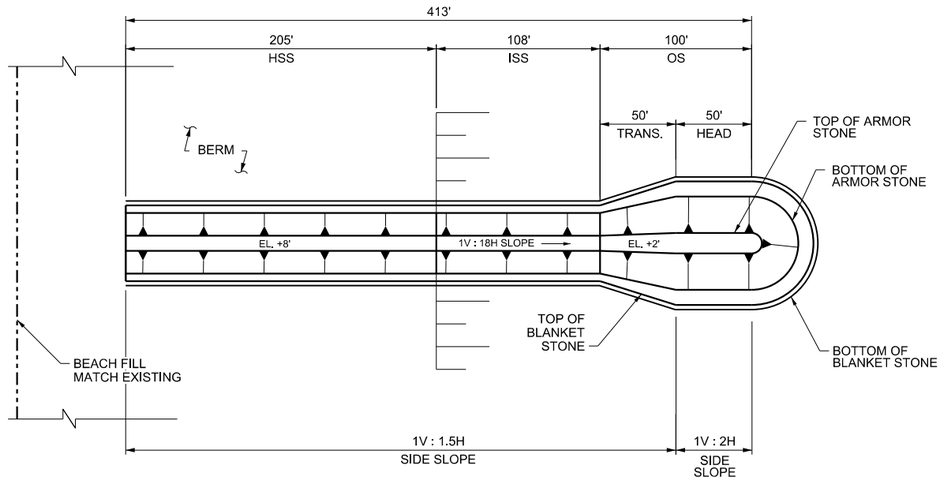
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

CROSS SECTIONS (SHEET 5 OF 5)

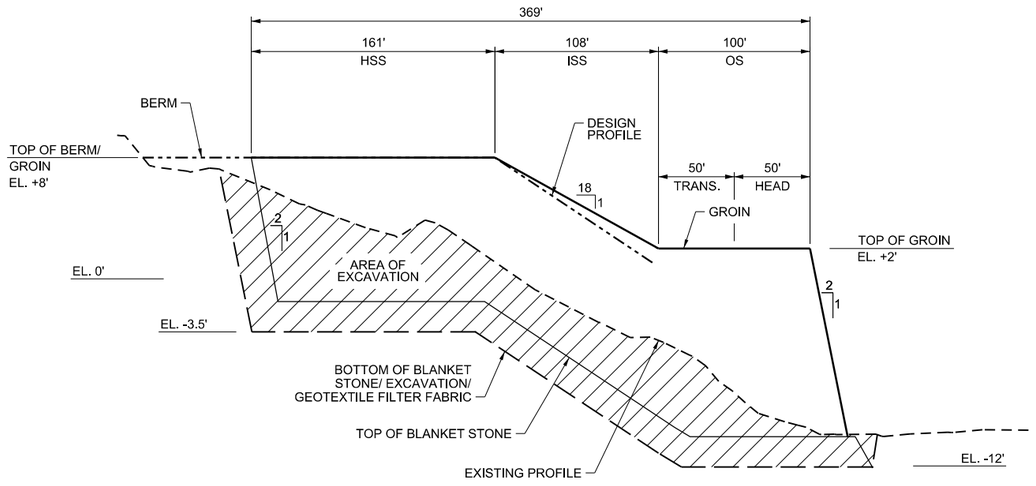
SHEET ID
CS-307
SHEET 26 OF 36



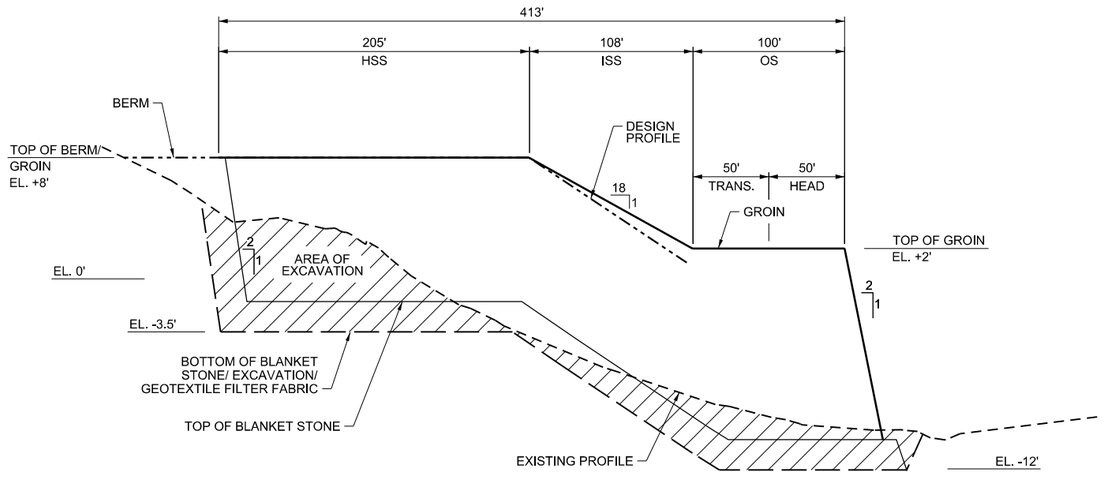
C1 CS-102 PLAN - GROIN 21
SCALE: 1"=50'



C4 CS-102 PLAN - GROIN 22
SCALE: 1"=50'



A1 CS-401 PROFILE - GROIN 21
SCALE: 1"=50'



A4 CS-401 PROFILE - GROIN 22
SCALE: 1"=50'

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. THE WIDTH OF THE DESIGN BERM IS GENERALLY 60 FEET OR MORE. THE SEAWARD CREST OF THE DESIGN BERM IS CONTROLLED BY THE ALIGNMENT OF THE BASELINE, WHICH DOES NOT ALWAYS FOLLOW THE BOARDWALK ALIGNMENT.
3. THE DISTANCE FROM THE BASELINE TO THE DESIGN SHORELINE IS ALWAYS 243.0 FEET. THE DESIGN SHORELINE IS ALIGNED WITH THE NATURAL SHORELINE. THE ALIGNMENT OF THE DUNE FOLLOWS THE UNNATURAL ALIGNMENT OF THE BOARDWALK.
4. REMOVE EXISTING ARMOR STONE AND RE-WORK AS NECESSARY TO CREATE CONTINUOUS INTERLOCKING GROIN STRUCTURE.
5. EXTENTS OF EXISTING GROIN ARE UNKNOWN AT THIS TIME. END OF EXPOSED GROIN HAS BEEN LOCATED FROM AERIAL IMAGERY. EXTENTS OF GROIN TO BE DETERMINED PRIOR TO PRELIMINARY DESIGN PHASE.
6. MATCH ELEVATION WITH EXISTING GROIN CREST.
7. EXISTING CONTOURS NOT SHOWN ON PLAN FOR CLARITY.
8. SEE SHEET CS-302 FOR COMPOSITE WALL SECTIONS.
9. SEE SHEET CS-404 FOR TYPICAL GROIN HSS, OS AND HEAD SECTIONS.

ABBREVIATION

EL.	ELEVATION
HSS	HORIZONTAL SHORE SECTION
ISS	INTERMEDIATE SLOPING SECTION
OS	OUTER SECTION
TRANS.	TRANSITION

PRELIMINARY
NOT FOR CONSTRUCTION

0 10' 20'
VERT. SCALE: 1"=10'

0 50' 100'
HOR. SCALE: 1"=50'

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-401.dgn
12/3/2018
1:17:38 PM
LAST PLOTTED BY: mestimable

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

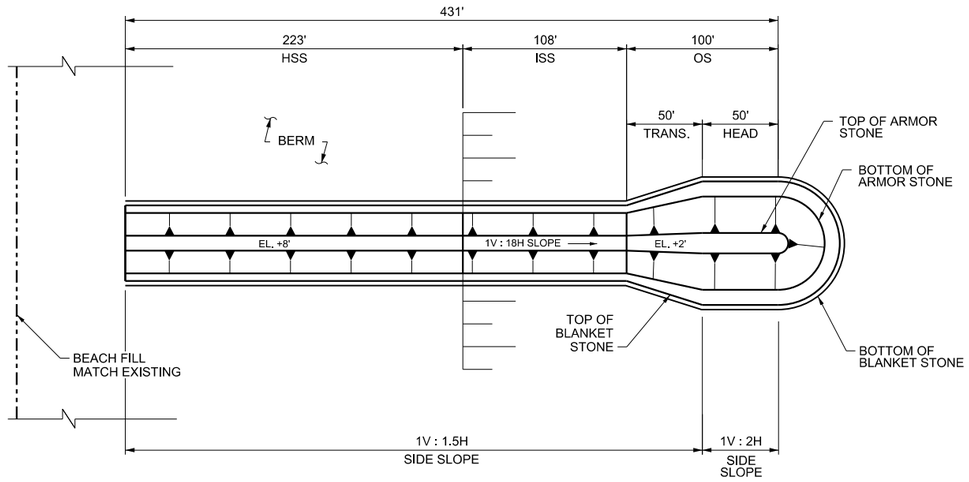
DESIGNED BY: RWH
DRWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: 1:1.0000
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-401.dgn
SIZE: ANSI D
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

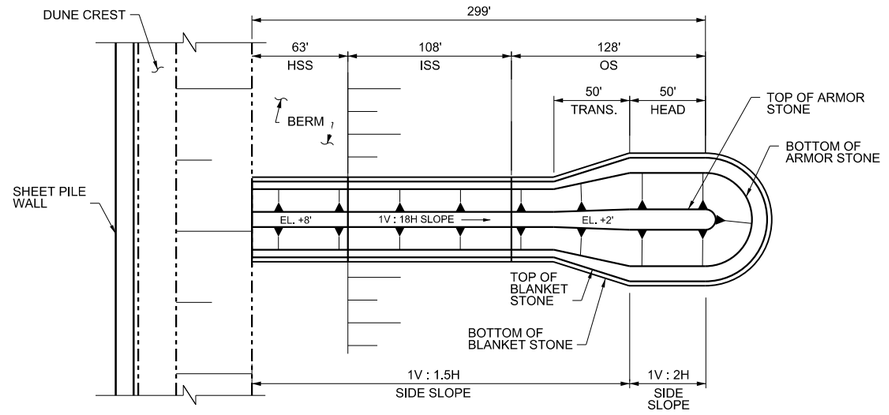
TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 2

SHEET ID
CS-401
SHEET 27 OF 36



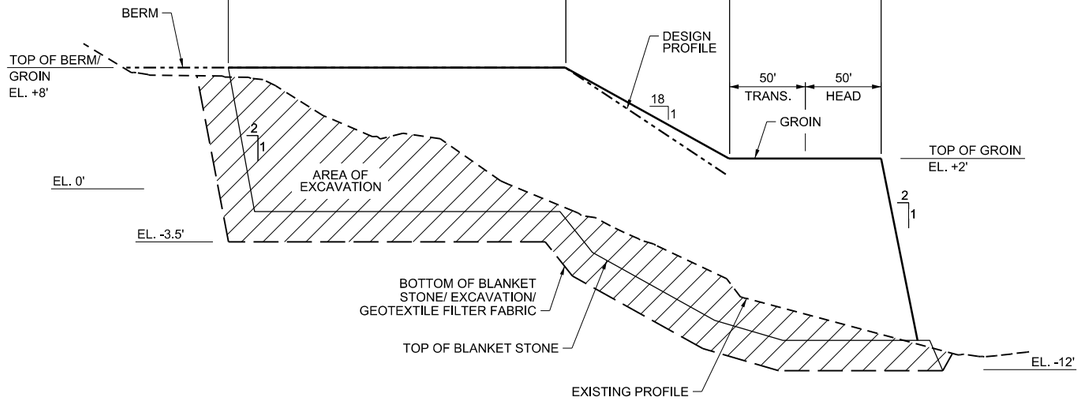
C1 CS-103 PLAN - GROIN 23

SCALE: 1"=50'



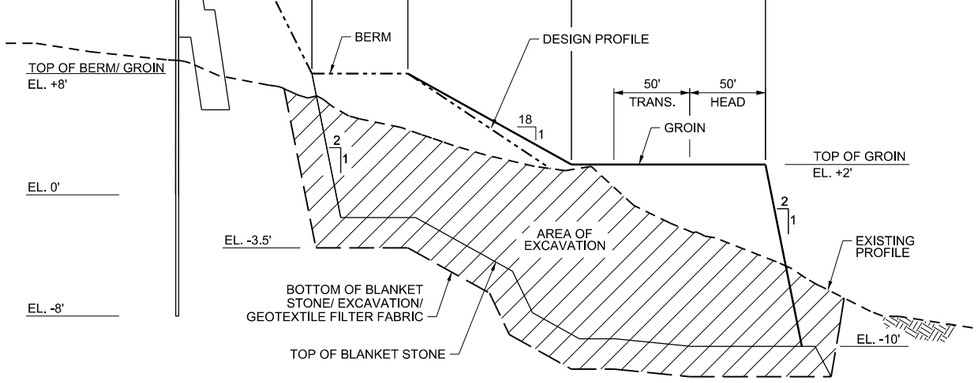
C4 CS-106 PLAN - GROIN 31 (121st STREET)

SCALE: 1"=50'



A1 CS-402 PROFILE - GROIN 23

SCALE: 1"=50'



A4 CS-402 PROFILE - GROIN 31 (121st STREET)

SCALE: 1"=50'

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. THE WIDTH OF THE DESIGN BERM IS GENERALLY 60 FEET OR MORE. THE SEAWARD CREST OF THE DESIGN BERM IS CONTROLLED BY THE ALIGNMENT OF THE BASELINE, WHICH DOES NOT ALWAYS FOLLOW THE BOARDWALK ALIGNMENT.
3. THE DISTANCE FROM THE BASELINE TO THE DESIGN SHORELINE IS ALWAYS 243.0 FEET. THE DESIGN SHORELINE IS ALIGNED WITH THE NATURAL SHORELINE. THE ALIGNMENT OF THE DUNE FOLLOWS THE UNNATURAL ALIGNMENT OF THE BOARDWALK.
4. REMOVE EXISTING ARMOR STONE AND RE-WORK AS NECESSARY TO CREATE CONTINUOUS INTERLOCKING GROIN STRUCTURE.
5. EXTENTS OF EXISTING GROIN ARE UNKNOWN AT THIS TIME. END OF EXPOSED GROIN HAS BEEN LOCATED FROM AERIAL IMAGERY. EXTENTS OF GROIN TO BE DETERMINED PRIOR TO PRELIMINARY DESIGN PHASE.
6. MATCH ELEVATION WITH EXISTING GROIN CREST.
7. EXISTING CONTOURS NOT SHOWN ON PLAN FOR CLARITY.
8. SEE SHEET CS-302 FOR COMPOSITE WALL SECTIONS.
9. SEE SHEET CS-404 FOR TYPICAL GROIN HSS, OS AND HEAD SECTIONS.

ABBREVIATION

EL.	ELEVATION
HSS	HORIZONTAL SHORE SECTION
ISS	INTERMEDIATE SLOPING SECTION
OS	OUTER SECTION
TRANS.	TRANSITION

PRELIMINARY
NOT FOR CONSTRUCTION

0 10' 20'
VERT. SCALE: 1"=10'

0 50' 100'
HOR. SCALE: 1"=50'

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:17:47 PM 12/3/2018 FILE: W912DS_A1_CS-402.dgn

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRWN BY: ME
SUBMITTED BY: SA
DATE: 12.05.18
CKD BY: MK
PLOT SCALE: 1:50000
SIZE: ANSI D
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-402.dgn
FILE NUMBER:

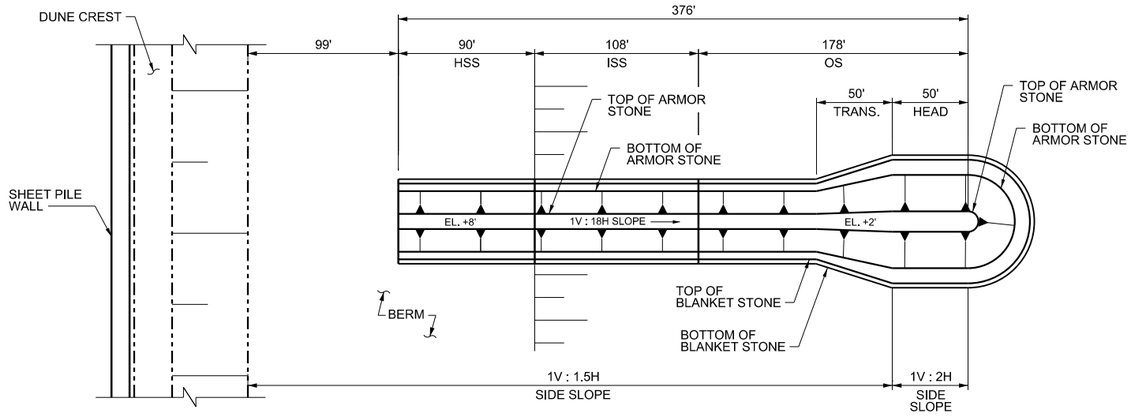
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

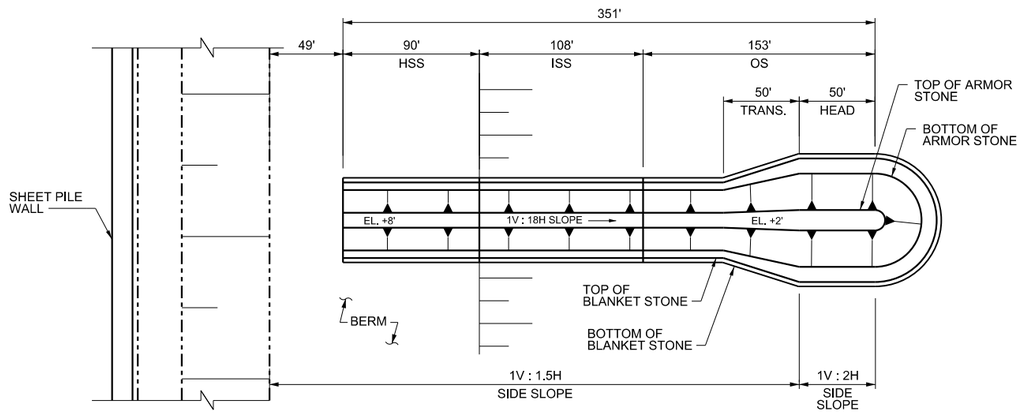
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 2 & 3

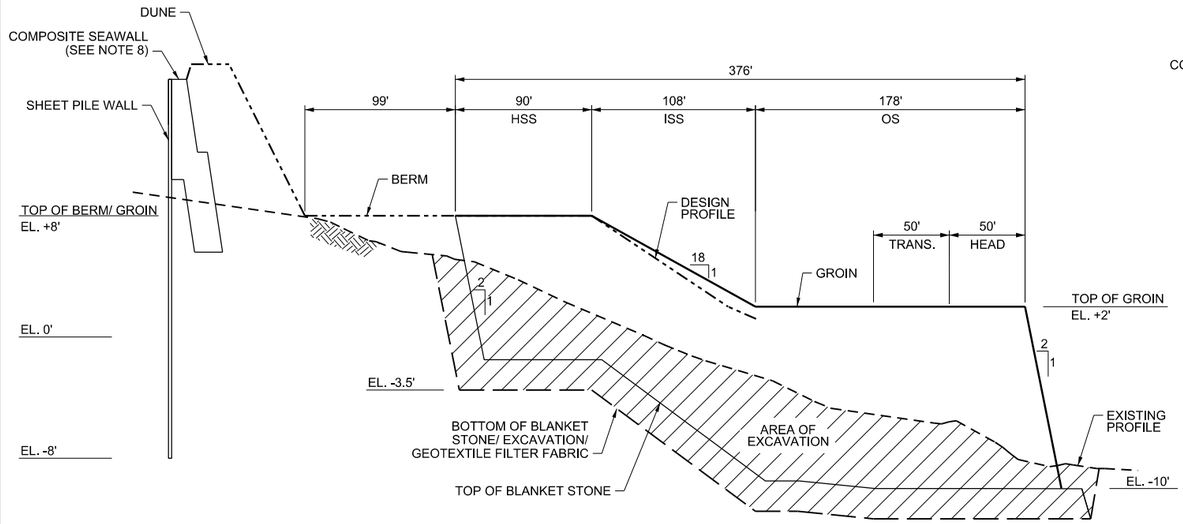
SHEET ID
CS-402
SHEET 28 OF 36



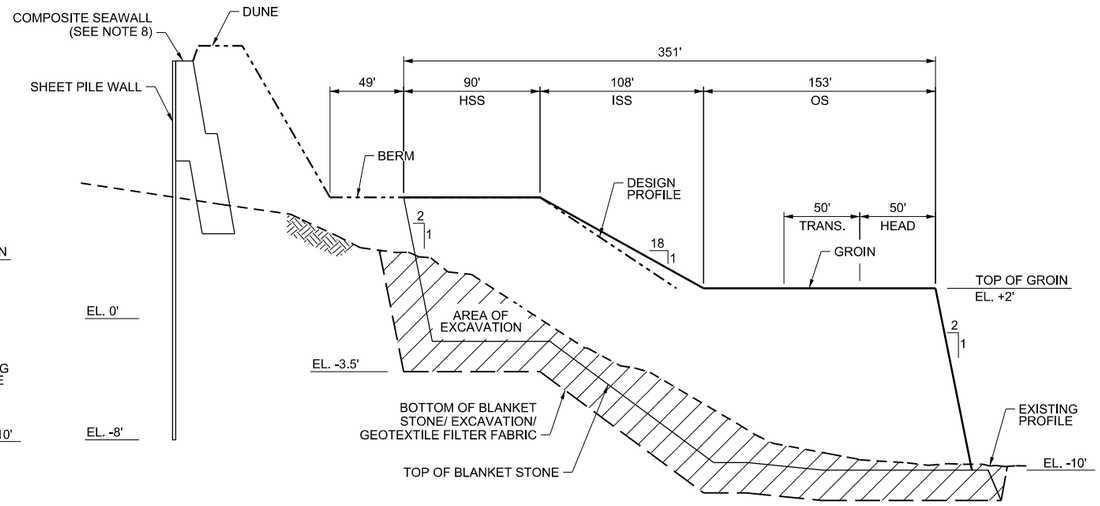
C1 CS-106 PLAN - GROIN 33 (115th STREET)
GROINS 32 & 34 SIMILAR
SCALE: 1"=50'



C4 CS-107 PLAN - GROIN 35 (110th STREET)
SCALE: 1"=50'



A1 CS-403 PROFILE - GROIN 33 (115th STREET)
GROINS 32 & 34 SIMILAR
SCALE: 1"=50'



A4 CS-403 PLAN - GROIN 35 (110th STREET)
SCALE: 1"=50'

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. THE WIDTH OF THE DESIGN BERM IS GENERALLY 60 FEET OR MORE. THE SEAWARD CREST OF THE DESIGN BERM IS CONTROLLED BY THE ALIGNMENT OF THE BASELINE, WHICH DOES NOT ALWAYS FOLLOW THE BOARDWALK ALIGNMENT.
3. THE DISTANCE FROM THE BASELINE TO THE DESIGN SHORELINE IS ALWAYS 243.0 FEET. THE DESIGN SHORELINE IS ALIGNED WITH THE NATURAL SHORELINE. THE ALIGNMENT OF THE DUNE FOLLOWS THE UNNATURAL ALIGNMENT OF THE BOARDWALK.
4. REMOVE EXISTING ARMOR STONE AND RE-WORK AS NECESSARY TO CREATE CONTINUOUS INTERLOCKING GROIN STRUCTURE.
5. EXTENTS OF EXISTING GROIN ARE UNKNOWN AT THIS TIME. END OF EXPOSED GROIN HAS BEEN LOCATED FROM AERIAL IMAGERY. EXTENTS OF GROIN TO BE DETERMINED PRIOR TO PRELIMINARY DESIGN PHASE.
6. MATCH ELEVATION WITH EXISTING GROIN CREST.
7. EXISTING CONTOURS NOT SHOWN ON PLAN FOR CLARITY.
8. SEE SHEET CS-302 FOR COMPOSITE WALL SECTIONS.
9. SEE SHEET CS-404 FOR TYPICAL GROIN HSS, OS AND HEAD SECTIONS.

ABBREVIATION

EL.	ELEVATION
HSS	HORIZONTAL SHORE SECTION
ISS	INTERMEDIATE SLOPING SECTION
OS	OUTER SECTION
TRANS.	TRANSITION

VERT. SCALE: 1"=10' (0, 10', 20')

HOR. SCALE: 1"=50' (0, 50', 100')

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-403.dgn
LAST PLOTTED BY: mestimable 1:17:57 PM 12/3/2018

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: 1:1.5000
PLOT DATE: 12.05.18
FILE NUMBER:
SIZE: ANSI D
FILE NAME: W912DS_A1_CS-403.dgn

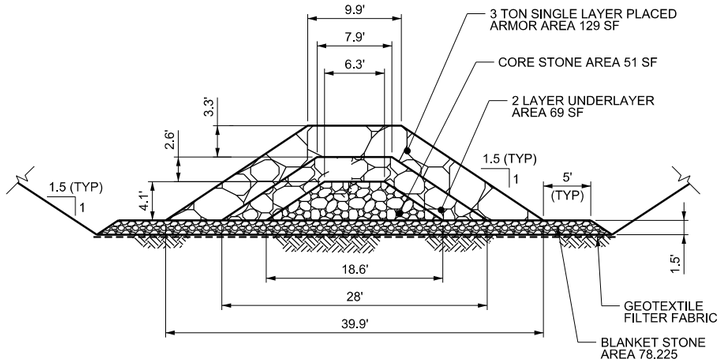
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 3

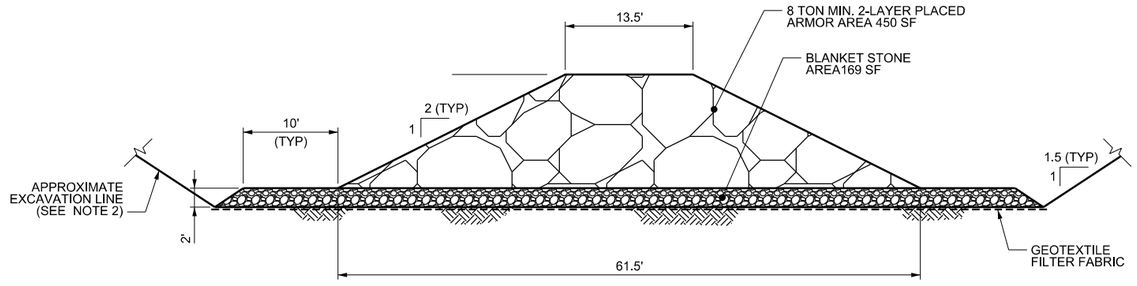
SHEET ID
CS-403
SHEET 29 OF 36



C2 SECTION - TYPICAL HSS

SCALE: 1/8"=1'-0"

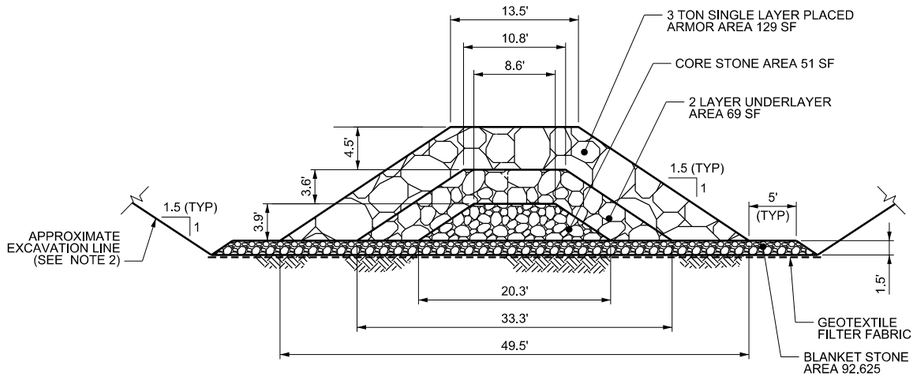
C-401 TO C-403



C2 SECTION - TYPICAL HEAD

SCALE: 1/8"=1'-0"

C-401 TO C-403



C2 SECTION - TYPICAL OS

SCALE: 1/8"=1'-0"

C-401 TO C-403

PRELIMINARY
NOT FOR CONSTRUCTION

NOTES

1. EXISTING GRADE NOT SHOWN FOR CLARITY.
2. EXCAVATE TO EXISTING GRADE TO FACILITATE GROIN CONSTRUCTION.

0 8' 16'
VERT. SCALE: 1/8"=1'-0"

0 8' 16'
HOR. SCALE: 1/8"=1'-0"

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

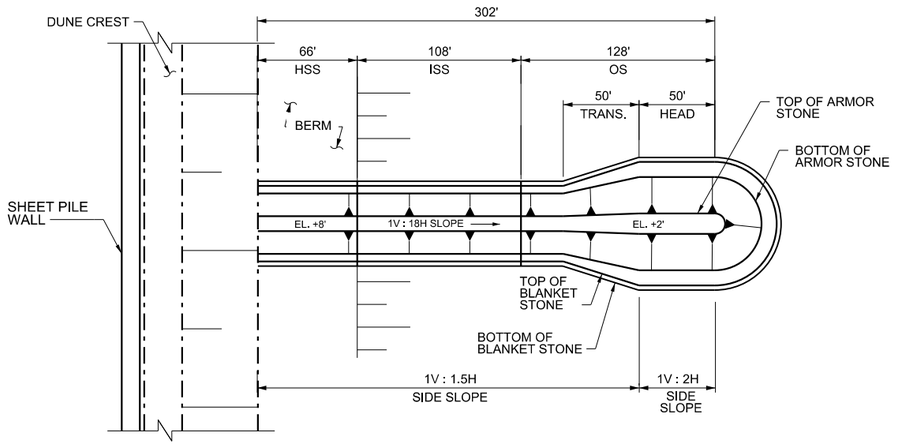
DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:1.00000
PLOT DATE: 12/3/2018
SIZE: ANSI D
FILE NAME: W912DS_A1_CS-404.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

INTEGRATED HURRICANE SANDY GENERAL
RE-EVALUATION REPORT AND ENVIRONMENTAL
IMPACT STATEMENT

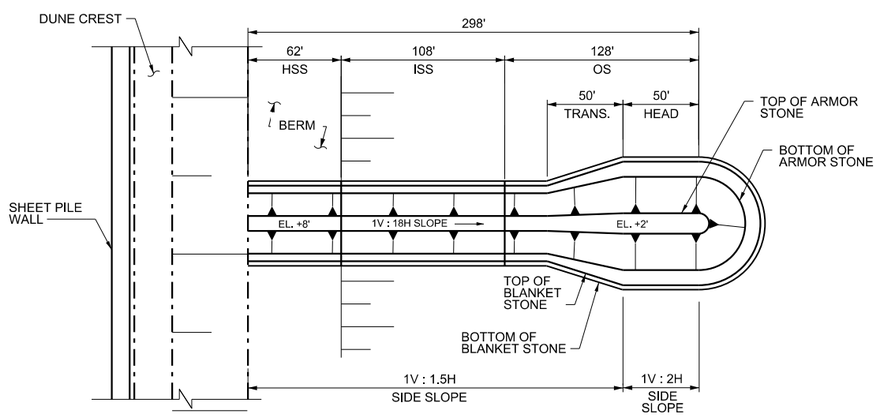
TYPICAL SECTION GROIN
CONSTRUCTION REACH 3

SHEET ID
CS-404
SHEET 30 OF 36

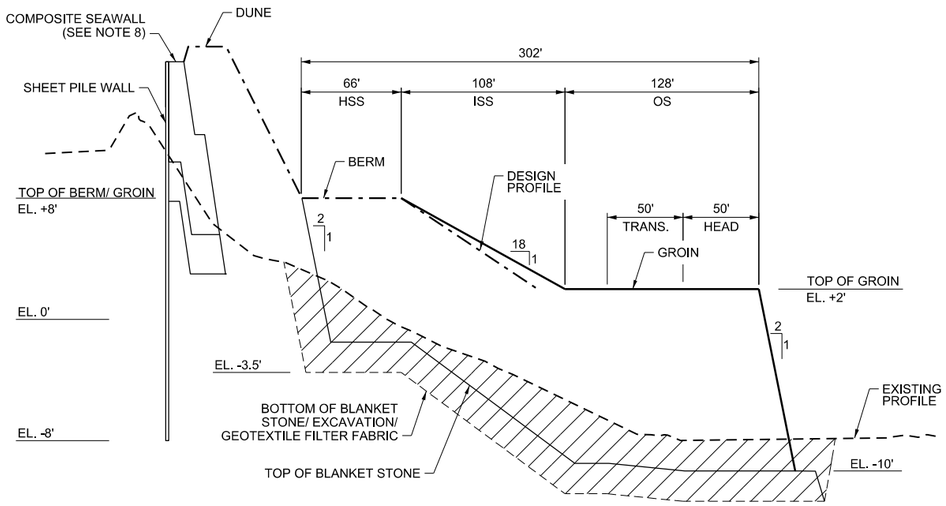
PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:18:07 PM 12/3/2018 FILE: W912DS_A1_CS-404.dgn



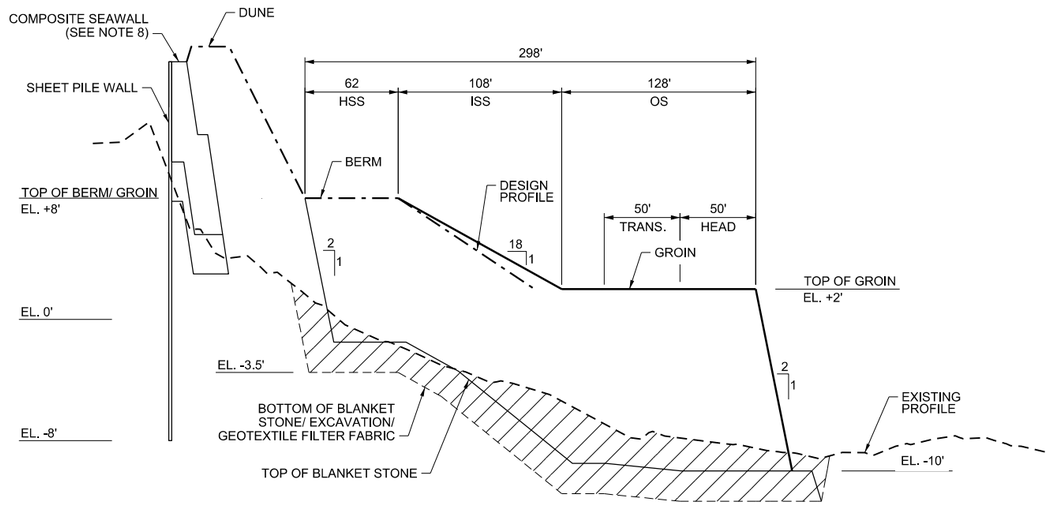
C1 CS-108 PLAN - GROIN 43 (104th STREET)
GROINS 42, 43, & 47 SIMILAR
SCALE: 1"=50'



C4 CS-109 PLAN - GROIN 44 (101st STREET)
GROINS 45, & 46 SIMILAR
SCALE: 1"=50'



A1 CS-405 PROFILE - GROIN 43 (104th STREET)
GROINS 42, 43, & 47 SIMILAR
SCALE: 1"=50'



A4 CS-405 PROFILE - GROIN 44 (101st STREET)
GROINS 45, & 46 SIMILAR
SCALE: 1"=50'

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. THE WIDTH OF THE DESIGN BERM IS GENERALLY 60 FEET OR MORE. THE SEAWARD CREST OF THE DESIGN BERM IS CONTROLLED BY THE ALIGNMENT OF THE BASELINE, WHICH DOES NOT ALWAYS FOLLOW THE BOARDWALK ALIGNMENT.
3. THE DISTANCE FROM THE BASELINE TO THE DESIGN SHORELINE IS ALWAYS 243.0 FEET. THE DESIGN SHORELINE IS ALIGNED WITH THE NATURAL SHORELINE. THE ALIGNMENT OF THE DUNE FOLLOWS THE UNNATURAL ALIGNMENT OF THE BOARDWALK.
4. REMOVE EXISTING ARMOR STONE AND RE-WORK AS NECESSARY TO CREATE CONTINUOUS INTERLOCKING GROIN STRUCTURE.
5. EXTENTS OF EXISTING GROIN ARE UNKNOWN AT THIS TIME. END OF EXPOSED GROIN HAS BEEN LOCATED FROM AERIAL IMAGERY. EXTENTS OF GROIN TO BE DETERMINED PRIOR TO PRELIMINARY DESIGN PHASE.
6. MATCH ELEVATION WITH EXISTING GROIN CREST.
7. EXISTING CONTOURS NOT SHOWN ON PLAN FOR CLARITY.
8. SEE SHEET CS-302 FOR COMPOSITE WALL SECTIONS.
9. SEE SHEET CS-406 FOR TYPICAL GROIN HSS, OS AND HEAD SECTIONS.

ABBREVIATION

EL.	ELEVATION
HSS	HORIZONTAL SHORE SECTION
ISS	INTERMEDIATE SLOPING SECTION
OS	OUTER SECTION
TRANS.	TRANSITION

PRELIMINARY
NOT FOR CONSTRUCTION

VERT. SCALE: 1"=10' (0, 10', 20')

HOR. SCALE: 1"=50' (0, 50', 100')

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-405.dgn
12/3/2018 1:18:16 PM
LAST PLOTTED BY: mestimable

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: 1:1.00000
PLOT DATE: 12/3/2018
FILE NUMBER:
SIZE: ANSI D
FILE NAME: W912DS_A1_CS-405.dgn

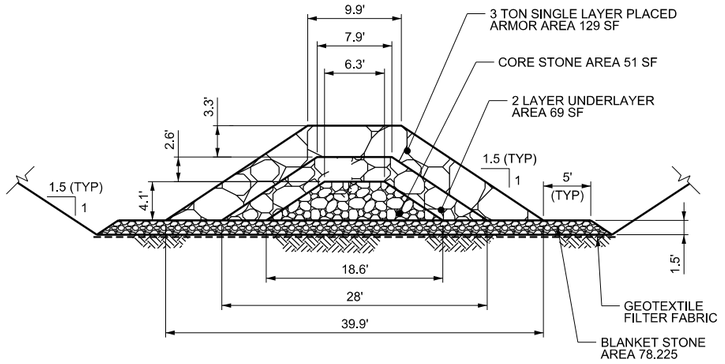
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

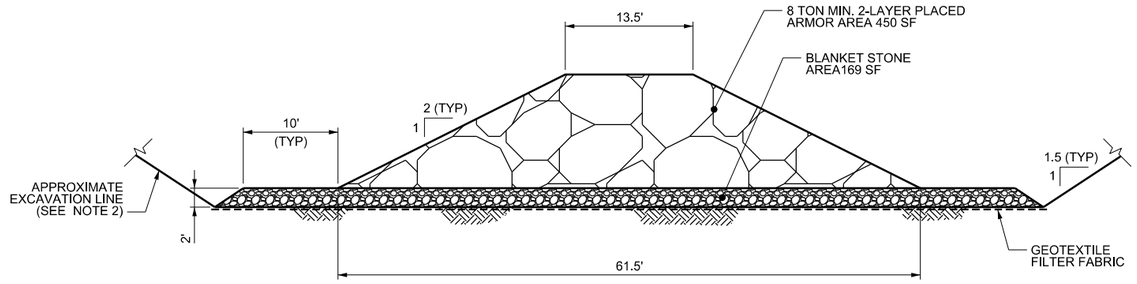
TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 4

SHEET ID
CS-405
SHEET 31 OF 36



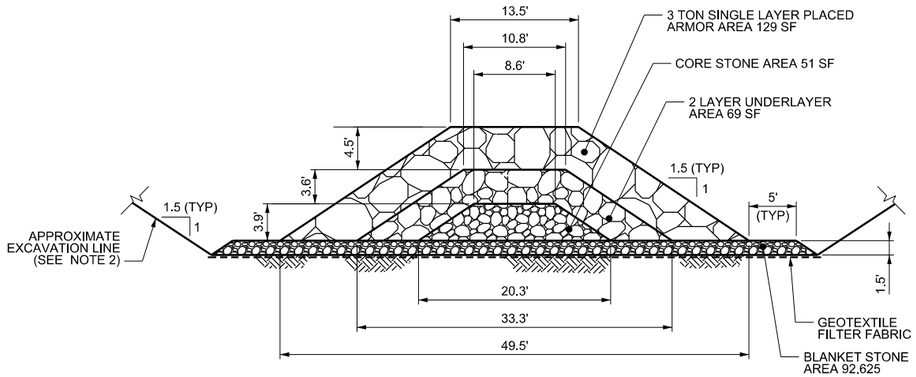
C2 / C-405 TYPICAL HSS

SCALE: 1/8"=1'-0"



C2 / C-405 TYPICAL HEAD

SCALE: 1/8"=1'-0"



C2 / C-405 TYPICAL OS

SCALE: 1/8"=1'-0"

NOTES

1. EXISTING GRADE NOT SHOWN FOR CLARITY.
2. EXCAVATE TO EXISTING GRADE TO FACILITATE GROIN CONSTRUCTION.

0 8' 16'

VERT. SCALE: 1/8"=1'-0"

0 8' 16'

HOR. SCALE: 1/8"=1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

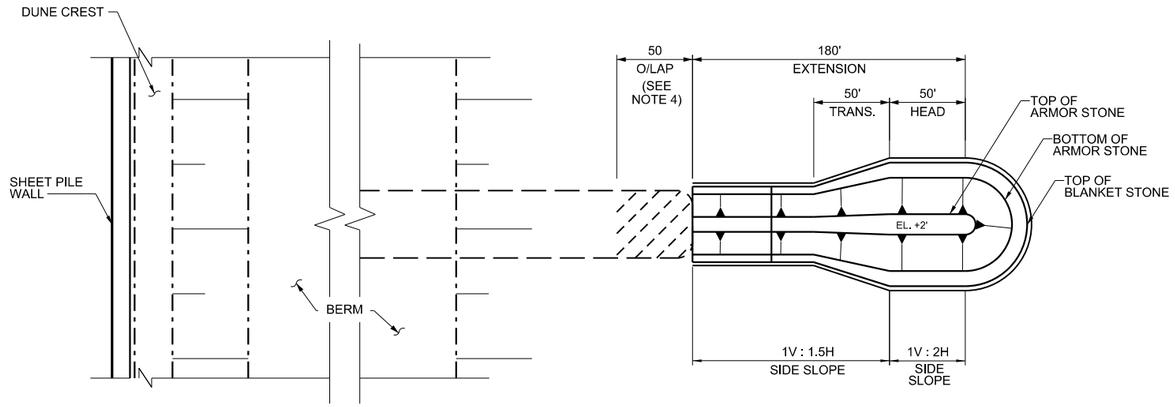
DESIGNED BY: RWH
DRWN BY: ME
SUBMITTED BY: SA
CKD BY: MK
PLOT SCALE: 1:1.000000
SIZE: ANSI D
DATE: 12/05/18
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 12/5/2018
FILE NAME: W912DS_A1_CS-406.dgn
FILE NUMBER:

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL SECTION GROIN CONSTRUCTION REACH 4

SHEET ID
CS-406
SHEET 32 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-406.dgn
12/3/2018
1:18:26 PM
LAST PLOTTED BY: mestimable



C2 / CS-113 PLAN - GROIN EXTENSION 51 (49th STREET)

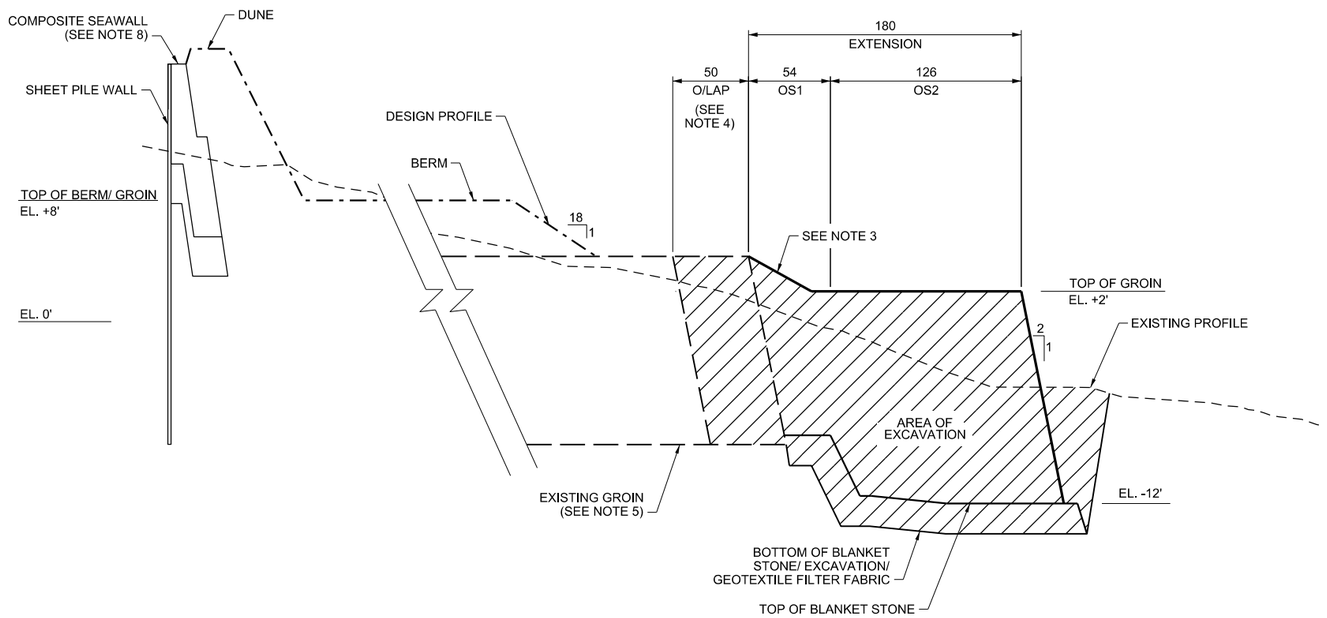
SCALE: 1"=50'

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. THE WIDTH OF THE DESIGN BERM IS GENERALLY 60 FEET OR MORE. THE SEAWARD CREST OF THE DESIGN BERM IS CONTROLLED BY THE ALIGNMENT OF THE BASELINE, WHICH DOES NOT ALWAYS FOLLOW THE BOARDWALK ALIGNMENT.
3. THE DISTANCE FROM THE BASELINE TO THE DESIGN SHORELINE IS ALWAYS 243.0 FEET. THE DESIGN SHORELINE IS ALIGNED WITH THE NATURAL SHORELINE. THE ALIGNMENT OF THE DUNE FOLLOWS THE UNNATURAL ALIGNMENT OF THE BOARDWALK.
4. REMOVE EXISTING ARMOR STONE AND RE-WORK AS NECESSARY TO CREATE CONTINUOUS INTERLOCKING GROIN STRUCTURE.
5. EXTENTS OF EXISTING GROIN ARE UNKNOWN AT THIS TIME. END OF EXPOSED GROIN HAS BEEN LOCATED FROM AERIAL IMAGERY. EXTENTS OF GROIN TO BE DETERMINED PRIOR TO PRELIMINARY DESIGN PHASE.
6. MATCH ELEVATION WITH EXISTING GROIN CREST.
7. EXISTING CONTOURS NOT SHOWN ON PLAN FOR CLARITY.
8. SEE SHEET CS-302 FOR COMPOSITE WALL SECTIONS.
9. SEE SHEET CS-410 FOR TYPICAL GROIN HSS, OS AND HEAD SECTIONS.

ABBREVIATION

EL.	ELEVATION
HSS	HORIZONTAL SHORE SECTION
ISS	INTERMEDIATE SLOPING SECTION
OS	OUTER SECTION
TRANS.	TRANSITION
O/LAP	OVERLAP



A2 / CS-407 PLAN - GROIN EXTENSION 51 (49th STREET)

GROINS 52 & 53 SIMILAR

SCALE: 1"=50'

PRELIMINARY
NOT FOR CONSTRUCTION

0 10' 20'
VERT. SCALE: 1"=10'

0 50' 100'
HOR. SCALE: 1"=50'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:50000
PLOT DATE: 12/3/2018
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILE NAME: W912DS_A1_CS-407.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

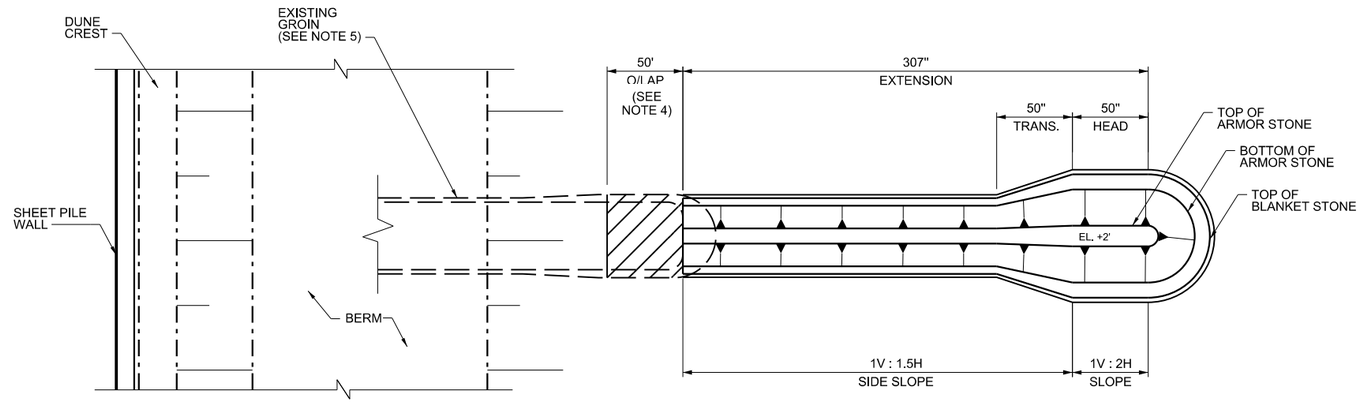
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 5

SHEET ID
CS-407
SHEET 33 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-407.dgn
12/3/2018
1:18:45 PM
LAST PLOTTED BY: mestimable



C2 / CS-114 PLAN - GROIN 61 (40th STREET)

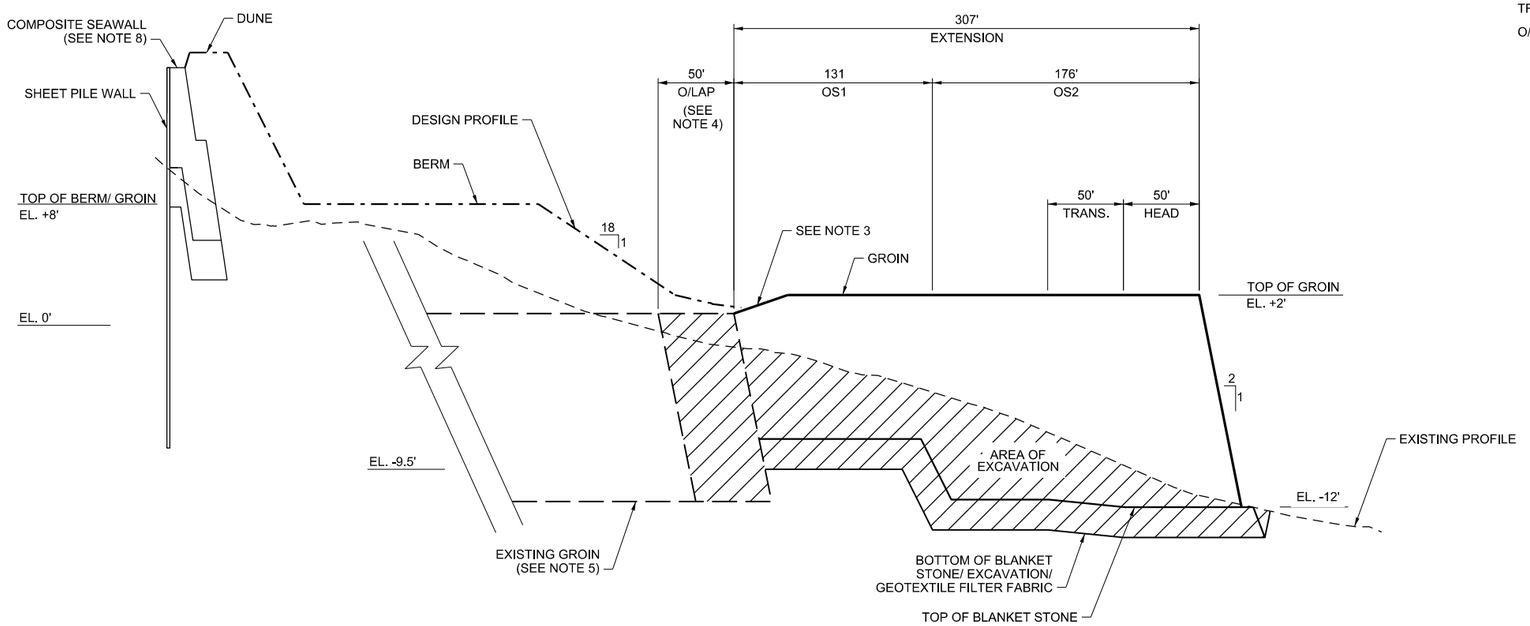
SCALE: 1"=50'

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. THE WIDTH OF THE DESIGN BERM IS GENERALLY 60 FEET OR MORE. THE SEAWARD CREST OF THE DESIGN BERM IS CONTROLLED BY THE ALIGNMENT OF THE BASELINE, WHICH DOES NOT ALWAYS FOLLOW THE BOARDWALK ALIGNMENT.
3. THE DISTANCE FROM THE BASELINE TO THE DESIGN SHORELINE IS ALWAYS 243.0 FEET. THE DESIGN SHORELINE IS ALIGNED WITH THE NATURAL SHORELINE. THE ALIGNMENT OF THE DUNE FOLLOWS THE UNNATURAL ALIGNMENT OF THE BOARDWALK.
4. REMOVE EXISTING ARMOR STONE AND RE-WORK AS NECESSARY TO CREATE CONTINUOUS INTERLOCKING GROIN STRUCTURE.
5. EXTENTS OF EXISTING GROIN ARE UNKNOWN AT THIS TIME. END OF EXPOSED GROIN HAS BEEN LOCATED FROM AERIAL IMAGERY. EXTENTS OF GROIN TO BE DETERMINED PRIOR TO PRELIMINARY DESIGN PHASE.
6. MATCH ELEVATION WITH EXISTING GROIN CREST.
7. EXISTING CONTOURS NOT SHOWN ON PLAN FOR CLARITY.
8. SEE SHEET CS-302 FOR COMPOSITE WALL SECTIONS.
9. SEE SHEET CS-410 FOR TYPICAL GROIN HSS, OS AND HEAD SECTIONS.

ABBREVIATION

EL.	ELEVATION
HSS	HORIZONTAL SHORE SECTION
ISS	INTERMEDIATE SLOPING SECTION
OS	OUTER SECTION
TRANS.	TRANSITION
O/LAP	OVERLAP



A2 / CS-408 PROFILE - GROIN 61 (40th STREET)

GROINS 62 SIMILAR

SCALE: 1"=50'

PRELIMINARY
NOT FOR CONSTRUCTION

0 10' 20'
VERT. SCALE: 1"=10'

0 50' 100'
HOR. SCALE: 1"=50'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
DATE: 12/05/18
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: 1:1.000000
PLOT DATE: 12/3/2018
FILE NUMBER:
SIZE: ANSI D
FILE NAME: W912DS_A1_CS-408.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

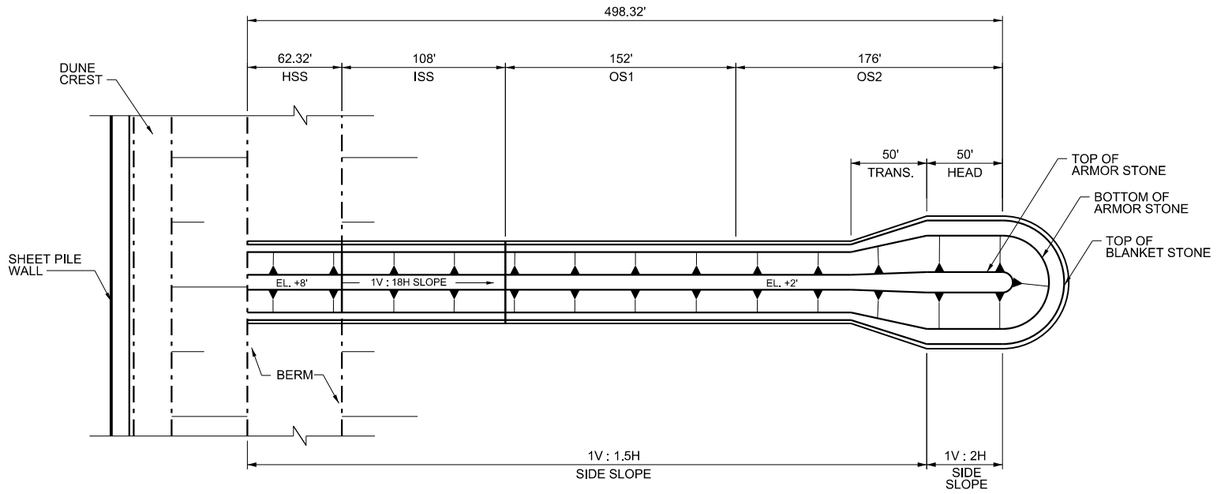
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 6A

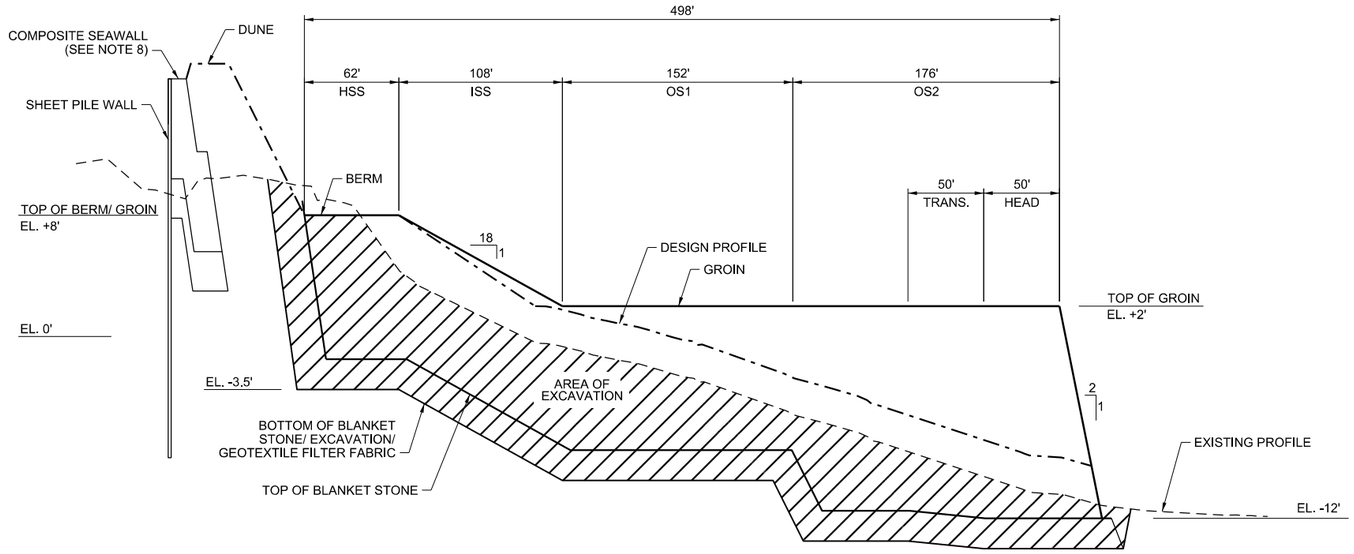
SHEET ID
CS-408
SHEET 34 OF 36

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
LAST PLOTTED BY: mestimable 1:19:50 PM 12/3/2018 FILE: W912DS_A1_CS-408.dgn



C2 / CS-115 PLAN - GROIN 63 (34th STREET)

SCALE: 1"=50'



A4 / CS-409 PROFILE - GROIN 63 (34th STREET)

SCALE: 1"=50'

PRELIMINARY
NOT FOR CONSTRUCTION

NOTES

1. EXISTING PROFILE IS BASED ON POST-SANDY SURVEY PERFORMED BY McKIM & CREED FROM FEBRUARY 25TH, 2013 TO MARCH 5TH, 2013.
2. THE WIDTH OF THE DESIGN BERM IS GENERALLY 60 FEET OR MORE. THE SEAWARD CREST OF THE DESIGN BERM IS CONTROLLED BY THE ALIGNMENT OF THE BASELINE, WHICH DOES NOT ALWAYS FOLLOW THE BOARDWALK ALIGNMENT.
3. THE DISTANCE FROM THE BASELINE TO THE DESIGN SHORELINE IS ALWAYS 243.0 FEET. THE DESIGN SHORELINE IS ALIGNED WITH THE NATURAL SHORELINE. THE ALIGNMENT OF THE DUNE FOLLOWS THE UNNATURAL ALIGNMENT OF THE BOARDWALK.
4. REMOVE EXISTING ARMOR STONE AND RE-WORK AS NECESSARY TO CREATE CONTINUOUS INTERLOCKING GROIN STRUCTURE.
5. EXTENTS OF EXISTING GROIN ARE UNKNOWN AT THIS TIME. END OF EXPOSED GROIN HAS BEEN LOCATED FROM AERIAL IMAGERY. EXTENTS OF GROIN TO BE DETERMINED PRIOR TO PRELIMINARY DESIGN PHASE.
6. MATCH ELEVATION WITH EXISTING GROIN CREST.
7. EXISTING CONTOURS NOT SHOWN ON PLAN FOR CLARITY.
8. SEE SHEET CS-302 FOR COMPOSITE WALL SECTIONS.
9. SEE SHEET CS-410 FOR TYPICAL GROIN HSS, OS AND HEAD SECTIONS.

ABBREVIATION

EL.	ELEVATION
HSS	HORIZONTAL SHORE SECTION
ISS	INTERMEDIATE SLOPING SECTION
OS	OUTER SECTION
OS1	OUTER SECTION 1
OS2	OUTER SECTION 2
TRANS.	TRANSITION

0 10' 20'
VERT. SCALE: 1"=10'

0 50' 100'
HOR. SCALE: 1"=50'

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\
FILE: W912DS_A1_CS-409.dgn
12/3/2018
1:19:39 PM
LAST PLOTTED BY: mestimable

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

DESIGNED BY: RWH
DRN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:50000
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_CS-409.dgn
FILE NUMBER:

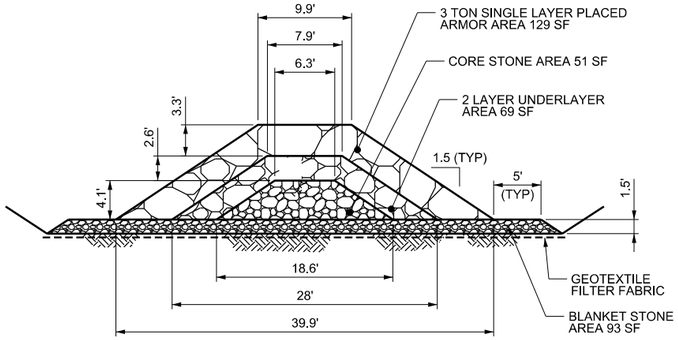
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL PLAN AND PROFILE GROIN CONSTRUCTION REACH 6A

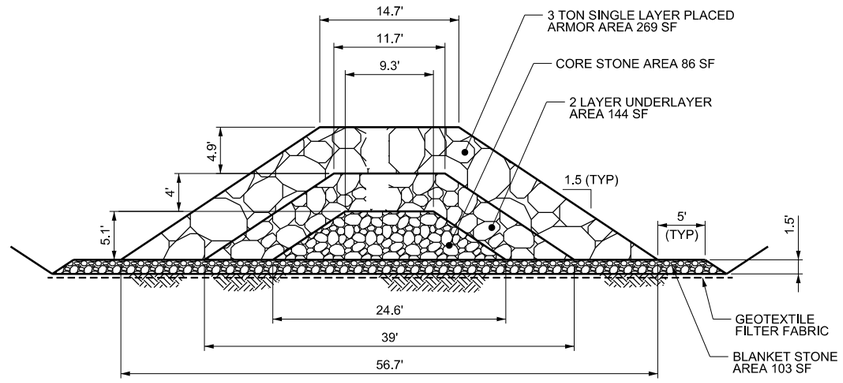
SHEET ID
CS-409
SHEET 35 OF 36



C2 SECTION - TYPICAL HSS

SCALE: 1/8"=1'-0"

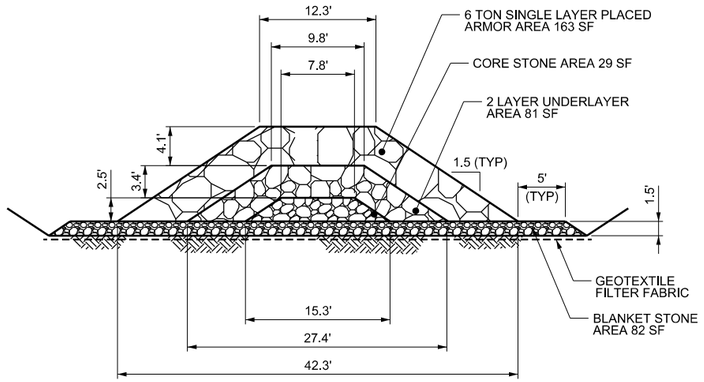
CS-407 TO CS-409



C2 SECTION - TYPICAL OS2

SCALE: 1/8"=1'-0"

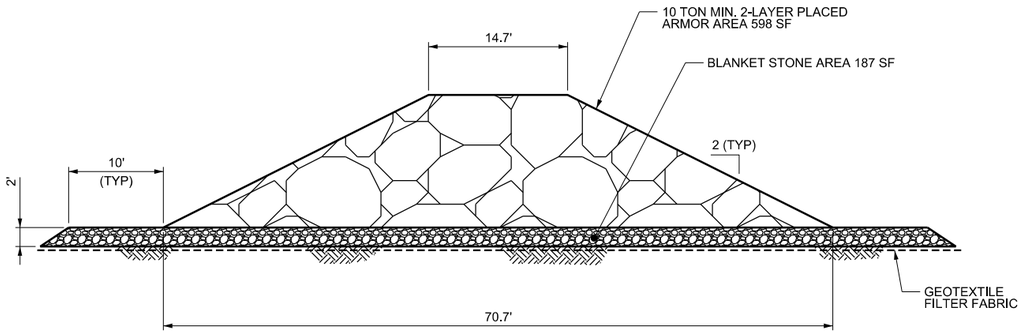
CS-407 TO CS-409



C2 SECTION - TYPICAL OS1

SCALE: 1/8"=1'-0"

CS-407 TO CS-409



C2 SECTION - TYPICAL HEAD

SCALE: 1/8"=1'-0"

CS-407 TO CS-409

PRELIMINARY
NOT FOR CONSTRUCTION

0 8' 16'

VERT. SCALE: 1/8"=1'-0"

0 8' 16'

HOR. SCALE: 1/8"=1'-0"

PATH: Q:\NY\9781-02\500_CADD_Active_GRR Report-App A1\

LAST PLOTTED BY: mestimable 12/3/2018 1:19:29 PM FILE: W912DS_A1_CS-410.dgn

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A1.C	12.05.18	MK
D	DRAFT FINAL GRR-APPENDIX A1.C	11.19.18	MK
C	DRAFT FINAL GRR-APPENDIX A1.C	08.30.18	MK
B	DRAFT FINAL GRR-APPENDIX A1.C	08.20.18	MK
A	DRAFT FINAL GRR-APPENDIX A1.B	07.19.18	MK

US Army Corps of Engineers®

DESIGNED BY: RWH
DRWN BY: ME
SUBMITTED BY: SA
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MK
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: 1:1.0000
PLOT DATE: 12/3/2018
FILE NUMBER:
FILE NAME: W912DS_A1_CS-410.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL
RE-EVALUATION REPORT AND ENVIRONMENTAL
IMPACT STATEMENT

TYPICAL SECTIONS
GROIN CONSTRUCTION REACH 6A

SHEET ID
CS-410
SHEET 36 OF 36

US Army Corps of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix A2

Jamaica Bay High Frequency Flood Risk Reduction Features Engineering and Design Appendix

December 2018

TABLE OF CONTENTS

LIST OF ACRONYMS 7
1 PROJECT DESCRIPTION 9
1.1 Overview of Engineering and Design Appendix 9
1.2 Project Background 9
1.3 Report Organization 10
2 RISK ASSESSMENT 11
2.1 Introduction 11
2.2 Mapping Areas at Risk 11
2.2.1 Stage Frequency Curves for Jamaica Bay 11
2.2.2 Projected Sea Level Change 13
2.2.3 Existing Ground Elevations 14
2.2.4 Methodology for Mapping Flood Extents 15
2.3 Selection of Flood Frequency for HFFRRF Study 17
2.4 Assets at Risk 19
3 DESIGN BASIS 22
3.1 General 22
3.1.1 Vertical and Horizontal Datum 22
3.1.2 Bathymetry, Topography and Shoreline Elevation 22
3.2 Coastal Engineering 22
3.2.1 Water Levels 22
3.2.2 Waves 23
3.3 Rainfall Run-off and Interior Drainage Considerations 25
3.4 Structural Engineering 25
3.4.1 Design Basis References 25
3.4.2 Design Elevations 26
3.4.3 Geometric Considerations 26
3.4.4 Material Unit Weights 27
3.4.5 Material Specifications 27
3.4.6 Design Loads 28
3.4.7 Stability Analysis for Gravity Structures 28
3.4.8 Geotechnical Considerations 29
3.4.9 Structural Conditions 29
3.5 Easements 29
4 HIGH FREQUENCY FLOOD RISK REDUCTION FEATURES 31
4.1 Development of Project Features 31

4.1.1 Development of Generic HFFRR-Features 31
4.1.2 Existing Shoreline Considerations 32
4.2 Low Floodwall, Medium Floodwall and High Floodwall 33
4.3 Low Berm, Medium Berm and High Berm 36
4.4 Shallow Bulkhead and Deep Bulkhead 38
4.4.1 Bulkhead Design 38
4.4.2 Bulkhead for Urban Application 41
4.4.3 Street End Bulkhead 42
4.5 Revetment with Floodwall 43
4.6 Vehicular Gate 45
4.7 Road Raising 46
4.8 Breakwater 46
4.9 In Water Gates and Related Structures 47
4.10 Hybrid Berm 47
4.11 Road Ramp 48
4.12 Natural and Nature Based Features (NNBF) 49
4.12.1 Natural and Nature Based Features (NNBF) – Phase 1 49
4.12.2 Natural and Nature Based Features (NNBF) – Phase 2 53
4.13 Drainage Features 54
4.13.1 Phase 1 Drainage Features 54
4.13.2 Phase 2 Drainage Features 56
5 PHASE 1 PROJECT SCREENING 57
5.1 Phase 1 Projects 57
5.1.1 Introduction 57
5.1.2 HFFRRF Projects for Jamaica Bay 59
5.2 Phase 1 Project Costs 65
5.3 Preliminary Screening of the HFFRRF Project Alternatives 66
5.4 Phase 1 Project Screening Synopsis 70
6 PHASE 2 PROJECT SCREENING 71
6.1 Introduction 71
6.2 HFFRRF Phase 2 Projects 73
6.2.1 Phase 2 Project Refinement and Interior Drainage 73
6.2.2 Phase 2 Project Descriptions 73
6.2.3 Habitat Restoration and Enhancement to Offset Permanent Impacts 79
6.3 Phase 2 Project Costs 80
6.4 Final Screening of HFFRRF Projects 81

6.5 Phase 2 Synopsis 82
6.5.1 Phase 2 Screening 82
6.5.2 Phase 2 Projects Selected 83
7 THE RECOMMENDED PLAN FOR JAMAICA BAY 84
7.1 The Recommended Plan 84
7.1.1 Mid-Rockaway Backbay with NNBFs 85
7.1.2 Cedarhurst-Lawrence 91
7.2 Quantities and Cost 91
7.3 Construction Schedule 92
7.4 Recommendations for PED 93
7.4.1 Component Revisions and Analyses 93
7.4.2 Recommended PED Analyses 96
REFERENCES 98
A. SUB-APPENDIX A2-A: HFFRRF PHASE 1 PROJECTS AND PROJECT MAPS 1
B. SUB-APPENDIX A2-B: HFFRRF PHASE 2 PROJECTS AND PROJECT MAPS 1
C. SUB-APPENDIX A2-C: HFFRRF SCREENING LEVEL COST ESTIMATES SUPPORTING DATA 1
D. SUB-APPENDIX A2-D: PHASE 2 WAVE MODELING FOR DESIGN BASIS UPDATE. 1
E. SUB-APPENDIX A2-E: INTERIOR DRAINAGE APPENDIX 1
F. SUB-APPENDIX A2-F: PLANS AND SECTIONS FOR THE RECOMMENDED PLAN FOR JAMAICA BAY 1

LIST OF TABLES

Table 2-1: Total Stage Frequency Elevations (ft, NAVD) based on FEMA* (2014) 12
Table 2-2: Total Stage Frequency Elevations (ft, NAVD88) based on FEMA* (year 2014) updated for 2068 MSL 14
Table 2-3: Count of Critical Infrastructure facilities within calculated flood extents for the Jamaica Bay HFFRRF Study Area 19
Table 2-4: Miles of Critical Infrastructure facilities within calculated flood extents for the Jamaica Bay HFFRRF Study Area 21
Table 3-1: Material Unit Weights 27
Table 3-2: Minimum Factors of Safety or Resultant Location Limits (EM 1110-2-2502) 29
Table 3-3: Easement Limits 30
Table 4-1: Feature Type Inclusion per Phase 32
Table 4-2: Existing shoreline features and general applicability of HFFRRF 33
Table 5-1: HFFRRF Phase 1 Projects 61

Table 5-2: Total Preliminary Project Cost for All Projects without and with inclusion if Natural and Nature Based Features—used for Preliminary Screening....66
Table 5-3: Phase 1 Screening Results. Benefits and Costs in 1,000 of Dollars....68
Table 6-1: HFFRRF Phase 2 Projects....74
Table 6-2: Interior Drainage Infrastructure for Phase 2 HFFRRF Projects....77
Table 6-3: Habitat Created for Mid-Rockaway Backbay with NNBFs in acres....80
Table 6-4: Total Project Cost for Phase 2 Projects with inclusion of Natural and Nature Based Features—used for Final Screening....80
Table 6-5: Phase 2 Screening Results....82
Table 7-1: MII Estimate Recommended Plan – HFFRRF for Jamaica Bay....92
Table A-1: Phase 1 Project Descriptions....1
Table B-1: Phase 2 Reach by Reach Project Data....1
Table D-2: Summary of required sill-crest elevation to meet transmitted wave-height target for NNBFs under different scenarios....13

LIST OF FIGURES

Figure 2-1: Location of output point CDM110 (also referred to as FIMP Station 61, FEMA at CDM Station 110 or NACCS Station 3992)....13
Figure 2-2: Map showing LiDAR Elevations extracted for Hammels vicinity, Rockaway....15
Figure 2-3: Flowchart illustrating methodology used for mapping flood extents for Jamaica Bay HFFRRF Study....17
Figure 2-4: Future 33%, 20% and 10% AEP (year 2068) Stage Flood Extents for Jamaica Bay HFFRRF Study Area....18
Figure 3-1: Distribution of 20% AEP (5-year RP) wave-height across Jamaica Bay....24
Figure 4-1: Low Floodwall Cross-Section....34
Figure 4-2: Medium Floodwall Cross-Section....35
Figure 4-3: High Floodwall Cross-Section....35
Figure 4-4: Typical Berm....36
Figure 4-5: Low Berm Cross-Section....37
Figure 4-6: Medium Berm Cross-Section....37
Figure 4-7: High Berm Cross-Section....37
Figure 4-8: Bulkhead at South 5th Street Brooklyn, NY....39
Figure 4-9: Shallow Bulkhead Cross-Section....40
Figure 4-10: Deep Bulkhead Cross-Section....41
Figure 4-11: Broad Channel Street End Bulkhead Typical Plan and Section (taken from DDC Project ID-HWQ1182A for illustrative purposes only)....42

Figure 4-12: Street End Bulkhead Cross-Section (typical section taken from DDC Project ID-HWQ1182A for illustrative purposes only) 43
Figure 4-13: Revetment Hunters Point, NY (photo credit: Nicole Avella) 44
Figure 4-14: Revetment with Floodwall Cross-Section 45
Figure 4-15: Road Raising Cross-Section 46
Figure 4-16: Breakwater Cross-Section 47
Figure 4-17: Hybrid Berm Cross-Section 48
Figure 4-18: Rock Sill and Wetland as NNBF in Brooklyn Bridge Park, Brooklyn, NY 49
Figure 4-19: NNBF Feature Type 1A, 1B, 2A and 2B Cross-Sections 53
Figure 5-1: Jamaica Bay Inundation Extents for the 20% AEP chance flooding (5-year RP) for the year 2068 and the areas of interest where HFFRRF Projects are developed 58
Figure 6-1: Jamaica Bay Inundation Extents for the 20% AEP chance flooding (5-year RP) for the year 2068 and the four (4) project areas for Phase 2 analysis. 72
Figure 7-1: Mid-Rockaway Backbay with NNBFs – Hammels Vicinity 87
Figure 7-2: Mid-Rockaway Backbay with NNBFs – Arverne Vicinity 88
Figure 7-3: Mid-Rockaway Backbay with NNBFs – Edgemere Vicinity 89
Figure 7-4: Cedarhurst-Lawrence 90
Figure 7-5: Schematic overview of the construction schedule for the Jamaica Bay Reach of the Recommended Plan 92
Figure 7-6: Graphic Presentation of Adaptability of HFFRF Projects 95
Figure D-1: NOAA High-resolution DEM in Jamaica Bay Study Area 2
Figure D-2: 1-D wave model transect locations for refinement of Design Wave condition 4
Figure D-3: Overview of wave model output showing predicted wave-heights 5
Figure D-4: Transect elevation profiles showing 1-D model wave-height transformation 6
Figure D-5: Transect elevation profiles showing 1-D model wave-height transformation 7
Figure D-6: Transect elevation profiles showing 1-D model wave-height transformation 8
Figure D-7: Transect elevation profiles showing 1-D model wave-height transformation 9
Figure D-8: Updated wave-heights at HFFRRF alignments using 1-D wave model to transform NACCS data 10
Figure D-9: Typical NNBF section 11
Figure D-10: Location of NNBF wave model transects 12
Figure D-11: 1-D model wave-height transformation across NNBFs 14

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Engineering Appendix A2

Jamaica Bay High Frequency Flood Risk Reduction Features (HFFRRF)

LIST OF ACRONYMS

AASHTO	American Association of State Highway Transportation Officials
ACES	Automated Coastal Engineering System
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BOD	Basis of Design
CPT	Cone Penetration Test
CY	Cubic Yards
DDR	Design Documentation Report
E&D	Engineering & Design
EL.	Elevation
EM	Engineering Manual
ETL	Engineering Technical Letter
ER	Engineering Regulation
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
FS	Factor of Safety
FWOP	Future Without Project
FWP	Future With Project
FWS	Fish and Wildlife Service
GIWW	Gulf Intracoastal Waterway
HAT	Highest Astronomical Tide
HSDRRS	Hurricane Storm Damage Risk Reduction System
ITR	Independent Technical Review
ISO	International Standards Organization
LAT	Lowest Astronomical Tide
MHHW	Mean Higher-High Water
MHW	Mean High Water
MSL	Mean Sea Level
MLW	Mean Low Water
MLLW	Mean Lower-Low Water
NACCS	North Atlantic Comprehensive Study
NAN	USACE New York District
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
O&M	Operation and Maintenance
PED	Pre-Construction Engineering and Design

QA	Quality Assurance
OSHA	US Department of Labor, Occupational Safety and Health Administration
RSLR	Relative Sea Level Rise
Rev	Revision
RSLR	Relative Sea Level Rise
ROW	Right of Way
SLR	Sea Level Rise
SPT	Standard Penetration Test
TOW	Top of Wall
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

1 PROJECT DESCRIPTION

1.1 Overview of Engineering and Design Appendix

This Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet Hurricane Sandy General Revaluation Report Engineering Appendix summarizes the multiple models and analyses applied to evaluate and compare alternative features for each planning reach within the study area. Since each planning reach is exposed to different risk mechanisms while they must collectively function as a system, the engineering appendices document the evaluation process in separate sub appendices which detail the specific analyses applied to confirm the recommended plan is engineering-wise feasible, complete and economically justified.

The USACE transition to SMART Planning is another reason why sub-appendices are included within the study document. The initial study was initially limited to the Atlantic Ocean Shoreline Planning Reach and was conducted as a legacy study. The engineering analyses were conducted to satisfy a more rigorous design level and the Atlantic Ocean shorefront summary engineering documents were written to satisfy those study requirements. The Jamaica Bay Planning Reach analysis was added following Hurricane Sandy and was conducted to broaden the recommended plan to the entire authorized study area and was conducted under SMART planning guidelines.

SMART planning documents propose a 10% design, documentation of risks and efforts to mitigate risks, and decisions made to expedite the opportunity for public and agency comment on the recommendation. More detailed design decisions are generally deferred to the Planning, Engineering and Design phase.

This Engineering & Design Appendix provides an overview of the analyses supporting the development of the High Frequency Flood Risk Reduction Features (HFFRRF) for Jamaica Bay. This appendix furthermore describes the development of HFFRRF Projects and a screening analysis of these projects to establish a viable plan to mitigate high frequency flood risk for Jamaica Bay.

1.2 Project Background

As a result of the Agency Decision Milestone (ADM), the storm surge barrier for the Jamaica Bay component of the previous Tentatively Selected Plan (see Draft General Reevaluation Report/Environmental Impact Statement (GRR/EIS) USACE-NAN (2016)), was moved into the New York - New Jersey Harbor and Tributaries Coastal Storm Risk Management Feasibility Study for further study and possible recommendation. Without the barrier, the communities surrounding Jamaica Bay still experience substantial risk of coastal flooding. Therefore, the study team sought to identify stand-alone features that could complement a potential future storm surge barrier, but also be economically justified on their own. Residents in many parts of the Jamaica Bay vicinity experience flooding due to high storm tides that occur relatively frequently. Since the proposed storm surge barrier would not be closed at every high tide, there is an opportunity to recommend

features to mitigate flood risk in high frequency tidal flooding events in which the proposed storm surge barrier would remain open.

1.3 Report Organization

In accordance with USACE's SMART Planning principles, the HFFRRF projects were developed at a level of detail required to make the decision at hand. Due to the large geographical area, complexities associated with civil work designs in highly developed urban areas, and the potential interaction between the design of perimeter flood risk reduction alignments and interior drainage infrastructure, a two-phased approach was developed. A two-phased approach facilitates a systematic, yet efficient methodology to screen HFFRRF project alternatives. Phase 1 included project definitions, HFFRR-Feature designs and establishing project alignments; a detailed drainage analysis and an assessment of the real estate cost were deferred to a later phase. This approach allowed the Project Delivery Team (PDT) to establish project construction cost and project benefits for a large number of projects and complete a first round of screening based on Benefit Cost Ratios (BCRs). In Phase 2, the Phase 1 projects were further refined, and a detailed drainage analysis and an assessment of the real estate cost was included. As such, a two-tier screening approach was established where the time consuming and resource intensive interior drainage analysis was completed only for the viable projects that passed to Phase 2.

This appendix includes a description of the risk assessment (Chapter 2) and a basis of design (Chapter 3) for the development of the flood risk reduction features. All features used within this study are described in Chapter 4. The development of the projects and first phase of screening are summarized Chapter 5, while the second and final screening phases are summarized in Chapter 6. Complete overviews of all "Phase 1" and "Phase 2" HFFRRF projects are included in Sub-Appendix A and B respectively. Chapter 7 summarizes the HFFRRF Projects for Jamaica Bay that are part of the Recommended Plan.

2 RISK ASSESSMENT

2.1 Introduction

The starting point for the development of the *high-frequency flood risk reduction features* (HFFRRFs) for Jamaica Bay was to identify areas most at risk of coastal flooding due to storm events and projected sea level change. This involved the creation of maps that showed potential flooded areas corresponding to different storm surge magnitudes and future levels of risk in the Project Study Area, which includes the entire main land perimeter of Jamaica Bay, west of Alternative 1-E barrier alignment. The Study Area includes parts of Kings, Queens, and Nassau counties in Long Island, NY. The features developed for the project areas identified as high risk are designed to reduce flood risk for these low lying coastal areas during relatively high frequency flooding events when the proposed storm surge barrier at the Rockaway Inlet entrance to Jamaica Bay might not be utilized.

To this end, a methodology was developed to identify areas susceptible to coastal flooding at different future stage frequencies. Based on the level of flooding, and the length of shoreline that would need to be protected to mitigate the effects of flooding at a given stage frequency, a design flood frequency was selected for the HFFRRF for Jamaica Bay that would result in a manageable number of project features over the Study Area. Analysis of each HFFRRF must show that the design is cost effective in order to be recommended (i.e. the benefit to the nation must exceed the cost).

2.2 Mapping Areas at Risk

2.2.1 Stage Frequency Curves for Jamaica Bay

Flooding in the Jamaica Bay area is caused by a combination of astronomical tide and storm induced water-level rise. The storm induced water-level rise is caused by a combination of the wind induced shear stresses, decreasing atmospheric pressure, and storm waves raising water-levels along the shore. The water-level rise due to the former two effects is defined as storm surge, and together with astronomical tide level is called the total stage. The FEMA (2014) analysis was used as the basis for estimating expected stage elevations for this study, for sake of consistency with the Jamaica Bay Planning Reach Reformulation Study (USACE, 2016).

FEMA conducted coastal flood studies to analyze storm surge using ADCIRC (ADvanced CIRCulation) model in conjunction with SWAN (Simulating WAves Nearshore model). The combined modeling also accounted for the increase in stillwater level caused by the waves breaking in the nearshore, which is called ‘wave setup’. This analysis produces the total stage elevations for the 1% annual chance flood event, or 1% annual exceedance probability (AEP) and are spatially variable. The FEMA (2014) modeling analysis led to the calculation of stage frequency statistics at several output points within the computational domain. The total stage

elevations for the 20, 10, 5, 2, and 1% annual chance flooding- including the effects of wave setup- were gathered from the FEMA (2014) modeling analysis for model computational points within the Project Study area to establish a total stage frequency curve at each point. These stage elevations however do not take into account all effects from waves coming ashore during storm events such as wave runup and wave heights, which are accounted for separately.

The FEMA stage elevations are computed with respect to the Mean Sea Level (MSL) of the current NOAA tidal epoch[1], which is 1982-2001. These elevations were updated to the present sea levels by adding the observed change in sea level at Sandy Hook, NJ from the middle of the tidal epoch, 1992 to 2018.

Two NOAA gages are available near the Project site; the Battery and Sandy Hook. Both gages are similar distances from the project site, i.e. approximately 12-15 miles. However, the Sandy Hook gage and the project area are more similar geologically as they are located in the Coastal Plain geologic formation, whereas the Battery gage is located on different geologic formations. Land subsidence is estimated at -2.17 mm/yr and -1.22 mm/yr at the Sandy Hook and Battery gages respectively. For comparison, Montauk Point, at the eastern end of Long Island, has an estimated vertical land movement of -1.23 mm/ yr (NOAA 2013). Direct estimates of vertical land subsidence for the project area are unavailable. Regionally, sea level rise for New York, Connecticut, and New Jersey ranges from 2.10 mm/yr at New London, CT to 3.97 mm/yr at Atlantic City, NJ, with Sandy Hook at 3.85 mm/yr (Gornitz at al. 2002). The Sandy Hook gage was chosen to represent sea level rise at the project site as the most appropriate available gage.

Historic information and local MSL trends used for the study area are provided by the NOAA/NOS Center for Operational Oceanographic Products and Services (CO-OPS) using the tidal gauge at Sandy Hook, New Jersey. This results in a correction of +0.34 ft to the stage elevations from FEMA. The final stage frequency curve at an example location within Jamaica Bay is presented in Table 2-1. The location of this point is shown in Figure 2-1.

Table 2-1: Total Stage Frequency Elevations (ft, NAVD[2]) based on FEMA* (2014)

Return Period[3] (years)	AEP (%)	Elevation based on year 1992 datum* (ft, MSL)	Elevation based on year 1992 datum* (ft, NAVD88)	Elevation based on year 2018 datum* (ft, NAVD88)
5	20	5.5	5.27	5.61
10	10	6.6	6.37	6.71
20	5	7.6	7.37	7.71
50	2	8.8	8.57	8.91
100	1	9.8	9.57	9.91

* FIMP Station 61, CDM Station 110, FEMA at CDM Station 110, NACCS Station 3992

[1] The 19-year period over which sea level observations are taken and reduced to obtain mean values for datum definition.

[2] North American Vertical Datum

[3] Return Period (RP) is the average number of years expected between occurrences of storms of the same severity.

Figure 2-1: Location of output point CDM110 (also referred to as FIMP Station 61, FEMA at CDM Station 110 or NACCS Station 3992)

2.2.2 Projected Sea Level Change

The projected sea level change estimates the change in the mean level of the bay on the scale of decades. Several factors could contribute to long-term change in mean sea levels. Eustatic sea level rise is an increase in global average sea level brought about by an increase to the volume of the world's oceans (thermal expansion). Relative sea level rise takes into consideration the eustatic increases in sea level, as well as local land movements of subsidence or lifting, and other local effects due to regional ocean dynamics.

The current guidance (ER 1100-2-8162) from the Corps states that proposed alternatives should be formulated and evaluated for a range of possible future local relative sea level rise rates. The relative sea level change (RSLC) rates shall consider as a minimum a low rate based on an extrapolation of the historic rate, and intermediate and high rates which include future acceleration of the eustatic sea level rise rate. The relative sea level change was calculated for the difference between the current project start date (year 2018), and the end of the 50 year project planning horizon (year 2068) per USACE ER 1100-2-8162. These rates of rise correspond to 0.65 feet, 1.1 feet, and 2.54 feet over 50 years (year 2018-year 2068) for the low, intermediate and high rates of relative sea level rise. The intermediate projection scenario of 1.1 feet of relative sea level rise between year 2018 and year 2068 has been used to define water-levels for this study at the end of project service life. This is consistent with the selection of the intermediate case sea level rise projection used for planning purposes in the Atlantic Shorefront Planning Reach of the Reformulation Study, as well as the Jamaica Bay Planning Reach (USACE, 2016).

A uniform relative rate of rise of 1.1 feet was applied to the spatially varying total stage calculated based on FEMA modeling in the previous section, to calculate 2068 water-levels corresponding to various annual chances of occurrence. Table 2-2 shows the updated stage frequency elevations for 2068 for same the location shown in Figure 2-1. Although the modeled water levels vary spatially within Jamaica Bay, this table is illustrative of the trends in present and future stage frequencies within Jamaica Bay. The annual probability of occurrence of a given stillwater elevation is found to approximately double between 2018 and 2068 due to the effect of the projected relative sea level rise during this period.

Table 2-2: Total Stage Frequency Elevations (ft, NAVD88) based on FEMA* (year 2014) updated for 2068 MSL

Return Period (years)	AEP (%)	Elevation based on year 1992* datum (ft, NAVD88)	Elevation based on year 2018* datum (ft, NAVD88)	Elevation including RSLC to year 2068 (ft, NAVD88)
3	33	4.07	4.41	5.51
5	20	5.27	5.61	6.71
10	10	6.37	6.71	7.81
20	5	7.37	7.71	8.81
50	2	8.57	8.91	10.01
100	1	9.57	9.91	11.01

* FIMP Station 61, CDM Station 110, FEMA at CDM Station 110, NACCS Station 3992

2.2.3 Existing Ground Elevations

Topographic data for New York City and Long Island based on LiDAR (Light Detection And Ranging) is available from USGS through NOAA's National Ocean Service. LiDAR surveys were most recently conducted in the Jamaica Bay area during March through April year 2014. The LiDAR measured surface elevations at an average post spacing of 0.7 meter or 2.3 feet. The elevation data was referenced to the NAVD88, GEOID12A vertical datum in metric units, and projected in horizontal coordinates of UTM, Zone 18, North American Datum of 1983 (year 2011), meters. The large extent of the survey data is broken up into smaller areas, with separate processed tiles of roughly 5,000 feet length available for download in LAZ format.

The LiDAR processing tiles in the study area were downloaded, and converted to raster images of 3-foot resolution to define existing ground elevations. Figure 2-2 shows the extracted elevations for the Hammels vicinity on the Rockaway peninsula.

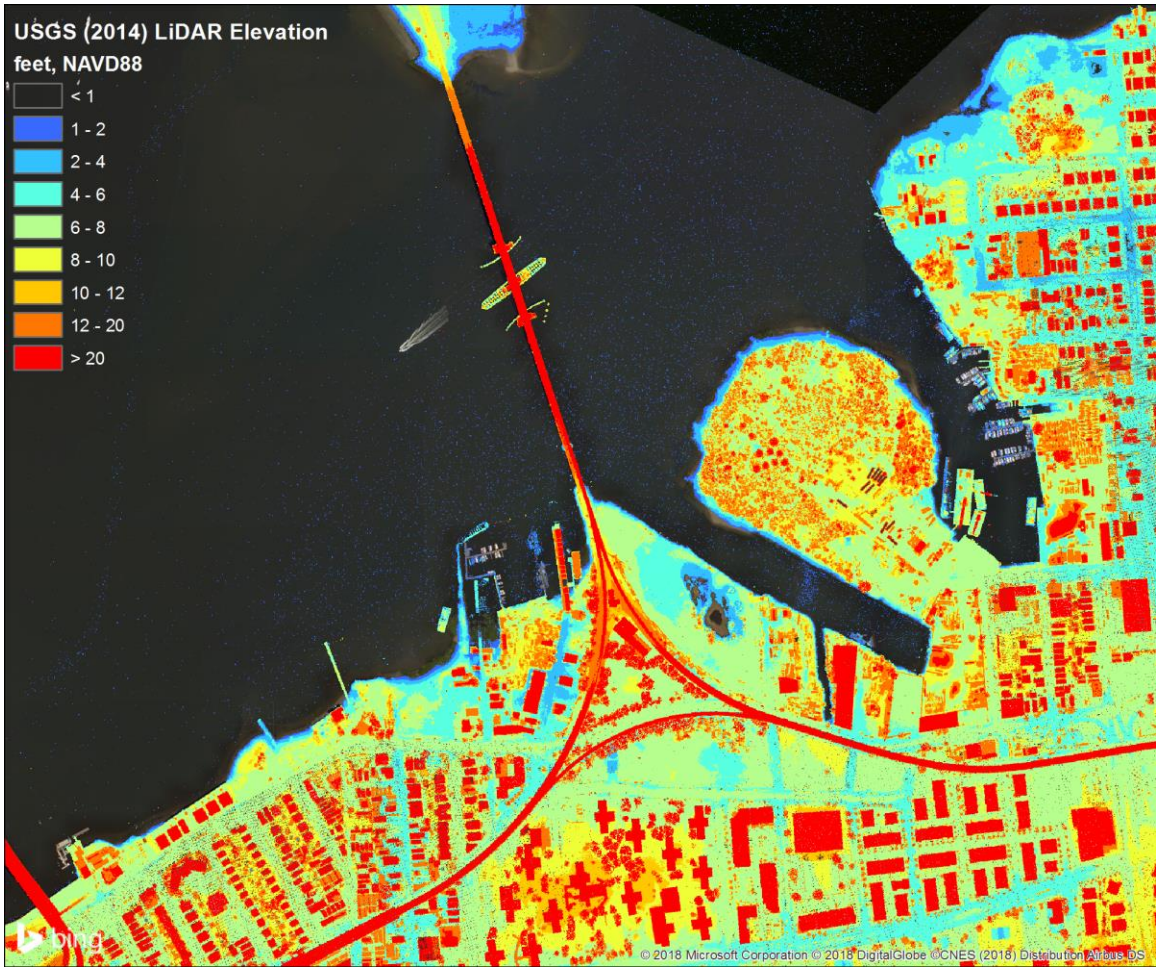


Figure 2-2: Map showing LiDAR Elevations extracted for Hammels vicinity, Rockaway

2.2.4 Methodology for Mapping Flood Extents

Areas at risk of future flooding due to tides, storm surge, wave setup, and projected sea level change, were mapped using a "bathtub" inundation analysis, which classifies coastal areas as flooded if their existing ground elevation is lower than the flood stage elevation, and are hydrologically connected to the bay. The year 2014 LiDAR ground elevations were subtracted from the spatially varying flood stage elevations computed as described in the previous sections to calculate an approximate inundation depth, and areas connected to the Jamaica Bay intertidal area with positive inundation depth were aggregated into the overall flood extent. Figure 2-3 shows a flowchart that summarizes the procedure followed for the mapping of approximate flood extents for the Jamaica Bay HFFRRF Study area.

However, it is important to note several simplifying assumptions made in the mapping of approximate flood extents. This analysis does not account for changing frequency of storms in the future due to climate change or other factors. It also does not account for any possible future

changes in local bathymetry, shoreline, or topography. Moreover, the inundation analysis in relying mostly on the stage elevations along the coastline, and it does not take into account several factors that might affect overland flow such as the duration of the storm, local land-use category, sub-surface drainage infrastructure, or presence of vegetation.

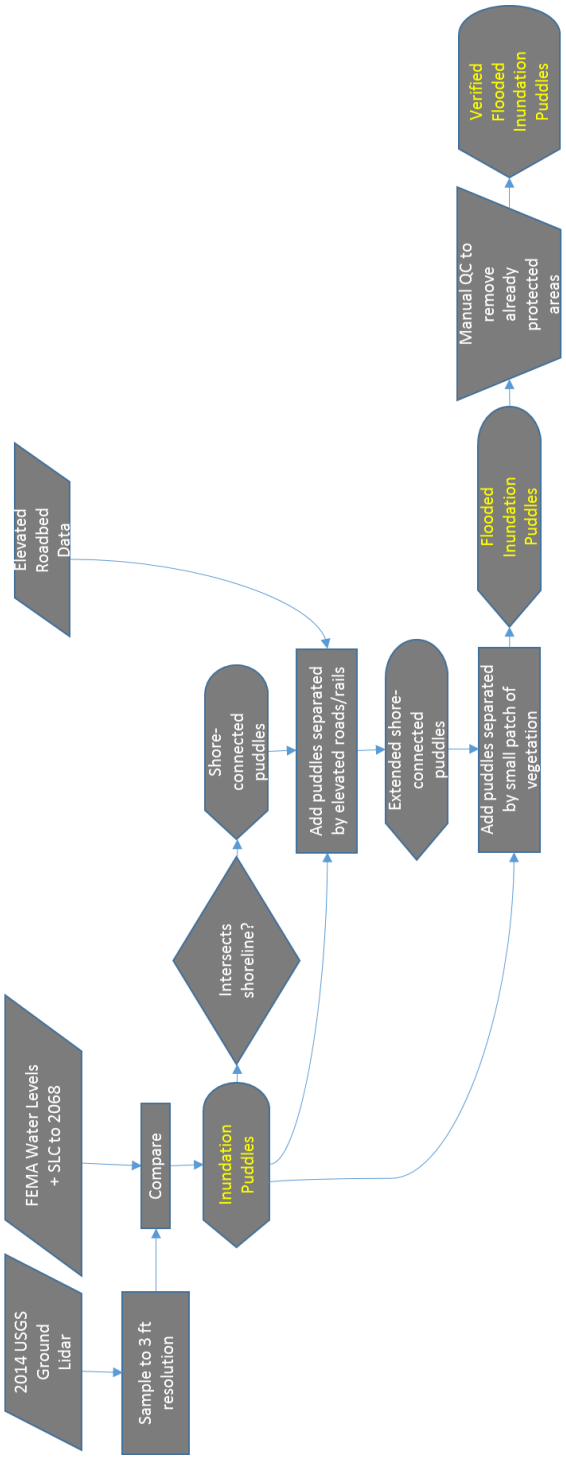


Figure 2-3: Flowchart illustrating methodology used for mapping flood extents for Jamaica Bay HFFRRF Study

2.3 Selection of Flood Frequency for HFFRRF Study

The flood extent mapping was performed starting with relatively lower stage elevations corresponding to a future 33% AEP (3-year RP) event in year 2068. The calculated flood extent map for such an event is shown in Figure 2-4. This shows relatively limited flooding, with mostly areas within the eastern Rockaway peninsula and Howard Beach and Canarsie neighborhood in Brooklyn being moderately affected. A similar flood extent map was calculated for approximately 1 foot higher stage elevations, corresponding to a future 20% AEP (5-year RP) event in year 2068. The corresponding flood extent map is also shown in Figure 2-4. In addition to the future 33% AEP (3-year RP) flood extent, this shows significantly higher flooding in Hammels, Arverne, and Edgemere neighborhoods of the Rockaway Peninsula, as well as increased flooding in the Five Towns area in Nassau County, and Broadchannel. The flood extents corresponding to even higher stage elevations corresponding to a future 10% AEP (10-year RP) event in year 2068 were also calculated as shown in Figure 2-4. This shows flooding occurring through most of the Jamaica Bay coastline of the Rockaway peninsula, as well as through most of Motts Creek into the Five Towns area of Nassau County. Providing effective risk reduction for such an event (10% AEP) would potentially require project features to be constructed along most of these coastlines, which were shown to be less efficient than operating the proposed tide gate at Rockaway Inlet.

In summary, flood extent maps were created for the Jamaica Bay side of the peninsula to assess the future year 2068 33%, 10% and 5% AEP floods - which are closely related to the current 20%, 10%, and 5% AEP floods (5, 10, and 20 year RP, respectively) floods. Inundation extents were analyzed to determine a tipping point of where significant flooding occurs. It is noted that the current 10% AEP showed significant flooding, as did the 5%, but that at the 5% the flooding was so extensive that it would require alignments more akin to the perimeter plan for Coastal Storm Risk Management (CSRM) (USACE-NAN, 2016). Since previously the barrier plan was already shown to be more cost effective than the perimeter plan and the HFFRRFs are meant to complement a potential future storm surge barrier and provide CSRM for the frequent flooding events for which the barrier would not be operated, thus the future 20% AEP flood frequency (5-year RP in year 2068) was selected as the flood frequency for the development of HFFRR features. The future 20% AEP (5 year RP in 2068), which amounts to a 10% AEP, or a 10 year RP in 2018 (see Table 2-2) incurs significant widespread flooding.

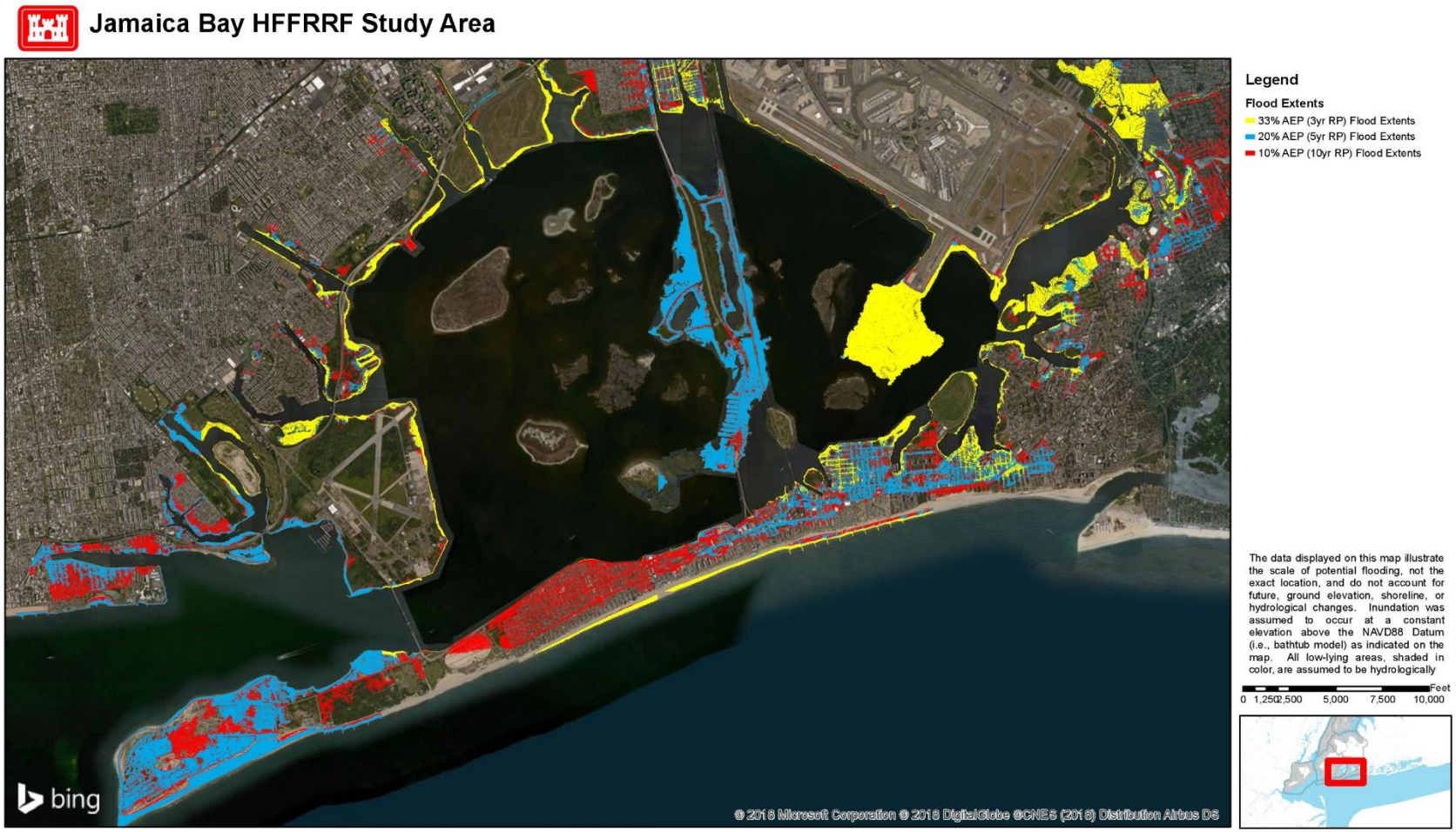


Figure 2-4: Future 33%, 20% and 10% AEP (year 2068) Stage Flood Extents for Jamaica Bay HFFRRF Study Area

2.4 Assets at Risk

The 20% AEP (5-year RP) flood frequency stage in year 2068 selected for the design of the HFFRR Features for Jamaica Bay affects over 75 miles of roads, and about 8,000 building footprints within the study area. For comparison, the 33% AEP (3-year RP) flood frequency affects about 16 miles of roads and 1,900 buildings, and the 10% AEP (10-year RP) flood frequency affects about 120 miles of roads and 14,000 buildings. These statistics are based on the road centerline and building footprints data from the NYC LION database and the Nassau County Five Towns study. Several of these assets serve as critical infrastructure systems for power, transportation, or emergency services.

Assets classified as Critical Infrastructure in the NY/NJ Harbor and Tributaries Study conducted by USACE were included in the computation of statistics of the critical infrastructure facilities within the Jamaica Bay HFFRRF Study Area. The Critical Infrastructure facilities were divided into several categories – namely, electrical, oil and gas, emergency/health, transportation, and education facilities. Geographic data on Critical Infrastructures under each category was obtained from the Homeland Infrastructure Foundation Level Database (HIFLD) available under the public domain from the U.S. Department of Homeland Security (DHS). Datasets not under the public domain, and available only with the proprietary Homeland Security Infrastructure Program (HSIP)-Gold license were not included in this analysis. Most of the datasets were represented as point features, which were considered to fall within a floodplain if the corresponding structure was within a 5 foot distance of a calculated flooded area. The count of such Critical Infrastructure facilities within each calculated flood-extent computed in the same manner is shown in Table 2-3. Other datasets such as oil pipelines, railroads, and tunnels were represented as line features, and the miles of such features intersecting flooded areas are shown in Table 2-4.

Table 2-3: Count of Critical Infrastructure facilities within calculated flood extents for the Jamaica Bay HFFRRF Study Area

Category	Type	Name	Source	In 33% AEP (3-year RP) Floodplain (Year 2068)	In 20% AEP (5-year RP) Floodplain (Year 2068)	In 10% AEP (10-year RP) Floodplain (Year 2068)
Electrical	Point	Electricity Generating Units	HIFLD	Duplicated in Electricity Power Generation Dataset		
	Point	Electricity Power Generation	HIFLD	0	0	0
	Point	Energy Distribution Contents Facilities	HSIP Gold			
	Point	Substations	HIFLD	1	2	5

Category	Type	Name	Source	In 33% AEP (3-year RP) Floodplain (Year 2068)	In 20% AEP (5-year RP) Floodplain (Year 2068)	In 10% AEP (10-year RP) Floodplain (Year 2068)
	Point	Nuclear Power Plants	HSIP Gold			
Gas Oil Port Facilities	Point	Natural Gas Compressor Stations	HIFLD	0	0	0
	Point	Natural Gas and Delivery Plant	HIFLD	0	0	0
	Point	Natural Gas Storage Facilities	HIFLD	0	0	0
	Point	Oil and Natural Gas Interconnects	HIFLD	0	0	0
	Point	Oil Refineries	HIFLD	0	0	0
	Point	Petroleum Pumping Stations	HIFLD	0	0	0
	Point	PCL Terminal, storage Facilities, Tanks and Farms	HSIP Gold			
	Line	Oil and Natural Gas Pipelines	HSIP Gold		N.A.	
Emergency Services	Point	Communication Centers (Cellular Towers)	HIFLD	0	0	0
	Point	Emergency Medical Service	HIFLD	3	5	8
	Point	Fire Stations	HIFLD	Duplicated in Emergency Medical Service Dataset		
	Point	Hospitals	HIFLD	0	0	0
	Point	Law Enforcement Location	HIFLD	1	2	4
	Point	Local Emergency Operations Centers	HIFLD	0	0	0
	Point	Historical Shelter System	HSIP Gold			
	Point	Nursing Homes	HIFLD	0	5	5
	Point	Waste Water Treatment Plants	HIFLD	0	1	1
Transport-ation	Point	Amtrak Station	HIFLD	0	0	0
	Point	Railroad Stations	HIFLD	Duplicated in Intermodal Terminal Facilities Dataset		

Category	Type	Name	Source	In 33% AEP (3-year RP) Floodplain (Year 2068)	In 20% AEP (5-year RP) Floodplain (Year 2068)	In 10% AEP (10-year RP) Floodplain (Year 2068)
	Point	Intermodal Terminal Facilities	HIFLD	0	6	7
	Point	Railroad Yards	HSIP Gold			
	Point	Road and Railroad Bridges	HIFLD	2	2	9
	Line	Road and Railroad Tunnels	HIFLD		N.A.	
	Line	Railroad	HIFLD		N.A.	
	Polygon	Airport Boundaries	HSIP Gold			
Education	Point	Public Schools	HIFLD	0	10	18
	Point	Private Schools	HIFLD	0	2	8
	Point	Day Care Centers	HIFLD	3	16	23
TOTAL				**10**	**51**	**88**

Table 2-4: Miles of Critical Infrastructure facilities within calculated flood extents for the Jamaica Bay HFFRRF Study Area

Category	Type	Name	Source	In 33% AEP (3-year RP) Flood Plain (Year 2068)	In 20% AEP (5-year RP) Flood Plain (Year 2068)	In 10% AEP (10-year RP) Flood Plain (Year 2068)
Gas Oil Port Facilities	Line	Oil and Natural Gas Pipelines	HSIP Gold			
Transport-ation	Line	Road and Railroad Tunnels	HIFLD	0	0	0
	Line	Railroads	HIFLD	2.0	4.2	5.9
TOTAL				**2.0**	**4.2**	**5.9**

3 DESIGN BASIS

3.1 General

Due to the fact that the shoreline conditions, e.g., natural, manmade, gradient, etc., vary throughout Jamaica Bay, a number of generalizations and assumptions were made to develop generic flood risk reduction features that could be applied at various locations. The following sections describe the development of a design basis for the HFFRRFs in Jamaica Bay.

3.1.1 Vertical and Horizontal Datum

Vertical elevations (EL.) of project components and features are referenced to the North American Datum of year 1988 (NAVD88), Geoid12A vertical reference system. All elevations throughout the report are referenced to NAVD88 Geoid12A and presented in feet unless otherwise stated.

The horizontal datum shall be the North American Datum of year 1983 (NAD83) Long Island, New York State Plane with units in feet, unless specifically noted otherwise.

3.1.2 Bathymetry, Topography and Shoreline Elevation

Bathymetric information was based on NOAA Navigation Charts (NOAA chart 12350, 12401, 12337, 12402, 12339, and 12366) and NOAA 1/9 arc-second DEMs available for Jamaica Bay as part of the NCEI Hurricane Sandy Digital Elevation Models. These DEMs integrate both bathymetric and topographic data at the coast.

High resolution topographic data was gathered from the post-Hurricane Sandy USGS LiDAR (https://lta.cr.usgs.gov/) imagery collected for New York City and Long Island between March, 2014 and April, 2014.

3.2 Coastal Engineering

3.2.1 Water Levels

Following the analysis described in Chapter 2, the stillwater levels corresponding to a 20% AEP, 5-year return period stage frequency on top of 2068 sea levels was used as the requirement for functional design of project features for HFFRR in Jamaica Bay. These stillwater elevations include the effects of tide, storm surge, and wave setup. The design water levels for function of the individual project features were determined based on nearest available FEMA (2014) model output, and updated to include the effects of sea level change as per USACE guidance as described in Section 2.2.2.

3.2.2 Waves

Wave conditions typically vary throughout Jamaica Bay. Depending on the project location, the project may be subject to ocean swell (e.g. Manhattan Beach), wind waves, ship waves (e.g. Beach Channel) or little to no wave energy (e.g. sheltered basins and canals).

3.2.2.1 Wave-Heights for Functional Design

Wave-heights along the shoreline of Jamaica Bay corresponding to different Annual Exceedance Probabilities (AEPs) were obtained from the USACE (2015) North Atlantic Comprehensive Coastal Study (NACCS) database. The analysis of extreme waves was conducted as part of the NACCS based on an STWAVE model for the North Atlantic Region. The NACCS simulations include 1,050 synthetic storms, and 100 historical storms. Expected significant wave-heights for the 20% AEP (5-year RP) were extracted from the database at 137 Save Points along the perimeter of Jamaica Bay shown in Figure 3-1. The data from the save points was applied to all of Jamaica Bay using Natural Neighbor interpolation.

However, for project features that are relatively sheltered or set back over 150 feet (approximately at least 3 wave-lengths) from the shoreline, the NACCS model wave-heights calculated at the shoreline might overstate the wave-heights likely to be observed at the feature location. For such locations, during Phase 1 of the screening analysis, a maximum design wave-height of one foot was applied. As part of Phase 2, the expected wave-heights were updated to account for wave transformation, and is documented in Sub-Appendix D.

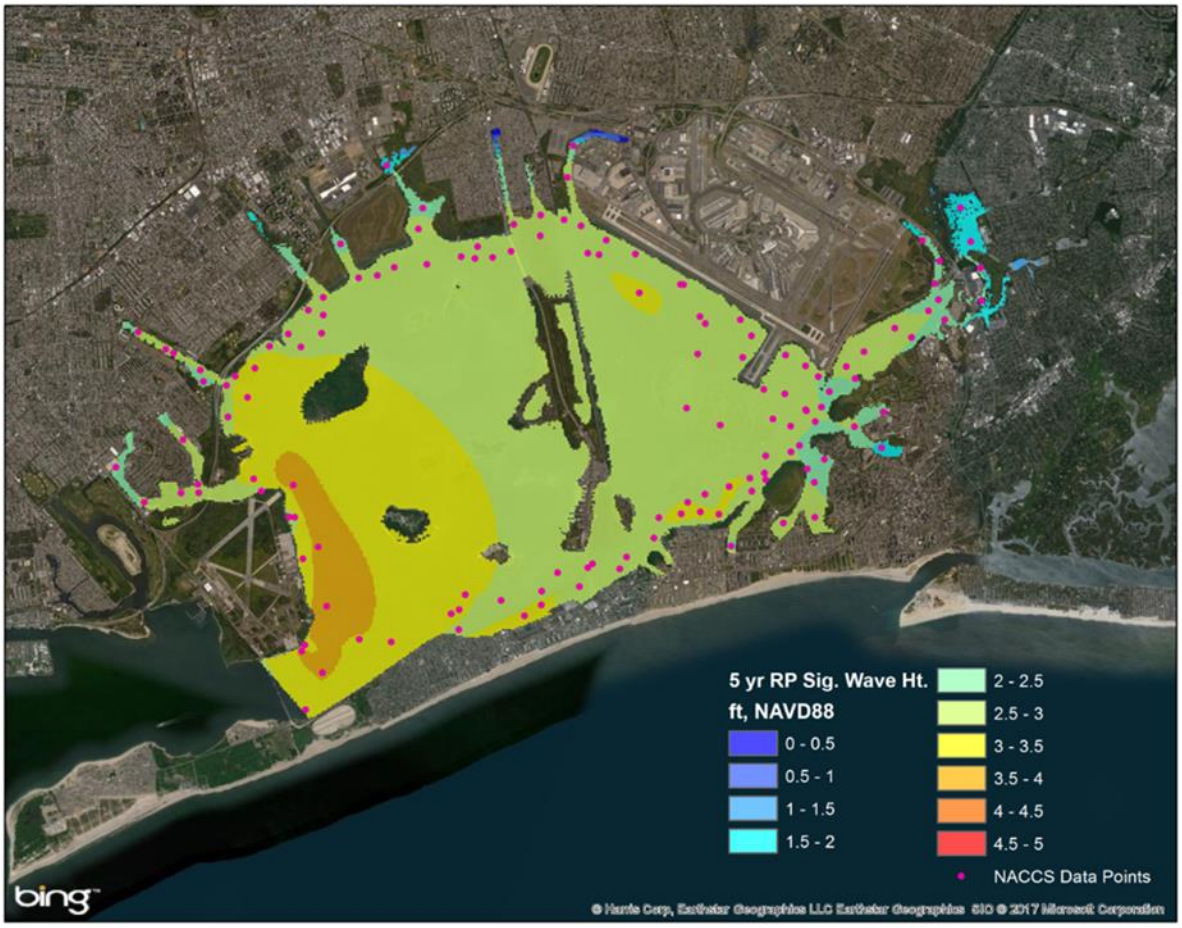


Figure 3-1: Distribution of 20% AEP (5-year RP) wave-height across Jamaica Bay.

Overtopping Criterion and Required Freeboard

Wave action superimposed with flood stage can generate significant overtopping of coastlines, potentially resulting in additional inundation of adjacent coastal areas. This would have implications for interior drainage infrastructure and the pump capacity requirements. A wave overtopping discharge of one liter per second per meter over about a thousand feet of shoreline would require a 50 cubic foot per second (cfs) discharge rate pump to provide drainage for additional inundation due to the overtopping. This requirement would increase should the wave overtopping discharge increases. Therefore, an overtopping threshold of one liter per second per meter was used to calculate freeboard requirements for features. The required wave freeboard was calculated for each project feature based on guidance in EurOtop II (2016) using the design wave-height at the project feature established as described previously.

3.2.2.2 Wave-Heights for Structural Design

For structural design or limit of feature failure, 100 year return period wave-heights were extracted for the Save Points within Jamaica Bay from the NACCS model database. The 100 year return

period wave condition corresponds approximately to a wave-height of about 3.5 feet and wave period of three seconds over most of Jamaica Bay, and this was selected as the design wave condition for the project features at the screening level of analysis.

Wave Forces

The wave forces on the project features were computed following the methodology developed by Goda (1974) as recommended in the USACE (2002) Coastal Engineering Manual, based on the selected 100 year design wave-height and wave period. The wave forces were computed for each project feature for several combinations of water level and wave-height, and the combination leading to the highest wave force on the structure was chosen as the design condition for that feature. The highest wave force on the feature typically occurs when the maximum design wave-height meets the crest elevation of the structure.

3.3 Rainfall Run-off and Interior Drainage Considerations

The preliminary screening was conducted on a design governed by the 20% AEP still water levels. Additional effort to assess interior drainage impacts and related costs, as well as real estate costs was undertaken in Phase 2 subsequent to the preliminary screening in Phase 1. For the preliminary screening, the definition of project alignments focused on smaller and more isolated flood prone areas. The preliminary screening level analysis was completed with the understanding that a detailed drainage assessment would be completed after the initial screening of HFFRRF Projects. This approach allowed the PDT to screen out non-viable HFFRRF alternatives without completing a resource intensive interior drainage analysis of all areas where HFFRRF project alternatives are defined. In other words, if a project did not pass the initial screening without a diligent analysis of interior drainage impacts, then it was screened out without further analysis since the additional interior drainage requirements would only further decrease the benefit to cost ratio.

3.4 Structural Engineering

3.4.1 Design Basis References

The following codes, references, and standards were used as a basis for the design of the HFFRRF:

1. American Association of State Highway and Transportation Officials (AASHTO). *Standard Specifications for Highway Bridges, 17th Edition.*
2. AASHTO. *Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Customary U.S. Units, 6th Edition.*
3. American Concrete Institute (ACI). *ACI 350-06 Code Requirements for Environmental Engineering Concrete Structures.*
4. ACI. *ACI 318-11 Building Code Requirements for Reinforced Concrete.*
5. American Institute of Steel Construction (AISC). *Manual of Steel Construction, Load and Resistance Factor Design (LRFD), 14th Edition.*

6. American Society of Civil Engineers (ASCE). *ASCE 24-14 Flood Resistant Design and Construction.*
7. ASCE. ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures.*
8. American Welding Society (AWS). *ANSI/ AWS D1.1-2010, Structural Welding Code – Steel.*
9. NYC Building Code (NYCBC), 2014.
10. United States Steel (USS). *U.S. Steel Sheet Piling Design Manual, 1984.*
11. United States Army Corps of Engineers (USACE). *HSDRRSDG Hurricane and Storm Damage Risk Reduction Design Guidelines with June 2012 updates.*
12. USACE. *Engineer Manual (EM) 1110-2-584 Hydraulic Steel Structures.*
13. USACE. *Engineer Manual (EM) 1110-2-1614, Design of Coastal Revetments, Seawalls and Bulkheads.*
14. USACE. *Engineer Manual (EM) 1110-2-2104 Strength Design for Reinforced Concrete Hydraulic Structures.*
15. USACE. *Engineer Manual (EM) 1110-2-2504 Design of Sheet Pile Walls.*
16. USACE. *Engineer Manual (EM) 1110-2-2906, Design of Pile Foundations.*
17. USACE. *Engineer Engineering Technical Letter (ETL) -1110-2-58, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, And Appurtenant Structures.*

3.4.2 Design Elevations

The design elevation of each HFFRRF is dependent on the site conditions and the feature type. The elevation of the top of flood risk reduction features is set to 20% AEP water level at the expected end of the project service life (year 2068), considering the overtopping criterion (threshold of 1 liter/s/m, see Section 3.2.2.)

While actual existing ground elevations vary around Jamaica Bay, general assumptions had to be made for the upland (protected side) ground elevation of the HFFRRF such that the feature designs were generic enough and implementable at various locations within the study area. The ground elevation at the shoreline in general varies between +3 feet NAVD88 and +7 feet NAVD88; the generic features designed for this study accommodate this variation.

3.4.3 Geometric Considerations

The HFFRRF were developed based on a range of generalized geometric considerations. These geometric considerations are necessary to ensure the proper function of, and safe access to, the HFFRRF. The geometric considerations for the HFFRRF project are listed below:

Access Ramp Slope (maximum): 10%

Patrol Road/Access Ramp Width – Single Lane (minimum / desirable): 12 feet / 16 feet

Patrol Road/Access Ramp Width – Two-Lanes (minimum / desirable): 24 feet / 32 feet

Living Shoreline Riparian Zone Width (minimum / desirable): 30 feet / 100 feet

Living Shoreline Riparian Zone Slope (minimum / desirable): 20h:1v / 50h:1v

Berm Crest Width (minimum/ desirable): 5 feet / 10 feet

Berm Front Slope (minimum/ desirable): 2h:1v / 3h:1v

Berm Back Slope (minimum/ desirable): 2h:1v / 3h:1v

Revetment Front Slope (minimum/ desirable): 2h:1v / 3h:1v

3.4.4 Material Unit Weights

The primary material unit weights for the HFFRRF include steel, concrete, water, riprap and granular fill. Unit weights are used to convert volume to weight in order to calculate the self-weight of the various features. The self-weights are then used in structural and stability calculations. The unit weights are also used to determine the costs of the structures. Material unit weights used for the project are listed in Table 3-1.

Table 3-1: Material Unit Weights

Material	Unit Weight (lbs/ft^3)
Steel	490
Concrete (normal weight)	150
Water (salt)	64
Riprap (armor, toe and underlayer stone)[4]	132
Fully-Compacted Granular Fill, **Total**	120

3.4.5 Material Specifications

Material specifications are used to ensure that the materials used will be uniform across the HFFRRF and of sufficient quality to ensure its proper function for the duration of the project service life. The following material specifications were used as the minimum parameters for the HFFRRF features. All materials shall be new and of the best quality of their respective kinds as described or if not stated, to be at least in accordance with the relevant American Society of Testing Materials (ASTM) Standards.

The followings are noted with respect to material specifications:

- Structural steel shall conform to – American Society for Testing and Materials specification (ASTM) A992 for wide flanges, A572 Grade 50 for other structural members.
- Steel sheeting, combi-wall systems and HP sections (HP 14X73, HP 14X89 etc.) shall conform to ASTM A690 or ASTM A572 Grade 50, steel pipe piles shall conform to ASTM A252 Grade 3 (50 ksi) or ASTM A572 Grade 50.

[4] Weight of riprap may vary based on the filling of the riprap voids over time.

- Steel reinforcement in concrete shall conform to ASTM A615, Grade 60.
- Reinforced concrete shall have a minimum 28-day compressive strength (f'c) of 4,000 psi, maximum water/cement ratio 0.40.
- Lean concrete shall have a minimum 28-day compressive strength (f'c) of 3,000 psi.
- Minimum cover to reinforcement for concrete exposed to marine environment shall be 4 inches.
- Structural steel members exposed to marine environment shall be coated or galvanized. Steel foundations in the water, such as steel sheeting and steel piles shall be coated with coal tar epoxy and include 1/16 in. corrosion allowance in wall thickness (5/16 in. minimum).

3.4.6 Design Loads

Design loads refers to the various types of forces that can reasonably be expected to act on the HFFRRF and are used in the structural design and stability analysis. The following design loads were used as the minimum criteria for the HFFRRF. The design codes, references, and standards are listed in Section 3.4.1 Design Basis References. The followings are used for design load calculations:

- Hydrostatic Loads – hydrostatic loads for the 100 year return period Design Storm Condition is based on the design storm stillwater levels (SWL) listed in the Section 3.4.1.
- Hydraulic & Wave Loads – hydrostatic loads for the 100 year return period Storm Conditions in Combination with the 100 year return period wave conditions.
- Vessel Impact – Not considered for feasibility (will be considered during PED).
- Debris Impact – Not considered for feasibility (will be considered during PED).
- Seismic Load – as per American Society of Civil Engineers standards (ASCE) 7-10 and The New York City Seismic Code.
- Wind Load – for structure Category IV, ASCE 7-10.
- Temperature – uniform change, 40°F drop and 30°F rise for moderate climate for both steel and concrete.
- Basic Load Combinations – as per Table 5.1 of Hurricane and Storm Damage Risk Reduction System Design Guidelines (HSDRRSDG) – see below for additional details.

3.4.7 Stability Analysis for Gravity Structures

A stability analysis was performed to ensure the HFFRRF would not fail due to instability. The three modes of instability are:

1) Sliding: The structure moving horizontally
2) Bearing: The structure sinks into the ground, caused by a lack of soil bearing capacity and/or an insufficient foundation design.

3) Resultant Location: The entire base must be in compression for the usual load condition to maintain full contact between the structure and the foundation. For storm conditions, 60% of the base shall be in compression.

The stability analysis follows United States Army Corps of Engineers (USACE) publications, minimum factors of safety and resultant location limit are provided in Table 3-2 below.

Table 3-2: Minimum Factors of Safety or Resultant Location Limits (EM 1110-2-2502)

	Sliding, Factor of Safety	Bearing, Factor of Safety	Resultant Location Limits
Operational Condition	1.5	3.0	100% of base in compression
Design Storm Condition	1.25	1.5	60% of base in compression

3.4.8 Geotechnical Considerations

Geotechnical considerations refer to the subsurface soil composition on which the HFFRRF will be built, i.e. bearing capacity, soil type, etc. No site specific geotechnical analysis was completed. In general, the structural analysis relied on the geotechnical analysis and data completed previously and reported in USACE-NAN 2016.

3.4.9 Structural Conditions

A coastal structures condition survey was not conducted. It is conservatively assumed that the majority of coastal structures, bulkheads, retaining walls, revetments etc., within the project areas are in poor condition, deteriorated, and are no longer functioning effectively. The majority of these structures are built on private property, and there is little evidence that the coastal structures are under periodic maintenance. The majority of these structures are built on private property, and there is little evidence that the coastal structures are under periodic maintenance. For the HFFRRF projects it is assumed that all existing coastal structures will be replaced and materials will be hauled offsite to a disposal facility.

3.5 Easements

In order to construct and then maintain the HFFRRF, USACE will require two easements: 1) Perpetual Flood Protection Levee Easement, 2) Temporary Work Area Easement. The Perpetual Flood Protection Levee Easement is based on guidance from ETL-1110-2-583 which details the requirements for vegetation free and vegetation managed zones. The Perpetual Flood Protection Levee Easement is furthermore based on USACE NAN project experience from projects within the region, as is the Temporary Work Area Easement. The Temporary Work Area Easement has

been established to allow for all construction, staging, grading, landscaping, and other construction-related activities. The Temporary Work Area Easement will remain active until final acceptance and contractor demobilization. The Perpetual Easement will be established to allow the HFFRRF structures to be inspected and maintained. It is permanent in nature and USACE will have the right to use the land within the easement lines. Given the close proximity to private property, additional refinement and site specific details will be required during the PED phase. Table 3-3 summarizes the Easement Limits.

Table 3-3: Easement Limits

	Perpetual Easement		Temporary Work Area Easement	
Feature Type	Flood Side [ft.]	Protected Side [ft.]	Flood Side [ft.]	Protected Side [ft.]
Low Floodwall	**18**	**15**	**25**	**25**
Medium Floodwall	**15**	**17**	**25**	**25**
High Floodwall	**15**	**19**	**25**	**25**
Low Berm	**28.5**	**39.5**	**30**	**40**
Medium Berm	**33.5**	**42.5**	**35**	**45**
High Berm	**43.5**	**54.5**	**45**	**55**
Hybrid Berm	**15**	**43**	**25**	**45**
Shallow Bulkhead	**17**	**15**	**25**	**15**
Deep Bulkhead	**18**	**15**	**25**	**15**
Revetment with Floodwall	**52**	**20**	**55**	**25**
In Water Gate	**18**	**15**	**25**	**25**

4 HIGH FREQUENCY FLOOD RISK REDUCTION FEATURES

4.1 Development of Project Features

4.1.1 Development of Generic HFFRR-Features

To generate project alternatives that would reduce the risk of flooding from high frequency storm events (i.e. the 20% AEP storm event in the year 2068), features that provide a flood risk reduction function were developed and designed. In accordance with USACE's SMART Planning principles, the features were prepared and developed at a level of detail required to make the decision at hand. Detailed design and analysis has progressed through the Feasibility Study and will be furthered in the Pre-Construction Engineering and Design (PED) Phase. As such, the two-tier screening approach detailed within this appendix resulted in a refinement of Phase 1 project features in Phase 2 and the development of additional HFFRRF to better match the site conditions of the Phase 2 projects. Generic features which are shared across both phases of the study include, among others, floodwalls, berms, bulkheads, and revetments. In conjunction with the flood risk reduction features, where erosion is a concern and the physical constraints of their locations are conducive, a series of Natural and Nature Based Features (NNBFs) were developed to control erosion and improve overall function and resilience of the HFFRRF. Especially for berms where NNBFs serve in the design as an integral engineering feature to the CSRM design in order to control erosion and help manage coastal flood risk.

In addition to the coastal flood risk reduction features, a series of drainage features were developed to be used in conjunction with the line of risk reduction. Drainage features are necessary to remove rain water runoff and overtopping stormwater from the protected side of the HFFRRF.

Apart from the generic HFFRRF described in this chapter, a few more specific feature designs were developed where required. Such features include a breakwater, in water gate structures, hybrid berm, road ramp, and road raising, amongst others. As certain Phase 1 project areas were screened out, some of the Phase 1 feature types were also screened out. A table detailing which feature types were included in the two phases of this study is shown below.

Table 4-1: Feature Type Inclusion per Phase

HFFRRF Type	Phase 1	Phase 2
Low Floodwall	√	√
Medium Floodwall	√	√
High Floodwall	√	√
Low Berm	√	√
Medium Berm		√
High Berm	√	√
Shallow Bulkhead	√	√
Shallow Bulkhead – Urban Application	√	√
Deep Bulkhead	√	√
Deep Bulkhead – Urban Application	√	
Street End Bulkhead	√	
Revetment with Floodwall	√	√
In Water Gate	√	
Hybrid Berm		√
Vehicular Gate	√	√
Road Ramp		√
Road Raising	√	
Breakwater	√	
NNBF	√	√
Drainage Features	√	√

4.1.2 Existing Shoreline Considerations

Existing shoreline features for all the project sites were assessed using publicly available satellite images. In general, the existing shoreline features were classified into the categories shown in Table 4-2. The potential for selection of the HFFRRF is partially informed by the existing conditions. This table presents the applicability of the generic measures by shoreline type. The design and variations of these features are informed on the existing shoreline type, shoreline condition, and land use. Typical application opportunities, constraints, and existing conditions were considered as well. A project alignment that reduces the risk of flooding consists of a series of adjoining HFFRRF. All features used within this study are described in the following sections.

Table 4-2: Existing shoreline features and general applicability of HFFRRF

	HFFRRF TYPE															
Existing Shoreline Features	Low Floodwall	Medium Floodwall	High Floodwall	Low Berm	Medium Berm	High Berm	Shallow Bulkhead	Shallow Bulkhead - Urban	Deep Bulkhead	Deep Bulkhead - Urban	Revetment with Floodwall	Natural and Nature Based Feature	Hybrid Berm	Vehicular Gate	Road Ramp	Road Raising
Natural Shoreline	√	√	√	√	√	√						√	√			
Revetment											√					
Bulkhead							√	√	√	√						
Parks or Wetlands	√			√	√	√						√	√			
Street End	√	√	√				√	√	√	√				√	√	√
Urban Waterfront Development	√	√	√				√	√	√	√				√	√	√
Industrial Waterfront Development	√	√	√				√	√	√	√				√	√	√

4.2 Low Floodwall, Medium Floodwall and High Floodwall

Floodwall systems are independent, single purpose structures that aim to provide flood protection. A floodwall is a reinforced concrete structure supported on steel H-piles. A steel sheet pile cut-off wall was provided for seepage control. Within the realm of providing risk reduction features to prevent inundation as a result of high frequency flooding, three types of prototypical floodwalls were designed and labeled “low,” “medium,” and “high.”

For the low floodwall design, the approximate existing ground elevation was assumed to be at El. 5 feet which is deemed appropriate for the typical site conditions. Note that there is no specific intent to significantly alter the existing upland ground elevations, however in order to provide a generic conceptual floodwall design generalizations were needed such that one prototypical design could be applicable at multiple locations. The L-shape reinforcement concrete structure terminates at El. 8 feet and is supported on the battered H-piles with the vertical steel sheet piles used as seepage control measure. A typical cross-section for the low floodwall is shown in Figure 4-1.

For the medium and high floodwall, the approximate existing ground elevations were assumed to be El. 5 feet and El. 3 feet and top of wall elevations were set at El. 10 feet and El. 11 feet, respectively. The reinforced concrete structure is shaped like an inverted "T" and is supported on pairs of vertical H-piles. Typical cross-sections for medium and high floodwall are shown in Figure 4-2 and Figure 4-3, respectively. Pile design depends on design loads and soil parameters. For this study, soil characteristics as described in Chapter 3 were used.

Due to the relatively small footprint, a floodwall is deemed suitable for flood-prone urban waterfront areas, both directly at the shoreline and farther inland, where there are no existing structures. It should be noted that flood-prone waterfront areas are likely to have poor soil conditions and require excavation and backfilling prior to construction.

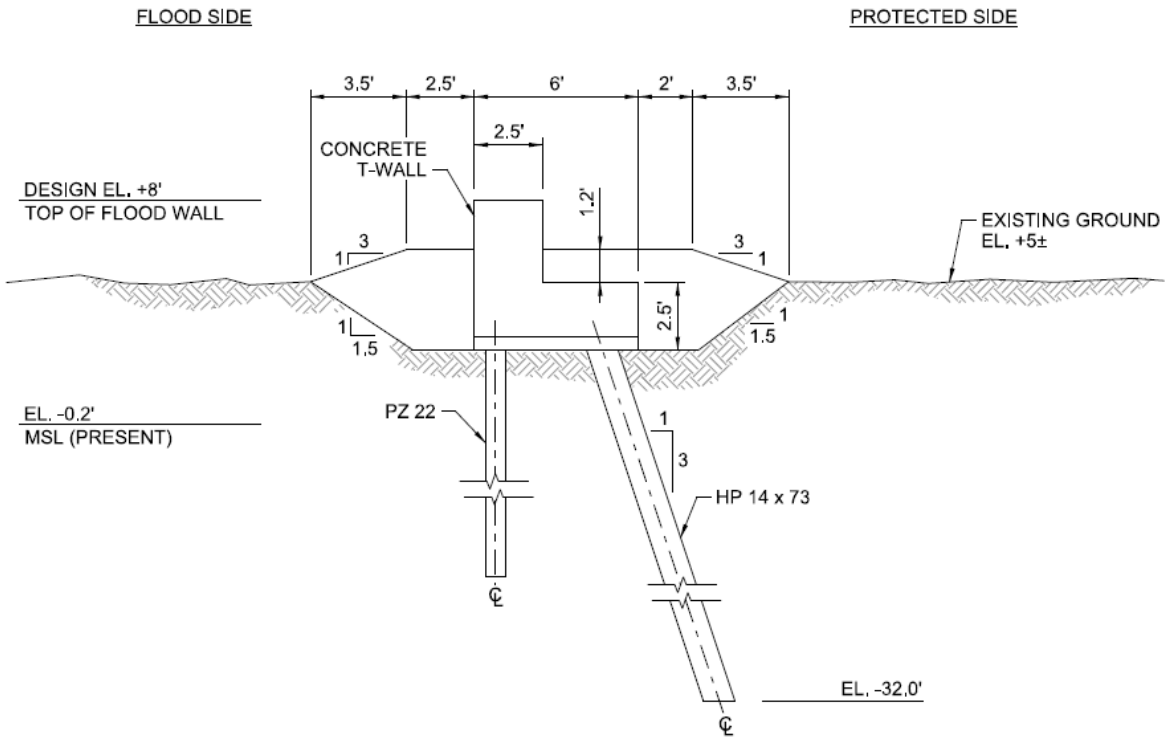


Figure 4-1: Low Floodwall Cross-Section

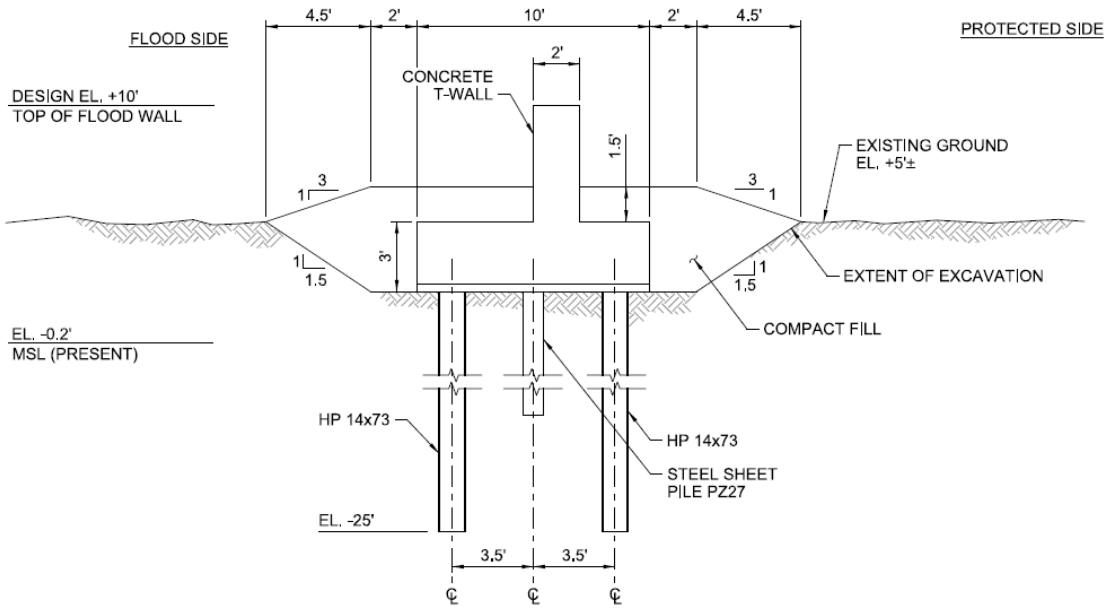


Figure 4-2: Medium Floodwall Cross-Section

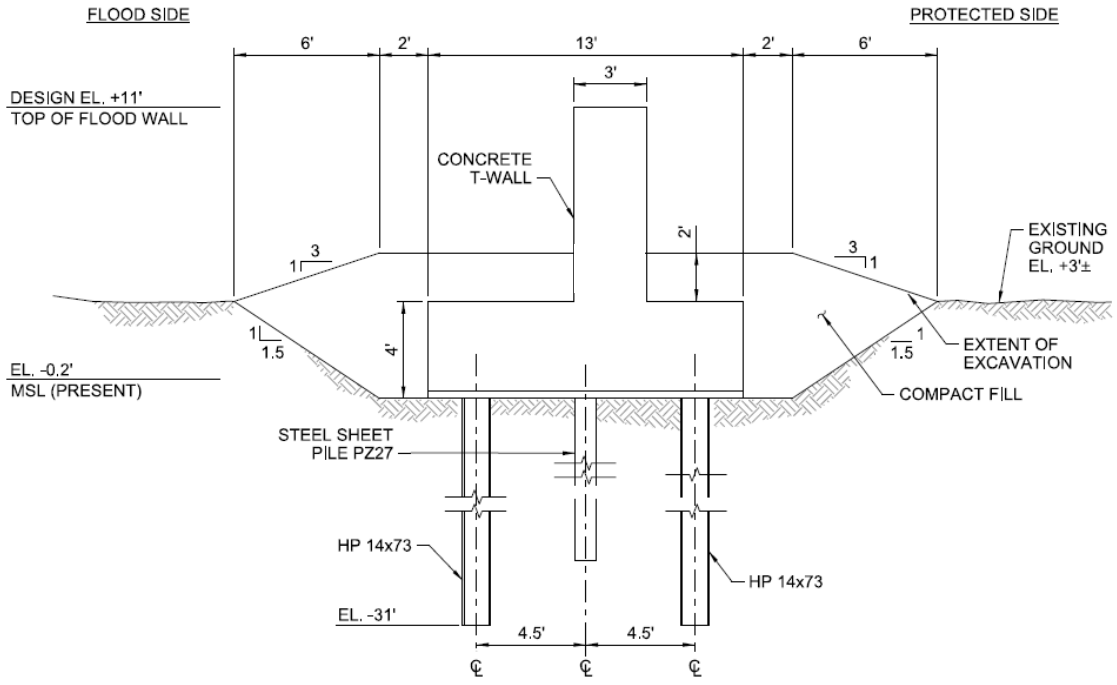


Figure 4-3: High Floodwall Cross-Section

4.3 Low Berm, Medium Berm and High Berm

Whereas floodwalls are made of materials such as concrete and steel, berms are made of compacted soil and vegetation and are considered to be a nature-based feature. Figure 4-4 shows the natural appearance of a typical berm. Berms are commonly used along rivers and bodies of water to prevent flooding of the adjacent inland grade elevation.

Figure 4-4: Typical Berm

Berms are typically constructed by piling earth on a cleared and leveled surface; soil is compacted into a large earthen structure that is wide at the base and tapers toward the top. The interior of the berm is a core composed of impervious material, usually clay, to form a watertight barrier to prevent or minimize seepage. Grass or some other type of non-woody vegetation are commonly planted on the berm to add stability and protection from erosion. The vegetation on the berm increases its aesthetic appeal. Berms can be further enhanced through combination with tidal marsh and rock sill NNBFs.

Berms on poor soil are subject to instability and settling, and therefore, require deeper excavation prior to construction. For this study, it was assumed the berm is founded on soil of medium quality. As discussed in Section 3.4.8, no site specific geotechnical analysis was completed. For the proto-typical design for the low berm, three feet of soft-consistency material would be excavated from the ground elevation of El. +5.5 feet. Similarly, for the medium and high berm, material would be excavated from the existing ground elevation of El. +4 feet and El. +3 feet, respectively.

To minimize seepage concerns, facilitate maintenance, and allow for ease of construction, a crest width of 5 feet and 7 feet was used for the low and medium berm design, respectively. Since the high berm also has to meet roadway requirements and future emergency needs, a 10-foot crest width was used in the design of the high berm. A side slope of 1 vertical on 2.5 horizontal was used for both the low, medium and high berm to minimize erosion and scour potential, and provide sufficient stability.

Due to the berm width and required setbacks, relatively large tracts of real estate are usually required. For this reason, berms are best suited along natural shoreline or parallel to the course of streams and basins within Jamaica Bay and set away some distance from the developed areas.

Figure 4-5, Figure 4-6 and Figure 4-7 show the typical low berm, medium berm, and high berm HFFRRF, respectively.

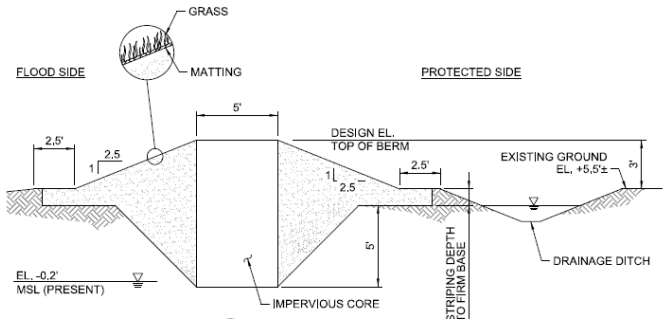


Figure 4-5: Low Berm Cross-Section

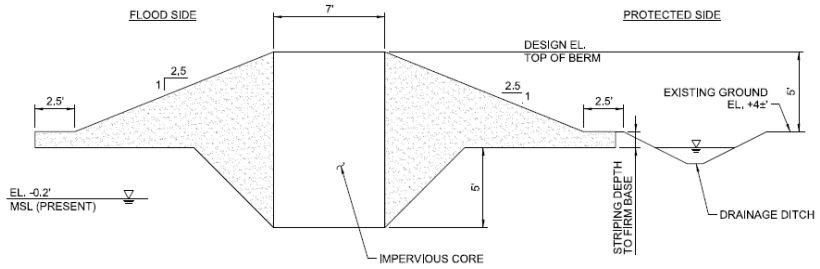


Figure 4-6: Medium Berm Cross-Section

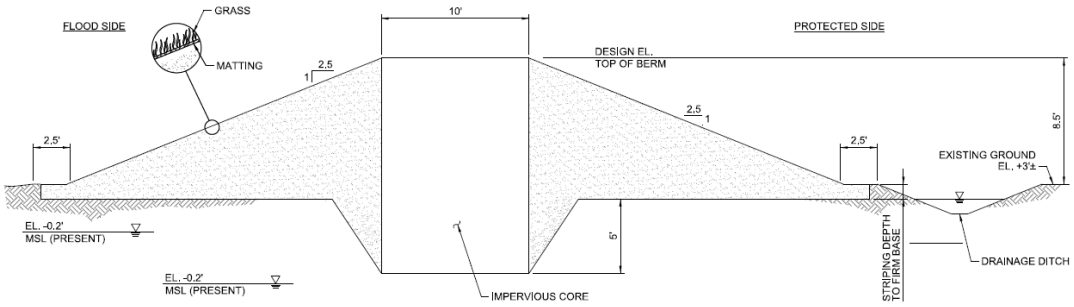


Figure 4-7: High Berm Cross-Section

4.4 Shallow Bulkhead and Deep Bulkhead

4.4.1 Bulkhead Design

A bulkhead wall is typically comprised of a steel sheet pile wall with or without a pile cap. The sheet pile wall is a row of vertical interlocking piles driven to form an integrated straight wall. Figure 4-8 shows an example of a bulkhead with concrete cap in Brooklyn, New York.

For this study, the bulkhead wall consists of a steel sheet pile wall with a reinforced concrete pile cap. On the protected side, the concrete cap extends down from El. 11 feet to the existing ground elevation at El. 7 feet. A concrete splash pad 5 feet wide at design existing ground elevation of El.7 feet was provided for scour protection. To fill in the gap between the new sheet piling and the existing bulkhead/shoreline, backfill was provided.

While their main function is usually to retain and prevent sliding of land, bulkheads, if vertically extended beyond existing grade and constructed watertight, can also reduce the risk of upland flooding. Bulkheads on poor soil require longer sheet pilings. Because flood-prone waterfront areas in Jamaica Bay are likely to have poor soil material, it was assumed that the soil in front of the sheet piling is characterized by poor sand. Soil behind the sheet piling was assumed to be backfill of medium sand up to existing ground elevation. Two different existing mudline elevations, El. -3 feet and El. -8 feet, were used to establish the design of the prototypical shallow and deep water bulkhead as HFFRR-Features, respectively. This was done to capture the varying conditions throughout Jamaica Bay in which bulkheads would be applied as generic measure. The deeper the water (lower mudline elevation), the heavier and longer the sheet piling required. Sheet size and length for the shallow and deep water bulkheads are shown in Figure 4-9 and Figure 4-10.

The relatively small footprint of a bulkhead renders it a preferred solution to urban or developed waterfront areas that are subjected to flooding. At some locations the Jamaica Bay waterfront can be characterized by a series of discontinuous and heterogeneous existing bulkheads that are privately owned with limited real estate for new structures. The Meadowmere (Queens), Arverne (Queens), Howard Beach (Queens) neighborhoods are just a few examples where such conditions exist. In order to develop a prototypical feature, as in the case of bulkhead construction, the existing bulkhead structure is assumed to be non-functional, because privately-owned bulkheads typically have no comprehensive maintenance program in place and hence likely experience some deterioration.

Figure 4-8: Bulkhead at South 5th Street Brooklyn, NY

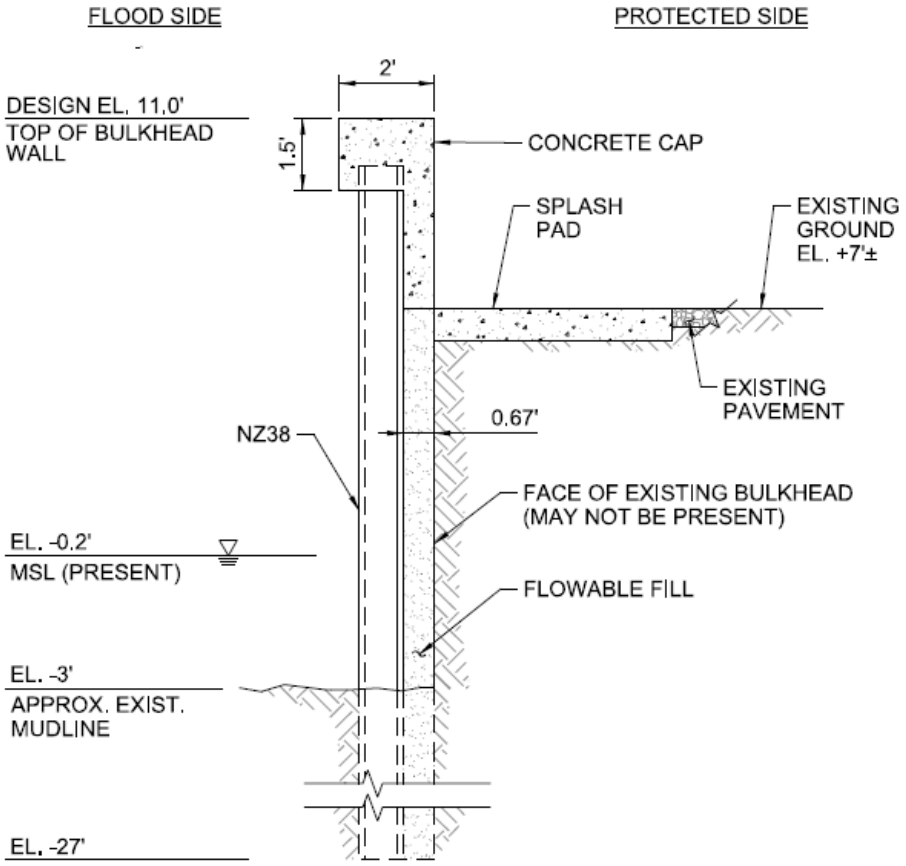


Figure 4-9: Shallow Bulkhead Cross-Section

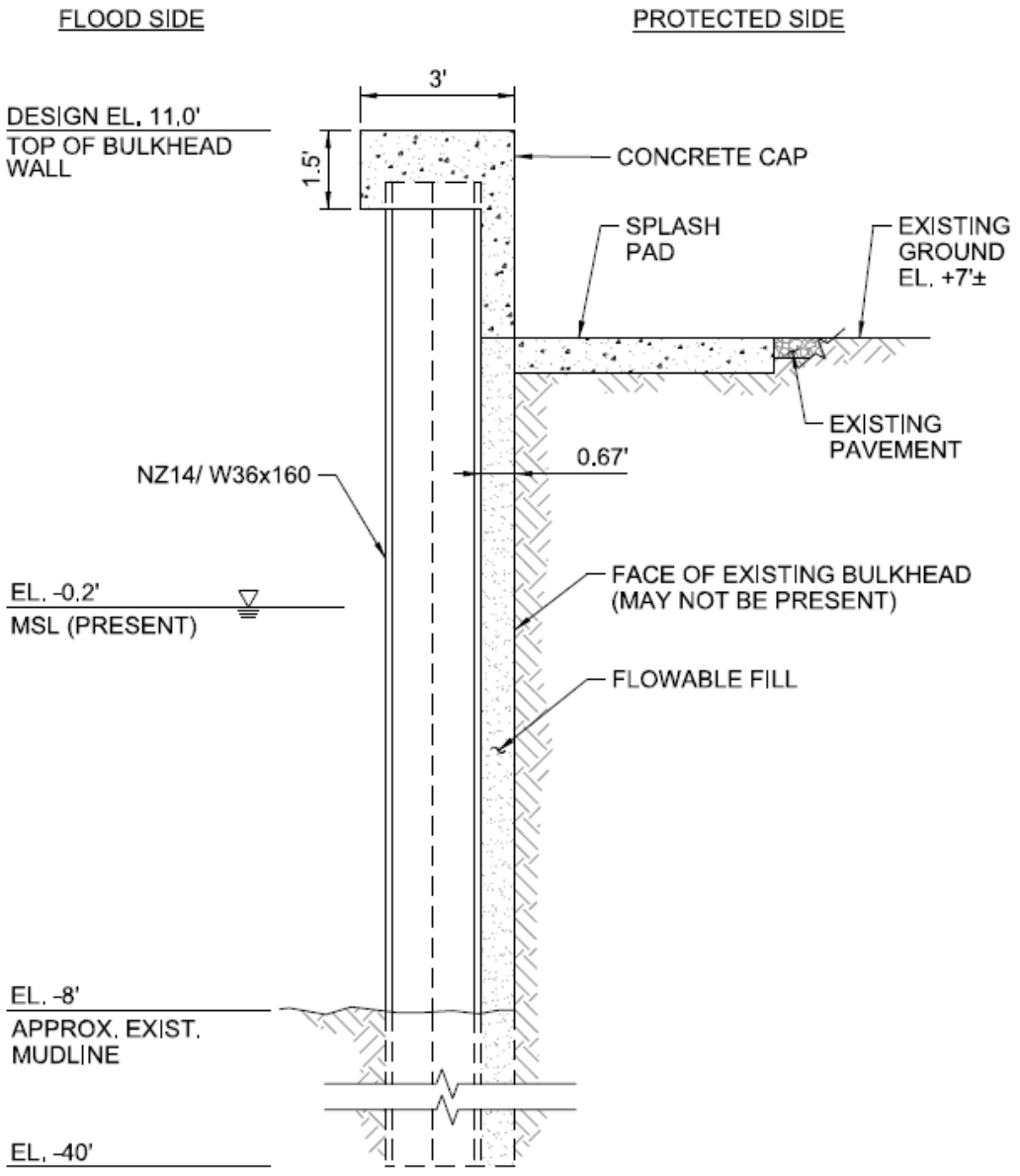


Figure 4-10: Deep Bulkhead Cross-Section

4.4.2 Bulkhead for Urban Application

In some cases, the base cost of bulkheads had to be adjusted to account for complex site conditions at locations where the upland is urban and is heavily developed, and associated complications that would arise during construction. These include a large number of overhanging porches, piles for floating boat docks, stairs, ramps, and various other structures obstructing the bulkhead. The cost of removing these structures and then replacing them with additional structures to allow access during construction, as well as the delay in construction were taken into consideration for bulkheads followed by the suffix "urban application."

4.4.3 Street End Bulkhead

This feature was a special feature type designed to tie into the new Broad Channel bulkheads which have been constructed as part of an unrelated street raising project in Broad Channel (DDC Project ID-HWQ1182A). The bulkheads are newly constructed, and removing them would unnecessarily increase cost; however they are not tall enough to meet the required design elevation. New piles will be driven to the ends of the Broad Channel bulkheads and concrete header beams will be added to raise the top of the structure to meet the design elevation required for this study. Figure 4-12 shows an excerpt from the Broad Channel street raising project plans. Figure 4-12 shows the bulkhead pile-cap extension for the street end tie-ins.

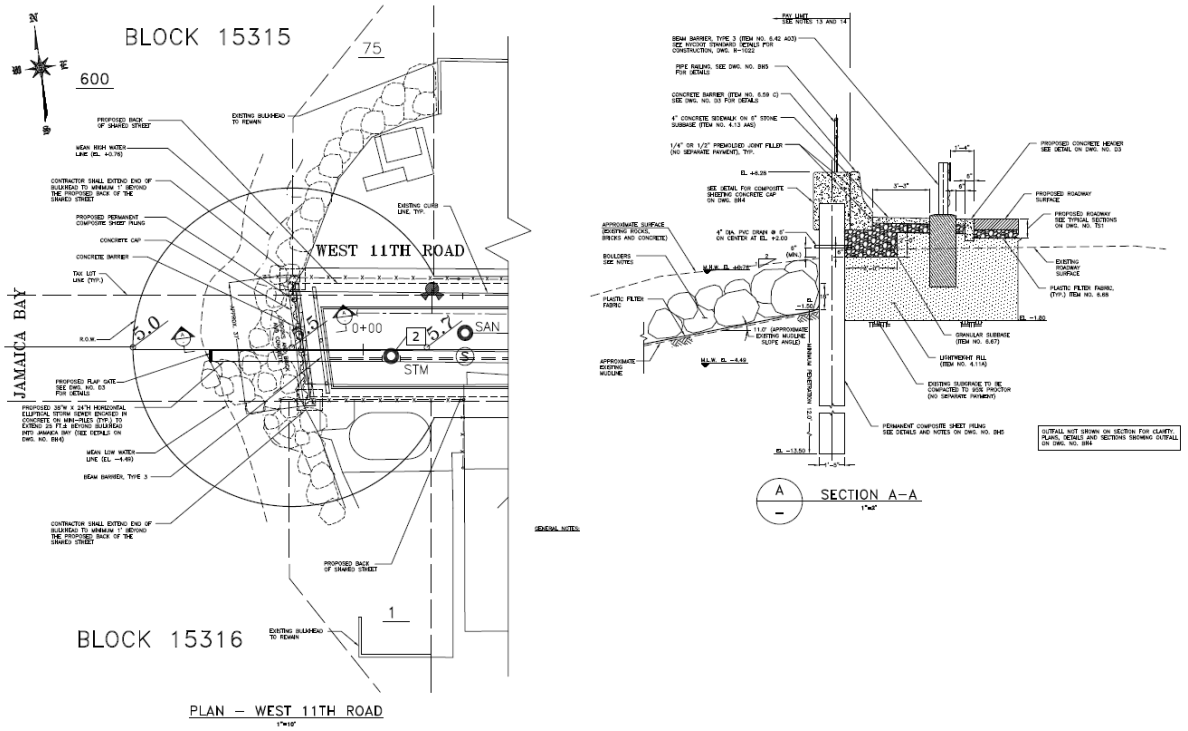


Figure 4-11: Broad Channel Street End Bulkhead Typical Plan and Section (taken from DDC Project ID-HWQ1182A for illustrative purposes only)

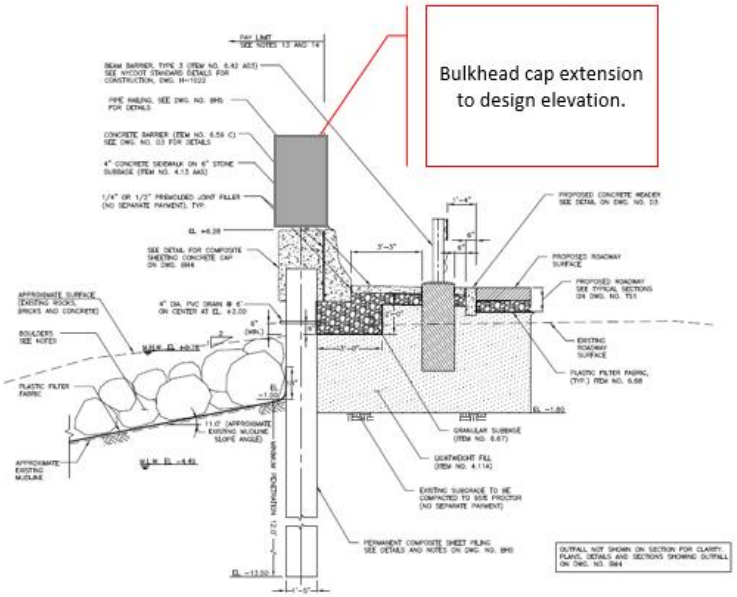


Figure 4-12: Street End Bulkhead Cross-Section (typical section taken from DDC Project ID-HWQ1182A for illustrative purposes only)

4.5 Revetment with Floodwall

Revetments are onshore structures made of erosion resistant material such as stone or concrete. They are typically built to protect the shoreline from erosion. Revetments are comprised of an armor layer, filter layer(s), and toe protection. The armor layer is designed to maintain the revetment's cross-section during wave action. The filter layer supports the armor, and it allows passage of water while retaining the underlying soil. The toe is to provide stability against undermining at the bottom of the structure. Figure 4-13 shows an example of a revetment in Hunter's Point New York City.

Figure 4-13: Revetment Hunters Point, NY (photo credit: Nicole Avella)

The generic revetment geometry is comprised of toe protection, underlayer and rock armor units (i.e. the seaward slope) and a short horizontal crest also comprised of rock. A concrete floodwall supported on steel sheet pile is provided behind the revetment. The cross-section of revetment with floodwall is shown in Figure 4-14.

It was assumed that for a prototypical design, with applications throughout Jamaica Bay, a revetment with 2-foot diameter armor stone, 5-inch diameter underlayer stone, 1.3-foot diameter toe armor stone and a slope of 2 (Horizontal):1(Vertical) would provide sufficient stability. The protective rock armor serves to hold the revetment in place and consist of two layers of rock. The underlayer acts as a drain parallel to the slope to prevent a build-up of water pressure under the armor layer and a filter to prevent the underlying soil from washing out. The two-layer underlayer would be on top of a geotextile. Toe protection is normally an integral part of the revetment structure and was designed to prevent the structural component from undermining as a result of wave and/or current-induced scour. The toe was comprised of two layers of toe armor stone with a width of 3.5 feet. The crest would be 6 feet wide and constructed in front of a floodwall. The floodwall consists of a concrete cap and steel sheet pilings. The top of the floodwall is at El. 9.5 feet and the design existing ground elevation is at El. 6 feet.

One of the more important variables of the revetment design is the seaward side slope which, together with the crest height, is generally dictated by soil conditions and revetment construction methods. For the purposes of this study, it was assumed that the revetment was founded on reasonably good quality soils which would not require foundation/ground improvements. Bottom elevation of the revetment was assumed to be at El. -8 feet. Actual elevations will vary across the study area, but for feasibility level analysis, it was considered a reasonable elevation for the revetment toe along Jamaica Bay shorelines.

The revetment, whereas effective at dissipating wave energy, cannot prevent coastal flooding since it is porous. The impervious concrete floodwall would be installed to prevent flooding. Revetments, especially the ones with stone armor, integrate well with the natural shoreline, their natural look in particular has a high aesthetic appeal.

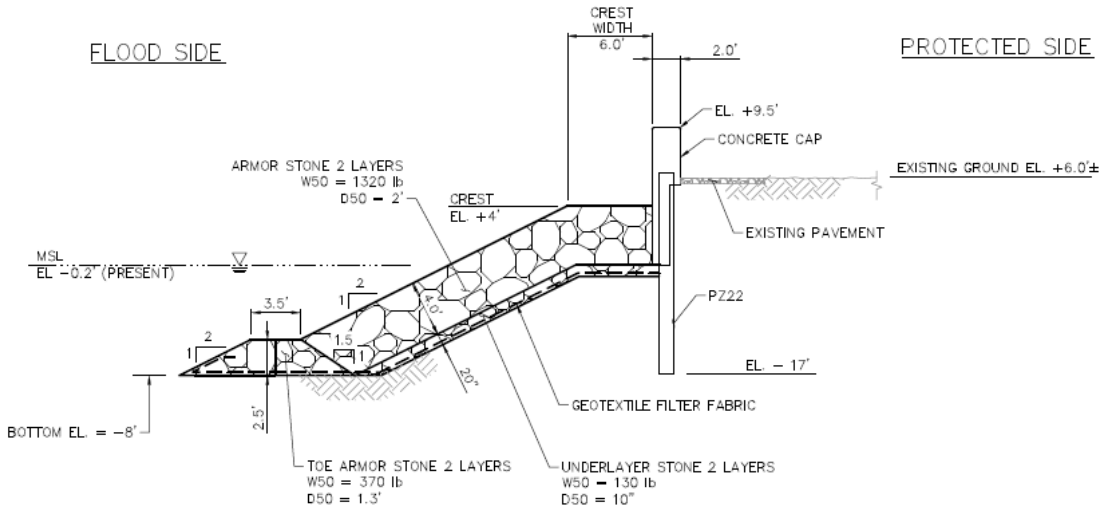


Figure 4-14: Revetment with Floodwall Cross-Section

4.6 Vehicular Gate

Vehicular gates are features added to a line of flood risk reduction, across a road or driveway, which allows for unimpeded access across the line of flood risk reduction during normal day-to-day conditions. Vehicular gates can be either manually or automatically operated. The HFFRRF prototypical vehicular gate is designed to be manually operated. Manually operated gates require operations personnel to physically go to the location of the gate and close it during storm conditions. The gate would then be locked into place to prevent tampering, and access to the flood side of the line of flood risk reduction would be impeded.

In general, swing gates and roller gates were considered initially, both gates have the advantage of simple and quick operation where no special skill or equipment are required. The roller gate was not selected because a level storage area immediately adjacent to the closure opening is necessary for roller gate operation and a (level) track will need to be maintained and inspected. A swing gate was used given the site constraints and upland use of the waterfront area.

4.7 Road Raising

Road raising consists of raising an existing road's surface elevation in order to use the road itself as a berm-like feature, thus reducing the risk of flooding on one side of the road. In order to raise the road surface, any connecting driveway or side street needs to be raised and ramped to meet the raised road. In addition, buried retaining walls are used to support the increased height of the roadway. The various construction activities required to complete the road raising often necessitate relocating and/or raising buried utilities and adding drainage inlets and pipes at the bottom of driveways to convey stormwater away from homes and businesses. Figure 4-15 shows a prototypical section for the road raising feature.

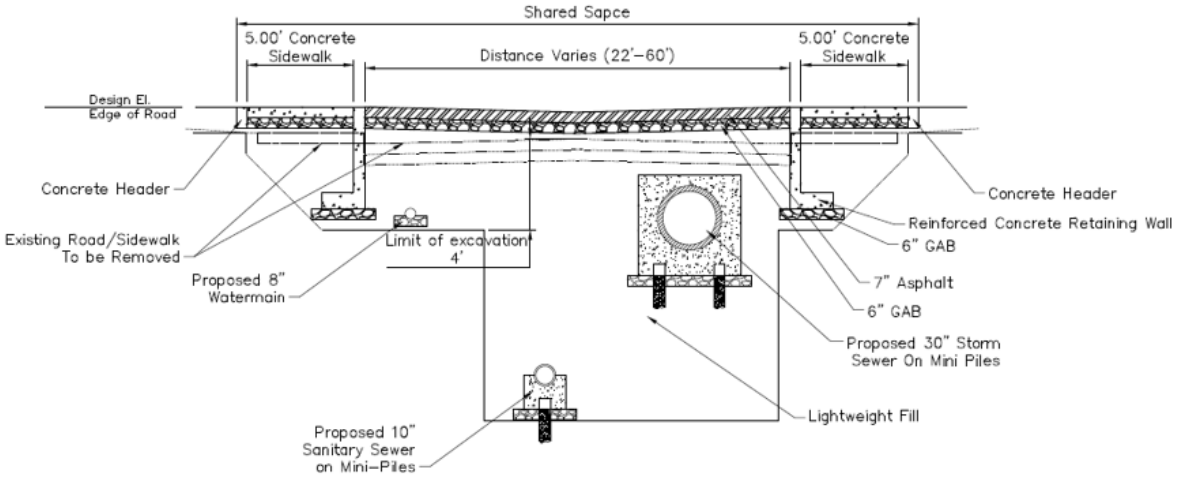


Figure 4-15: Road Raising Cross-Section

4.8 Breakwater

Breakwaters are structures constructed in the water, either offshore or nearshore, that can absorb wave energy and reduce the wave exposure of flood risk reduction features landward of it. It should be noted that the feature was used in this study only for the Broad Channel project. For that location, a rubble mound breakwater with a side slope of 1 vertical on 1.5 horizontal was designed;

the breakwater has two layers of armor stones on top of two layers of underlayer stone. The underlayer stone is in turn placed over a core of smaller bedding stone.

The breakwater will provide habitat to mussels, shellfish and other marine life. Since shellfish thrive in intertidal zones, to maximize the habitat for reef shellfish, the crest was determined to be 20 feet, with a toe width of approximately 127 feet on each side of the breakwater. Figure 4-16 shows a typical cross-section of a breakwater.

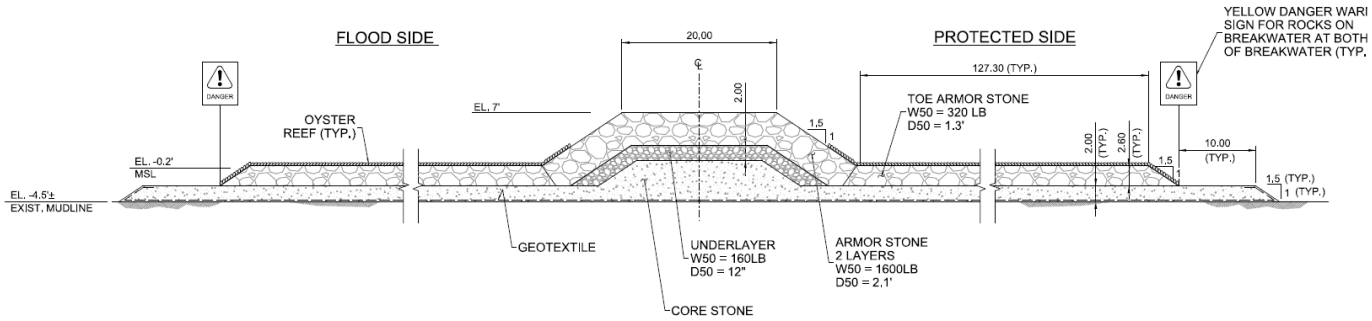


Figure 4-16: Breakwater Cross-Section

4.9 In Water Gates and Related Structures

The designs for in water floodgates and tie-in structures for Head of Bay and Old Howard Beach were developed based on, and assumed to be equal to the preliminary gate design outlined in USACE-NAN (2016). In general, the in water gate structure is comprised of a steel gate, reinforced concrete monolith and pile foundation. The gate monolith would be tied into high ground on each side using tie-in T-walls.

At Head of Bay, a combination of a Sector Gate and Lift Gate was used. The use of a Sector Gate will allow for unrestricted navigation. It is anticipated that both the sector gate and lift gate will remain open for all normal channel operating conditions and closed prior to the arrival of a storm. The top of the gates as well as the associated tie-in structures were determined to be El. 10.3 feet. The sill elevation was assumed to be at El. -20 feet.

At Howard Beach, Sector Gates were used at Shellbank Creek and Hawtree Basin. The operation and design of the two sets of Sector Gate are similar to the one at Head of Bay. However, the top of the gates was set at El. 8 feet while the sill elevation was assumed to be at El. -20 feet.

4.10 Hybrid Berm

As explained in Section 4.3, in general, berms integrate well into the natural landscape but have a relatively large footprint.

In areas where a regular berm as a HFFRRF would be appropriate but a lack of available real estate renders the option impractical, a hybrid berm was used. The hybrid berm has the aesthetic advantage of a regular berm on the protected side, as well as the benefit of a reduced footprint. The hybrid berm is comprised of a berm on the protected side, riprap on the flood side and a vertical steel sheet pile wall in the middle. The steel sheet pile wall is equipped with a reinforced concrete pile cap that runs flush with the top of the berm. Since the sheet pile wall will act against any seepage concerns the impervious core has been replaced with regular earth. The riprap with a slope of 1 vertical on 2 horizontal was used to provide scour protection. Similar to the low, medium and high berms, a protected side berm slope of 1 vertical on 2.5 horizontal was used. The hybrid berm has a crest width of 5 feet, a design height of 3.5 feet and a design existing ground elevation of El. +6'. Figure 4-17 shows the typical cross-section of a hybrid berm.

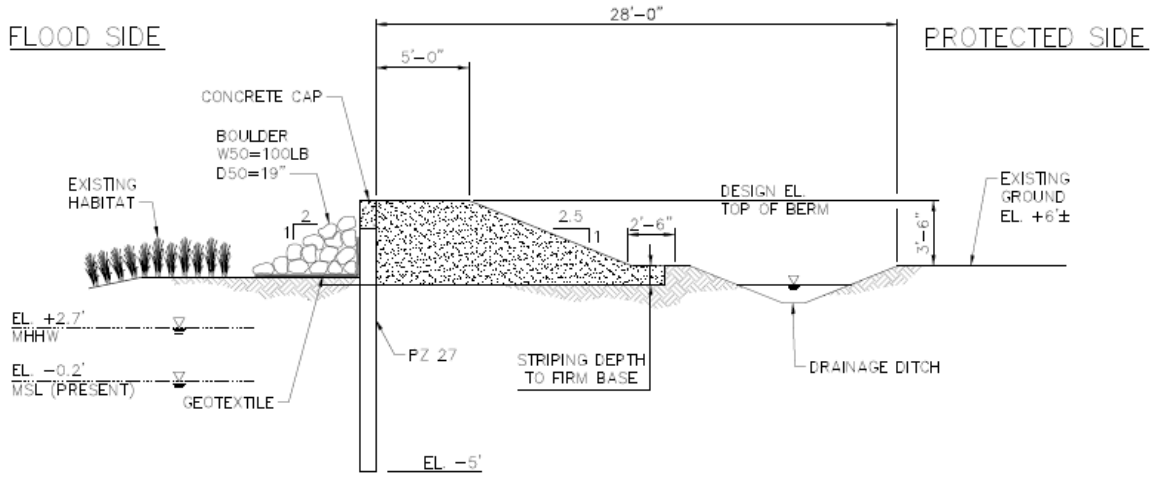


Figure 4-17: Hybrid Berm Cross-Section

4.11 Road Ramp

Road ramps are a means of allowing both vehicular and pedestrian access to the flood side of a line of risk reduction. They consist of two drive lanes and can be designed with sidewalks to allow for safe pedestrian access. The road ramps for this project were designed to be used in conjunction with low floodwalls. In order to allow a vehicle towing a boat to use the ramps without bottoming out, a design length of 85 feet from the bottom of either end of the ramp was used. A culvert would be put under the road ramp to convey drainage to nearby outfalls/pump stations, as needed.

4.12 Natural and Nature Based Features (NNBF)

As described in Section 4.1, a series of Natural and Nature Based Features (NNBFs) were developed as an integral engineering feature to the CSRM design in order to control erosion and reduce wave energy exposure to HFFRRF. Especially for berms, which are expected to be overtopped frequently throughout their project life, NNBFs can improve the overall function and resilience of the HFFRRFs. In addition, they provide a variety of ecosystems services increasing the overall ecological resiliency of the bay. They provide adaptive features, such as improved wetlands habitats and a more natural shoreline that can migrate with rising sea levels in the future. It should be noted that the NNBF design has progressed through the two phases of screening. During Phase 1 generic prototypical NNBF designs were established which would be applicable along Jamaica Bay shorelines, while in Phase 2 a more site specific preliminary NNBF design was established that was informed by the updated site conditions of the screened project and project alignments.

Figure 4-18: Rock Sill and Wetland as NNBF in Brooklyn Bridge Park, Brooklyn, NY

4.12.1 Natural and Nature Based Features (NNBF) – Phase 1

The NNBF design includes placement of a stone toe protection and rock sill structure at or just off the existing shoreline to attenuate wave action and allow tidal marsh to establish between the rock sill and the berm. Sometimes termed "living shoreline," the sill structures provide protection for the subtidal and intertidal habitats as well as providing hard bottom habitat for increased ecological production. The shore slope behind the structure will be regraded to reduce risk of erosion further

and create elevation gradients and substrates for establishment of tidal marsh. In addition, the graded habitat behind the structure will be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems. The wetland and benthic habitat created by the NNBFs also helps to offset the impacts to habitat from the construction of the HFFRRFs and make the project self-mitigating as a whole. Beyond that, the NNBFs provide numerous additional long-term ecological benefits including provision of various ecosystem services, including carbon and nutrient sequestration, increase productivity by restoration of aquatic and terrestrial wildlife habitats, including primary nursery areas for fisheries, and cultural benefits such as aesthetic benefits to the community. The dynamic character of NNBF's and full ecological benefits are fully described in the ERDC report SR-15-1 (Bridges et al., 2014). The report identifies numerous ecological services, in addition to the structural and erosion protection services provided by breakwater and sill structures.

This type of NNBF also provides opportunity for shellfish and ribbed mussel NNBF habitat, as the rock sills can provide excellent settling and growth spaces for shellfish. Many living shoreline applications are developed with shellfish attractant materials and substrates incorporated for just that reason. The protected subtidal habitats created behind the rock sills also promote the establishment of more productive habitats such as development of seagrasses and other diverse habitats, thereby improving ecological function.

The areas where NNBFs are proposed have erosion problems which have resulted in degraded habitats and degraded coastal storm risk management capacity. The proposed NNBFs are a mechanism for controlling erosion in the system and have the added benefit of providing additional habitat, which allow the project to self-mitigate for other impacts to wetlands caused by the HFFRRF berms and floodwalls. The NNBFs were planned in co-location with the flood risk reduction features in order to take advantage of their capacity to improve the function and resilience of those "grey" features. Located on the unprotected side of the flood risk reduction features, the toe features and bands of tidal wetland vegetation included in the NNBFs will act to dampen incoming waves during storm conditions and potentially reduce wave overtopping. Tidal wetlands also continually adapt to the changing water elevations as sea levels rises. As the sea slowly rises, the lower and intermediate marsh will gradually migrate landward, replacing the scrub shrub habitats, and will continue to provide a protective buffer for the flood risk reduction features over time and increasing the inherent adaptability of the HFFRRF to sea level rise.

The primary factor governing the form of the NNBFs is the amount of horizontal space available between the flood risk reduction feature and the existing shoreline and/or the near-shore shallow littoral shelf. The design will, where possible, re-establish a graded habitat environment which is less susceptible to erosion, more inherently adaptable to sea level rise, and has the added benefit of increased habitat diversity, including valuable maritime forest and intertidal habitats (sub-tidal, smooth cordgrass and salt hay habitats) along shorelines in front of flood risk reduction features where that horizontal space was 200-250 feet or less, the NNBF only includes two stages of Intertidal Marsh vegetation: the low marsh stage, typically dominated by Smooth Cordgrass

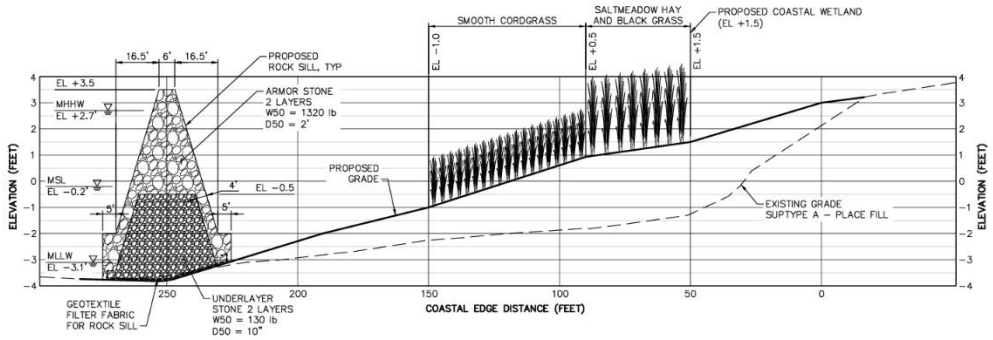
(*Spartina alternaflora*); and the intermediate marsh stage, typically dominated by Salt Meadow Hay (*Spartina patens*) and Black Grass (*Juncus gerardi*). These are referred to as Type 1 NNBFs. Where the horizontal space was more than 250 feet wide, a third stage of marsh was added: High Marsh, which includes shrub species such as Marsh Elder (*Iva frutescens*) and Groundsel Bush (*Baccharis halimifolia*). These are referred to as Type 2 NNBFs.

In some locations too narrow to accommodate the NNBF, the constraint could be overcome by setting the rock toe protection elements of the NNBF slightly off the existing shoreline and placing sufficient fill behind them to achieve the elevations and slope gradients necessary to establish tidal marsh. This strategy could only be utilized if the bathymetry of the existing shoreline exhibited gradual slopes to shallow bottoms just offshore, and it was given preference where aerial photography or field reconnaissance indicated active erosion and/or shoreline retreat from past extents. These NNBFs are referred to as Subtype A.

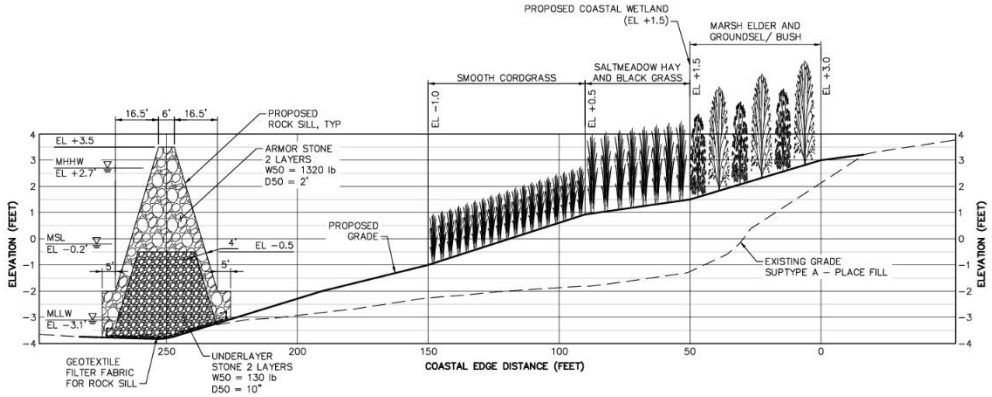
Some existing marsh areas and fringes between the flood control features and the water's edge have been invaded by the non-native invasive, Common Reed (*Phragmites australis*). Along these shorelines it was deemed desirable to excavate landward to remove the invasive and establish appropriate slopes and elevations for restoration of native species marsh. In these instances, preliminary plans call for removal of the top 2.0-2.5 feet of existing soil to eliminate the *Phragmites* rhizomes. This approach was also more conducive where rapidly descending bathymetry made stepping off shore with the slope toe structure impractical. Such NNBFs are referred to as Subtype B.

Combination of these NNBF approaches resulted in four NNBF prototypes used for the Phase 1 analysis as follows (See Figure 4-19):

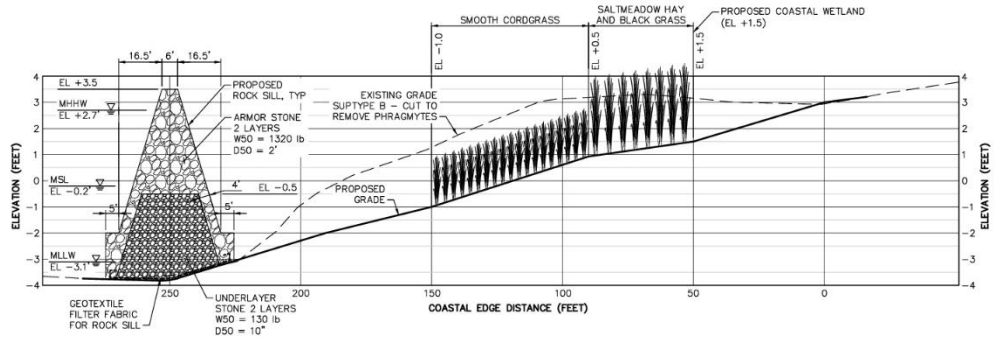
1. NNBF Type 1A – Shoreline Extension with Intertidal Marsh
2. NNBF Type 2A – Shoreline Extension with Intertidal and High Marsh
3. NNBF Type 1B – Shoreline Excavation for *Phragmites* Removal with Intertidal Marsh
4. NNBF Type 2B – Shoreline Excavation for *Phragmites* Removal with Intertidal and High Marsh



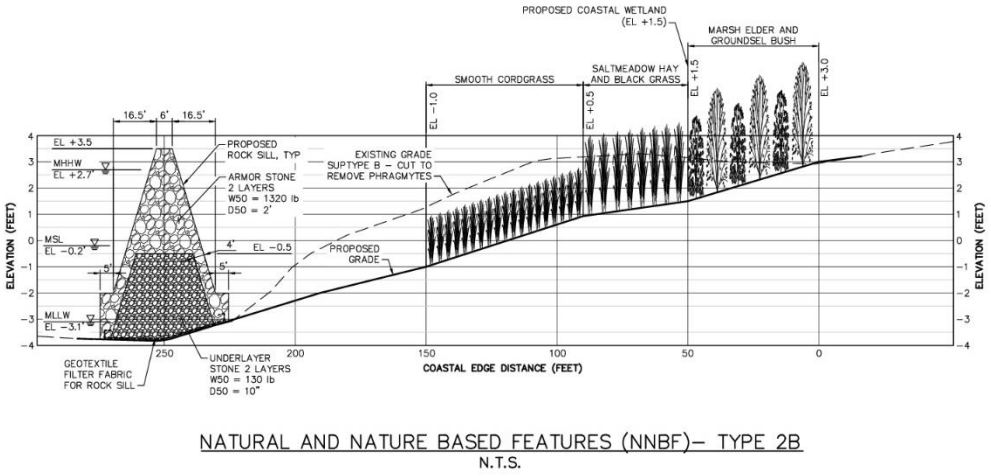
NATURAL AND NATURE BASED FEATURES (NNBF)– TYPE 1A
N.T.S.



NATURAL AND NATURE BASED FEATURES (NNBF)– TYPE 2A
N.T.S.



NATURAL AND NATURE BASED FEATURES (NNBF)– TYPE 1B
N.T.S.



NATURAL AND NATURE BASED FEATURES (NNBF)– TYPE 2B
N.T.S.

Figure 4-19: NNBF Feature Type 1A, 1B, 2A and 2B Cross-Sections

4.12.2 Natural and Nature Based Features (NNBF) – Phase 2

In Phase 2 of the screening, the NNBFs were further refined and co-located with the flood risk reduction features in order to take advantage of their capacity to improve the function and resilience of the structural features.

The refinement of the NNBFs include additional provisions for restoring impacted or eroded shorelines which includes both re-grading of the shoreline and removal of invasive species. Inclusion of features such as the hybrid berm also allowed for additional habitat areas. Regrading for specific sub-habitat types will ecologically engineer the shoreline to provide the maximum habitat diversity in the available space. The plans include the following potential elements (moving shoreward from sill to uplands):

- Placement of a hard substrate (Rock Sill) which will allow encrusting organisms to develop including mussels and other shellfish
- establishment of a low energy subtidal habitat, providing essential nursery habitats conducive to the establishment of submerged aquatic vegetation (SAV)
- Re-establishment of low intertidal marsh habitat, (Common Smoothgrass) especially in shallow eroded intertidal shoreline areas
- Placement and enhancement of intermediate intertidal habitats (Salt Meadow Hay; Black Grass)
- Removal of invasive species (*Phragmites*)
- Development of high marsh (infrequently flooded) dominated by scrub/shrub habitat (Marsh Elder; Groundsel)

The planting plan allows for a re-establishment of a more natural shoreline gradient, using excavation/fill in the appropriate segments, and the establishment of natural marsh elements appropriate for the elevation and tidal regime. The design includes the identification of potential locations where the project team believes these elements will likely fit, but final design and siting will depend on a final feature alignments and detailed delineation of existing grades and elevations.

The final rock sill geometries were refined adaptively, taking into account a more refined bathymetry, adjacent shoreline features, detailed wave environment and where to establish passages for both improved tidal exchange and organism movement. In some cases, the elevation may be adjusted if local wave conditions warrant and/or if aesthetic reasons changes are necessary.

4.13 Drainage Features

As introduced in Section 4.1, a series of drainage features were developed to be used in conjunction with the HFFRRF.

4.13.1 Phase 1 Drainage Features

4.13.1.1 Drainage Considerations

Structures such as the floodwall, bulkhead, revetment and berm have the potential to trap rainfall runoff associated with storms on the landward side, creating an additional flooding hazard. To mitigate this hazard, drainage infrastructure was considered for such projects. Because of the large number and variations of projects in Phase 1 of this feasibility study, a uniform cost per linear foot was developed for two scenarios, based on 1,000-foot hypothetical design lengths. The first scenario was for systems installed where open space is available and flood risk reduction berms could be constructed in conjunction with drainage ditches leading to outlet vaults. The second scenario was for sites with limited space, where hard structures like floodwalls and bulkheads would be constructed along with storm drainage piping leading to outlet vaults. In both cases, it was assumed that the drainage infrastructure would only collect runoff currently flowing to the surface water over land, and that there would be no interaction between the proposed infrastructure and existing drainage infrastructure. The design assumptions are detailed in the following sections.

4.13.1.2 Watershed Delineations

In order to lay out a conceptual storm drainage design that could collect runoff from areas currently draining over land directly to the surface water, the size of the direct drainage areas had to be considered. Approximate watershed boundaries were determined at some sites using LiDAR topographic data in conjunction with Google Earth to determine the locations of any existing storm drainage inlets. It was found that most of the direct drainage watersheds were fairly narrow and that inlet locations would not typically be based upon flow capacity requirements.

4.13.1.3 Inlet Spacing (limited space scenario only)

Since the direct drainage watershed areas were typically long and narrow, inlets were spaced based upon practical considerations, such as maximum practical pipe lengths between access points for maintenance, or for making turns in the pipe system, rather than being controlled by inlet flow collection capacity. For estimating drainage infrastructure costs, the assumption was made that there would be four inlets per thousand feet. At sites where space was available for constructing open channels, collection piping and inlet costs were not included in the cost estimate.

4.13.1.4 Outlet Vault Spacing

Regular discharge points from the drainage system must be incorporated in order to avoid very long pipe or open channel runs and thus excessively deep pipes and structures. The assumption was made that the upstream ends of pipe runs would have a minimum of 1.5 feet of cover. This would result in a 15-inch pipe having an upstream pipe invert depth of approximately 3 feet. Assuming a pipe slope of 0.5 percent, the downstream pipe invert would be 5 feet deep on a 400-foot run and 6 feet deep on a 600-foot run (assuming flat topography). Since a high water table is likely be present in most of the system locations, the assumption was made that drainage piping and open channel runs would be limited to 250 feet in length before reaching an outlet, which would result in a downstream invert elevation a little over 4 feet deep.

4.13.1.5 Pipe Sizing (limited space scenario only)

Collection piping was not sized in detail at this conceptual stage of the project. General assumptions were made about widths of direct drainage watershed areas and watershed impervious percentages based on surveys of the project locations. Using these assumptions, it was estimated that a 15-inch pipe on a 0.5- percent slope would reach flow capacity during the 10% AEP (10-year RP), 5-minute storm peak intensity (crown of the pipe) after collecting runoff from approximately 500 feet of project length. Since the maximum pipe runs until reaching an outlet vault are 250 feet, 15-inch or 18-inch diameter pipes along the runs are expected to suffice. An 18-inch pipe diameter for the full run length was assumed during cost estimating to be conservative and to potentially size the system to route larger storm events. At sites where space was available for constructing open channels, collection piping costs were not included in the cost estimate. Discharge pipes leaving the vaults were assumed to be 24-inch diameter.

4.13.1.6 Vault Design

Vaults were sized based upon assumed invert depths of incoming pipes and the length and width necessary to house a sluice gate that fits a 24-inch by 24-inch opening. The vault was assumed to include two chambers. The first chamber functions as a junction for the incoming pipes, with a single outlet opening to the second chamber (over which the sluice gate is installed). A 24-inch Prestressed Concrete Cylinder Pipe (PCCP) would route stormwater from the second chamber to the downstream surface water. An elastomeric check valve would be installed at the end of each outlet pipe, along with a concrete headwall and riprap energy dissipater. The use of PCCP was

assumed in the cost estimates because they come in longer sections, thus fewer joints, which can be beneficial in levee applications where seepage can be a concern. The joints can also be secured to reduce the likelihood of separation from settling or other forces.

4.13.2 Phase 2 Drainage Features

A key characteristic of Phase 2 was the completion of an interior drainage analysis for each of the Phase 2 project locations. The interior drainage analysis and characteristics regarding the drainage features for Phase 2 is described in Sub-Appendix D. The Phase 2 interior drainage analysis resulted in updates to and site specific designs of stormwater management for each of the Phase 2 projects – which then replaced all of the work done in Phase 1, thus replacing and updating the cost estimates for drainage features in Phase 2.

5 PHASE 1 PROJECT SCREENING

5.1 Phase 1 Projects

5.1.1 Introduction

Following the risk assessment presented in Chapter 2, low lying coastal neighborhood areas within Jamaica Bay were identified as areas where HFFRRF could be implemented. The Phase 1 preliminary screening and subsequent feasibility design and analysis was performed only on the areas identified as potentially having viable economically justified stand-alone projects.

Other parts of the Jamaica Bay shoreline that are subject to flooding were not included; such areas are characterized by natural or undeveloped areas or isolated structures. Inclusion of HFFRRF projects for such locations would garner minimal reduction to the overall flood risk within Jamaica Bay and as such only marginally contribute to the overall objective of the project. Examples of such exclusions, amongst others, are geographically much smaller areas with very few assets at risk, undeveloped urban lots adjacent to Jamaica Bay, isolated developed but privately-owned lots with one single owner, and natural shorelines and parklands.

In Phase 1 of the Feasibility Study for HFFRRF for Jamaica Bay, areas for study were identified, analyzed, and screened for feasibility. A general grouping of viable low lying coastal neighborhoods was completed, and the following areas were identified where HFFRRF could be implemented:

1. Mid-Rockaway Jamaica Bay side, which includes Hammels, Arverne, and Edgemere
2. Motts Basin, Norton Basin and the Inwood Marina Area,
3. Head of Bay and the adjoining Nassau County watershed, including Cedarhurst-Lawrence, and Meadowmere,
4. Old Howard Beach,
5. Canarsie, and
6. Broad Channel.

These general areas are graphically presented in Figure 5-1.

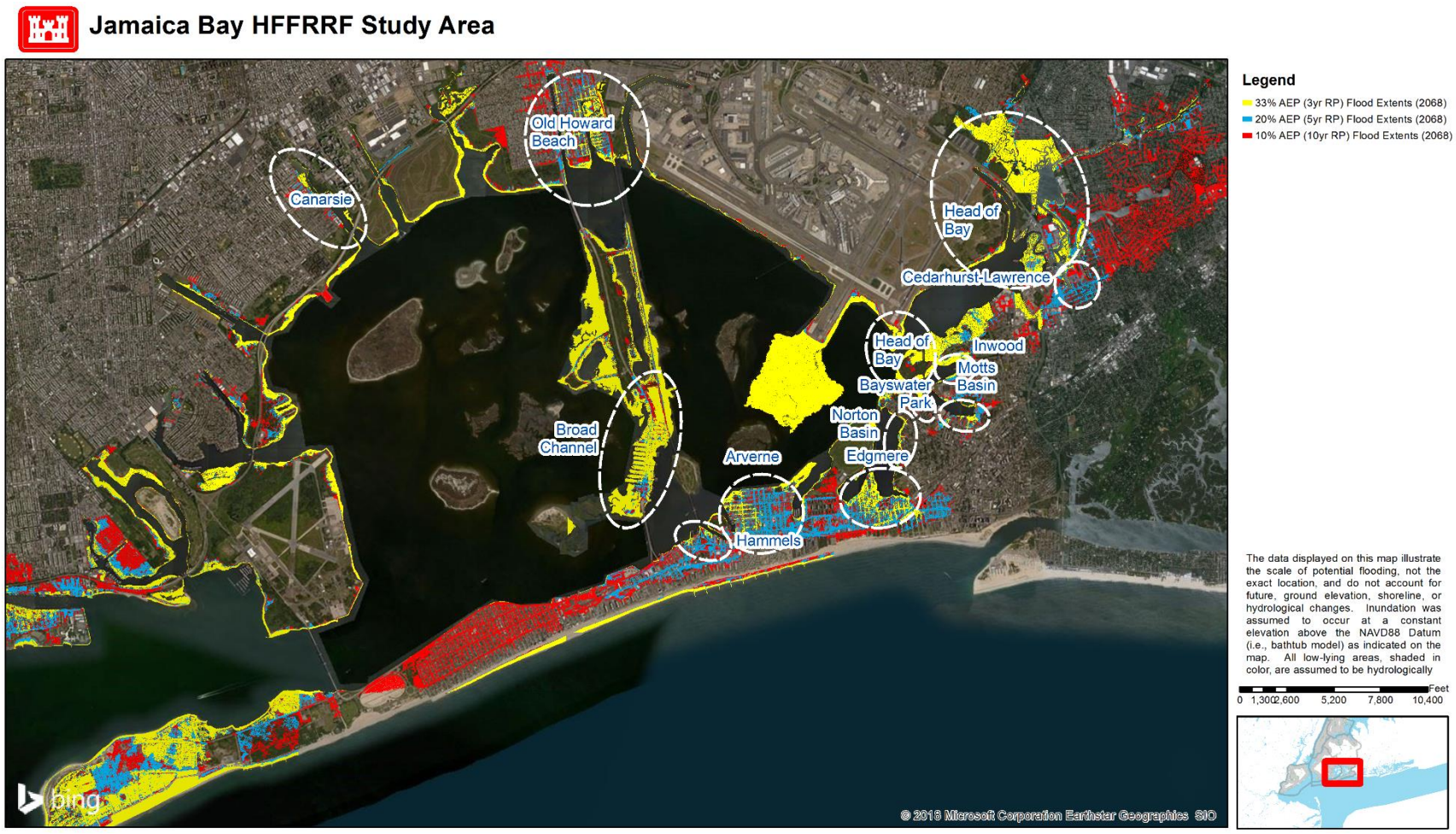


Figure 5-1: Jamaica Bay Inundation Extents for the 20% AEP chance flooding (5-year RP) for the year 2068 and the areas of interest where HFFRRF Projects are developed

For these areas project alignments were defined following the coastal edge while keeping as many assets on the land side of the alignment as practically deemed feasible. Projects were developed by considering realistic project extents, established based on shoreline type, length, topography, neighborhood, land use, planning considerations, project scope, inundation extents, flooding pathway, and existing topography. The goal was to ensure adequate tie in of the HFFRRF projects to higher ground elevations. Project segments were aggregated by the project area they fell within, and project IDs were assigned to each combination of segments. A detailed description of the projects is provided in the next section.

In accordance with USACE's SMART Planning principles, and similar to the development of the project features (HFFRRF), the projects were developed at a level of detail required to make the decision at hand. For Phase 1 this meant that a detailed drainage analysis or an evaluation of the real estate cost was temporarily omitted. This approach allowed the PDT to establish project construction cost and benefits efficiently for a large number of projects and complete a first round of screening based on Phase 1 BCRs. As such, a two-tier screening approach was established where the time consuming and resource intensive interior drainage analysis was only completed for the viable projects that passed on to Phase 2. Through this two-tier screening approach, the time, effort, and expense of doing a more detailed analysis is limited to a smaller number of projects most likely to be included in the Recommended Plan.

5.1.2 HFFRRF Projects for Jamaica Bay

The USACE planning approach supports an integrated approach to reducing coastal risks and increasing human and ecosystem community resilience through a combination of NNBF, non-structural measures and structural measures.

A total of twenty-three (23) HFFRRF projects were delineated and designed. Each project consists of a single or multiple alignment(s), which in turn consist of one single or multiple HFFRRF (s). For ease of reference numerical project IDs were assigned to each project's combination of HFFRRFs. A total of seventeen (17) HFFRRF projects were defined where the design would only include prototypical structural measures (i.e. HFFRRF as described in section 4.2 through 4.11). These are projects 1 through 17, and an overview of these projects is provided in the Table 5-1 below. Maps that display the alignments are included in Sub-Appendix A. An additional six (6) projects were designed for those areas where the structural measures could be integrated with NNBFs. These projects were given the numeric project IDs of 102 through 107.

Not all projects included co-located NNBFs because many of the project locations were not suitable for development of such applications. In order to plan the NNBFs, the site of each flood risk reduction feature was evaluated for the presence and quality of existing sensitive habitats (e.g. tidal marshes, maritime forests, submerged aquatic vegetation). Those sites, or portions of sites,

where healthy wetlands and maritime forests already exist did not require constructed NNBF to perform their CSRM functions, and there was thus no need to cause impacts to the existing high quality habitat. Shorelines where the NNBF conflicted with existing anthropogenic infrastructure, such as docks and marina facilities, were also avoided. NNBFs were also deemed infeasible on shorelines where the localized bathymetry descended rapidly to deep water, or the amount of horizontal space between the flood control feature and the descent to deep water was too narrow to create sufficient marsh to make the NNBF effective and sustainable.

Conversely, shorelines with suitable bathymetry, available horizontal space, and limited existing infrastructure, were deemed suitable for the NNBFs to be included in the HFFRRF design. With regard to habitats, the NNBFs were deliberately targeted to locations where erosion is a concern as evidenced by the fact that wetland habitats have been lost or degraded. In actively eroding shorelines and tidal marshes where the native species have been displaced by invasive *Phragmites*, sometimes known as Common Reed, vegetation management will be necessary since the root structures of *Phragmites* are thick and extensive and could potentially compromise an adjacent berm. Therefore, for those NNBF-suitable locations where *Phragmites* has invaded, the NNBFs were planned to include excavation of the top layers of soil where the *Phragmites* rhizomes exist, and replacement with clean soil and re-establishment of native wetland vegetation species.

It should also be noted that the living shoreline applications represented by these NNBFs represent excellent opportunities to integrate hard-bottom or reef restoration efforts, as oyster reefs, along with other bivalves, to help to manage coastal storm risk. Oyster restoration has been an ongoing effort in Jamaica Bay, which had been one of the most abundant and valuable oyster fisheries in the region up until the 1920s. Recent oyster restoration efforts have been exerted in Jamaica Bay under the Billion Oyster Project (2018), but that project has experienced mixed success. Zarnoch and Schreibman (2012) pointed to challenges including very limited availability of suitable substrate for oyster attachment and growth, and lack of sufficient densities of adult oysters to produce larval stock. However, their study also indicated that water quality was not preventing oyster growth and maturation in the Bay. Oysters (and coral reefs) provide CSRM benefits such as breaking of waves, attenuation of wave energy and slowing inland water transfer (Bridges et al. 2014). In that light, the NNBFs set forth herein, with their stone toe protection/breakwater elements, could represent excellent opportunities to introduce important suitable shellfish reef substrate into the shorelines of Jamaica Bay. The stone rock sill elements could be constructed of material conducive to shellfish attachment and growth and could be covered with a veneer of bagged shellfish shells, or other proprietary shellfish attractant surfaces to help establish a productive reef. In any case, the addition of suitable hard substrate in the littoral areas of Jamaica Bay will provide an excellent resource as a source of perennial shellfish larvae for the bay as a whole.

Additionally, there is an opportunity to place ribbed mussels in these areas, similar to the projects initiated by the New York DEP in 2011, which provided hard structures for ribbed mussel attachment (DEP, 2016). Along with oysters and other shellfish, ribbed mussels provide valuable

filtration services, improving water quality in the bay. They also form the basis of a complex estuarine food web and they increase overall secondary productivity, support a broader and healthier estuarine community thereby supporting several fisheries. By including both oysters and ribbed mussels as target restoration species, there is a higher likelihood that at least one will successfully recruit and reproduce on their own.

Details on the HFFRRF Projects that are inclusive of NNBFs are provided in Table 5-1, and maps displaying the alignments of these projects and the locations for NNBFs are included in Sub-Appendix A. It should be noted that all structural HFFRRF for these projects are identical to the equally named, but differently numbered, projects that include NNBFs; the only difference is the addition of the NNBFs.

Table 5-1: HFFRRF Phase 1 Projects

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
1	Hammels (Queens)	This project consists of a series of floodwalls and is set back from the coastline to minimize conflicts with existing waterfront facilities. A total of six (6) vehicular gates are included to maintain access to the waterfront.[5]		3,100
2	Arverne (Queens)	Project follows the coastline of the Arverne peninsula and includes a total of 11 HFFRRF segments to suit the changing conditions in landscape and land use along the proposed project. Four (4) vehicular gates are included to maintain access to the waterfront industrial sites and marina.[6]		12,300
102	Arverne with NNBF	The Arverne project is enhanced with NNBFs at three locations.		12,300
		1) The north-west corner of the peninsula (Brant Point). Existing habitat include mud flats, high marsh and invasive marsh (*Phragmites*). The proposed NNBF would employ the installation of rock sills off the existing, eroding shoreline to protect the toe of the slope and dampen incoming waves so the existing shoreline could be regraded and potentially extended seaward. The proposed NNBF also includes the removal of the	2A	

[5] This was a conservative estimate and in Phase 2 all but one vehicular gate were switched to road ramps.

[6] This was a conservative estimate and in Phase 2 all but one vehicular gate were switched to road ramps.

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
		Phragmites and expansion/restoration of the intertidal wetland habitat and high marsh. The existing upland maritime forest between the berm feature and the wetlands are to remain undisturbed.		
		2) At the north-east corner of the peninsula where there is currently a narrow beach (DuBois Point), between Beach 69th and just east of Beach 65th Street a NNBF is proposed that includes the construction of rock sills to create an intertidal flat. Further upslope and to the east intertidal marsh can be restored. The existing upland maritime forest is to remain undisturbed.	1A	
		3) To the east of Marina 59, much of the existing marsh along the shoreline is dominated by *Phragmites*. The proposed NNBF includes restoration of an intertidal flat, supported by rock sills, and excavation of the *Phragmites* such that intertidal and high marsh can be restored.	2B	
3	Edgemere (Queens)	Project consists out of two approx. 3,000 foot segments, i.e. a medium floodwall for the west side and a high berm on the east side of the peninsula. One vehicular gate is included to maintain access to the waterfront.		6,300
103	Edgemere with NNBF	On the east side of the Edgemere neighborhood the proposed NNBF would restore and further enhance existing wetland habitat. A large area of wetland habitat is proposed to be restored and created between the HFFRRF high berm and the newly constructed rock sill, just off of the existing coastline. The proposed NNBF includes the removal of the *Phragmites* and restoration of the intertidal habitat and high marsh such that both type 2A and type 2B are implemented.	2A/2B	6,300
4	Norton Basin (Queens)	Project follows the coastal edge of Norton Drive and consist of approximately 2,400 foot segment of floodwall.		2,400
104	Norton Basin with NNBF	At Norton Basin the proposed NNBF includes creation/restoration of the intertidal habitat and high marsh adjacent to Norton Drive. The wetland habitat and appropriate grades along the extended shoreline would be supported by the construction of a rock sill in the water side	1A/2A	2,400

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
		and construction of a medium floodwall on the landward side.		
5	Bayswater Park (Queens)	This project consists of an approximately 1,400 foot long berm that follows the coastal edge.		1,500
105	Bayswater Park With NNBF	Although currently healthy upland maritime forest exists at this location, there is an opportunity to enhance the HFFRRF with the creation of additional wetland habitat. The proposed NNBF includes the removal of *Phragmites* and restoration of the intertidal marsh. A rock sill would be constructed to support an extension of the existing shoreline. The existing upland maritime forest is to remain undisturbed.	1A/1B	1,500
6	Motts Basin S (Queens)	Project follows the southern perimeter of Motts Basin residential neighborhood as well as the low lying coastline of the Long Island Power Authority substation and the Inwood material terminal.		3,800
106	Motts Basin S With NNBF	For Motts Basin South an opportunity exists to enhance wetland habitat between Dickens Street and Pinson Street on the water side of the proposed HFFRRF. In the horizontal direction there are few constraints at this location, and the proposed NNBF includes extension of the shoreline and restoration of the intertidal and high marsh.	2A	3,800
7	Motts Basin N (Nassau County)	Project follows a short section of roadway (Waterfront Blvd.) in Nassau County set back from the northern perimeter of Motts Basin. Construction of a low floodwall would reduce the risk of coastal flooding of residential and commercial parcels on the north side of Motts Basin		700
107	Motts Basin N With NNBF	Similarly as with Motts Basin South, good conditions exist to enhance the HFFRR-Feature with NNBFs and habitat restoration. The proposed NNBF includes extension of the shoreline and restoration of the intertidal and high marsh.	1A /2A	700
8	Inwood Marina (Nassau County)	This project provides flood risk reduction to the residential neighborhood to the east of the		2,700

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
		Inwood Marina. Two (2) vehicular gates are included to maintain waterfront access.		
9	Head of Bay Gate (Queens / Nassau County)	Equal to the alternative as proposed in Appendix A2 of the GRR, a storm surge barrier at this location would provide flood risk reduction for low lying coastal areas at the far eastern extent of Jamaica Bay and along adjoining waterbodies in Nassau County. A barrier at this single location could reduce risk for the extensive area for eastern end of Jamaica Bay. (If this barrier is deemed not viable, additional smaller projects provide options for isolated areas, as included in project 12 through 16 below.)		3,000
10	Old Howard Beach (Queens)	Similar to the alternative as proposed in Appendix A2 of the GRR, storm surge barriers at both Shell Bank Creek and Hawtree Basin and connecting HFFRRF to tie the alignment in to higher ground would provide flood risk reduction for the Howard Beach area.		3,700
11	Canarsie (Brooklyn)	This project includes flood risk reduction features along Fresh Creek such that the lowest portions of the shoreline would be elevated. Revetments would be placed where revetments currently exist. A floodwall is proposed to be constructed along a portion of E 108th Street.		2,700
12	Cedarhurst-Lawrence (Nassau County)	This project follows a section of the Nassau Expressway with a low floodwall for approximately 1,100 feet.[7] The project also includes two sections of bulkhead on either side of the canal next to the Lawrence High School. A short section of floodwall connects the bulkhead on the west side to high ground.		1,800
13	Meadowmere (Queens)	The Meadowmere alignment consists of a 3,700 foot length of bulkhead around the northern end of the Meadowmere Park Island. A low berm (650 ft) on the west side and a floodwall (1300) on the east side connect the		6,700

[7] This section was later removed as an unrelated road raising project will provide a flood barrier in this area.

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
		bulkhead to a 1,000 foot long revetment on the southern end of the island.		
14	Meadowmere N (Queens)	This project provides flood risk reduction to the residential neighborhoods along Bayview Avenue and Broad Street in the Meadowmere area. The alignment consists a 1,000 foot berm (700 foot high and 300 foot low berm) and approximately a 3,700 foot bulkhead.		4,800
15	Meadowmere E (Queens)	This project consists of a 1,600 foot bulkhead around the peninsula parallel with 1st and 3rd Streets off of Rockaway Boulevard.		1,600
16	Rosedale (Queens)	The Rosedale project is a 1,900 floodwall that connects Brookville Boulevard in the south and high ground further north.		1,900
17	Broad Channel (Queens)	This project consists of urban bulkheads and road raisings on the west side of the island and berms and road raisings on the east side. There are also berms around two parks, at the northern and southern ends of the island. The project also has a 1,600 foot breakwater off of the west side of the island.		28,700

***NNBF TYPES ARE AS FOLLOWS PER DESCRIPTION IN SECTION 4.12.1**
NNBF TYPE 1A – SHORELINE EXTENSION WITH INTERTIDAL MARSH
NNBF TYPE 1B – SHORELINE EXTENSION WITH INTERTIDAL AND HIGH MARSH
NNBF TYPE 2A – SHORELINE EXCAVATION FOR *PHRAGMITES* REMOVAL WITH INTERTIDAL MARSH
NNBF TYPE 2B – SHORELINE EXCAVATION FOR *PHRAGMITES* REMOVAL WITH INTERTIDAL AND HIGH MARSH

5.2 Phase 1 Project Costs

Project costs were estimated following the completion of the conceptual design for each project inclusive of structural features and NNBFs. Project cost include the construction cost, Pre-construction Engineering and Design (PED), construction administration, Operations and Maintenance (O&M) cost and contingencies. The details with respect to establishing the total project cost estimates for Phase 1 are documented within Sub-Appendix C. Table 5-2 below provides an overview of the project costs for the Phase 1 projects. As noted previously, the project cost developed for Phase 1 did not include real estate cost or mitigation cost.

Table 5-2: Total Preliminary Project Cost for All Projects without and with inclusion if Natural and Nature Based Features—used for Preliminary Screening

Project ID	Project Name	Perimeter Length (ft)	Total Project Cost (Q4 2017 price level)*
1	Hammels	3,100	$17.2 M
2	Arverne	12,300	$58.1 M
102	Arverne with NNBF	12,300	$69.6 M
3	Edgemere	6,300	$25.8 M
103	Edgemere with NNBF	6,300	$34.2 M
4	Norton Basin	2,400	$13 M
104	Norton Basin with NNBF	2,400	$20.7 M
5	Bayswater Park	1,500	$1.3 M
105	Bayswater Park with NNBF	1,500	$5.2 M
6	Motts Basin South (S)	3,800	$21.9 M
106	Motts Basin South with NNBF	3,800	$25.8 M
7	Motts Basin North (N)	700	$1.7 M
107	Motts Basin North with NNBF	700	$5.9 M
8	Inwood Marina	2,700	$13.1 M
9	Head of Bay Gate	3,000	$787.9 M
10	Old Howard Beach	3,700	$259.4 M
11	Canarsie	2,700	$8.4 M
12	Cedarhurst-Lawrence	1,800	$8.4 M
13	Meadowmere	6,700	$44.3 M
14	Meadowmere North (N)	4,800	$34.8 M
15	Meadowmere East (E)	1,600	$14.1 M
16	Rosedale	1,900	$10.3 M
17	Broad Channel	28,700	$287.8 M

*Does not include real estate nor mitigation costs

5.3 Preliminary Screening of the HFFRRF Project Alternatives

In support of the first round of screening of the HFFRRF projects the economic benefits were analyzed. Benefits modeling is detailed in the Economics Appendix (Appendix B), the Benefit Cost Ratio (BCR) of each of the alternatives was calculated and the project characteristics were tabulated to facilitate screening. Screening results are presented in Table 5-3.

All projects where NNBFs had been identified were included in the preliminary screening with NNBFs, except for Motts Basin North. For Motts Basin North further analysis of the existing habitat showed high quality mudflats, with mussel reefs. This is an existing NNBF and conversion

to intertidal marsh would negatively impact the existing habitat with a habitat transfer. As such, the NNBF part of the Motts Basin North design was screened out.

For more than half of the Phase 1 projects the BCR was well below unity, i.e. Bayswater, Norton Basin, Motts Basin South, Inwood Marina, Head of Bay Gate, Meadowmere, Meadowmere North, Meadowmere East, Rosedale and Broad Channel. Without consideration of real estate cost the annualized costs exceed the benefits, and as a result these projects were screened out and not carried forward for further analysis. Conversely, Canarsie, Cedarhurst-Lawrence, Hammels, Arverne and Edgemere have BCRs above unity, resulting in a positive screening outcome.

Finally, the Old Howard Beach project has a positive BCR (1.0) but its total project costs are estimated to exceed the $259 Million shown in Table 5-2. First, the calculated BCR is currently at unity while a key assumption of the Phase 1 screening is that real estate cost and a detailed interior drainage analysis have not yet been included. Hence, if this project would advance to the second phase of analysis, the project costs are likely to increase, and the BCR would decrease below unity. Secondly, given that the storm surge barrier for Jamaica Bay is still recommended for further study – and the HFFRRF Feasibility Study's goal is to reduce flood risk in anticipation of the construction of a storm surge barrier and thereby reduce the need for frequent operation (and as such reduce storm surge barrier O&M cost) – it does not seem to be supportable to invest more than $260 M in this second large civil works project that would incur its own expensive O&M.

Table 5-3: Phase 1 Screening Results. Benefits and Costs in 1,000 of Dollars

Project	Without Project EAD[8]	With Project EAD	Annual Benefits	Total Project Cost	Annual Cost	Net Benefits	BCR	Passed (Y/N)	Reason for Screening Out	# of Struc-tures
Canarsie	$5,245	$4,001	$1,244	$8,403	$367	$877	3.4	YES		222
Hammels	$6,921	$5,358	$1,563	$17,215	$733	$830	2.1	YES		88
Arverne with NNBF	$23,613	$17,525	$6,088	$69,616	$2,899	$3,189	2.1	YES		715
Motts Basin North	$709	$572	$137	$1,707	$77	$60	1.8	YES		18
Edgemere with NNBF	$13,733	$12,298	$1,435	$34,204	$1,408	$27	1.0	YES	Best buy is with NNBF	702
Old Howard Beach	$32,578	$21,686	$10,892	$259,395	$10,719	$173	1.0	NO	Total cost negates objective	986
Bayswater with NNBF	$312	$296	$16	$5,239	$225	-$209	0.1	NO	BCR <1	9
Norton Basin With NNBF	$458	$429	$29	$20,703	$828	-$799	0.0	NO	BCR <1	19
Motts Basin South with NNBF	$2,510	$2,229	$281	$25,826	$1,055	-$774	0.3	NO	BCR <1	118
Inwood Marina	$1,689	$1,346	$343	$13,059	$553	-$210	0.6	NO	BCR <1	60
Head of Bay Gate	$115,378	$100,956	$14,422	$787,940	$32,423	-$18,001	0.4	NO	BCR <1	1,368
Cedarhurst-Lawrence	$12,649	$9,713	$2,936	$8,401	$352	$2,584	8.3	YES		128
Meadowmere	$2,726	$2,203	$523	$44,330	$1,814	-$1,291	0.3	NO	BCR <1	99
Meadowmere N	$6,917	$6,338	$579	$34,841	$1,399	-$820	0.4	NO	BCR <1	38

[8] Equivalent Annual Damage: This is the annualized damage accounting for changes in expected damage over time – in this case due to sea level change between the base year and the final year of the analysis period.

Project	Without Project EAD[8]	With Project EAD	Annual Benefits	Total Project Cost	Annual Cost	Net Benefits	BCR	Passed (Y/N)	Reason for Screening Out	# of Struc-tures
Meadowmere E	$682	$358	$324	$14,135	$565	-$241	0.6	NO	BCR <1	25
Rosedale	$978	$630	$348	$10,316	$423	-$75	0.8	NO	BCR <1	104
Broad Channel	$11,204	$7,967	$3,237	$287,842	$10,622	-$7,385	0.3	NO	BCR <1	764

5.4 Phase 1 Project Screening Synopsis

During the first phase of screening process in support of the feasibility study for HFFRRF Projects for Jamaica Bay, an initial screening effort was undertaken to identify potentially feasible projects. From the twenty-three (23) projects analyzed a select set of six (6) HFFRRF projects were carried forward into the Phase 2 analysis. The Hammels, Arverne and Edgemere projects were combined going into Phase 2 because all three projects passed the initial screening and their geographic proximity and adjoining storm water sewer sheds justifies aggregation of these project areas into one larger project area. These three projects aggregated and the project was renamed to "Mid-Rockaway Jamaica Bay with NNBFs."

6 PHASE 2 PROJECT SCREENING

6.1 Introduction

Upon completion of the Phase 1 screening as presented in Chapter 5, the second Phase of the two-tier screening approach was initiated. Phase 2 included a more time consuming and resource intensive interior drainage analysis for the smaller number of viable projects passing out of Phase 1. As a result of Phase 1 the following low lying coastal neighborhood areas were identified as areas where High Frequency Flood Risk Reduction Features (HFFRRF) could be implemented and further refinement was warranted to complete the feasibility level study:

1. Mid-Rockaway Backbay with NNBFs, which includes Hammels, Arverne, and Edgemere
2. Motts Basin North
3. Canarsie
4. Cedarhurst-Lawrence

These four project locations are graphically presented in Figure 6-1.

Additional analyses were completed in this second phase to progressively converge to higher level of detail after completion of the preliminary screening documented within the previous chapter. The second phase of the screening included:

- An analysis of existing drainage infrastructure and an analysis of impacts to the existing drainage system as a result of the construction of HFFRRF Projects

- A cost estimate to account for modifications to the existing drainage infrastructure and/or construction of new drainage infrastructure as part of the HFFRRF projects

- Analysis of wave-height for the project areas and establishing the required freeboard for the features

- A more detailed analysis of the potential impacts to wetland habitat and a more detailed analysis of the NNBF designs that are part of the screened HFFRRF Projects

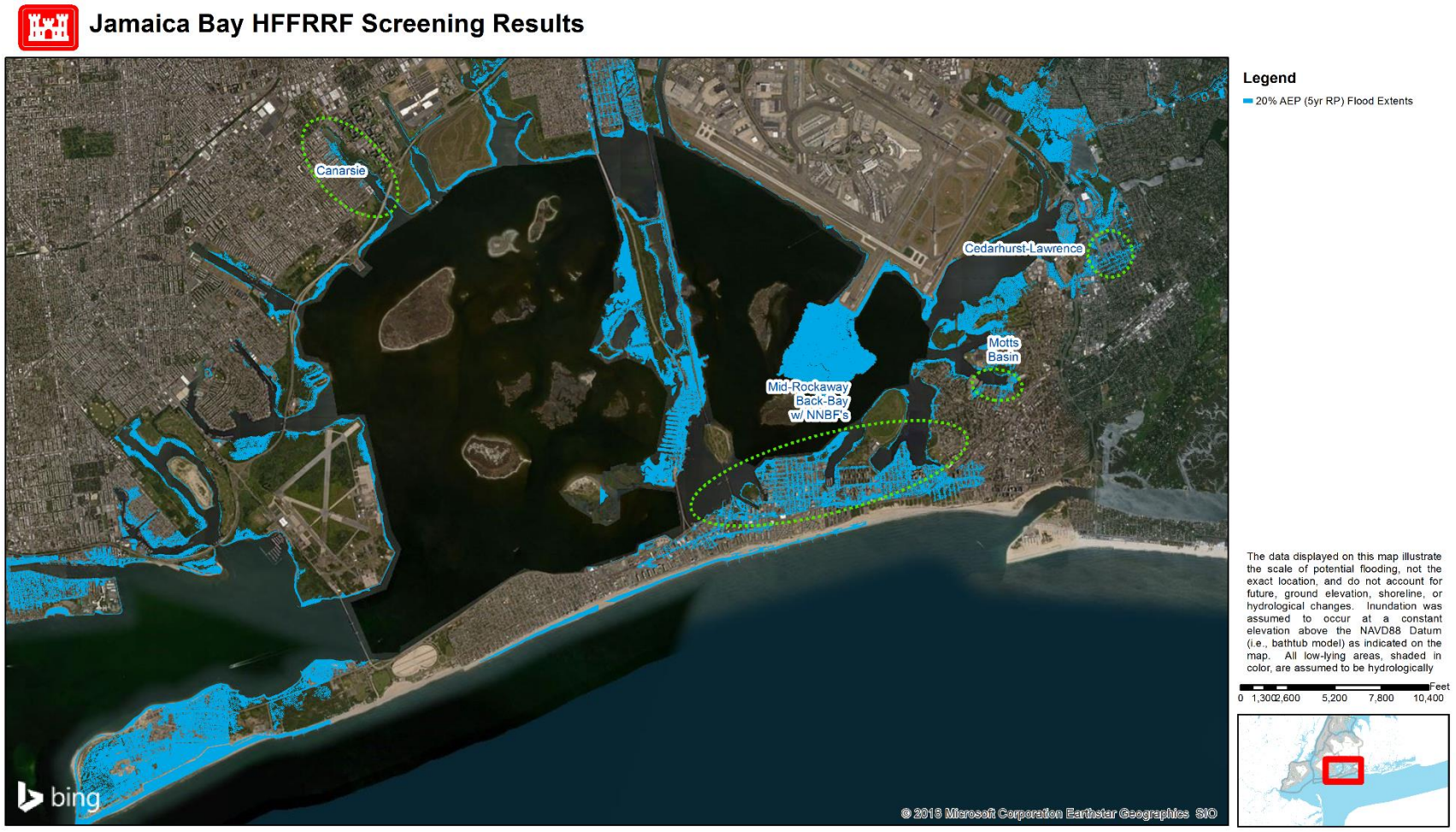


Figure 6-1: Jamaica Bay Inundation Extents for the 20% AEP chance flooding (5-year RP) for the year 2068 and the four (4) project areas for Phase 2 analysis.

6.2 HFFRRF Phase 2 Projects

6.2.1 Phase 2 Project Refinement and Interior Drainage

A total of four (4) HFFRRF projects were delineated and refined during the second phase of the HFFRRF feasibility study. Each project consists of a single or multiple alignment(s), which in turn consist of one single or multiple HFFRRF. During Phase 2 the alignments and feature types of the projects were updated and modified where needed as a result of ongoing refinement of the designs. The most notable difference compared to the Phase 1 screening was the completion of the interior drainage analysis (documented in Sub-Appendix D) for the Phase 2 projects.

As stated in U.S. Army Corps of Engineers EM 1110-2-1413, "Hydrologic Analysis of Interior Areas", the design Minimum Facility should provide interior flood relief such that during low exterior stages (at gravity conditions for normal astronomic tide) the local storm drainage system (typical 10-year design storm) functions essentially as it would without the Coastal Storm Risk Management System in place.

The Minimum Facility is intended to ensure that the existing drainage system performs the same with and without the project put in place as to avoid induced flood damages. This is the starting point from which all additional interior drainage alternatives can be evaluated. Additional interior drainage measures may be designed to further reduce interior water levels beyond the Minimum Facility. These additional interior facilities must be incrementally justified. For each project area and within each interior drainage subbasin, the economics for a series of alternative interior drainage measures were evaluated to determine the alternative providing the highest level of net benefits to the individual project areas. Sub-Appendix E includes the Interior Drainage analysis.

6.2.2 Phase 2 Project Descriptions

Additional refinements to the project designs were a result of many factors, including but not limited to Non-Federal sponsor feedback, adjustments to accommodate interior drainage and storage capacity considerations, and minimization of impacts to wetland habitat. As detailed in Chapter 4, specific features such as the Hybrid Berm and the Road Ramp were developed to allow for project design refinement and improve overall completeness and acceptability of each project. In addition, the NNBF designs moved away from the more generic prototypical application from Phase 1 and towards site specific NNBF designs in Phase 2 (see also section 4.12). Furthermore, wave-heights were assessed in more detail on a site-by-site basis, which allowed for the refinement of project elevations as well as an update to the rock sill design which is part of the NNBF. The Phase 2 wave modeling is documented in Sub-Appendix D.

Brief descriptive overviews of the Phase 2 refined projects are provided in Table 6-1. Maps displaying the project alignments and extents are included in Sub-Appendix B. A detailed

overview of the pump station capacities, new outfalls and outfall modifications is included within Sub-Appendix E and a summary is provided in Table 6-2.

Table 6-1: HFFRRF Phase 2 Projects

ID	Project Name (Borough or County)	Notes	Length [ft]
1	Mid-Rockaway Backbay with NNBFs (Queens)	This project area includes the Edgemere, Arverne, and Hammels project alignments from Phase 1. Of the previously used eleven (11) vehicular gates all but one has been replaced with road ramps.	22,700
	Hammels	The Mid-Rockaway Backbay HFFRRF project alignment that consists out of approximately 2,550 ft of Low Floodwall and a total of six road ramps that provide risk reduction to the Hammels area. Three (3) new outfalls (5 ft x 3 ft) are included within the project. The three (3) existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge to result in flow reversal and cause flooding through the drainage system. In addition, two (2) new pump stations are included within the design.	
	Arverne	The Mid-Rockaway Backbay HFFRRF project alignment the follows the coastal edge of Arverne and constitutes of multiple HFFRR-Features to best match the existing shoreline conditions as well as minimizing impacts. The alignment consists of the construction of approximately 3,170 ft of Low Floodwall, 480 ft of Medium Floodwall, 440 ft of High Floodwall, 2,490 ft of Low Berm, 580 ft of hybrid Berm, 3,950 ft of Bulkhead and 990 ft of Revetment as well as three areas where NNBFs are integrated into the design (discussed below separately). Three (3) road ramps and one (1) vehicular gate are included to maintain access to the waterfront. Eight (8) existing outlets will be modified to add a valve chambers that will include a sluice gate and flap valve to prevent high tides or storm surge to result in flow reversal and cause flooding through the drainage system. Eight (8) new outfalls (5 ft x 3 ft) are included within the project. In addition, three (3) new pump stations are included within the design.	
	Arverne NNBF description	Arverne 1) The north-west corner of the Arverne peninsula (Brant Point). Existing habitat include mud flats, intermediate and high marsh with some fringes of invasive marsh (*Phragmites*). The proposed NNBF would employ the installation of rock sills off the existing, eroding shoreline to protect the toe of the	

	slope and dampen incoming waves so the existing shoreline could be regraded and potentially extended seaward. The proposed NNBF also includes the removal of the *Phragmites* and creation/restoration of the intertidal wetland habitat and high marsh. Some existing uplands features are to be regraded to high marsh. A portion of the existing upland maritime forest between the berm feature and the wetlands are to remain undisturbed and expanded where practical.
Arverne NNBF description	Arverne 2) At the north-east corner (CS-103) of the peninsula where there is currently a narrow beach (DuBois Point), in between Beach 69th and just east of Beach 65th Street a NNBF is proposed that includes the construction of rock sills to create an intertidal flat and replanting with smooth cordgrass (low marsh). The rock sills provide an excellent habitat for attached fauna such as ribbed mussels and shellfish, which help to attenuate wave action. Based on coordination with local and state agencies conducting shellfish (i.e. ribbed mussel) restoration in Jamaica Bay, we will consider in the final design, additional options of materials or techniques (such as pre-seeding mats with bivalves) to ensure success. Further upslope and to the east intertidal marsh can be regraded to provide high marsh habitat adjacent to the existing upland habitats providing a buffer in anticipation of rising sea-level.
Arverne NNBF description	Arverne 3) To the east of Marina 59, much of the existing intertidal marsh along the shoreline is healthy low and intermediate marsh with some fringes infested by *Phragmites*. The proposed NNBF includes restoration of an intertidal flat, protected by rock sills, and regrading of the higher elevations areas to accommodate the establishment of intertidal marsh similar to the adjacent natural marsh areas. The rock sills provide an excellent habitat for attached fauna such as ribbed mussels and shellfish, which help to attenuate wave action.
Edgemere	The Mid-Rockaway Backbay HFFRRF project alignment then follows the coastal edge of Edgemere where a series of HFFRR-Features are interlinked to form the perimeter line of risk reduction to best match the existing shoreline conditions and avoid and minimize impacts. This area also includes two areas where NNBFs are implemented, one on the east and one on the west side of the peninsula (descriptions provided below. The alignment consists out of approximately 480ft of Medium Floodwall, 660 ft of high floodwall, 1,510 ft of Low Berm, 2,060 ft of Medium Berm, 80 ft of High Berm, 2,260 ft of Hybrid Berm and 440 ft of Bulkhead. One (1) road ramp is included to

		maintain access to the waterfront. Three (3) existing outlets will be modified to prevent high tides or storm surge to result in flow reversal and cause flooding through the drainage system. Twelve (12) new outfalls (5 f tx 3 ft) are included within the project and three (3) new pump stations are included within the design.	
	Edgemere NNBF description	Edgemere 1) On the west side of the Edgemere neighborhood, the proposed NNBF design with the establishment of the rock sill, will protect some of the existing eroding wetlands habitats, both subtidal and intertidal, and provide for some areas where high Marsh – Scrub/Shrub habitat can be established. The new habitats will also help provide protection for the berm. The rock sills provide an excellent habitat for attached fauna such as ribbed mussels and shellfish, which help to attenuate wave action as well.	
	Edgemere NNBF description	Edgemere 2) On the east side of the Edgemere neighborhood the proposed NNBF would restore and further enhance existing wetland habitat. A large area of wetland habitat is proposed to be restored and created between the HFFRRF berm and hybrid berm and the newly constructed rock sill, just off of the existing coastline. A hybrid berm was selected in many locations as feature here are placed as far upland to minimize the impacts on the existing wetlands. It allows for minimal habitat impacts and provides space for additional natural habitat development which protects the berm from erosion. The proposed NNBF includes the removal of the *Phragmites* where appropriate, and restoration of the intertidal habitats including planting of smooth cordgrass and high marsh at appropriate elevations, as well as ribbed mussel and reef restoration, which will aid in attenuating wave action.	
2	Motts Basin N (Nassau County)	Project follows a short section of roadway (Waterfront Blvd.) in Nassau County set back from the northern perimeter of Motts Basin. Construction of a low floodwall would reduce the risk of coastal flooding of residential and commercial parcels on the north side of Motts Basin	700
3	Canarsie (Brooklyn)	This project includes flood risk reduction features along Fresh creek such that the lowest portions of the shoreline would be elevated. Revetments would be placed where revetments currently exist. A floodwall is proposed to be constructed along a portion of E 108th Street.	2,800

4	Cedarhurst-Lawrence (Nassau County)	This project includes a section of bulkhead around the end the basin/canal that is situated to the north of Johnny Jack Park and west of the Lawrence High School. As well as small section of floodwall to connect the bulkhead on the west side to high ground. When the existing drainage outlets are blocked by high tail waters a storm drain system will direct runoff towards a new pump station. The preliminary pump station capacity is estimated to be approximately 40cfs.	1,000

Table 6-2: Interior Drainage Infrastructure for Phase 2 HFFRRF Projects

Project Name (Drainage Basin)	Drainage Sub-Basin	Outfall Size	Outfall Location
Mid-Rockaway Backbay with NNBFs (Hammels)	H1	TBD	Existing Outfall ROC-656
	H1	5'x3'	Outfall H1-1, Approximately 70 feet east of Beach 85th Street
	H1	TBD	Existing Outfall ROC-657
	H2	5'x3'	Outfall H2-1, Approximately 350 feet west of Beach 80th Street
	H2	5'x3'	Outfall H2-2, Approximately 100 feet east of Beach 79th Street
	H2	TBD	Existing Outfall ROC-653
Mid-Rockaway Backbay with NNBFs (Arverne)	A1	TBD	Existing Outfall ROC-633
	A1	TBD	Existing Outfall ROC-634
	A1	TBD	Existing Outfall ROC-40062
	A1	5'x3'	Outfall A1-1 located at the end of Hillmeyer Avenue.
	A1	5'x3'	Outfall A1-2 located adjacent to Hillmeyer Avenue and Barbadoes Avenue.
	A1	TBD	Existing Outfall ROC-658
	A1	5'x3'	Outfall A1-3
	A1	TBD	Existing Outfall ROC-659
	A2	5'x3'	Outfall A2-1 located on Bayfield Avenue 150 feet west of Beach 65th Street.
	A2	5'x3'	Outfall A2-2 located at the east end of DE Costa Avenue.
	A2	5'x3'	Outfall A2-3 located at the east end of Burchell Road.
	A3	TBD	Existing Outfall ROC Located at the east end of Thursby Avenue.
	A3	TBD'	Existing Outfall ROC-636

	A3	5'x3'	Outfall A3-1 located 250 north of Beach Channel Drive on 58 Street.
	A3	TBD	Existing Outfall ROC-635
	A3	5'x3'	Outfall A3-2 located 50 north of Beach Channel Drive on 58 Street.
Mid-Rockaway Backbay with NNBFs (Edgemere)	E1	TBD	Existing Outfall ROC-648
	E1	5'x3'	Outfall E1-1 located on Norton Avenue between Beach 47th and 48th Streets.
	E1	5'x3'	Outfall E1-2 located on Norton Avenue between Beach 46th and 45th Streets.
	E1	5'x3'	Outfall E1-3 located on Beach 45th Street north of Hough Place.
	E1	5'x3'	Outfall E1-4 located on the north end of Beach 45th Street.
	E1	5'x3'	Outfall E1-5 located 550 feet north of Hough Place.
	E1	5'x3'	Outfall E1-6 located 500 feet north of Hough Place.
	E1	TBD	Existing Outfall ROC-637
	E1	5'x3'	Outfall E1-7 located north of Beach 40th Street.
	E2	TBD	Existing Outfall ROC-638
	E2	5'x3'	Outfall E2-1 located 50 feet east of Beach 37th Street.
	E2	5'x3'	Outfall E2-2 located 50 feet east of Beach 37th Street.
	E2	5'x3'	Outfall E2-3 located 50 feet east of Beach 36th Street.
	E2	5'x3'	Outfall E2-4 located 50 feet east of Beach 36th Street.
	E2	5'x3'	Outfall E2-5 located between Beach 36th Street and Beach 35th Street.
Motts Basin	L1	TBD	Existing Outfall
Cedarhurst-Lawrence	L1	TBD	Existing Outfall
	L1	TBD	Existing/New Culvert (500 feet from Peninsula Boulevard).
	L1	TBD	Existing/New Culvert (500 feet from Peninsula Boulevard).
	L1	5'x3'	Outfall L-1, Approximately 250 feet from Peninsula Boulevard
Canarsie			Based on the evaluation of the interior water surface elevation and net benefits, no interior drainage plan that would result in a HFFRRF with a BCR above 1.0 was identified. Accordingly there is not a Preferred Drainage Plan identified for the Canarsie drainage basin. Even with the pumps and improved gravity outlet drainage system, flood elevations for a 50% AEP rainfall occurring with the design storm tide are not reduced significantly (see Sub-Appendix E for details)_

TBD: Outfall size To Be Determined, pending surveys during PED

6.2.3 Habitat Restoration and Enhancement to Offset Permanent Impacts

The opportunity to create and/or restore subtidal and intertidal wetlands habitats is one of the key features of the NNBF approach as detailed within this appendix. A series of NNBFs were developed as part of the proposed HFFRRFs to not only control erosion and help manage coastal flood risk, but to provide opportunities for habitat restoration and enhancement to offset unavoidable permanent impacts to federal and state regulated areas. These NNBFs provide the ecological benefits and were incorporated in final design to also recognize future federal, state, and city permitting requirements:

- Restoration and/or creation of both low and high marsh habitats. Specifically, these efforts target the following:
    - Restoration of low marsh habitat in existing mudflat areas proximate to highly erosional shorelines.
    - Restoration and/or creation, as well as enhancement, of high marsh habitat in adjacent uplands that are dominated by common reed (*Phragmites australis*) and other invasive species.
- Creation of rock sill features that provide protection for the subtidal and intertidal habitats, as well as provide a hard bottom habitat for increased ecological production. These features provide additional opportunities for shellfish and ribbed mussel habitat creation.
- Restoration of maritime forest (upland) within upland ruderal and urban habitats that have been significantly impacted by historic and current anthropogenic disturbance. While in upland habitats, these efforts account for anticipated state and city level permitting requirements.

A full analysis of the mitigation is provided in the body of the main report text. Table 6-3 provides an overview of the habitat created. Based on the current HFFRRF alignments and existing habitats, it is estimated that approximately 9.4 acres of new habitat will result from the current configuration, while the permanent impact is estimated at 3.7acres (see main body text, section 6.5 of this GRR/EIS).

Table 6-3: Habitat Created for Mid-Rockaway Backbay with NNBFs in acres

Habitat Type	Restoration/Creation		Enhancement		Total
	Mid-Rockaway Backbay with NNBFs		Mid-Rockaway Backbay with NNBFs		
	Edgemere	Arverne	Edgemere	Arverne	
Intertidal Wetland	3.042	4.606	0.468	-	8.116
Maritime Forest	-	1.348	-	-	1.348
Total	3.042	5.954	0.468		9.464

The designs of the HFFRRF and the habitats created will enhance the ecological resilience of the area by providing a diverse set of habitats that will dynamically change with changing conditions such as sea level rise.

6.3 Phase 2 Project Costs

Project construction costs were estimated once the Phase 2 conceptual design for each project was completed. For Phase 2 the project construction is inclusive of all structural features such as the interior drainage features, pump stations and the HFFRRFs (inclusive of NNBFs). Total project cost include the construction cost, Pre-construction Engineering and Design (PED), construction administration, Real Estate and Operations and Maintenance (O&M) cost and contingencies. The details with respect to establishing the total project cost estimates are documented within the Sub-Appendix C. Table 6-4 below provides an overview of the project costs for the Phase 2 projects.

Table 6-4: Total Project Cost for Phase 2 Projects with inclusion of Natural and Nature Based Features—used for Final Screening

Project ID	Project Name	Perimeter Length (ft)	Project Cost
1	Mid-Rockaway Backbay with NNBFs	22,700	$194 M
2	Motts Basin N	700	$2.6 M
3	Canarsie	2,800	$27.7 M
4	Cedarhurst-Lawrence	1,000	$13.6 M

The inclusion of the costs for drainage infrastructure (new outfalls, modification to existing outfalls and inclusion of pump stations) and real estate increased the project cost compared to the Phase 1 project costs. The Canarsie project cost increased most substantially from $8.4 Million in Phase 1 to $27.7 Million in Phase 2.

6.4 Final Screening of HFFRRF Projects

Along with the refinement of the project designs, the benefits modeling was updated and refined to accurately capture the changes in the project design. The inclusion of interior drainage features and pump stations resulted in changes in residual damages and thus changes in project benefits. After completion of the benefits modeling and interior drainage optimization (see Sub-Appendix E) the Benefit Cost Ratio (BCR) was calculated. Screening results for the Phase 2 projects are presented in Table 6-5.

The results of the Phase 2 screening results, based on BCR, presented in Table 6-5 indicate that three (3) out of the four (4) projects are cost effective. Benefit estimates include the reduced damages as result of coastal flooding as well as a reduction in damages as a result of all interior flooding. The Canarsie project has a BCR below unity and is not selected to move forward. The other three project alternatives will be included within the TSP.

Table 6-5: Phase 2 Screening Results

		Mid-Rockaway Backbay with NNBF's	Canarsie	Cedarhurst - Lawrence	Motts Basin North (no Pumps)
Without Project Damages	Annual Damages	$44,304,000	$4,424,000	$12,655,000	$710,000
With Project Damages	Line of Risk Reduction Damages	$30,585,000	$3,557,000	$6,858,000	$484,000
	Interior Drainage Damages	$1,845,000	$692,000	$643,000	$86,000
	Annual Damages	$32,430,000	$4,249,000	$7,501,000	$570,000
Benefits	Annual Benefits	$11,874,000	$175,000	$5,154,000	$140,000
Costs	Total Project Cost	$194,009,000	$27,675,000	$13,573,000	$ 2,596,000
	Annual Cost	$8,507,000	$1,262,000	$607,000	$111,000
Net Benefits	Net Annual Benefits	$3,367,000	($1,087,000)	$4,547,000	$29,000
	BCR	1.4	0.1	8.5	1.3

6.5 Phase 2 Synopsis

6.5.1 Phase 2 Screening

The second phase of the screening detailed within this chapter included an analysis of existing drainage infrastructure and an analysis of the Minimum Facility, which is intended to ensure that the existing drainage system performs the same with and without the project put in place as to avoid induced flood damages. Project Cost was calculated and included estimates to account for modifications to the existing drainage infrastructure and construction of new drainage infrastructure as part of the HFFRRF projects. In addition a more detailed analysis of the potential impacts to wetland habitat was completed and the project NNBF designs were further refined and planned in co-location with the flood risk reduction features in order to take advantage of their capacity to improve the function and resilience of the structural features.

6.5.2 Phase 2 Projects Selected

In Phase 2 additional analyses were completed to progressively converge to a higher level of detail for the HFFRRF Projects. Four (4) projects were screened and three (3) projects were identified based on a BCR ratio greater than 1.0 (See Table 6-5). However due to changes to the cost estimates resulting from the Cost Certification Review, the estimated cost to construct Motts Basin North increased by approximately 20% as result of an increase in both estimated construction and real estate cost. The increase in cost was due to an increase in the sheet pile quantities for the low-floodwall and the project's sensitivity to an increase in construction cost for this particular HFFRR-Feature. This caused the benefit to cost ratio to decrease below 1.0 and be eliminated from the Recommended Plan as it has negative net benefits and is therefore not economically justified.

In summary, the following two HFFRRF projects were brought forward to the recommended plan:

1. Mid-Rockaway Backbay with NNBFs
2. Cedarhust-Lawrence

7 THE RECOMMENDED PLAN FOR JAMAICA BAY

7.1 The Recommended Plan

The communities surrounding Jamaica Bay experience substantial risk for coastal flooding. Therefore, the study team sought to identify stand-alone project features that could complement a potential future storm surge barrier, but also be economically justified on their own. Residents in many parts of the Jamaica Bay vicinity experience flooding due to high tides that occur frequently. Since a storm surge barrier would not be closed at every high tide, there is an opportunity to recommend features to mitigate flood risk in high frequency tidal flooding events in which the proposed storm surge barrier would remain open.

Low lying coastal neighborhood areas within Jamaica Bay were identified as areas where High Frequency Flood Risk Reduction Features (HFFRRF) could be implemented. Features that provide a flood risk reduction function were developed and designed to generate project alternatives that would reduce the risk of flooding from high frequency storm events. The future (year 2068) 20% AEP stage elevation is selected for this study[9]. The 20% AEP stage elevation, albeit spatially variable, is approximately equal to an elevation of +7 feet NAVD88 for the study area. HFFRRF include, amongst others, floodwalls, berms, bulkheads and revetments. With ground elevations varying, prototypical HFFRRF heights (measured from ground elevation) range between 3 feet and 8 feet.

Project alignments were defined through an approach that generally selected and placed HFFRRF along the coastal edge while protecting as many existing assets as was practically feasible. Projects were developed by considering realistic project extents, where the determination of a realistic project extents was established based on shoreline type, length, topography, neighborhood, land use, planning considerations, project scope, inundation extents, flooding pathway, and existing topography.

Two phases of feasibility design, analysis and project screening on cost and benefit was performed to evaluate viable economically justified stand-alone projects. Two (2) projects were selected to be included within the Recommended Plan:

1. Mid-Rockaway Backbay with NNBFs
2. Cedarhurst-Lawrence

Detailed plans for the projects and sections for the HFFRRF that are included within the Recommended Plan are provided in Sub-Appendix F.

[9] The future 20% AEP (5 year Return Period in 2068) amounts to a 10% AEP in 2018, or a 10 year Return Period stage elevation.

7.1.1 Mid-Rockaway Backbay with NNBFs

The Mid-Rockaway Backbay with NNBFs project consists of a risk reduction alignment that encompasses three (3) neighborhoods on the coastal edge of Jamaica Bay between Beach 35th Street and Beach 88th Street in Queens, NY. For ease of reference the three areas are described separately.

Hammels: A HFFRRF project alignment that consists of approximately 2550 feet of Low Floodwall and a total of six road ramps provides risk reduction to the Hammels area (Figure 7-1). Three (3) new outfalls (5ft x 3ft) at Beach 85th, Beach 80th and Beach 79th Street are included within the project. The three (3) existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge to result in flow reversal and cause flooding through the drainage system. In addition, two (2) new pump stations are included within the design: one 100 cfs pump station at the end of Beach 87th Street, and one 180 cfs pump station near the intersection of Beach Channel Drive and Beach 78th Street.

Arverne: The project alignment follows the coastal edge of Arverne and consists of multiple HFFRRF to best match the existing shoreline conditions and minimize impacts. The alignment consists of the construction of approximately 3170 feet of Low Floodwall, 480 feet of Medium Floodwall, 440 feet of High Floodwall, 2490 feet of Low Berm, 1140 feet of Medium Berm, 580 feet of Hybrid Berm, 3950 feet of Bulkhead, and 990 feet of Revetment as well as three areas where NNBFs are integrated into the design (Figure 7-2). Wetland habitat is created in co-location with the berms. Since the NNBFs are located on the unprotected side of the HFFRRF, the toe protection features and bands of tidal wetland vegetation included in the NNBFs will act to dampen incoming waves during storm conditions and reduce the risk of overtopping. The NNBFs also present an opportunity to re-establish sub-tidal, intertidal and supratidal habitats to create a nature based shoreline that is resilient to both moderate storm events and encroaching sea level and will allow for the migration of these natural features shoreward, increasing the lifetime of the habitats. As part of the project eight (8) existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge to result in flow reversal and cause flooding through the drainage system. Eight (8) new outfalls (5ft x 3ft) are included within the project. In addition, three (3) new pump stations are included within the design. The pump stations are preliminarily located within the vicinity of the intersection of Beach 72nd street and De Costa Avenue, north of De Costa Avenue just east of the intersection of Beach 63rd Street and De Costa Avenue, and at the eastern end of Thursby Avenue. Furthermore, three (3) road ramps and one (1) vehicular gate are included to maintain access to the waterfront.

Edgemere: The project alignment follows the coastal edge of Edgemere and includes two areas, one on the east and one on the west side of the peninsula, where NNBFs are implemented (Figure 7-3). A series of HFFRRF are interlinked to form the perimeter line of risk reduction to best match the existing shoreline conditions and avoid and minimize impacts. The alignment consists of approximately 480 feet of Medium Floodwall, 660 feet of high floodwall, 1510 feet of Low Berm, 2060 feet of Medium Berm, 80 feet of High Berm, 2260 feet of Hybrid Berm, and 440 feet of

Bulkhead. One (1) road ramp is included to maintain access to the waterfront. Three (3) existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge to result in flow reversal and cause flooding through the drainage system. Twelve (12) new outfalls (5ft x 3ft) are included within the project. In addition, three (3) new pump stations are included within the design. Due to the size of the area and difficulties in draining all of the drainage area to a single site, one of the drainage subbasins (E1) is proposed to have two pump stations. One pump station would be located near Norton Avenue and Beach 49th Street, and the other would be near Beach 43rd Street and Hough Place, with a combined capacity of approximately 210 cfs. A third pump station drains the remainder of the Edgemere area and is proposed to be located near Beach 38th Street with an estimated capacity of 120 cfs.

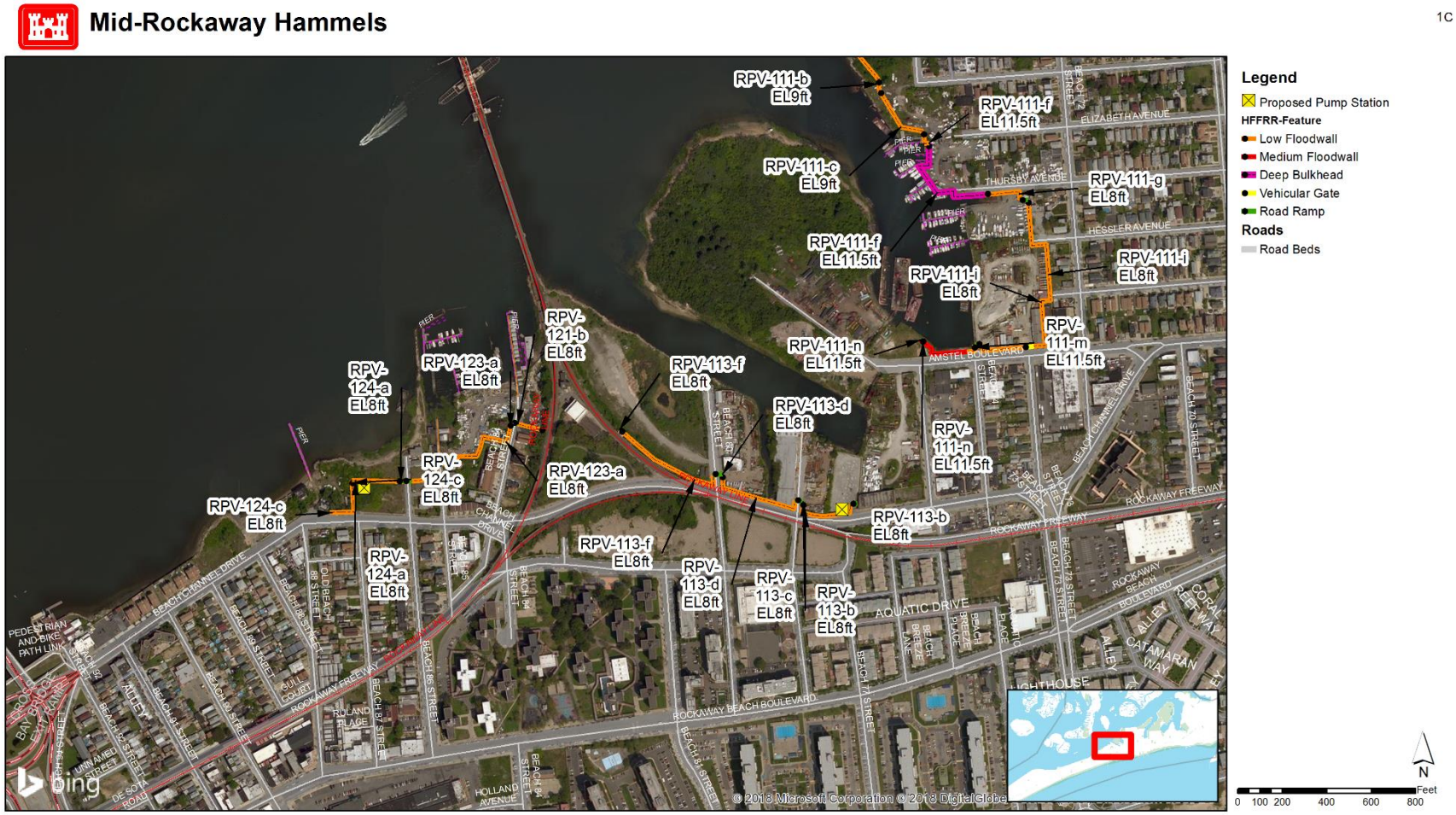


Figure 7-1: Mid-Rockaway Backbay with NNBFs – Hammels Vicinity

Figure 7-2: Mid-Rockaway Backbay with NNBFs – Arverne Vicinity

Figure 7-3: Mid-Rockaway Backbay with NNBFs – Edgemere Vicinity

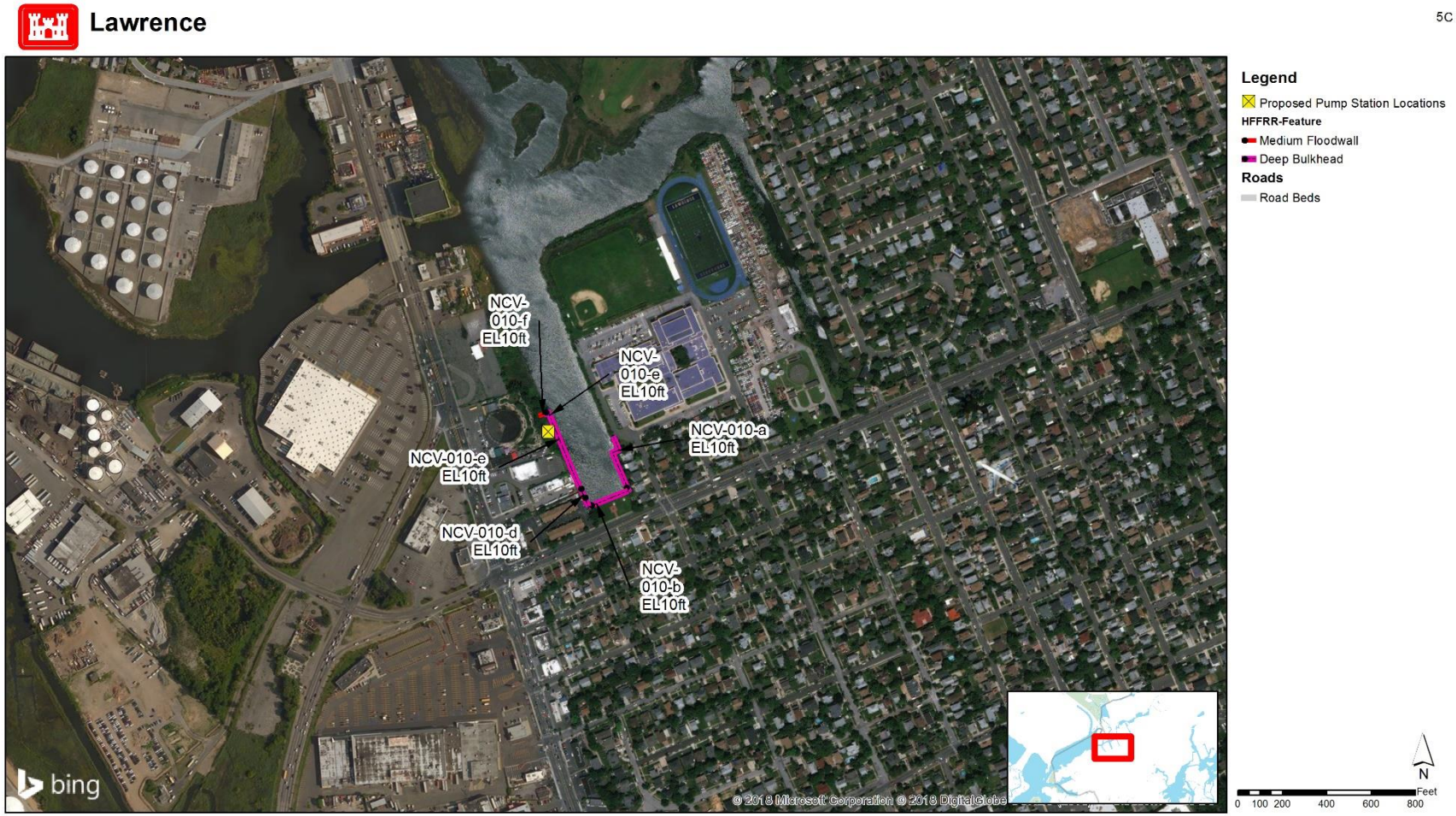


Figure 7-4: Cedarhurst-Lawrence

7.1.2 Cedarhurst-Lawrence

The Cedarhurst-Lawrence project is located in Nassau County and crosses the border between the Village of Cedarhurst and the town of Hempstead. The project alignment follows the edge of the basin/canal that is situated to the north of Johnny Jack Park and to the west of the Lawrence High School. The project alignment follows the water's edge and includes approximately 960 feet of Bulkhead and a short section of approximately 25 feet of Medium Floodwall. There are three (3) existing outfalls in the area where the bulkhead will be raised. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. When the drainage outlets are blocked by high tides, a storm drain system will direct runoff towards a new pump station. The preliminary pump station capacity is estimated to be approximately 40 cfs, and will be situated at the north-eastern end of the project area as shown in Figure 7-4.

7.2 Quantities and Cost

Cost estimates for the Recommended Plan were developed at an April 1st 2018 price level for labor, material and equipment. The material quantities for the Recommended Plan have been developed from the plans shown in Sub-Appendix F, and full details on the development of the Recommended Plan cost estimate are provided within Appendix C. The MII Estimate is included in Appendix C and includes the details of the estimate including the different tasks required to complete the construction. Details provided for these tasks include the production rate of the crews and the crew composition, including the equipment used and the number and description of labor categories required. To estimate the cost of the pump stations, cost curves were used. The cost risk analysis determined the contingency to be 28.36%, making the total project cost (fully funded) $261.6 million for budgeting purposes. The Civil Work Breakdown Structure (CWBS) feature codes as shown in Table 7-1 are utilized to establish the project cost. The project cost presented in Table 7-1 are a summary of the detail in Appendix C.

Table 7-1: MII Estimate Recommended Plan – HFFRRF for Jamaica Bay

CWBS account code #	HFFRRF Project Account Code Description	Total Project Cost (Fully Funded)
	Mid-Rockaway Backbay with NNBFs	**$199,798,000**
01	Lands and Damages	$17,687,000
02	Utility Relocations	$5,636,000
11	Levees and Floodwalls	$127,473,000
13	Pump Stations	$47,256,000
18	Cultural Resource Preservation	$1,746,000
	Cedarhurst-Lawrence	**$15,208,000**
01	Lands and Damages	$915,000
02	Utility Relocations	$238,000
11	Levees and Floodwalls	$9,214,000
13	Pump Stations	$3,809,000
18	Cultural Resource Preservation	$1,032,000
30	Pre-Construction Engineering and Design	$23,545,000
31	Construction Management	$13,054,000
	Total	**$251,605,000**

7.3 Construction Schedule

The construction schedule for the Jamaica Bay Reach is included in Appendix C. The total duration is approximately 46 months. Figure 7-5 shows the current construction schedule for the 2 projects that are part of the recommended plan.

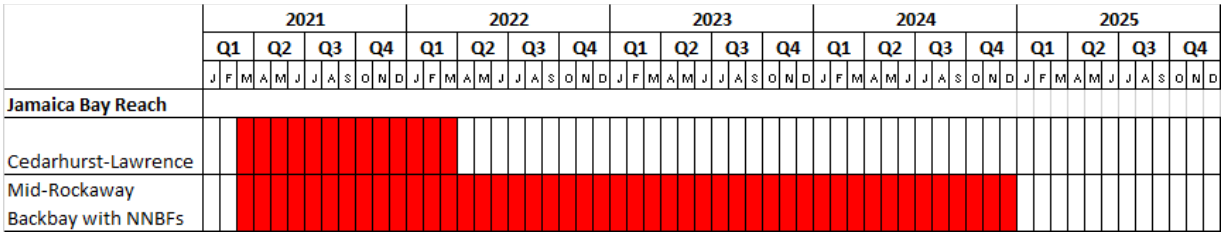


Figure 7-5: Schematic overview of the construction schedule for the Jamaica Bay Reach of the Recommended Plan

7.4 Recommendations for PED

This Engineering & Design Appendix provides an overview of the analyses supporting the development of the HFFRRF for Jamaica Bay. This appendix furthermore describes the development of HFFRRF Projects and a screening analysis of these projects to establish a feasible plan to mitigate for high frequency flood risk in Jamaica Bay. Based on the data gathered during the feasibility study and engineering analyses, a preliminary design for the HFFRRF projects has been completed. It should be noted that HFFRRF designs are prototypical in nature and are not site-specific designs. The dimensions and sizing of the individual features in this study are preliminary, based on the study area conditions and sufficient for feasibility level study. It is expected that HFFRRF designs would be further refined in PED. The preliminary designs shall not be construed as requirements for actual dimensions for implementation. Significant additional engineering analysis is required to substantiate the designs of the flood risk reduction features, the drainage infrastructure and the pump stations including, but not limited to, a full evaluation of topographical and bathymetric elevations, subsurface soil conditions, inventory and investigation of existing structures and utilities. More details regarding recommendations are provided below.

7.4.1 Component Revisions and Analyses

It can be noted that based upon the review of the proposed project during the feasibility phase, DEC will require further justification or component revisions to ensure the protection of water quality, habitat quality, and public access during the PED Phase.

Of special note is also the analysis of the adaptability of the HFFRRF projects in the face of changing sea levels. Feature heights will be finalized during the PED phase and additional analysis is recommended to document the adaptability of the projects under the consideration of sea level rise scenarios. The HFFRRF have been designed for future 20% AEP water levels with consideration of the intermediate SLC scenario. If the realized SLC exceeds the design SLC and closely resembles the USACE high SLC scenario, then adaptation is expected to be required in the year 2044 for those feature that provide the flood risk reduction function. In general there are two adaptability options: 1) With a storm surge barrier for Jamaica Bay in place; operate the storm surge barrier more frequently and 2) Without a storm surge barrier in place; address larger wave overtopping volumes with collection systems and/or pumps and retrofit HFFRRF features to allow for an increase in elevation.

In addition, rock sills and the NNBFs are considered to be adaptable. The placement of additional stone over time allows for an increase in crest elevation of rock sills with sea level rise in the event that realized RSLC exceeds the projection. The designs also include an expectation that the protected habitats behind the sill features would migrate shoreward and the fill/cut elevations chosen in most cases are designed to allow for that migration. Thus, the NNBFs proposed herein are intrinsically adaptive features and consist of improved wetland habitats and a more natural shoreline that can migrate with rising sea levels in the future.

Finally, albeit that the HFFRRF elevations exceed the year 2018 10% AEP water levels, over time, and with rising sea levels is not expected that all HFFRRF elevations will be above furtur 10% AEP water levels. Finally, in all instances the 1% AEP water level is expected to exceed the lowest HFFRR-Feature elevation and therefore the project elevation. The reader is referred to Figure 7-6 for a graphic representation of the adaptability of HFFRRF Projects. A revised and detailed analysis of adaptability is recommended for the PED phase.

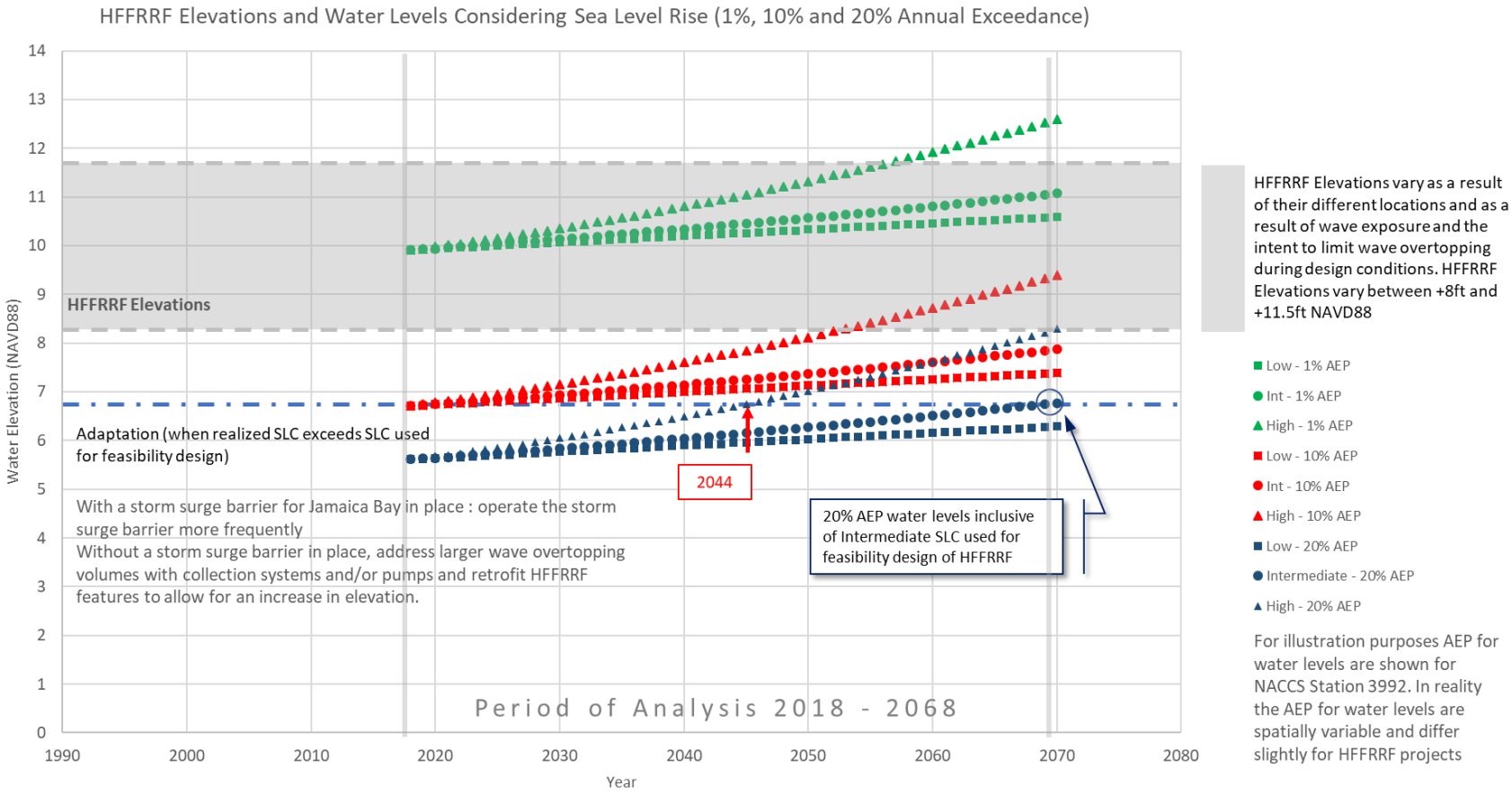


Figure 7-6: Graphic Presentation of Adaptability of HFFRF Projects

7.4.2 Recommended PED Analyses

A preliminary, non-exhaustive listing of potential future engineering analyses and design refinements for PED include the following:

- Geotechnical data collection (site specific borings and geotechnical data collection),
- Bathymetric and topographic data collection,
- Utility survey and an inventory and condition assessment of existing structures and utilities for the project area,
- Site specific design for all HFFRRF including detailed structural, geotechnical and civil engineering analyses and design,
- Design and engineering analysis regarding HFFRRF site integration, notably roadway design for road ramps and all features in close proximity to DOT right-of-way,
- Given the close proximity to private property, additional refinement and site-specific details will need to be worked out to establish the permanent and temporary easements,
- Refinement of project elevations and design of the HFFRRF transitions between different feature types,
- For the AEP stage elevations relevant to the HFFRRF design it can be noted that the underlying tides play a more dominant role and it is recommended to further communicate this concept with the public to increase awareness of risk. For example, the 20% AEP water level can be a result of high tides with a relative small storm surge or a low tide with a relatively large storm surge. For extreme events, i.e. lower AEP events, the storm surge component is the dominant contributor to the total stage elevation regardless of whether the event coincides with high or low tides. This is important from a risk communication perspective since smaller meteorological events may not deserve the same attention but can result in flooding if they coincide with high tides.
- Bayswater Park and Beach 35th St are currently being redesigned by DOT and Parks. The design of the proposed berm will be further coordinated with both agencies.
- Refined engineering analyses and design for the pump stations, pump capacities and new drainage infrastructure,
- Refined design and engineering analyses of modifications and connections to existing drainage infrastructure,
- NNBF designs include the preliminary identification of locations where these elements will likely fit, but final design and NNBF siting will depend on final feature alignments and detailed delineation of existing grades and elevations,
- Detailed 2D wave modeling and analysis of wakes from Ferry/Commercial/Recreation vessels at different tidal elevations to optimize rock sill designs and freeboard requirements of HFFRRF, and
- Analysis of temporary construction features.

It is further recommended that all refinements and analyses are coordinated with the appropriate agencies with respect to future and ongoing infrastructure upgrades, park and recreational developments, environmental remediation and housing developments.

REFERENCES

Billion Oyster Project. 2018. Information on the effort to restore a sustainable oyster population and to foster awareness, affinity, and understanding of the New York Harbor by engaging New Yorkers directly in the work of restoring one billion oysters. New York (NY). https://billionoysterproject.org/ (accessed July 3rd 2018).

Bridges, T. S., Wagner, P. W., Burks-Copes, K. A., Bates, M. E., Collier, Z., Fischenich, C. J., Gailani, J. Z., Leuck, L. D., Piercy, C. D., Rosati, J. D., Russo, E. J., Shafer, D. J., Suedel, B. C., Vuxton, E. A., and Wamsley, T. V. (2014). *Use of natural and nature-based features (NNBF) for coastal resilience*. ERDC SR-15-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Cialone, M. A., Massey, T. C., Anderson, M. E., Grzegorzewski, A. S., Jensen, R. E., Cialone, A., Mark, D. J., Pevey, K. C., Gunkel, B. L., McAlpin, T. O., Nadal-Caraballo, N. C., Melby, J. A., Ratcliff, J. J. (2015) North Atlantic Coast Comprehensive Study (NACCS) coastal storm model simulations: waves and water levels. Technical report, Coastal and Hydraulics Laboratory, US Army Corps of Engineers (USACE), Engineer Research and Development Center, Vicksburg, MS.

EurOtop (2016). Manual on wave overtopping of sea defences and related structures. An overtopping manual largely based on European research, but for worldwide application. Second Edition. Authors: Van der Meer, J. W., N. W. H., Allsop, T. Bruce, J. DeRouck, A. Kortenhaus, T. Pullen, H. Schüttrumpf, P. Troch, and B. Zanuttigh

Gornitz, et, al "Impacts of Sea Level Rise in the New York City Metropolitan Area", Global and Planetary Changes 32 (2002) 61- 88, 2002 Elsevier Science B.V.

Jamaica Bay Watershed Protection Plan, 2016 Update. 2016. New York City Department of Environmental Protection - Bureau of Environmental Planning and Analysis. October 1, 2016 DEP

NOAA Technical Report NOS CO-OPS 065 'Estimating Vertical Land Motion form Long Term Tide Guage Rec-ords', May, 2013

RAMPP (2014). Region II Storm Surge Project – Recurrence Interval Analysis of Coastal Storm Surge Levels and Wave Characteristics, FEMA to HSFE02-09-J-001.

USACE (2002). Coastal Engineering Manual (EM 1110-2-1100). Washington, DC: Department of the Army.

USACE (2013). Incorporating Sea Level Change in Civil Works Programs (ER-1100-2-8162).

USACE (2015). North Atlantic Coast Comprehensive Study (NACCS): Coastal Storm Hazards from Virginia to Maine. ERDC/CHL TR-15-5 Technical Report, Nov 2015. Authors: Nadal-Caraballo N.C., J.A. Melby, V.M. Gonzalez, and A.T. Cox

USACE-NAN (2016). Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay - Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement.

USGS Lidar https://lta.cr.usgs.gov/

C. B. Zarnoch and M. P. Schreibman 2012. Growth and Reproduction of Eastern Oysters, Crassostrea Virginica, in a New York City Estuary: Implications for Restoration. Urban Habitats. Volume 7 March 2012.

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Sub Appendix A2-A: HFFRRF Phase 1 Projects and Project Maps

US Army Corps of Engineers

A. SUB-APPENDIX A2-A: HFFRRF PHASE 1 PROJECTS AND PROJECT MAPS

The table below list all Phase 1 projects and some key characteristics. Subsequent pages display plan view maps of each of the Phase 1 projects.

Table A-1: Phase 1 Project Descriptions

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
1	Hammels (Queens)	This project consists of a series of floodwalls and is set back from the coastline to minimize conflicts with existing waterfront facilities. A total of six (6) vehicular gates are included to maintain access to the waterfront.[9]		3,100
2	Arverne (Queens)	Project follows the coastline of the Arverne peninsula and includes a total of 11 HFFRRF segments to suit the changing conditions in landscape and land use along the proposed project. Four (4) vehicular gates are included to maintain access to the waterfront industrial sites and marina.[10]		12,300
102	Arverne with NNBF	The Arverne project is enhanced with NNBFs at three locations.		12,300
		1) The north-west corner of the peninsula (Brant Point). Existing habitat include mud flats, high marsh and invasive marsh (*Phragmites*). The proposed NNBF would employ the installation of rock sills off the existing, eroding shoreline to protect the toe of the slope and dampen incoming waves so the existing shoreline could be regraded and potentially extended seaward. The proposed NNBF also includes the removal of the *Phragmites* and expansion/restoration of the intertidal wetland habitat and high marsh. The existing upland maritime forest between the	2A	

[9] This was a conservative estimate and in Phase 2 all but one vehicular gate were switched to road ramps.

[10] This was a conservative estimate and in Phase 2 all but one vehicular gate were switched to road ramps.

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
		berm feature and the wetlands are to remain undisturbed.		
		2) At the north-east corner of the peninsula where there is currently a narrow beach (DuBois Point), between Beach 69th and just east of Beach 65th Street a NNBF is proposed that includes the construction of rock sills to create an intertidal flat. Further upslope and to the east intertidal marsh can be restored. The existing upland maritime forest is to remain undisturbed.	1A	
		3) To the east of Marina 59, much of the existing marsh along the shoreline is dominated by *Phragmites*. The proposed NNBF includes restoration of an intertidal flat, supported by rock sills, and excavation of the *Phragmites* such that intertidal and high marsh can be restored.	2B	
3	Edgemere (Queens)	Project consists out of two approx. 3,000 foot segments, i.e. a medium floodwall for the west side and a high berm on the east side of the peninsula. One vehicular gate is included to maintain access to the waterfront.		6,300
103	Edgemere with NNBF	On the east side of the Edgemere neighborhood the proposed NNBF would restore and further enhance existing wetland habitat. A large area of wetland habitat is proposed to be restored and created between the HFFRRF high berm and the newly constructed rock sill, just off of the existing coastline. The proposed NNBF includes the removal of the *Phragmites* and restoration of the intertidal habitat and high marsh such that both type 2A and type 2B are implemented.	2A/2B	6,300
4	Norton Basin (Queens)	Project follows the coastal edge of Norton Drive and consist of approximately 2,400 foot segment of floodwall.		2,400
104	Norton Basin with NNBF	At Norton Basin the proposed NNBF includes creation/restoration of the intertidal habitat and high marsh adjacent to Norton Drive. The wetland habitat and appropriate grades along the extended shoreline would be supported by the construction of a rock sill in the water side and construction of a medium floodwall on the landward side.	1A/2A	2,400

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
5	Bayswater Park (Queens)	This project consists of an approximately 1,400 foot long berm that follows the coastal edge.		1,500
105	Bayswater Park With NNBF	Although currently healthy upland maritime forest exists at this location, there is an opportunity to enhance the HFFRRF with the creation of additional wetland habitat. The proposed NNBF includes the removal of *Phragmites* and restoration of the intertidal marsh. A rock sill would be constructed to support an extension of the existing shoreline. The existing upland maritime forest is to remain undisturbed.	1A/1B	1,500
6	Motts Basin S (Queens)	Project follows the southern perimeter of Motts Basin residential neighborhood as well as the low lying coastline of the Long Island Power Authority substation and the Inwood material terminal.		3,800
106	Motts Basin S With NNBF	For Motts Basin South an opportunity exists to enhance wetland habitat between Dickens Street and Pinson Street on the water side of the proposed HFFRRF. In the horizontal direction there are few constraints at this location, and the proposed NNBF includes extension of the shoreline and restoration of the intertidal and high marsh.	2A	3,800
7	Motts Basin N (Nassau County)	Project follows a short section of roadway (Waterfront Blvd.) in Nassau County set back from the northern perimeter of Motts Basin. Construction of a low floodwall would reduce the risk of coastal flooding of residential and commercial parcels on the north side of Motts Basin		700
107	Motts Basin N With NNBF	Similarly as with Motts Basin South, good conditions exist to enhance the HFFRR-Feature with NNBFs and habitat restoration. The proposed NNBF includes extension of the shoreline and restoration of the intertidal and high marsh.	1A /2A	700
8	Inwood Marina (Nassau County)	This project provides flood risk reduction to the residential neighborhood to the east of the Inwood Marina. Two (2) vehicular gates are included to maintain waterfront access.		2,700

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
9	Head of Bay Gate (Queens / Nassau County)	Equal to the alternative as proposed in Appendix A2 of the GRR, a storm surge barrier at this location would provide flood risk reduction for low lying coastal areas at the far eastern extent of Jamaica Bay and along adjoining waterbodies in Nassau County. A barrier at this single location could reduce risk for the extensive area for eastern end of Jamaica Bay. (If this barrier is deemed not viable, additional smaller projects provide options for isolated areas, as included in project 12 through 16 below.)		3,000
10	Old Howard Beach (Queens)	Similar to the alternative as proposed in Appendix A2 of the GRR, storm surge barriers at both Shell Bank Creek and Hawtree Basin and connecting HFFRRF to tie the alignment in to higher ground would provide flood risk reduction for the Howard Beach area.		3,700
11	Canarsie (Brooklyn)	This project includes flood risk reduction features along Fresh Creek such that the lowest portions of the shoreline would be elevated. Revetments would be placed where revetments currently exist. A floodwall is proposed to be constructed along a portion of E 108th Street.		2,700
12	Cedarhurst-Lawrence (Nassau County)	This project follows a section of the Nassau Expressway with a low floodwall for approximately 1,100 feet.[11] The project also includes two sections of bulkhead on either side of the canal next to the Lawrence High School. A short section of floodwall connects the bulkhead on the west side to high ground.		1,800
13	Meadowmere (Queens)	The Meadowmere alignment consists of a 3,700 foot length of bulkhead around the northern end of the Meadowmere Park Island. A low berm on the west side and a floodwall on the east side connect the bulkhead to a 1,000 foot long revetment on the southern end of the island.		6,700

[11] This section was later removed as an unrelated road raising project will provide a flood barrier in this area.

ID	Project Name (Borough or County)	Notes	NNBF Type*	Length [ft]
14	Meadowmere N (Queens)	This project provides flood risk reduction to the residential neighborhoods along Bayview Avenue and Broad Street in the Meadowmere area.		4,800
15	Meadowmere E (Queens)	This project consists of a 1,600 foot bulkhead around the peninsula parallel with 1st and 3rd Streets off of Rockaway Boulevard.		1,600
16	Rosedale (Queens)	The Rosedale project is a 1,900 floodwall that connects Brookville Boulevard in the south and high ground further north.		1,900
17	Broad Channel (Queens)	This project consists of urban bulkheads and road raisings on the west side of the island and berms and road raisings on the east side. There are also berms around two parks, at the northern and southern ends of the island. The project also has a 1,600 foot breakwater off of the west side of the island.		28,700

*NNBF Types are as follows per description in section 4.12.1
NNBF Type 1A – Shoreline Extension with Intertidal Marsh
NNBF Type 1B – Shoreline Extension with Intertidal and High Marsh
NNBF Type 2A – Shoreline Excavation for *Phragmites* Removal with Intertidal Marsh
NNBF Type 2B – Shoreline Excavation for *Phragmites* Removal with Intertidal and High Marsh

Canarsie

Legend

HFFRR-Feature

- Low Floodwall
- Revetment
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Canarsie

Legend

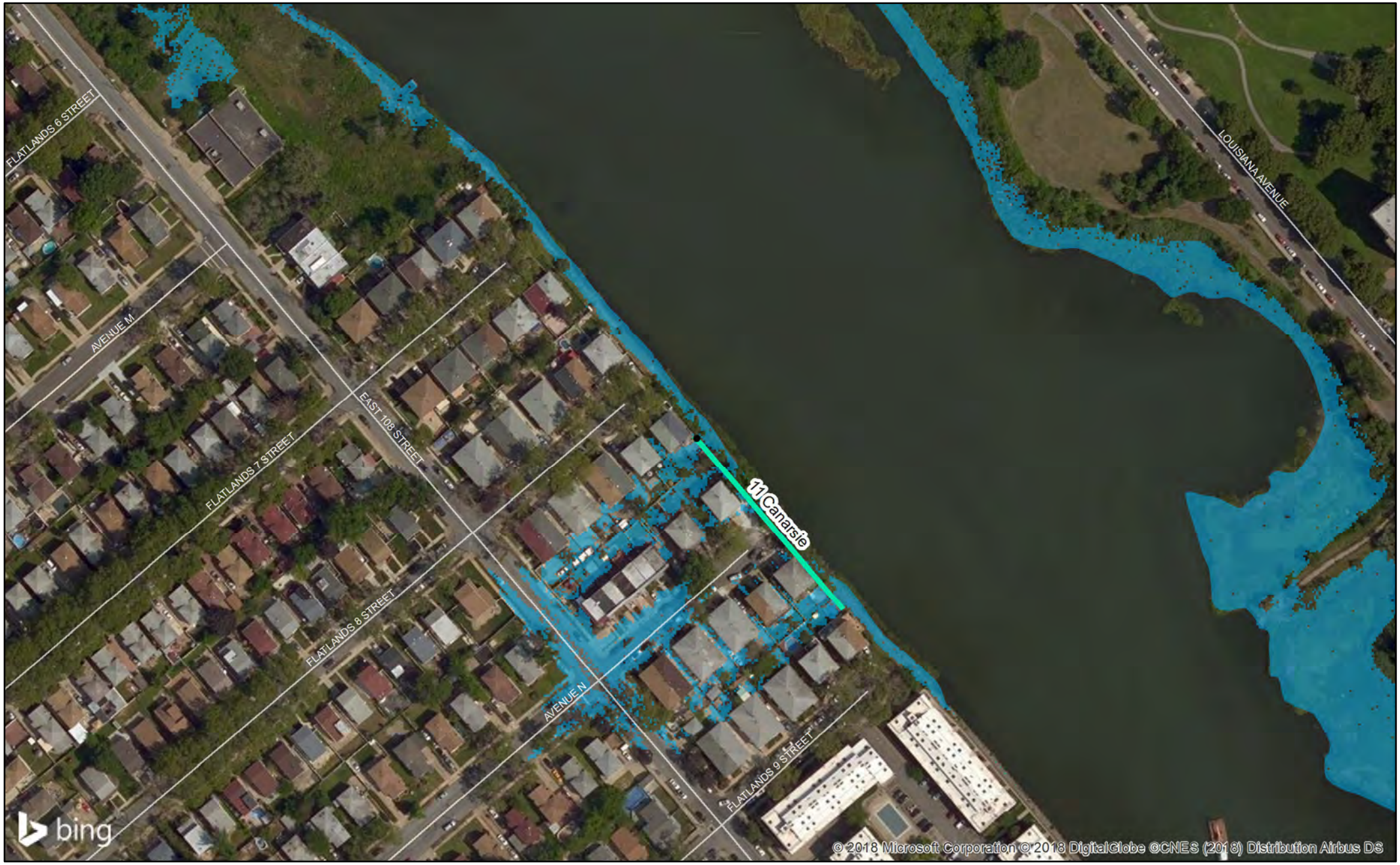
HFFRR-Feature

- Low Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Canarsie



Legend

HFFRR-Feature

- Revetment
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Old Howard Beach

Legend

HFFRR-Feature

- Medium Floodwall
- Low Berm
- In Water Gate
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Old Howard Beach

Legend

HFFRR-Feature

- Medium Floodwall
- Low Berm
- In Water Gate
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Rosedale

Legend

HFFRR-Feature

- Medium Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Rosedale

Legend

HFFRR-Feature

- Medium Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Meadowmere N

Legend

HFFRR-Feature

- Low Berm
- High Berm
- Deep Bulkhead
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Meadowmere N

Legend

HFFRR-Feature

- High Berm
- Deep Bulkhead
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Meadowmere

Legend

HFFRR-Feature

- Deep Bulkhead
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Meadowmere

Legend

HFFRR-Feature

- Medium Floodwall
- Low Berm
- Deep Bulkhead
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Meadowmere

Legend

HFFRR-Feature

- Medium Floodwall
- Low Berm
- Revetment
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Meadowmere E

Legend

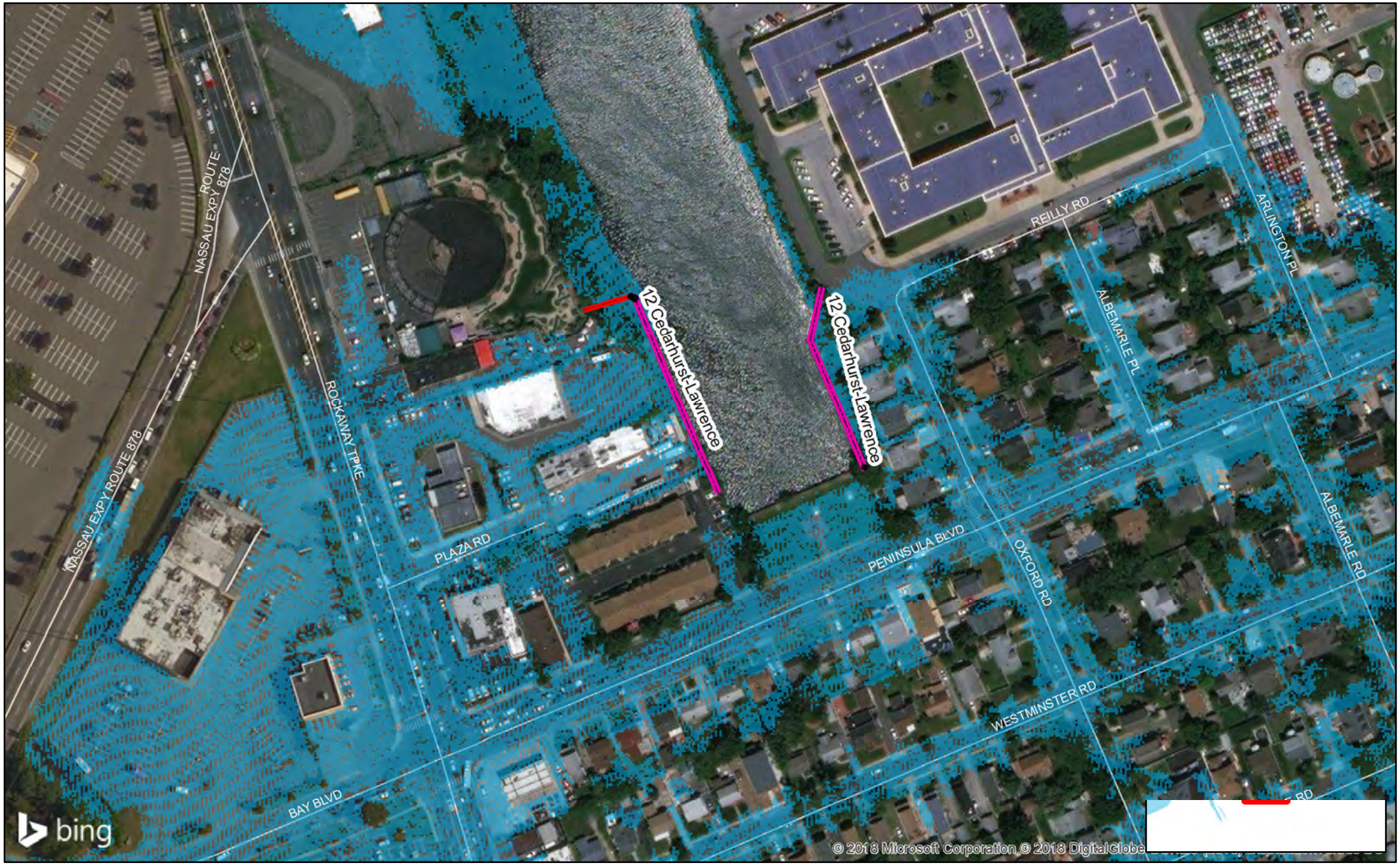
HFFRR-Feature

- Low Berm
- Deep Bulkhead
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Cedarhurst-Lawrence



Legend

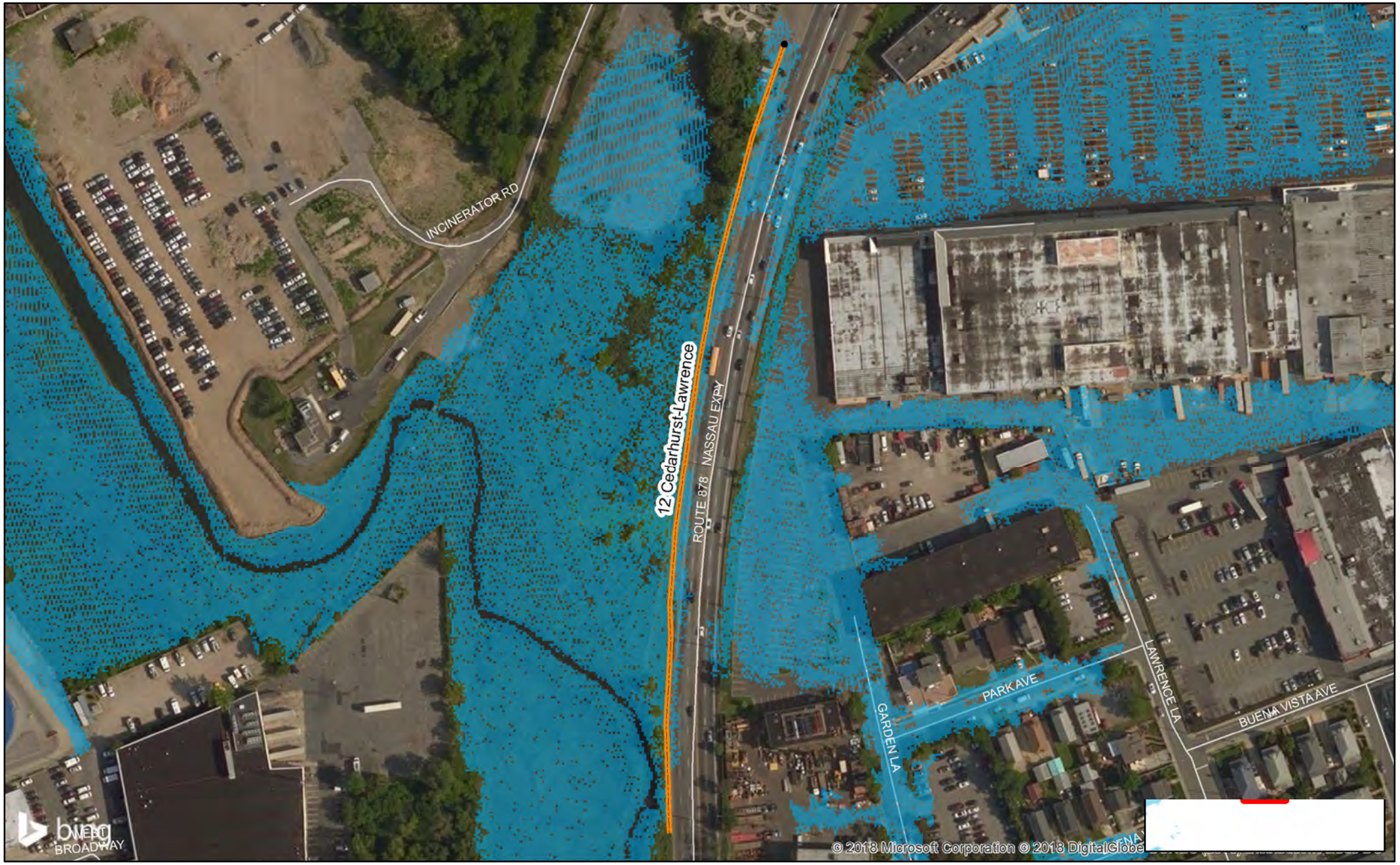
HFFRR-Feature

- Medium Floodwall
- Deep Bulkhead
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Cedarhurst-Lawrence



Legend

HFFRR-Feature

- Low Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Head of Bay Gate

Legend

HFFRR-Feature

- High Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Head of Bay Gate

Legend

HFFRR-Feature

- Medium Floodwall
- High Floodwall
- In Water Gate
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Head of Bay Gate

Legend

HFFRR-Feature

- High Berm
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Inwood Marina

Legend

- Vehicular Gates

HFFRR-Feature

- Medium Floodwall
- Low Berm
- Shallow Bulkhead
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Motts Basin N

Legend

HFFRR-Feature

- Low Floodwall
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Motts Basin S

Legend

HFFRR-Feature

- Medium Floodwall
- Shallow Bulkhead
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)
- Nassau County Streets

N

0 30 60 120 180 240 Feet

Motts Basin S

Legend

HFFRR-Feature

- Medium Floodwall
- Shallow Bulkhead
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Bayswater Park

Legend

HFFRR-Feature

- Low Berm
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Norton Basin

Legend

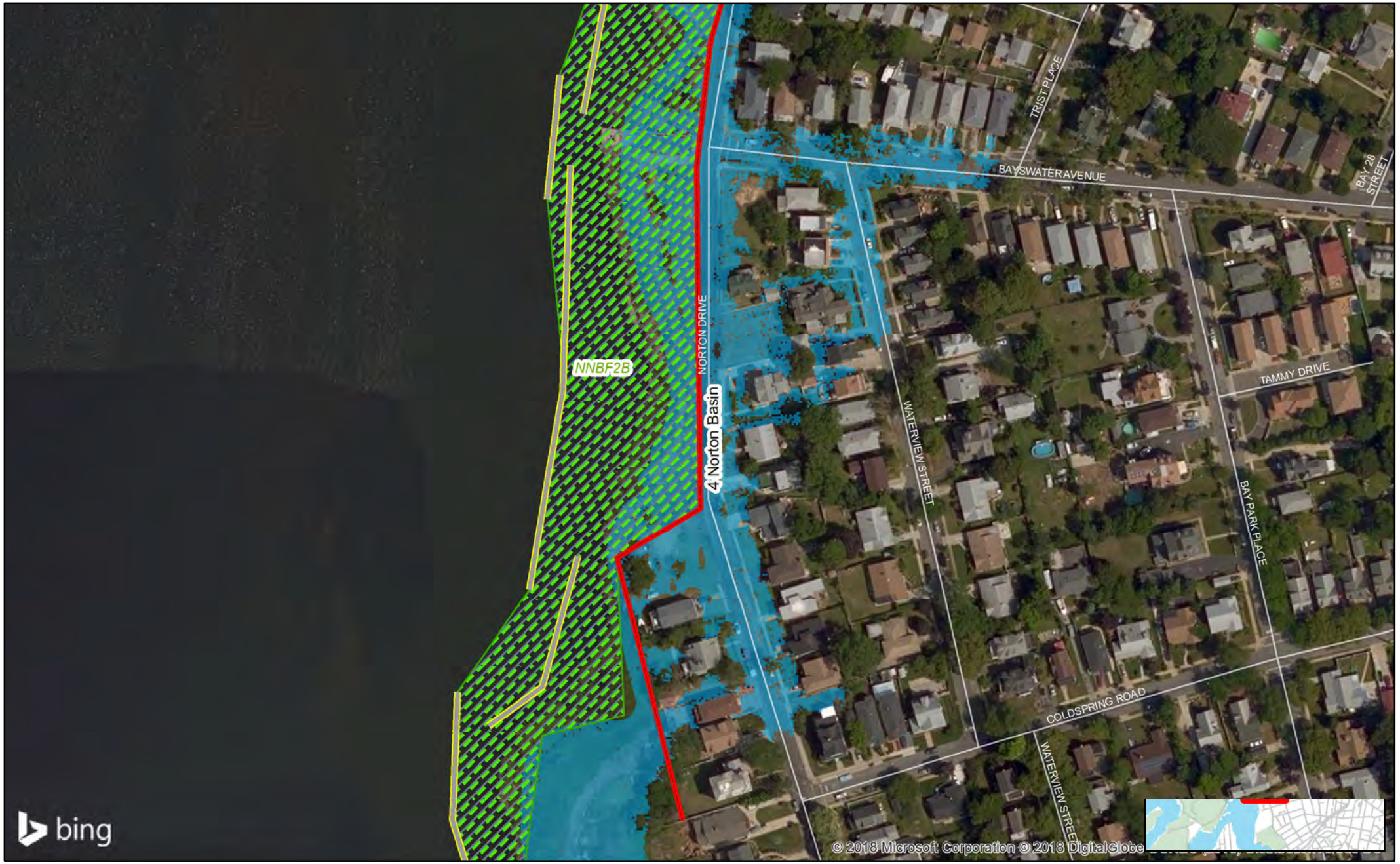
HFFRR-Feature

- Medium Floodwall
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Norton Basin



Legend

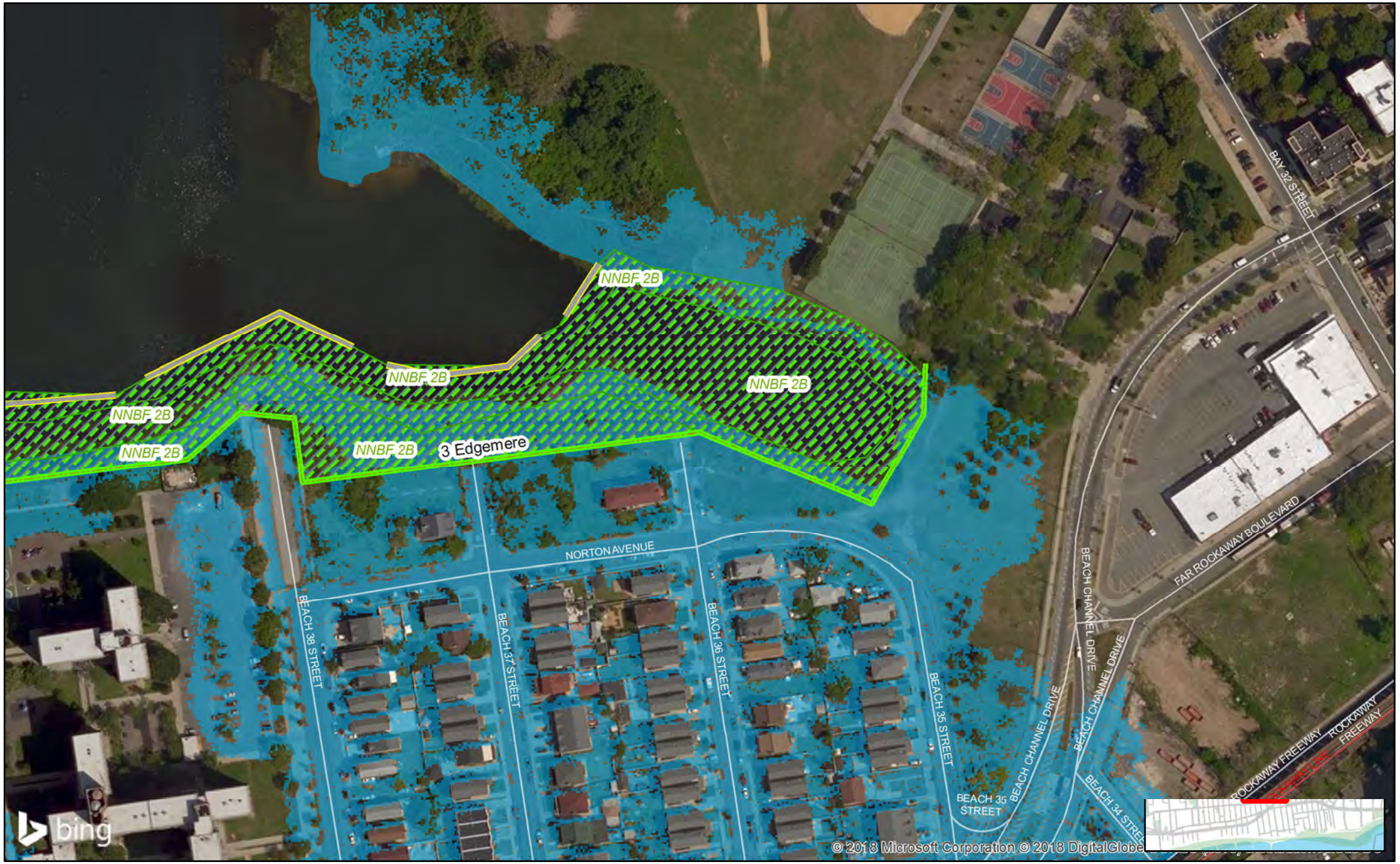
HFFRR-Feature

- Medium Floodwall
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Edgemere



Legend

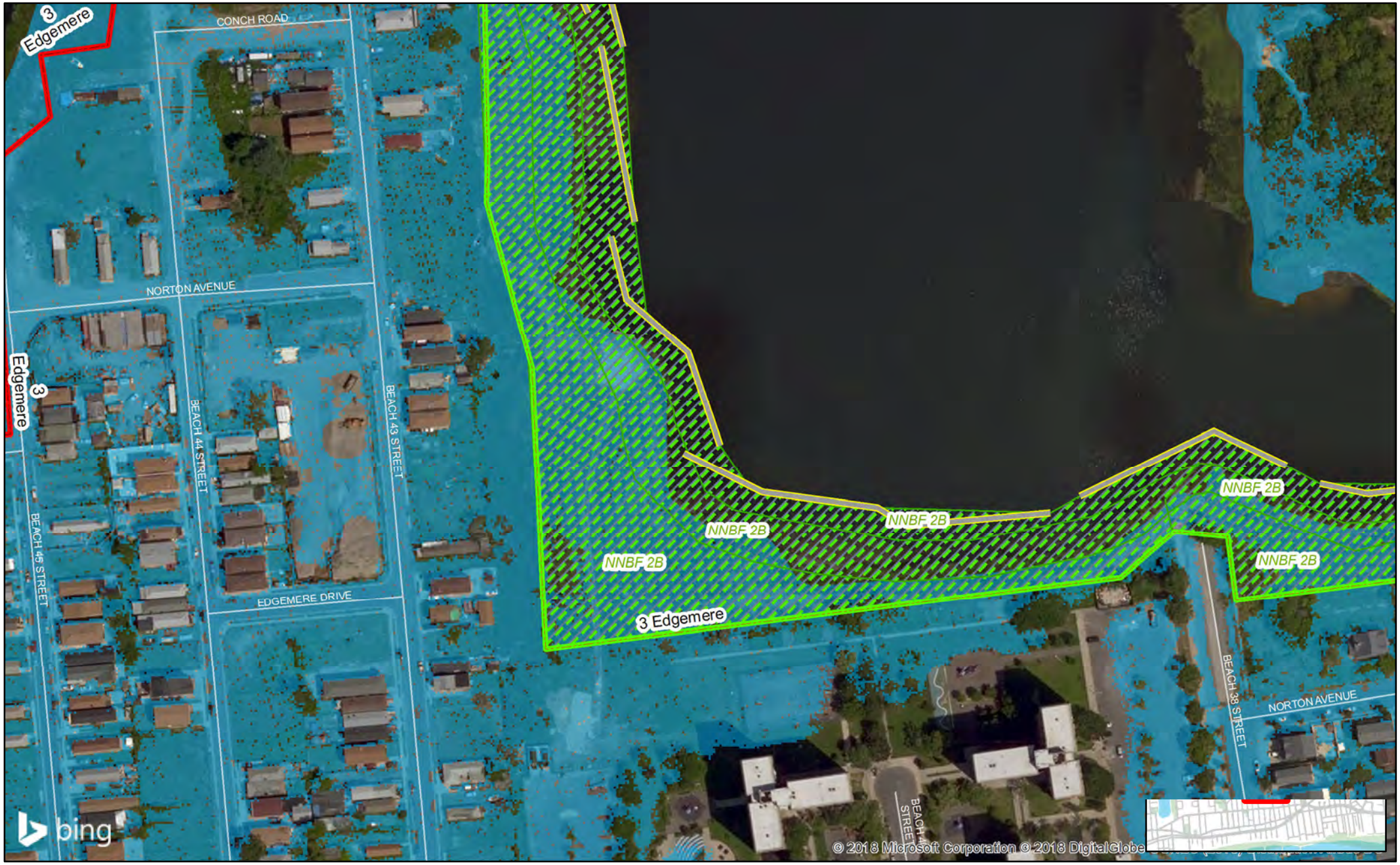
HFFRR-Feature

- High Berm
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Edgemere



Legend

HFFRR-Feature

- Medium Floodwall
- High Berm
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Edgemere

Legend

- Vehicular Gates

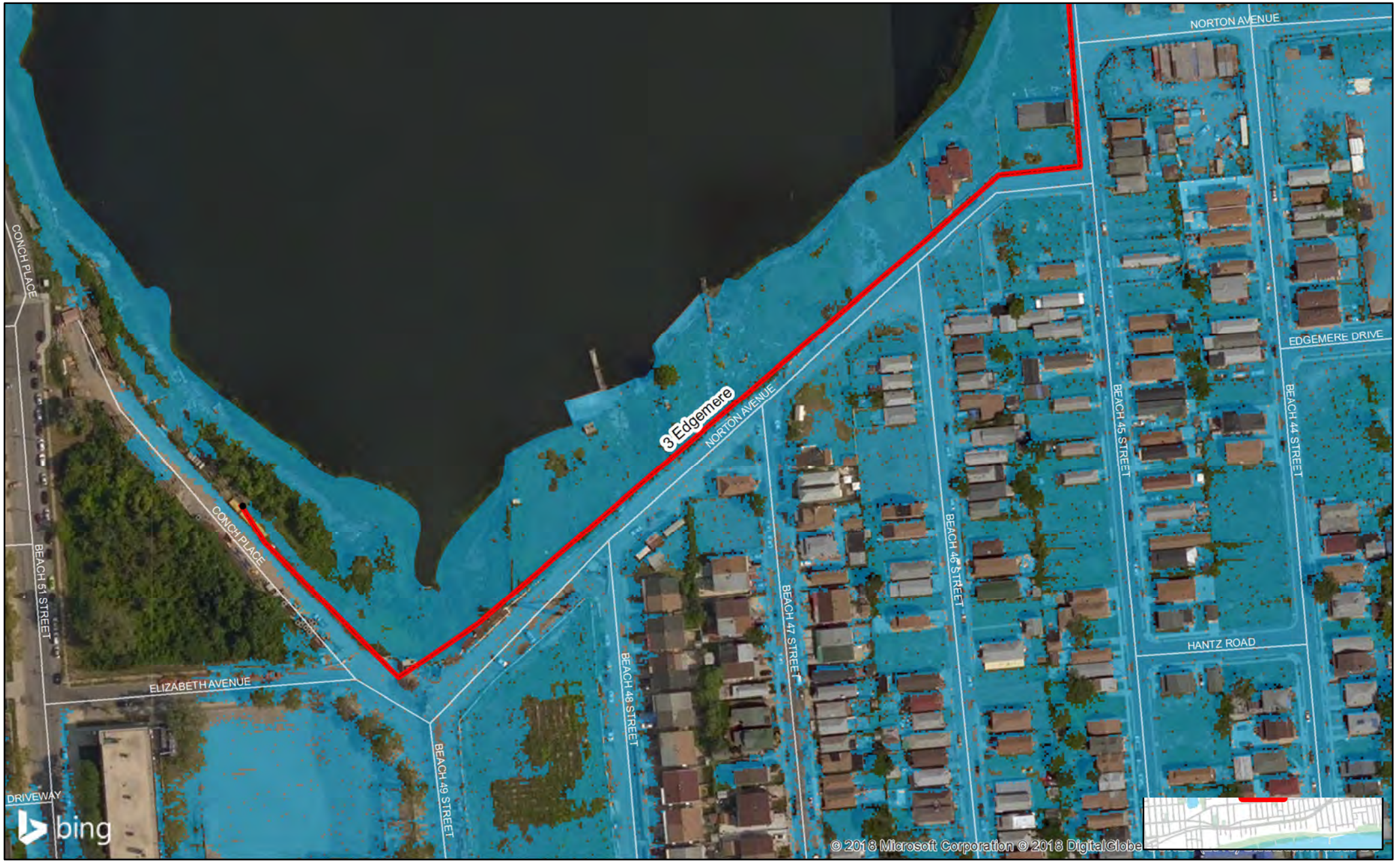
HFFRR-Feature

- Medium Floodwall
- High Berm
- Shallow Bulkhead
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Edgemere



Legend

HFFRR-Feature

- Medium Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Arverne

Legend

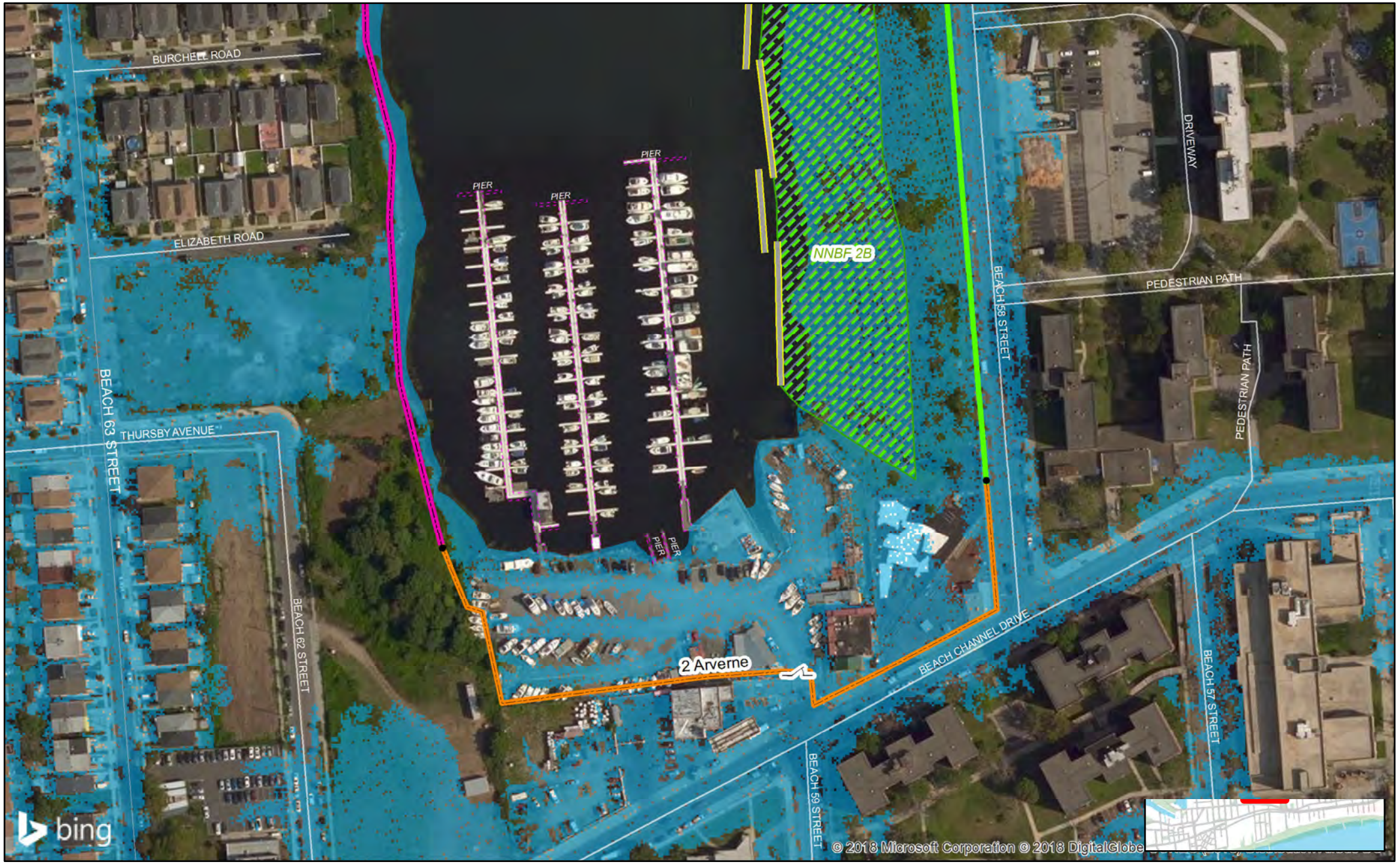
HFFRR-Feature

- Low Berm
- Deep Bulkhead
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 35 70 140 210 280 Feet

Arverne



Legend

- Vehicular Gates

HFFRR-Feature

- Low Floodwall
- Low Berm
- Deep Bulkhead
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Arverne

Legend

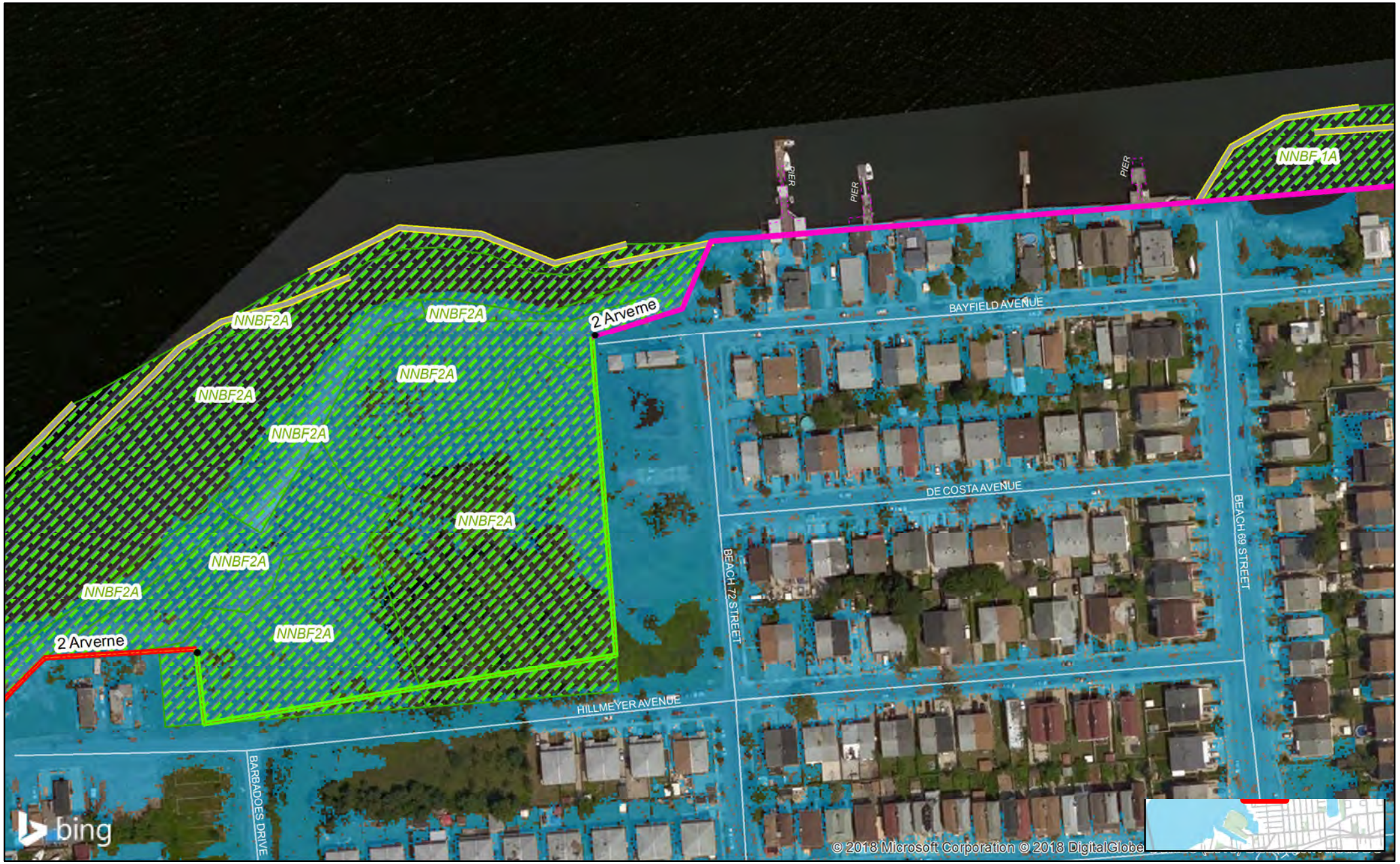
HFFRR-Feature

- Low Berm
- Shallow Bulkhead
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

Feet
0 30 60 120 180 240

Arverne



Legend

HFFRR-Feature

- High Floodwall
- High Berm
- Shallow Bulkhead
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Arverne

Legend

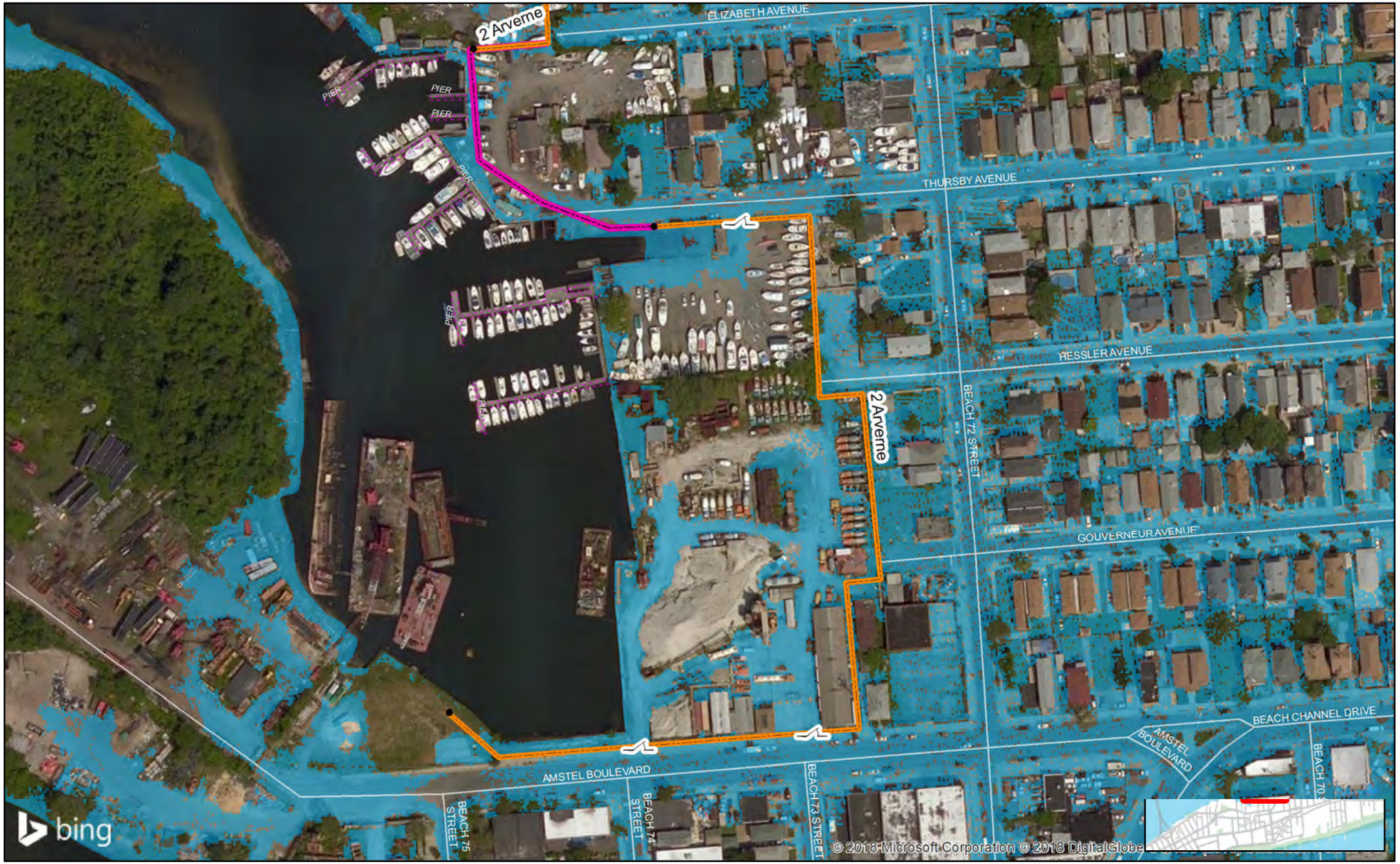
HFFRR-Feature

- Low Floodwall
- High Floodwall
- High Berm
- Deep Bulkhead
- NNBF
- NNBF
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 35 70 140 210 280 Feet

Arverne



Legend

- Vehicular Gates

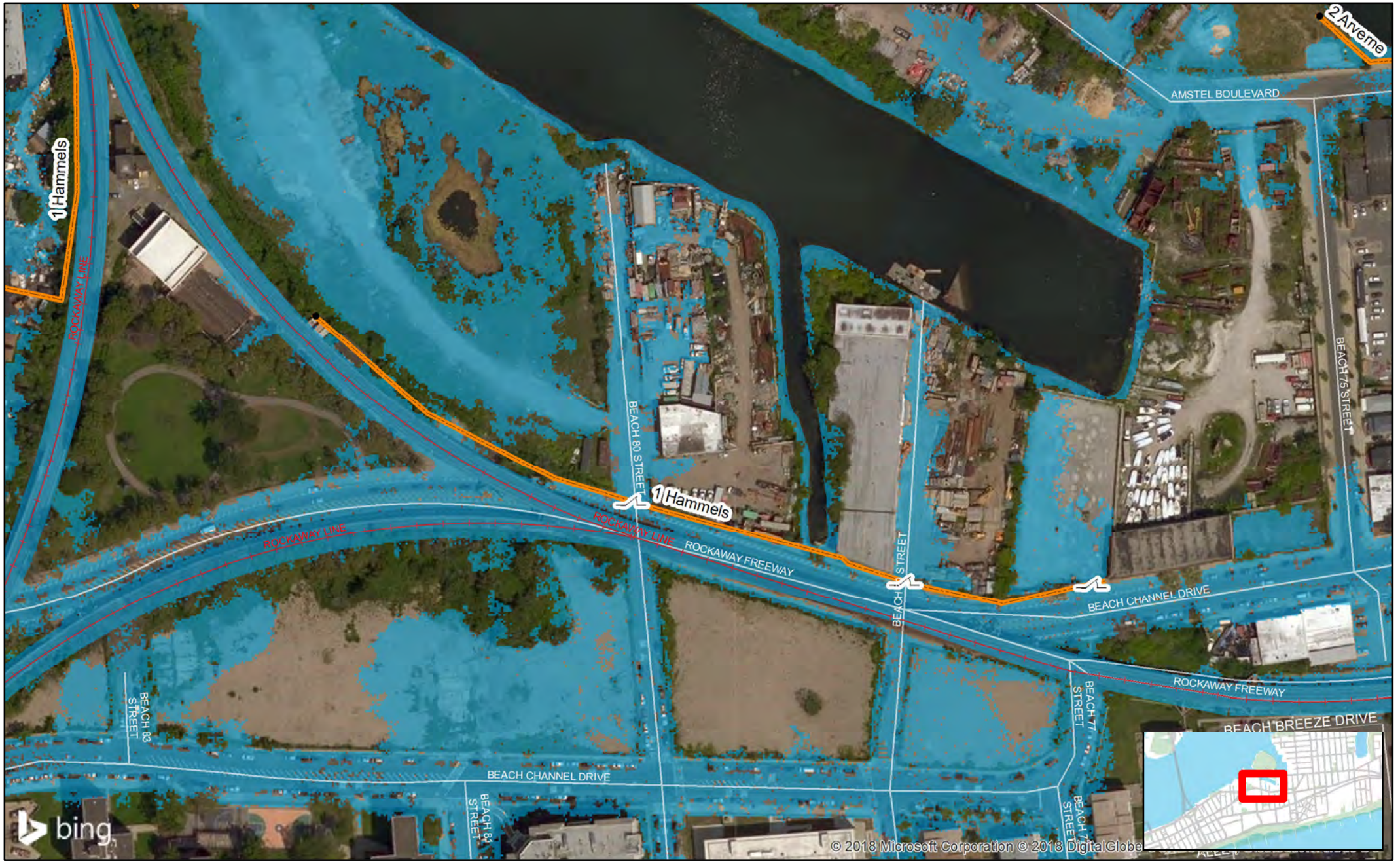
HFFRR-Feature

- Low Floodwall
- Deep Bulkhead
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Hammels



Legend

- Vehicular Gates

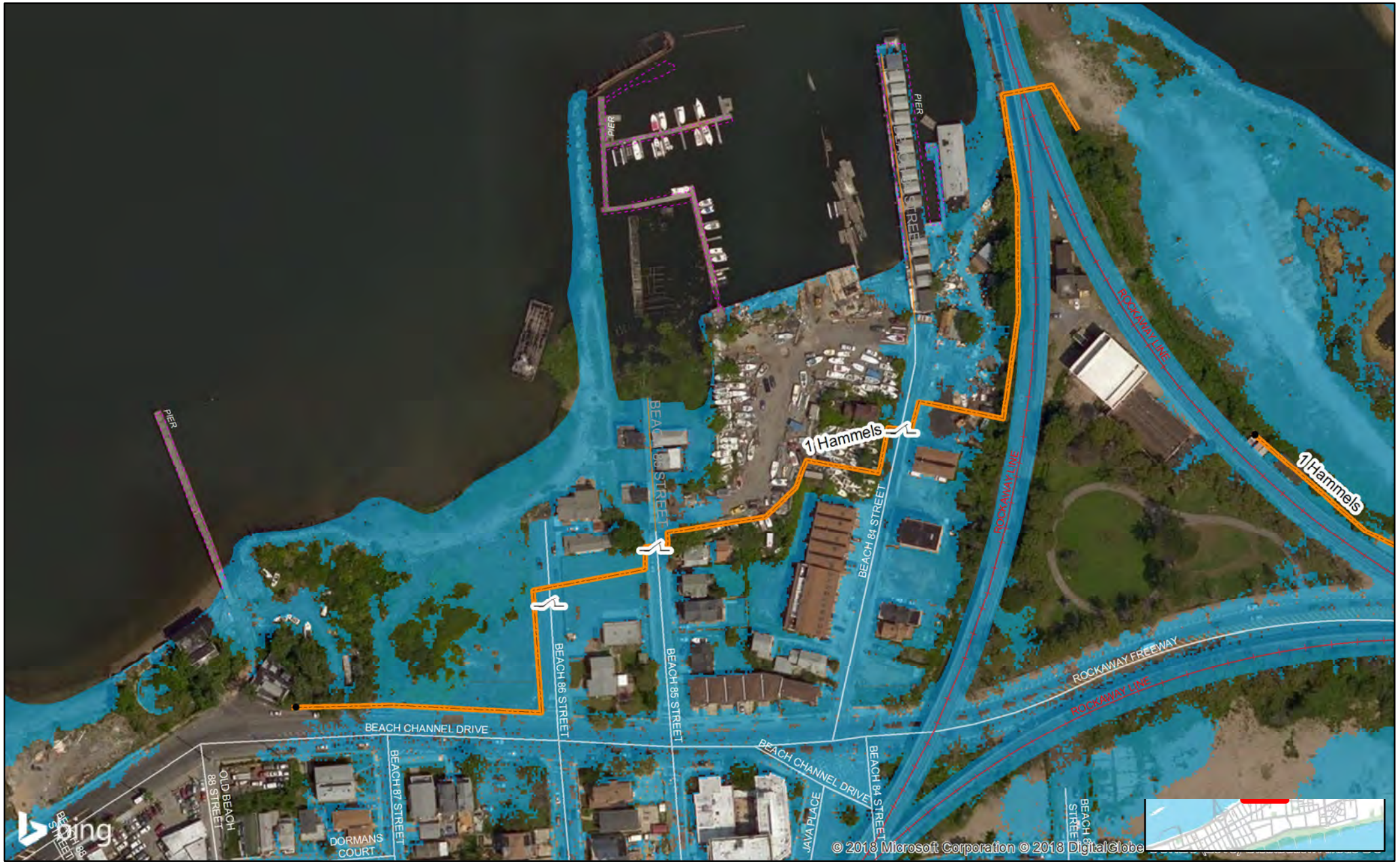
HFFRR-Feature

- Low Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Hammels



Legend

- Vehicular Gates

HFFRR-Feature

- Low Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)

N

0 30 60 120 180 240 Feet

Broad Channel

Legend

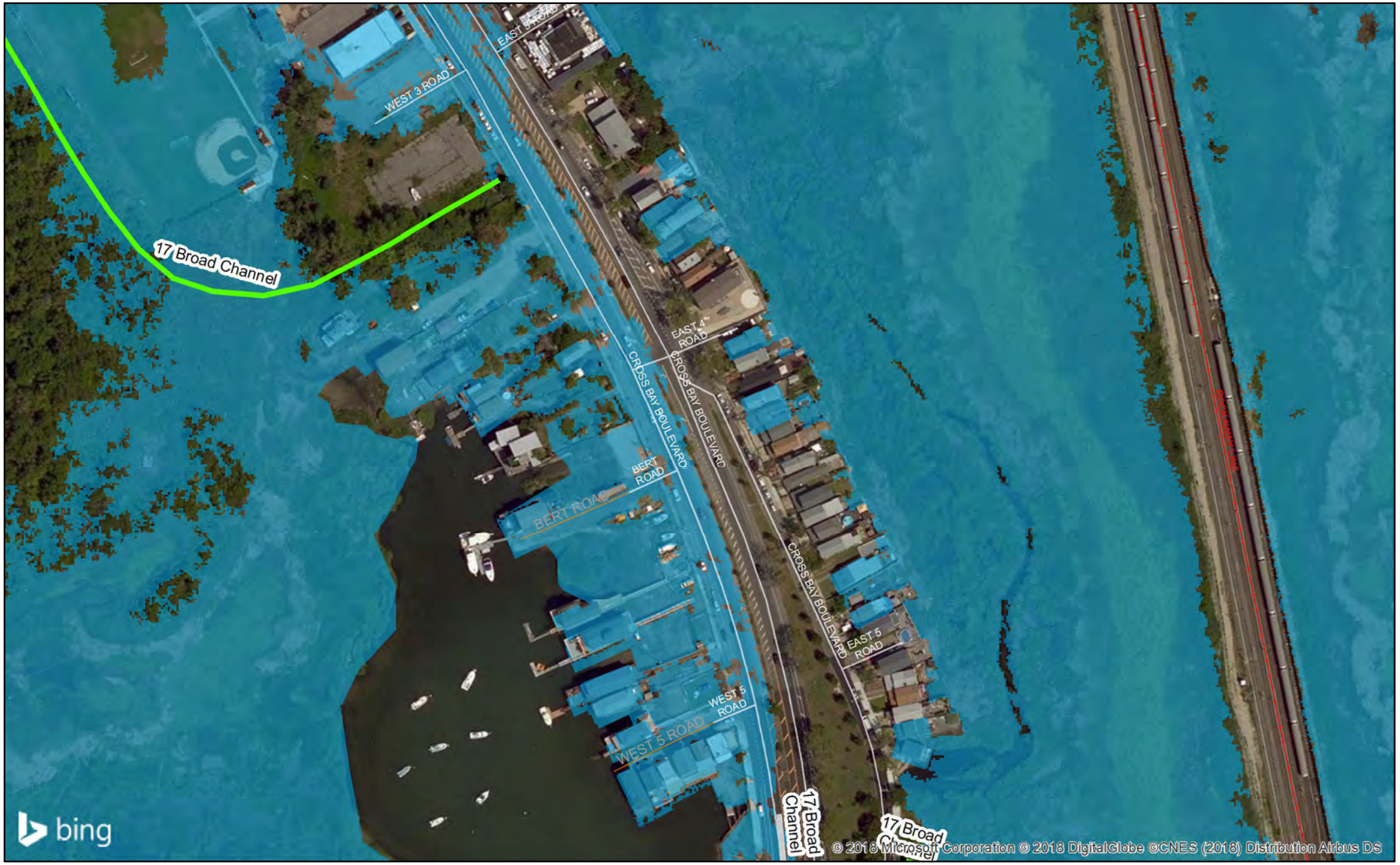
HFFRR-Feature

Low Berm

N

0 30 60 120 180 240 Feet

Broad Channel



Legend

HFFRR-Feature

- Low Berm
- Road Raising

N

0 30 60 120 180 240 Feet

Broad Channel

Legend

HFFRR-Feature

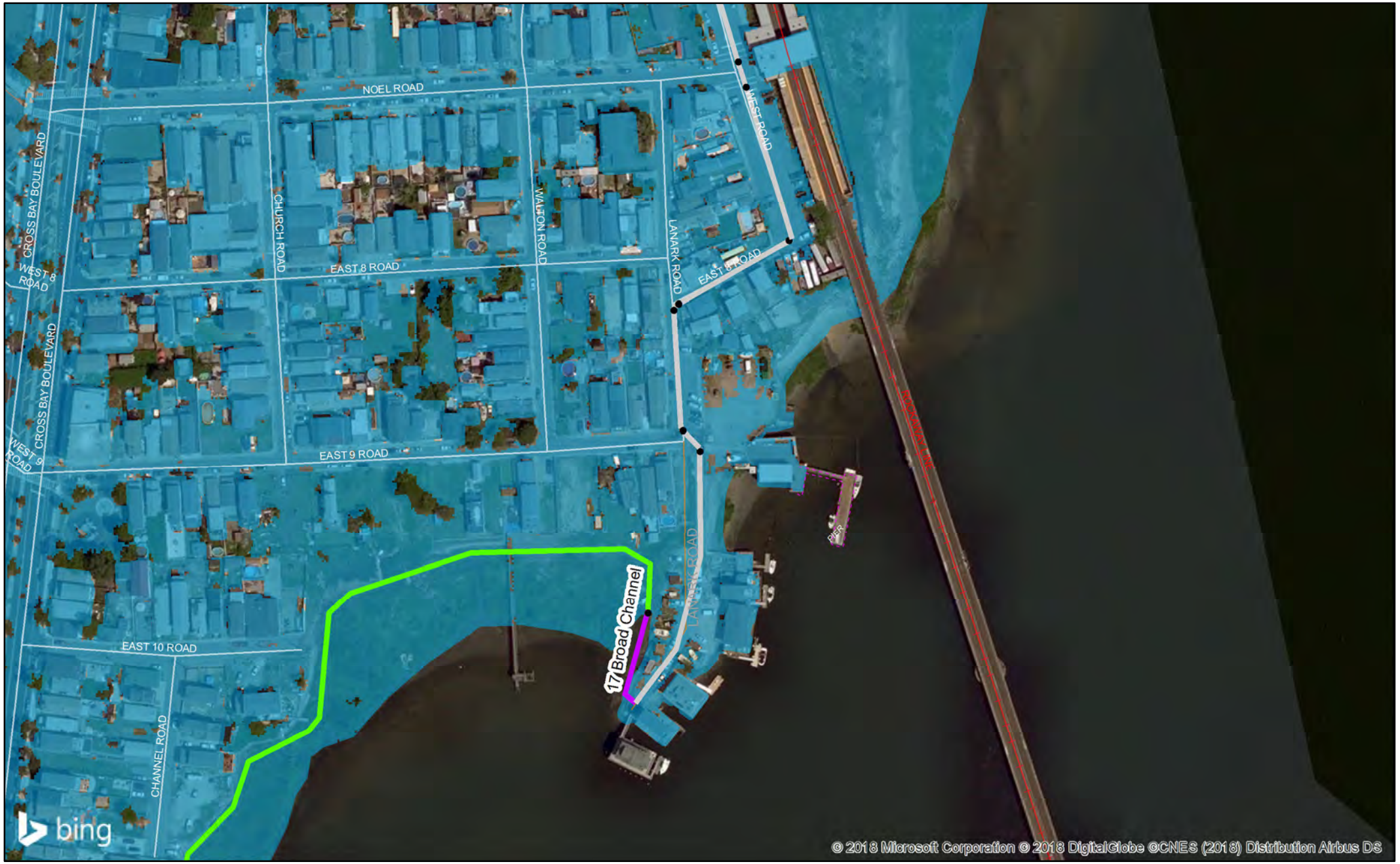
- Low Berm
- Road Raising

N

Feet

0 30 60 120 180 240

Broad Channel



Legend

HFFRR-Feature

- Low Berm
- Shallow Bulkhead - Urban
- Road Raising

N

0 30 60 120 180 240 Feet

Broad Channel

Legend

HFFRR-Feature

- Low Berm
- Deep Bulkhead - Urban
- Shallow Bulkhead - Urban
- Road Raising
- Street End Bulkhead

N

0 30 60 120 180 240 Feet

Broad Channel

Legend

HFFRR-Feature

- Low Berm
- Shallow Bulkhead -
- Road Raising
- Street End Bulkhead

N

0 30 60 120 180 240 Feet

Broad Channel

Legend

HFFRR-Feature

- Low Berm
- High Berm
- Deep Bulkhead - Urban
- Shallow Bulkhead - Urban
- Road Raising
- Street End Bulkhead

N

0 30 60 120 180 240 Feet

Broad Channel

Legend

HFFRR-Feature

- Low Berm
- High Berm
- Shallow Bulkhead -
- Road Raising

N

0 30 60 120 180 240 Feet

Broad Channel

Legend

HFFRR-Feature

Low Berm

N

0 30 60 120 180 240 Feet

Broad Channel

Legend

HFFRR-Feature

- Deep Bulkhead - Urban
- Shallow Bulkhead - Urban
- Street End Bulkhead
- Breakwater

N

0 30 60 120 180 240 Feet

Broad Channel

Legend

HFFRR-Feature

- Shallow Bulkhead - Urban
- Street End Bulkhead
- Breakwater

N

0 30 60 120 180 240 Feet

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Sub Appendix A2-B: HFFRRF Phase 2 Projects

US Army Corps of Engineers

B. SUB-APPENDIX A2-B: HFFRRF PHASE 2 PROJECTS AND PROJECT MAPS

The table below list all Phase 2 projects on a reach by reach basis.

RPV = Rockaway Peninsula Vicinity

FCV = Fresh Creek Vicinity

NCV = Nassau County Vicinity

Subsequent pages display plan view maps of each of the Phase 2 projects.

Table B-1: Phase 2 Reach by Reach Project Data

Project Location	Reach-ID	Feature Type	Length (ft)	Approx. Ground Elevation	Design Elevation	Feature Top Elevation
Mid-Rockaway Backbay with NNBFs	RPV-081-a	Low Berm	278	4.0	7.8	8.0
	RPV-081-aa	Hybrid Berm	299	4.5	7.8	8.0
	RPV-081-b	Medium Berm	585	4.0	9.4	9.5
	RPV-081-c	Medium Berm	65	4.0	9.4	9.5
	RPV-081-d	Medium Berm	855	4.0	9.4	9.5
	RPV-081-e	Hybrid Berm	161	5.0	9.4	9.5
	RPV-081-f	Hybrid Berm	334	5.0	9.4	9.5
	RPV-082-a	Hybrid Berm	348	5.0	9.4	9.5
	RPV-082-b	Shallow Bulkhead	40	5.0	8.8	9.0
	RPV-082-c	Hybrid Berm	233	5.0	9.4	9.5
	RPV-082-d	Shallow Bulkhead	85	5.0	8.8	9.0
	RPV-082-e	Hybrid Berm	178	5.0	9.4	9.5
	RPV-082-f	Shallow Bulkhead Urb	192	5.0	8.8	9.0
	RPV-082-g	Medium Floodwall	203	5.0	7.8	8.0
	RPV-083-a	Road Ramp	53	5.0	7.8	8.0
	RPV-084-a	Medium Floodwall	275	5.0	7.8	9.5
	RPV-084-b	High Berm	81	7.0	12.4	12.5
	RPV-084-c	Medium Berm	560	6.5	11.0	11.5
	RPV-085-a	High Floodwall	664	5.0	11.0	11.5
	RPV-085-b	Low Berm	849	5.0	7.8	8.0
	RPV-085-c	Low Berm	69	5.0	7.8	8.0
	RPV-085-d	Low Berm	313	5.0	7.8	8.0
	RPV-091-a	Low Berm	653	6.0	9.5	9.5
	RPV-091-b	Low Berm	60	6.0	9.5	9.5
	RPV-091-c	Low Berm	366	6.0	9.5	9.5

Mid-Rockaway Backbay with NNBFs	RPV-091-d	Low Floodwall	524	5.0	7.9	8.0
	RPV-091-e	Road Ramp	40	5.0	7.9	8.0
	RPV-091-f	Low Floodwall	622	5.0	7.9	8.0
	RPV-091-g	Revetment	150	5.5	10.5	10.5
	RPV-091-h	Revetment	26	5.5	10.5	10.5
	RPV-091-i	Shallow Bulkhead	380	5.5	11.1	11.5
	RPV-091-j	Revetment	538	5.5	10.5	10.5
	RPV-092-a	Revetment	273	5.5	10.5	10.5
	RPV-092-b	Deep Bulkhead	318	5.5	11.1	11.5
	RPV-093-a	Low Berm	1415	5.0	7.8	8.0
	RPV-093-b	Hybrid Berm	292	6.0	8.0	8.0
	RPV-094-a	Shallow Bulkhead	176	5.5	9.5	10.0
	RPV-094-b	Shallow Bulkhead	69	5.5	9.5	10.0
	RPV-094-c	Shallow Bulkhead	716	5.5	9.5	10.0
	RPV-094-d	Shallow Bulkhead Urb	146	5.5	9.5	10.0
	RPV-094-e	Shallow Bulkhead Urb	54	5.5	9.5	10.0
	RPV-094-f	Shallow Bulkhead	345	5.5	9.5	10.0
	RPV-094-g	Shallow Bulkhead Urb	694	5.5	11.0	11.5
	RPV-094-i	Shallow Bulkhead	119	5.5	11.0	11.5
	RPV-094-j	Shallow Bulkhead	135	5.5	11.0	11.5
	RPV-094-k	Medium Floodwall	118	4.0	11.5	11.5
	RPV-095-a	Medium Berm	1138	7.0	12.4	12.5
	RPV-096-a	High Floodwall	439	5.5	11.0	11.5
	RPV-097-a	Deep Bulkhead	267	5.0	11.0	11.5
	RPV-111-a	Low Floodwall	281	5.5	8.9	9.0
	RPV-111-b	Low Floodwall	50	5.5	8.9	9.0
	RPV-111-c	Low Floodwall	296	5.5	8.9	9.0
	RPV-111-d	Low Floodwall	54	5.5	8.9	9.0
	RPV-111-e	Low Floodwall	21	5.5	8.9	9.0
	RPV-111-f	Deep Bulkhead	536	6.0	11.1	11.5
	RPV-111-g	Low Floodwall	195	6.0	7.9	8.0
	RPV-111-h	Road Ramp	37	6.0	7.9	8.0
	RPV-111-i	Low Floodwall	820	6.0	7.9	8.0
	RPV-111-j	Vehicular Gate	25	6.0	7.9	8.0
	RPV-111-k	Low Floodwall	237	6.0	7.9	8.0
	RPV-111-l	Road Ramp	34	6.0	7.9	8.0
	RPV-111-m	Low Floodwall	67	6.0	11.1	11.5
	RPV-111-n	Medium Floodwall	247	6.0	11.1	11.5
	RPV-113-a	Road Ramp	33	6.0	7.9	8.0
	RPV-113-b	Low Floodwall	303	6.0	7.9	8.0
	RPV-113-c	Road Ramp	40	6.0	7.9	8.0
	RPV-113-d	Low Floodwall	434	6.0	7.9	8.0

Mid-Rockaway Backbay with NNBFs	RPV-113-e	Road Ramp	44	6.0	7.9	8.0
	RPV-113-f	Low Floodwall	545	6.0	7.9	8.0
	RPV-121-b	Low Floodwall	125	5.0	7.8	8.0
	RPV-122-a	Road Ramp	31	5.0	7.8	8.0
	RPV-123-a	Low Floodwall	474	5.0	7.8	8.0
	RPV-123-b	Road Ramp	30	5.0	7.8	8.0
	RPV-123-c	Low Floodwall	185	5.0	7.8	8.0
	RPV-123-d	Road Ramp	40	5.0	7.8	8.0
	RPV-124-a	Low Floodwall	214	5.0	7.8	8.0
	RPV-124-b	Low Floodwall	16	5.0	7.8	8.0
	RPV-124-c	Low Floodwall	253	5.0	7.8	8.0
Motts Basin North	RPV-072-a	Low Floodwall	536	6.0	7.7	8.0
	RPV-072-b	Medium Floodwall	47	6.0	7.7	8.0
	RPV-072-c	Low Floodwall	105	6.0	7.7	8.0
Canarsie	FCV-067-a	Revetment	562	6.0	9.5	9.5
	FCV-067-b	Low Floodwall	612	6.0	8.0	8.0
	FCV-067-c	Low Floodwall	48	6.0	8.0	8.0
	FCV-067-d	Low Floodwall	751	6.0	8.0	8.0
	FCV-067-e	Low Floodwall	29	6.0	8.0	8.0
	FCV-067-f	Low Floodwall	266	6.0	8.0	8.0
	FCV-067-g	Revetment	238	6.0	9.4	9.5
	FCV-067-h	Revetment	52	6.0	9.4	9.5
	FCV-067-i	Revetment	234	6.0	9.4	9.5
Cedarhurst-Lawrence	NCV-010-a	Deep Bulkhead	286	4.0	9.7	10.0
	NCV-010-b	Deep Bulkhead	192	4.0	9.7	10.0
	NCV-010-c	Deep Bulkhead	57	4.0	9.7	10.0
	NCV-010-d	Deep Bulkhead	43	4.0	9.7	10.0
	NCV-010-e	Deep Bulkhead	385	4.0	9.7	10.0
	NCV-010-f	Medium Floodwall	23	5.5	9.7	10.0

Canarsie

Legend

N

Project Alignments (v20180717)

HFFRR-Feature

- Low Floodwall
- Revetment
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street
- Alley

0 40 80 160 240 320 Feet

Canarsie

Legend

N

Project Alignments (v20180717)

HFFRR-Feature

- Low Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street
- Alley

0 40 80 160 240 320 Feet

Canarsie

Legend

N

Project Alignments (v20180717)

HFFRR-Feature

- Low Floodwall
- Revetment
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street

0 40 80 160 240 320 Feet

Motts Basin N

The data displayed on this map illustrate the scale of potential flooding, not the exact location, and do not account for future, ground elevation, shoreline, or hydrological changes. Inundation was assumed to occur at a constant elevation above the NAVD88 Datum (i.e., bathtub model) as indicated on the map. All low-lying areas, shaded in color, are assumed to be hydrologically "connected". Actual flooding extents may vary due to the temporal characteristics of a coastal flooding event as well as the potential combined effects of rainfall run-off, back flow through existing stormwater infrastructure, and seepage.

Legend

Project Alignments

HFFRR-Feature

- Low Floodwall
- Medium Floodwall
- 20% AEP (5yr RP) Flood Extents (2068)

Nassau County

- Nassau County Streets
- City Street

N

0 40 80 160 240 320 Feet

Edgemere

The data displayed on this map illustrate the scale of potential flooding, not the exact location, and do not account for future ground elevation, shoreline, or hydrological changes. Inundation was assumed to occur at a constant elevation above the NAVD88 Datum (i.e., bathtub model) as indicated on the map. All low-lying areas, shaded in color, are assumed to be hydrologically "connected". Actual flooding extents may vary due to the temporal characteristics of a coastal flooding event as well as the potential combined effects of rainfall run-off, back flow through existing stormwater infrastructure, and seepage.

Legend

N

Proposed Pump Station Locations

NNBF Gains Areas

Planting

- Scrub-shrub
- Smooth Cordgrass

Project Alignments

HFFRR-Feature

- Rock Sill
- Low Berm
- Medium Berm
- Hybrid Berm

20% AEP (5yr RP) Flood Extents (2068)

City Street

Railroad Track

0 40 80 160 240 320 Feet

Edgemere

The data displayed on this map illustrate the scale of potential flooding, not the exact location, and do not account for future, ground elevation, shoreline, or hydrological changes. Inundation was assumed to occur at a constant elevation above the NAVD88 datum (i.e., bathtub model) as indicated on the map. All low-lying areas, shaded in color, are assumed to be hydrologically "connected". Actual flooding extents may vary due to the temporal characteristics of a coastal flooding event as well as the potential combined effects of rainfall run-off, back flow through existing stormwater infrastructure, and seepage.

Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

- Salt Meadow Hay
- Scrub-shrub
- Smooth Cordgrass

Project Alignments (v20180717)

HFFRR-Feature

- Rock Sill
- High Floodwall
- Medium Berm
- Hybrid Berm
- Shallow Bulkhead
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street

0 40 80 160 240 320 Feet

Edgemere

Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

- Salt Meadow Hay
- Scrub-shrub
- Smooth Cordgrass

Project Alignments (v20180717)

HFFRR-Feature

- Rock Sill
- Medium Floodwall
- High Floodwall
- Medium Berm
- High Berm
- Hybrid Berm
- Shallow Bulkhead
- Shallow Bulkhead Urban
- Road Ramp
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street
- Physical Non-Street Feature

0 40 80 160 240 320 Feet

Edgemere

The data displayed on this map illustrate the scale of potential flooding, not the exact location, and do not account for future ground elevation, shoreline, or hydrological changes. Inundation was assumed to occur at a constant elevation above the NAVD88 Datum (i.e., bathtub model) as indicated on the map. All low-lying areas shaded in color, are assumed to be hydrologically "connected". Actual flooding extents may vary due to the temporal characteristics of a coastal flooding event as well as the potential combined effects of rainfall run-off, back flow through existing stormwater infrastructure, and seepage.

Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

- Salt Meadow Hay
- Scrub-shrub

Project Alignments (v20180717)

HFFRR-Feature

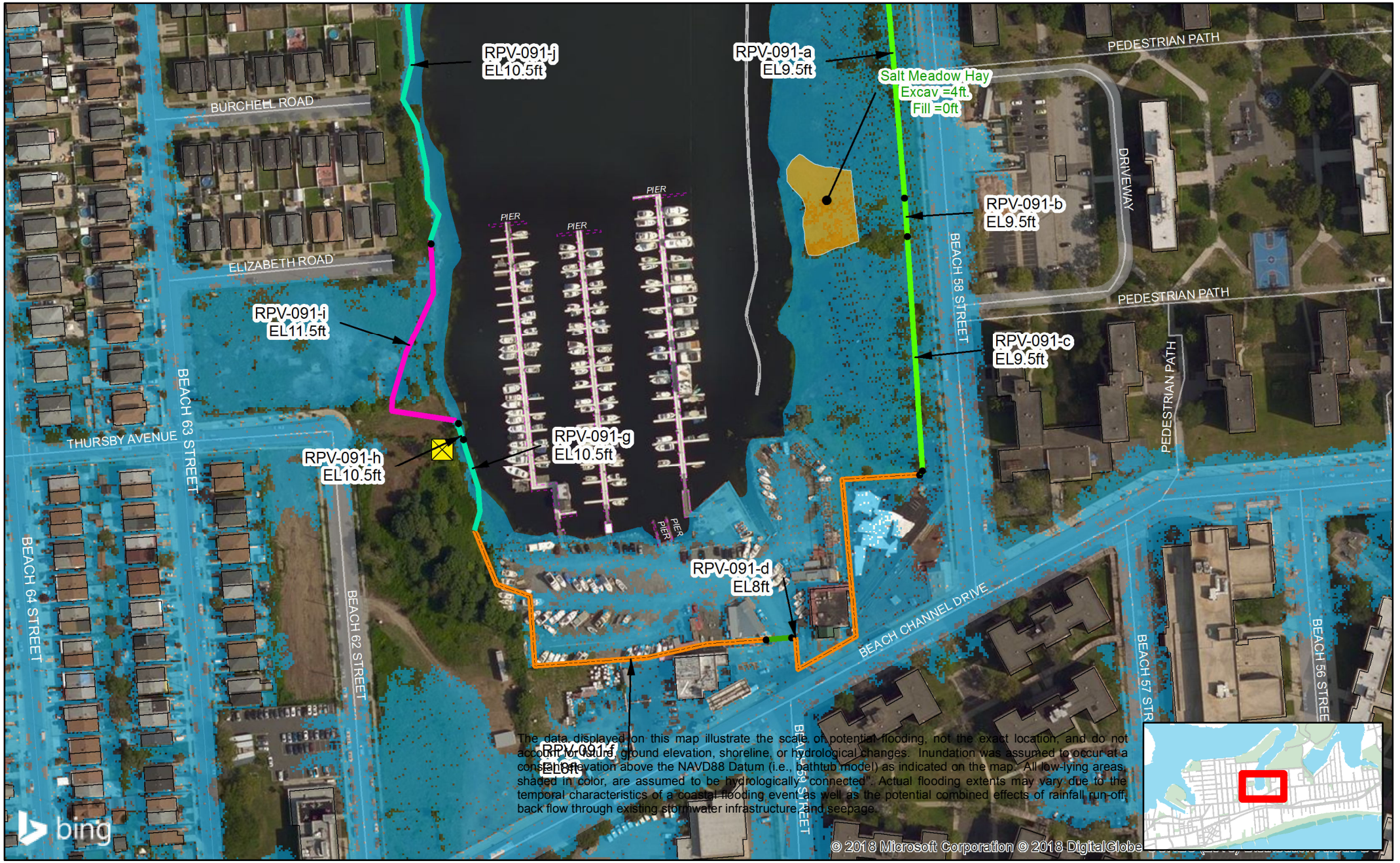
- Rock Sill
- High Floodwall
- Low Berm
- Hybrid Berm

20% AEP (5yr RP) Flood Extents (2068)

City Street

0 40 80 160 240 320 Feet

Arverne



The data displayed on this map illustrate the scale of potential flooding, not the exact location, and do not account for future ground elevation, shoreline, or hydrological changes. Inundation was assumed to occur at a constant elevation above the NAVD88 Datum (i.e., bathtub model) as indicated on the map. All low-lying areas, shaded in color, are assumed to be hydrologically connected". Actual flooding extents may vary due to the temporal characteristics of a coastal flooding event as well as the potential combined effects of rainfall run-off, back flow through existing stormwater infrastructure, and seepage.

Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

Salt Meadow Hay

Project Alignments (v20180717)

HFFRR-Feature

- Rock Sill
- Low Floodwall
- Low Berm
- Shallow Bulkhead
- Revetment
- Road Ramp

20% AEP (5yr RP) Flood Extents (2068)

City Street

Private Street; 6, V

Physical Non-Street Feature

0 40 80 160 240 320 Feet

Arverne

The data displayed on this map illustrate the scale of potential flooding, not the exact location, and do not account for future, ground elevation, shoreline, or hydrological changes. Inundation was assumed to occur at a constant elevation above the NAVD88 Datum (i.e., bathtub model) as indicated on the map. All low-lying areas, shaded in color, are assumed to be hydrologically "connected". Actual flooding extents may vary due to the temporal characteristics of a coastal flooding event as well as the potential combined effects of rainfall run-off, back flow through existing stormwater infrastructure, and seepage.

Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

- Canopy Tree
- Smooth Cordgrass

Project Alignments (v20180717)

HFFRR-Feature

- Rock Sill
- Low Berm
- Deep Bulkhead
- Revetment
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street
- Private Street; 6, V

0 40 80 160 240 320 Feet

Arverne

Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

- Canopy Tree
- Salt Meadow Hay
- Smooth Cordgrass

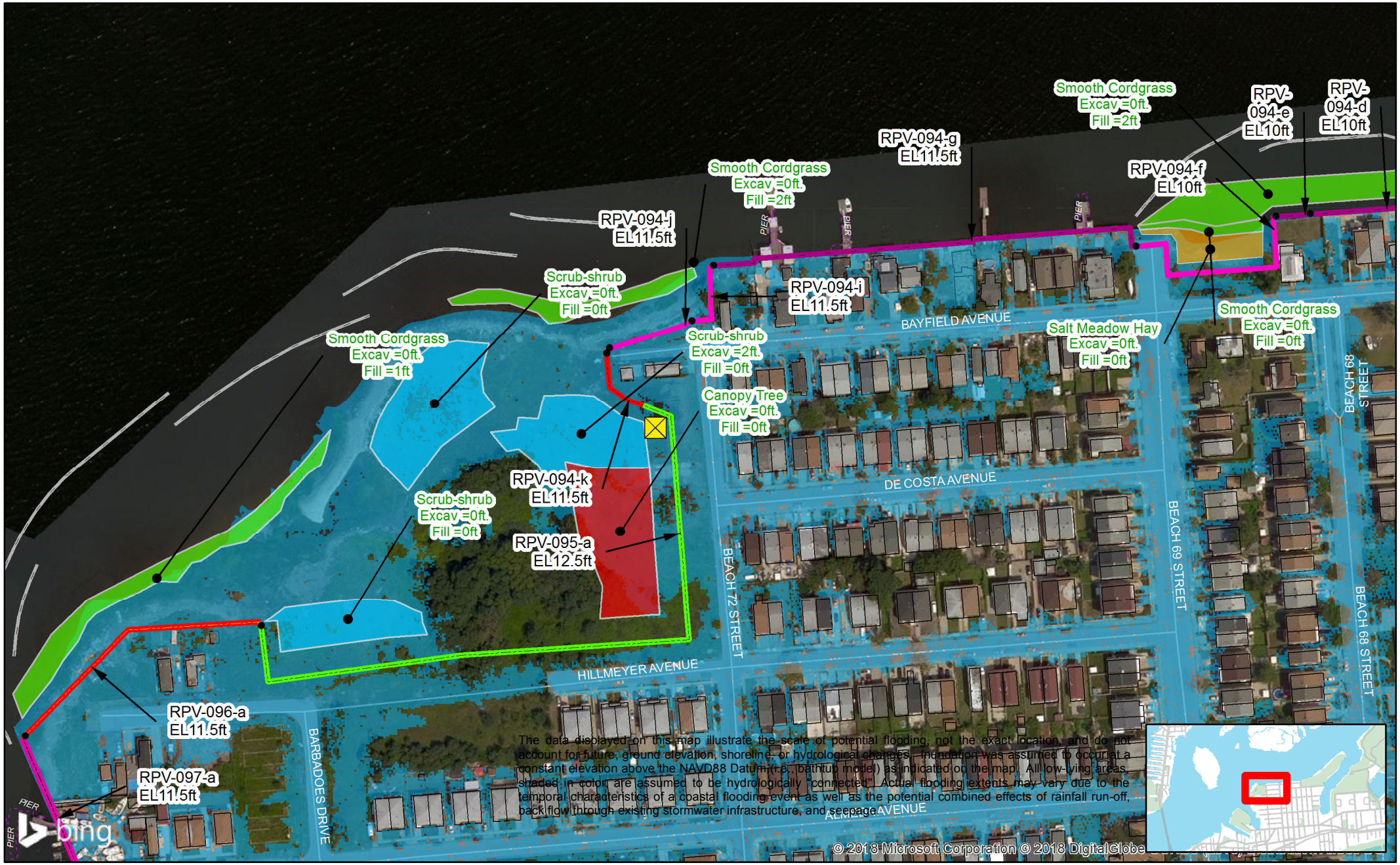
Project Alignments (v20180717)

HFFRR-Feature

- Rock Sill
- Low Berm
- Hybrid Berm
- Shallow Bulkhead
- Shallow Bulkhead Urban
- Revetment
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street
- Private Street; 6, V

0 40 80 160 240 320 Feet

Arverne



Legend

N

Proposed Pump Station Locations

NNBF Gains Areas

Planting

- Canopy Tree
- Salt Meadow Hay
- Scrub-shrub
- Smooth Cordgrass

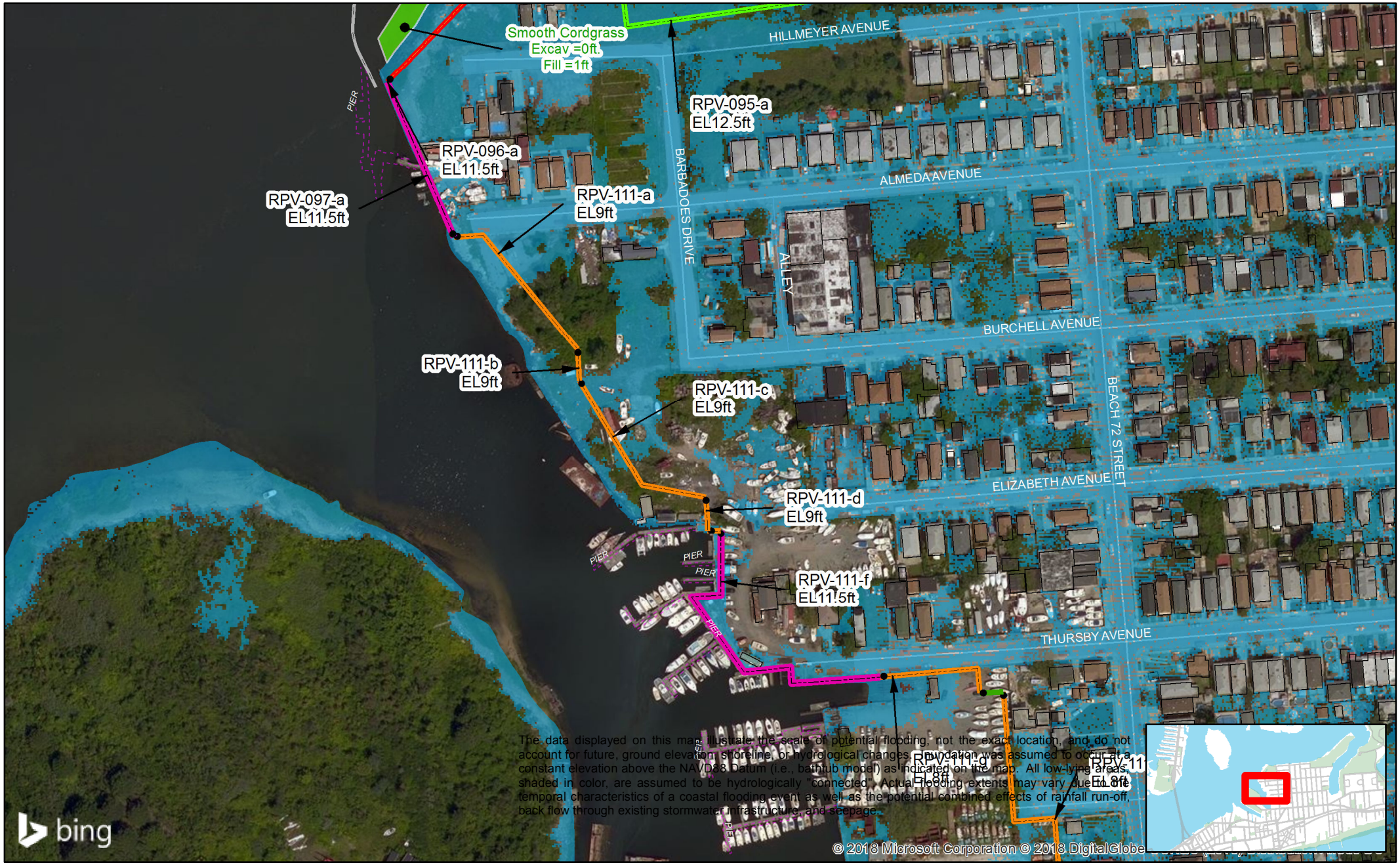
Project Alignments

HFFRR-Feature

- Rock Sill
- Medium Floodwall
- High Floodwall
- Medium Berm
- Deep Bulkhead
- Shallow Bulkhead
- Shallow Bulkhead Urban
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street
- Physical Non-Street Feature
- Alley

0 40 80 160 240 320 Feet

Arverne



The data displayed on this map illustrate the scale of potential flooding, not the exact location, and do not account for future, ground elevation, shoreline, or hydrological changes. Inundation was assumed to occur at a constant elevation above the NAVD88 Datum (i.e., bathtub model) as indicated on the map. All low-lying areas, shaded in color, are assumed to be hydrologically "connected". Actual flooding extents may vary due to the temporal characteristics of a coastal flooding event as well as the potential combined effects of rainfall run-off, back flow through existing stormwater infrastructure, and seepage.

Legend

NNBF Gains Areas

Planting

- Smooth Cordgrass

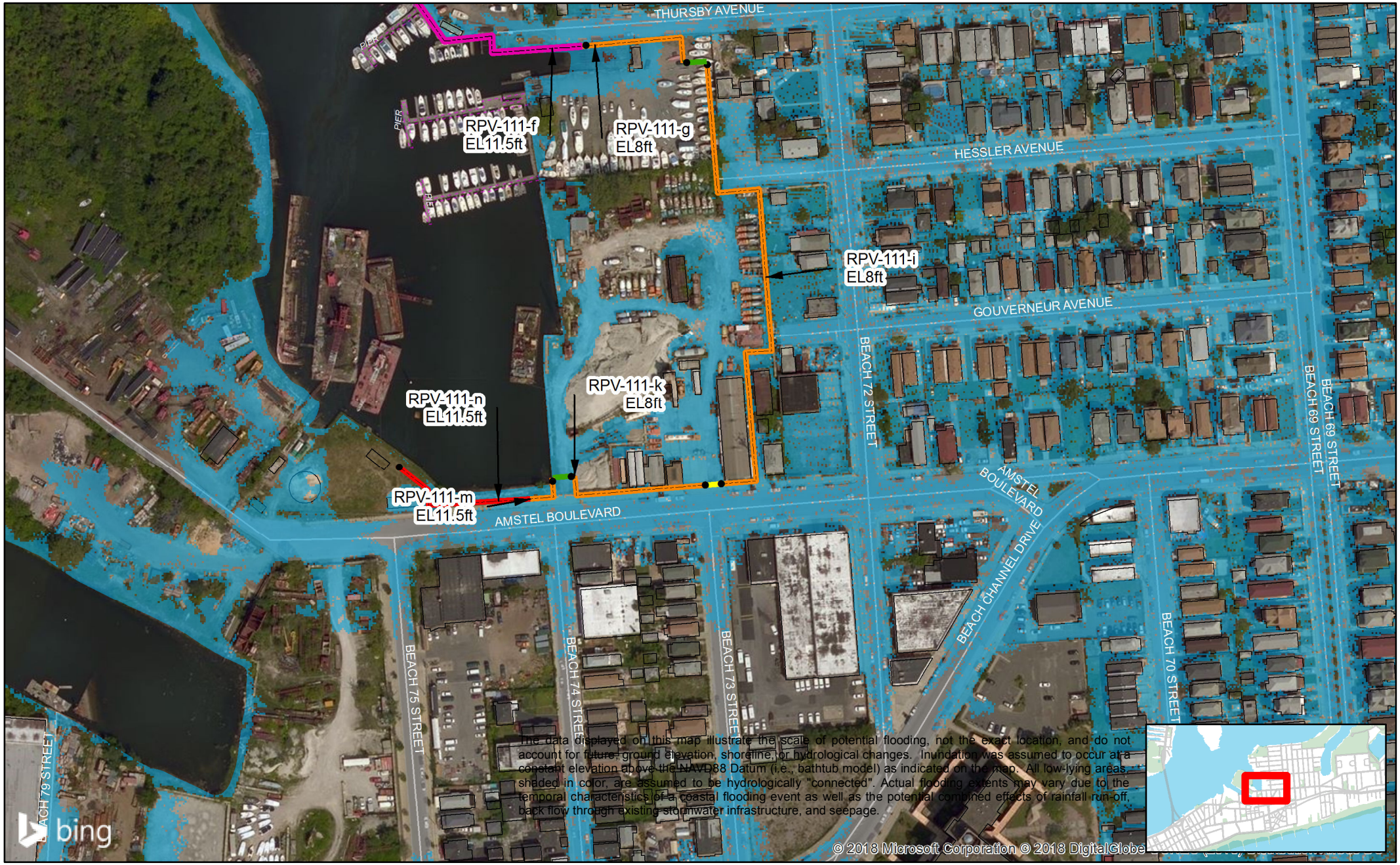
Project Alignments

HFFRR-Feature

- Rock Sill
- Low Floodwall
- High Floodwall
- Medium Berm
- Deep Bulkhead
- Road Ramp
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street
- Physical Non-Street Feature
- Alley

N

0 40 80 160 240 320 Feet



Legend

Project Alignments

HFFRR-Feature

- Low Floodwall
- Medium Floodwall
- Deep Bulkhead
- Vehicular Gate
- Road Ramp

20% AEP (5yr RP) Flood Extents (2068)

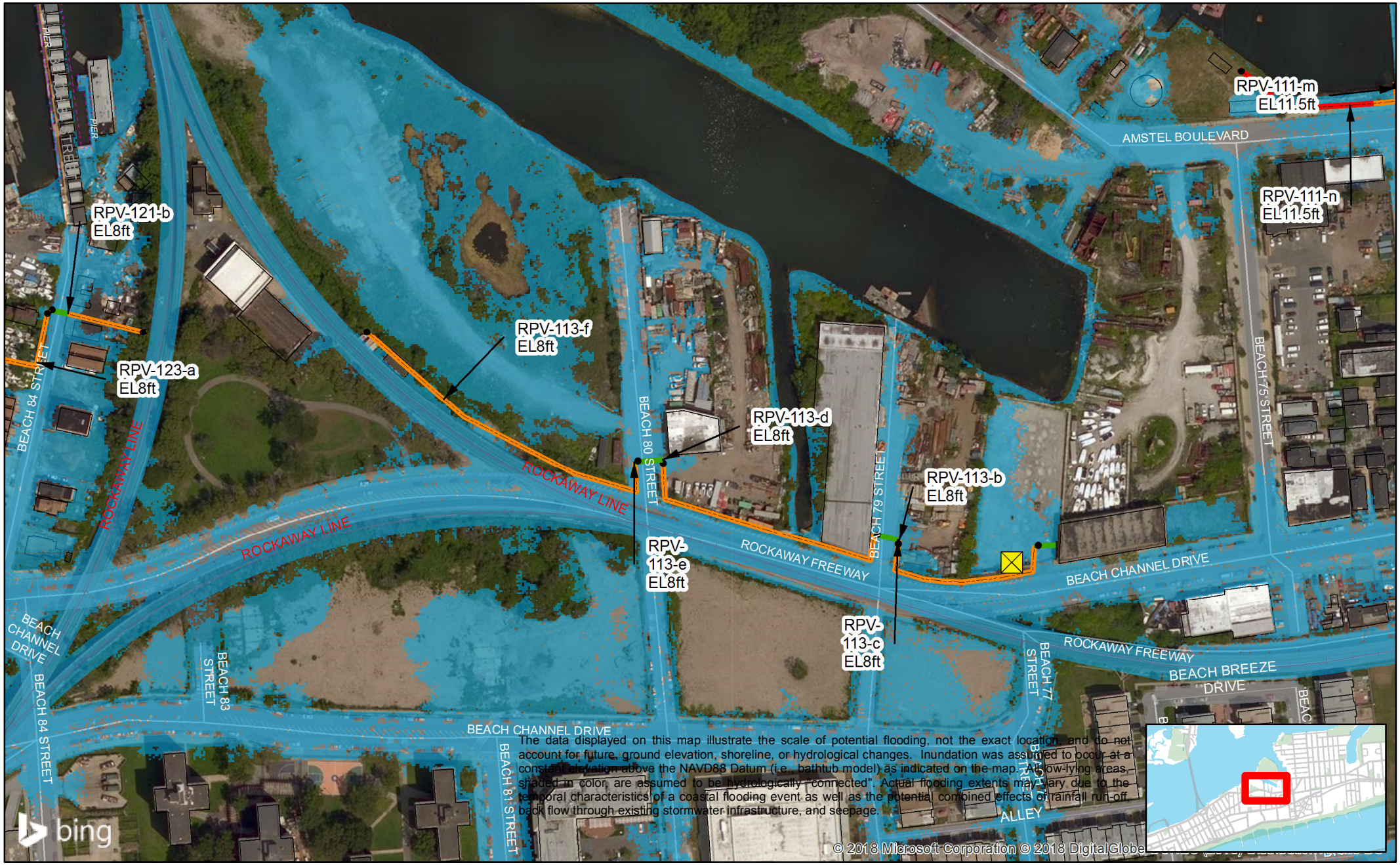
City Street

Physical Non-Street Feature

N

0 40 80 160 240 320 Feet

Hammels



The data displayed on this map illustrate the scale of potential flooding, not the exact location, and do not account for future, ground elevation, shoreline, or hydrological changes. Inundation was assumed to occur at a constant elevation above the NAVD88 Datum (i.e., bathtub model) as indicated on the map. All low-lying areas, shaded in color, are assumed to be hydrologically "connected". Actual flooding extents may vary due to the temporal characteristics of a coastal flooding event as well as the potential combined effects of rainfall run-off, back flow through existing stormwater infrastructure, and seepage.

Legend

N

Proposed Pump Station Locations

Project Alignments

HFFRR-Feature

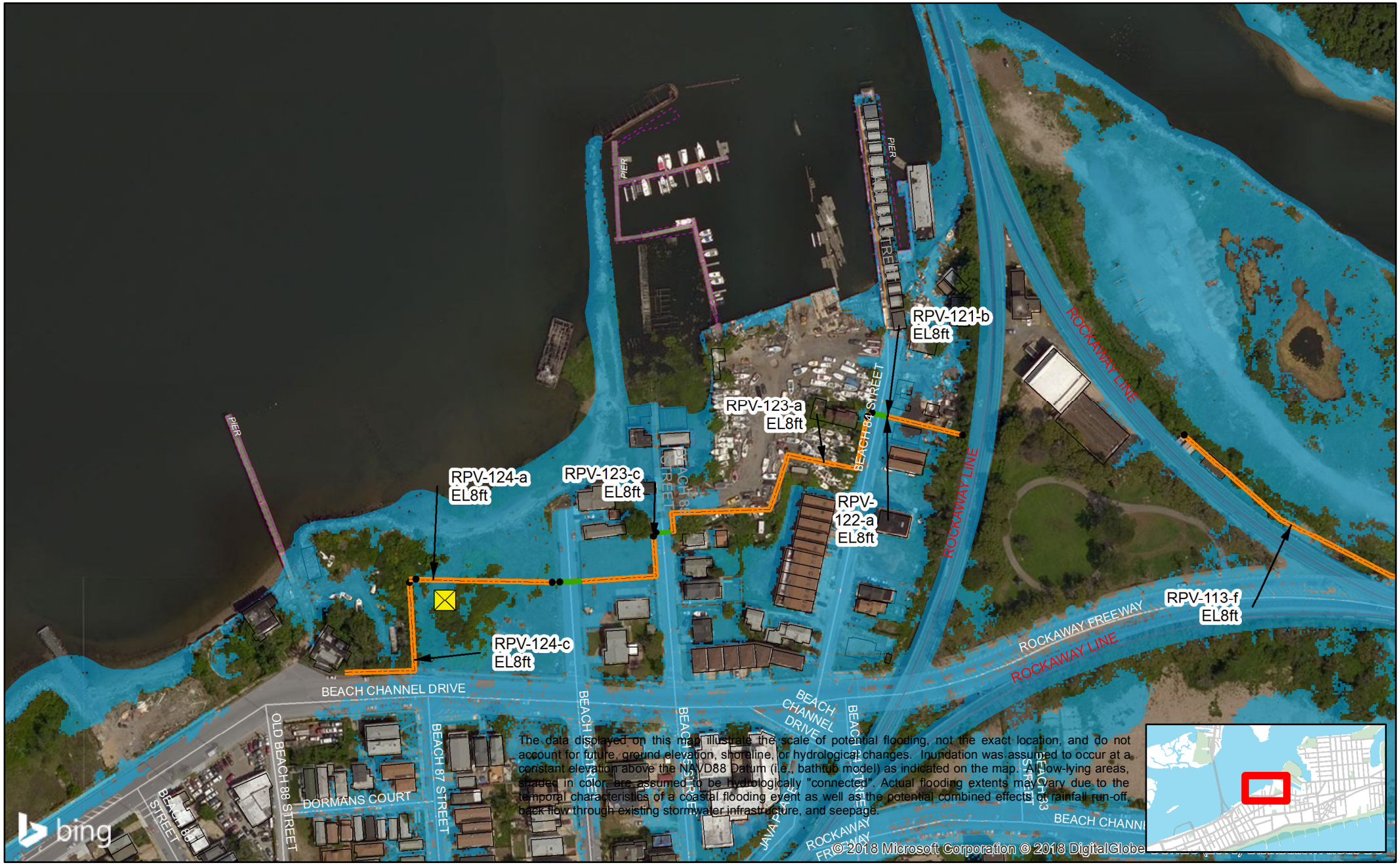
- Low Floodwall
- Medium Floodwall
- Road Ramp

20% AEP (5yr RP) Flood Extents (2068)

- City Street
- Railroad Track
- Private Street; 6, V
- Physical Non-Street Feature
- Alley
- Addressable Path

0 40 80 160 240 320 Feet

Hammels



Legend

N

Proposed Pump Station Locations

Project Alignments (v20180717)

HFFRR-Feature

- Low Floodwall
- Road Ramp
- 20% AEP (5yr RP) Flood Extents (2068)
- City Street
- Railroad Track
- Physical Non-Street Feature
- Addressable Path

0 40 80 160 240 320 Feet

Cedarhurst-Lawrence

Legend

N

Proposed Pump Station Locations

Project Alignments (v20180717)

HFFRR-Feature

Medium Floodwall

Deep Bulkhead

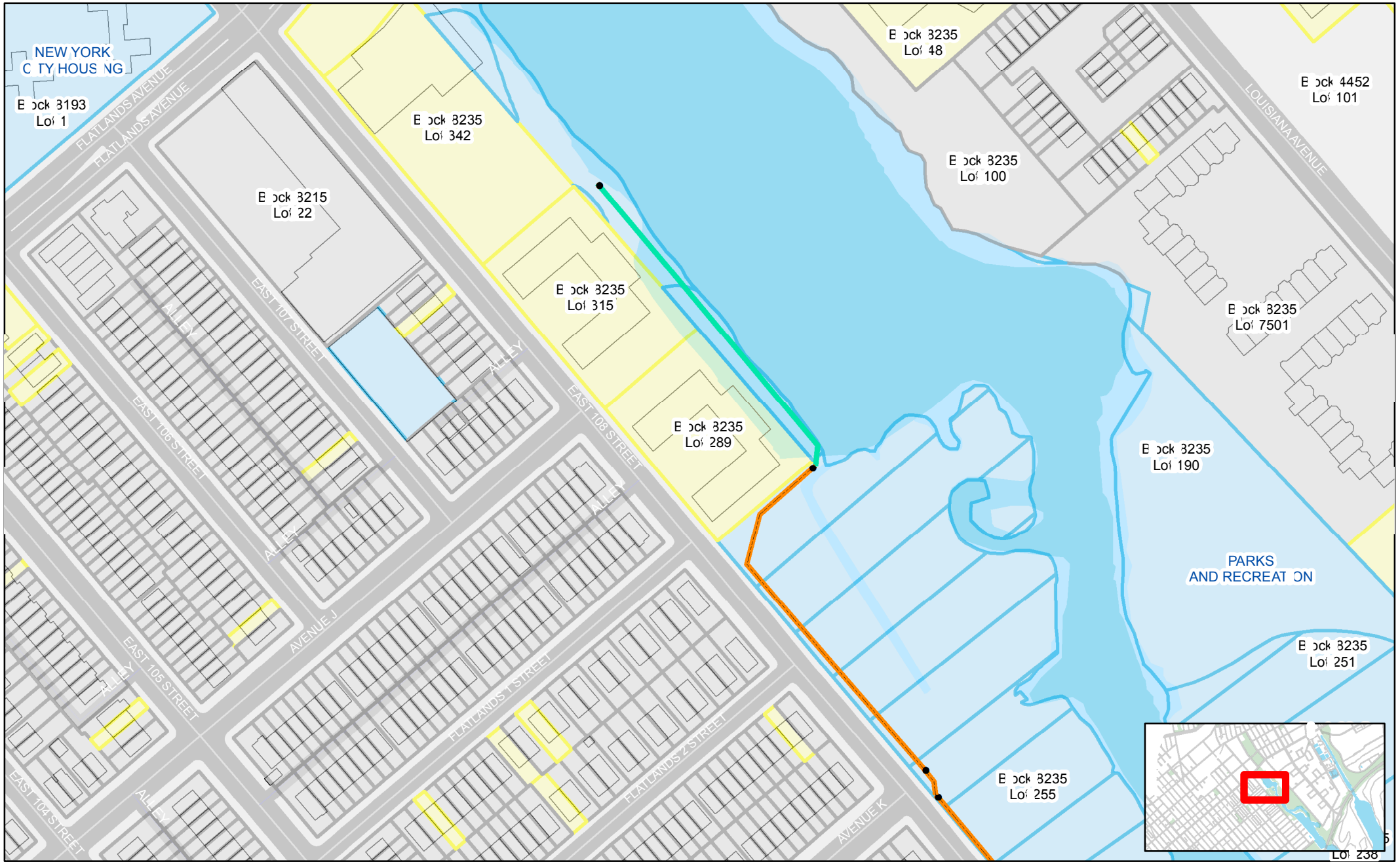
20% AEP (5yr RP) Flood Extents (2068)

Nassau County Streets

Nassau County Streets

0 40 80 160 240 320 Feet

Canarsie



Legend

N

Project Alignments (v20180717)

HFFRR-Feature

- Low Floodwall
- Revetment

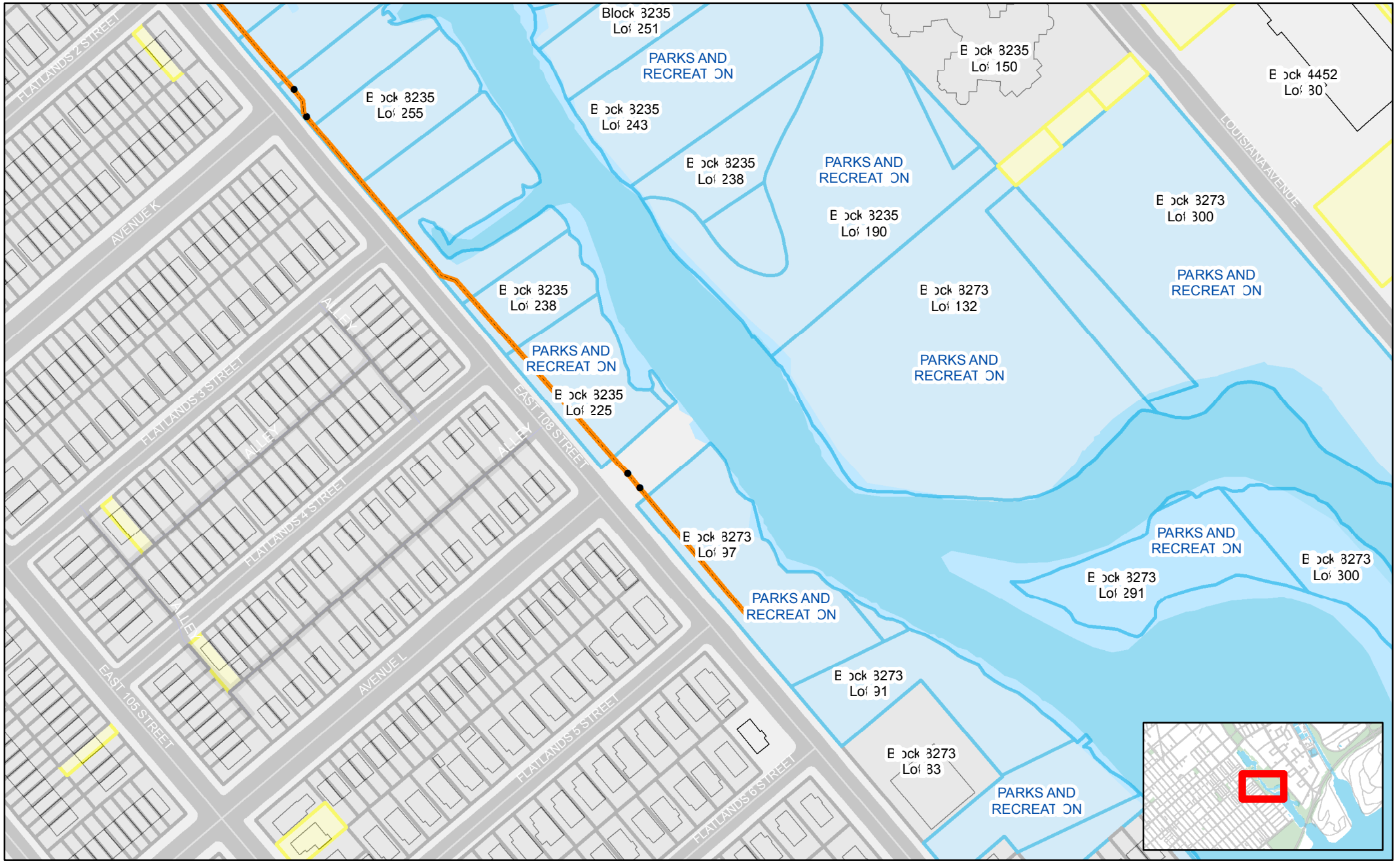
PLTBrooklyn

OwnType

- City
- Private
- City Street
- Alley

0 40 80 160 240 320 Feet

Canarsie



Legend

Project Alignments

HFFRR-Feature

Low Floodwall

PLTBrooklyn

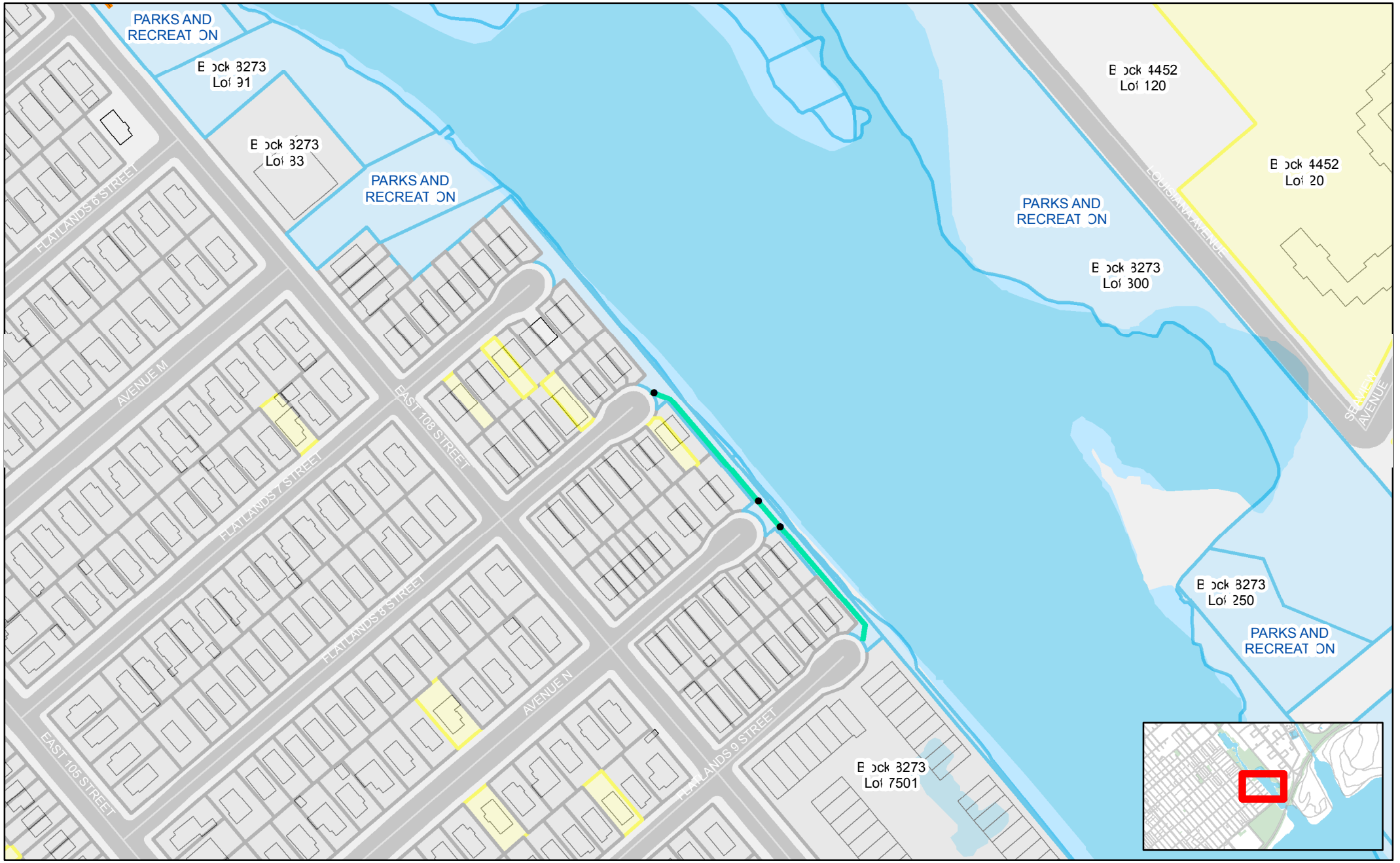
OwnType

- City
- Private
- City Street
- Alley

N

0 40 80 160 240 320 Feet

Canarsie



Legend

Project Alignments

HFFRR-Feature

- Low Floodwall
- Revetment

PLTBrooklyn

OwnType

- City
- Private
- City Street

N

0 40 80 160 240 320 Feet

Motts Basin N

Legend

Project Alignments

HFFRR-Feature

- Low Floodwall
- Medium Floodwall

PLTQueens

OwnType

- City

Nassau County

- Nassau County Streets
- City Street
- Work Area
- Perpetual Easement

N

0 40 80 160 240 320 Feet

Edgemere

Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

- Scrub-shrub
- Smooth Cordgrass

Project Alignments (v20180717)

HFFRR-Feature

- Rock Sill
- Low Berm
- Medium Berm
- Hybrid Berm

PLTQueens

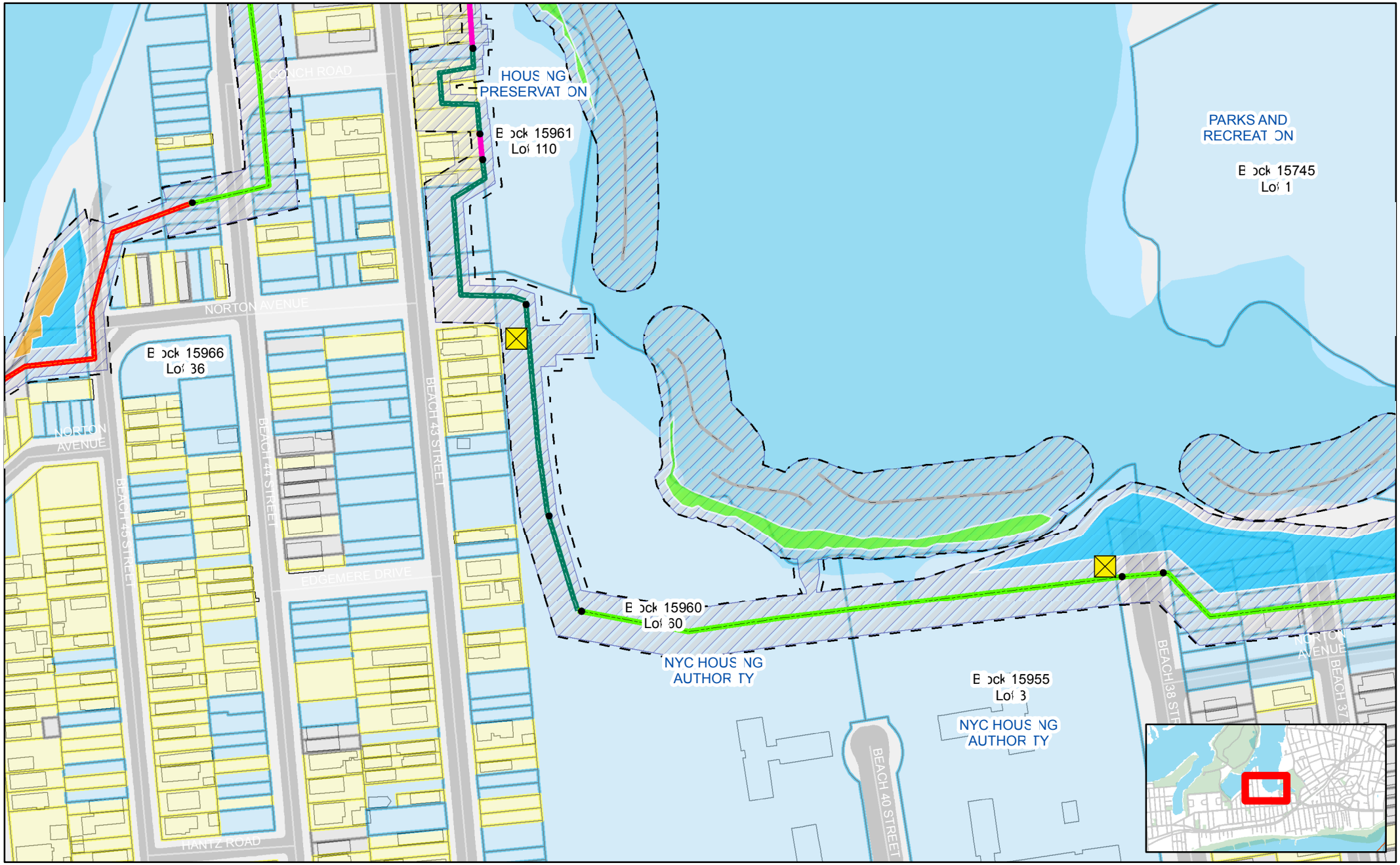
OwnType

- City
- Private
- City Street
- Railroad Track
- Work Area Easement
- Perpetual Easement

Feet

0 40 80 160 240 320

Edgemere



Legend

Proposed Pump Station Locations

NNBF Gains Areas

Planting

- Salt Meadow Hay
- Scrub-shrub
- Smooth Cordgrass

Project Alignments

HFFRR-Feature

- Rock Sill
- High Floodwall
- Medium Berm
- Hybrid Berm
- Shallow Bulkhead

PLTQueens

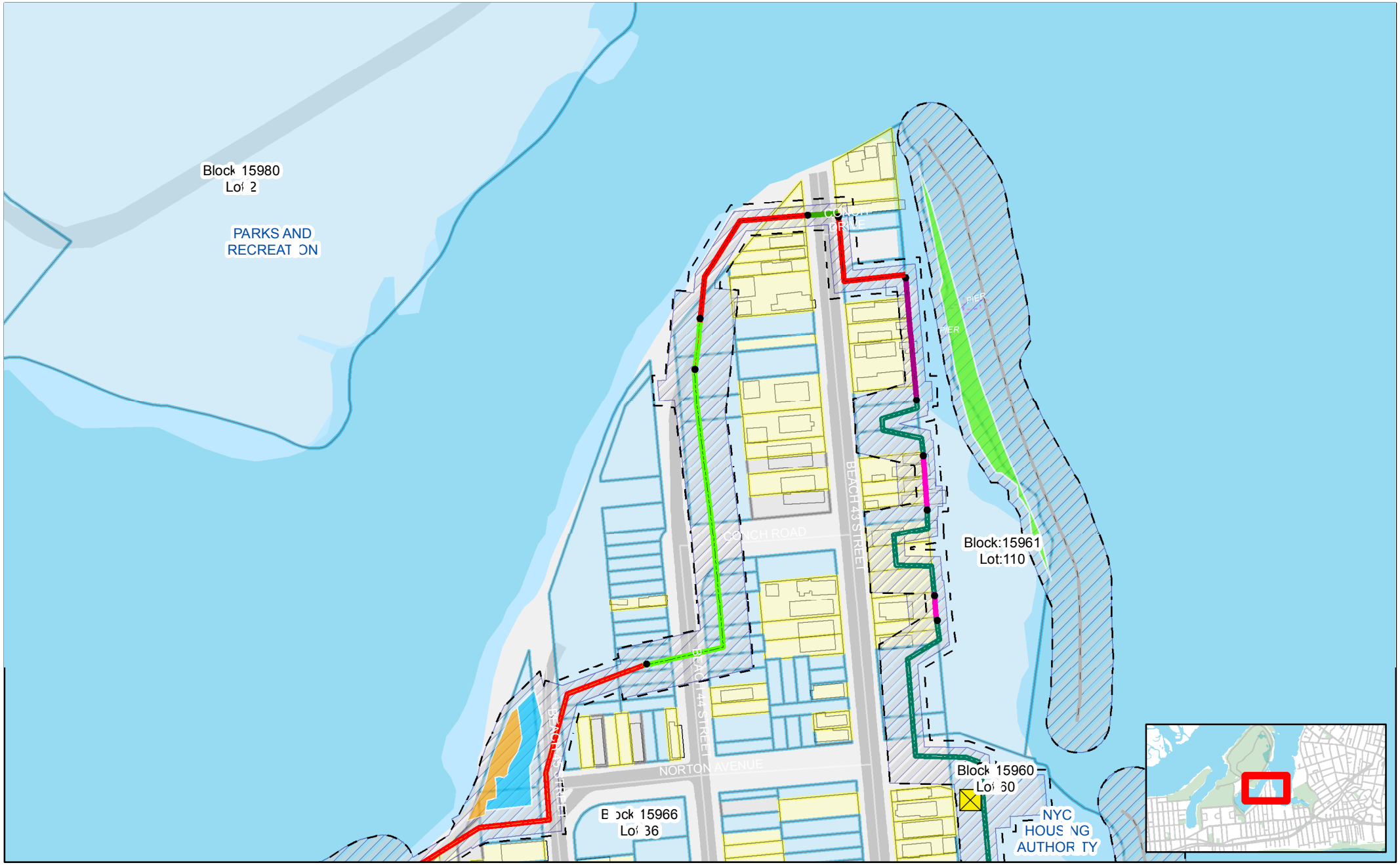
OwnType

- City
- Private
- City Street
- Work Area
- Perpetual Easement

N

0 40 80 160 240 320 Feet

Edgemere



Legend

Proposed Pump Station Locations

NNBF Gains Areas

Planting

- Salt Meadow Hay
- Scrub-shrub
- Smooth Cordgrass

Project Alignments

HFFRR-Feature

- Rock Sill
- Medium Floodwall
- High Floodwall
- Medium Berm
- High Berm
- Hybrid Berm
- Shallow Bulkhead
- Shallow Bulkhead Urban
- Road Ramp

PLTQueens

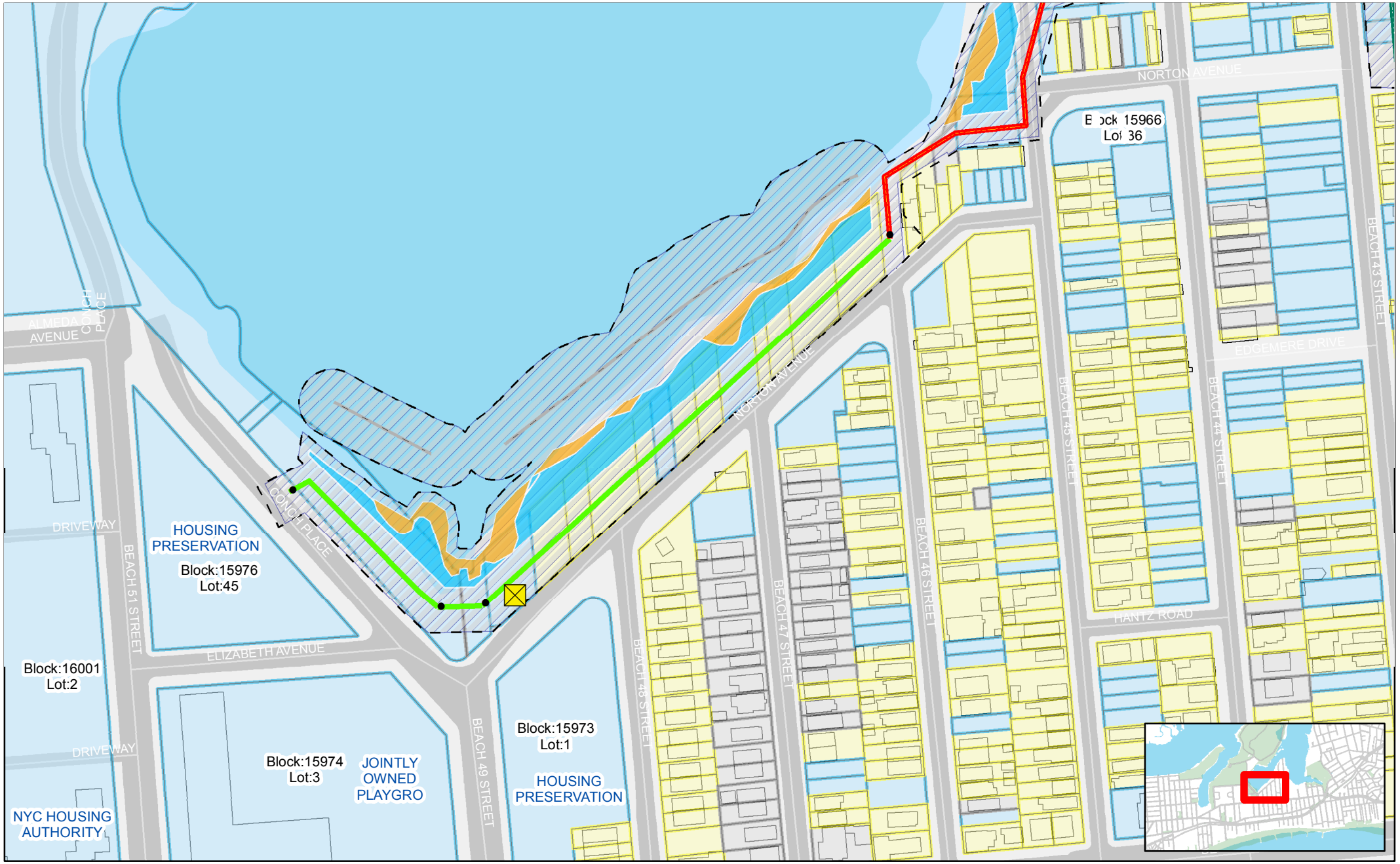
OwnType

- City
- Private
- City Street
- Physical Non-Street Feature
- Work Area
- Perpetual Easement

N

0 40 80 160 240 320 Feet

Edgemere



Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

- Salt Meadow Hay
- Scrub-shrub

Project Alignments (v20180717)

HFFRR-Feature

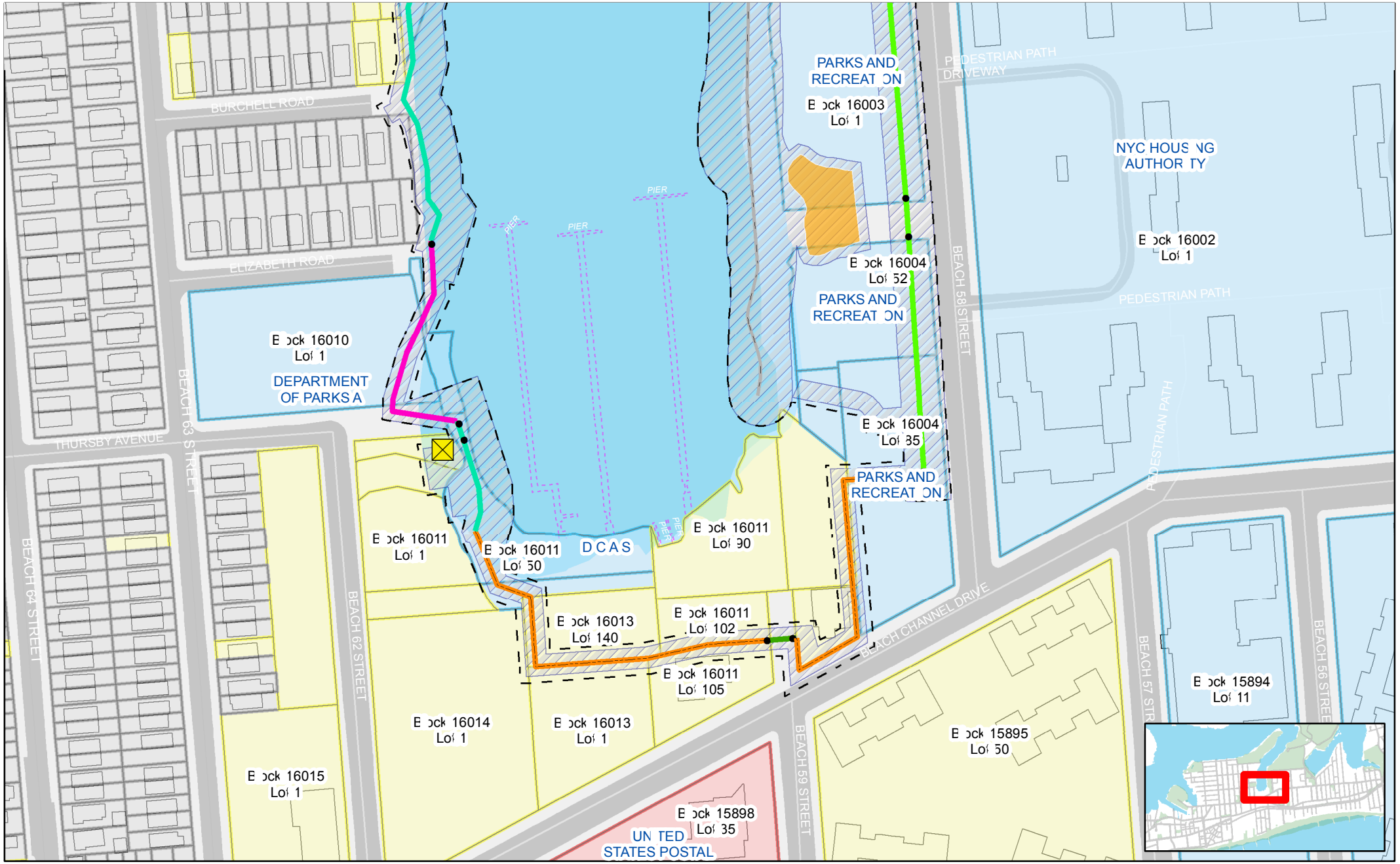
- Rock Sill
- High Floodwall
- Low Berm
- Hybrid Berm

PLTQueens

OwnType

- City
- Private
- City Street
- Work Area Easement
- Perpetual Easement

0 40 80 160 240 320 Feet



Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

- Salt Meadow Hay

Project Alignments

HFFRR-Feature

- Rock Sill
- Low Floodwall
- Low Berm
- Shallow Bulkhead
- Revetment
- Road Ramp

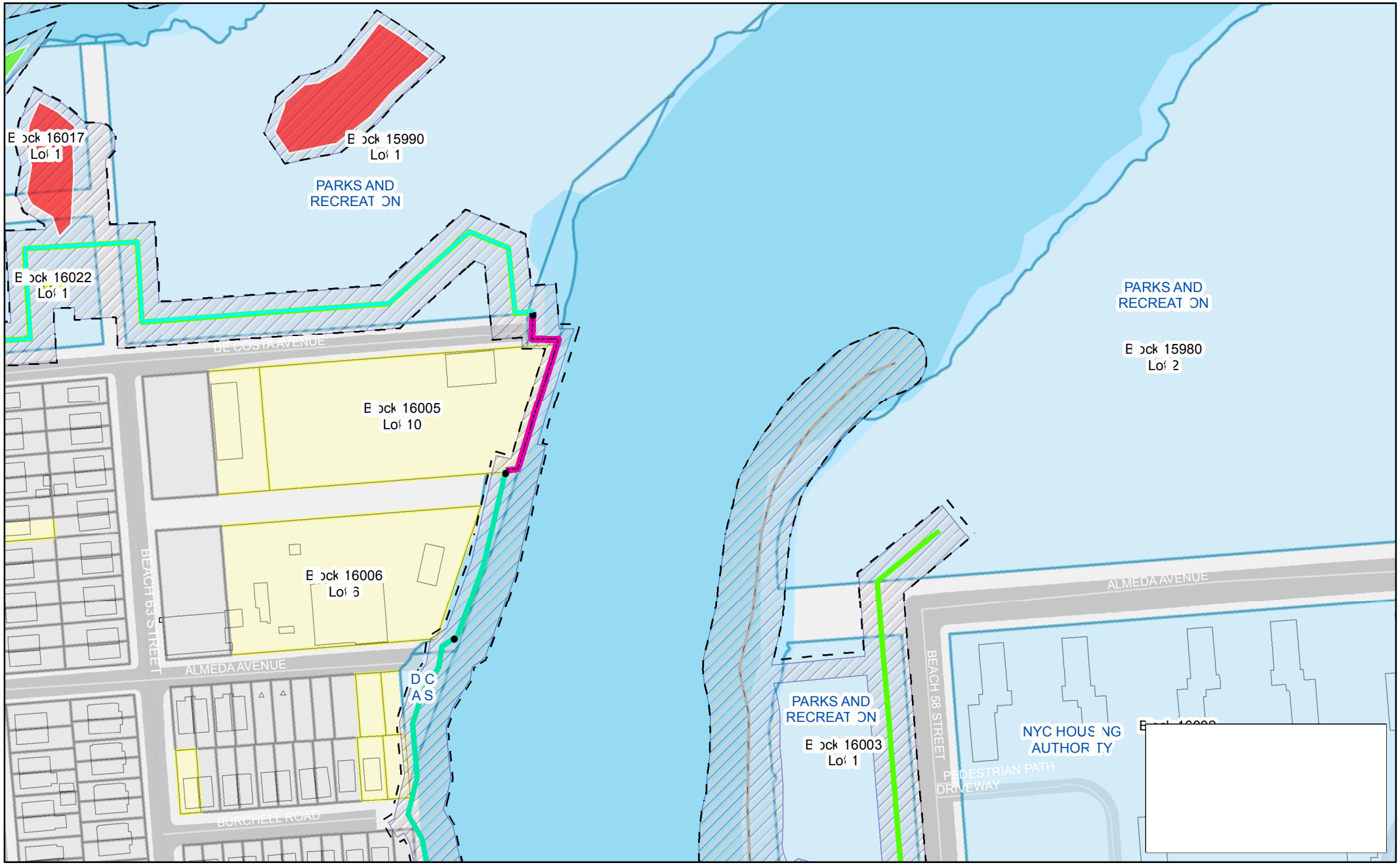
PLTQueens

OwnType

- City
- Federal
- Private
- City Street
- Private Street; 6, V
- Physical Non-Street Feature
- Work Area Easement
- Perpetual Easement

0 40 80 160 240 320 Feet

Arverne



Legend

N

Proposed Pump Station Locations

NNBF Gains Areas

Planting

- Canopy Tree
- Smooth Cordgrass

Project Alignments

HFFRR-Feature

- Rock Sill
- Low Berm
- Deep Bulkhead
- Revetment

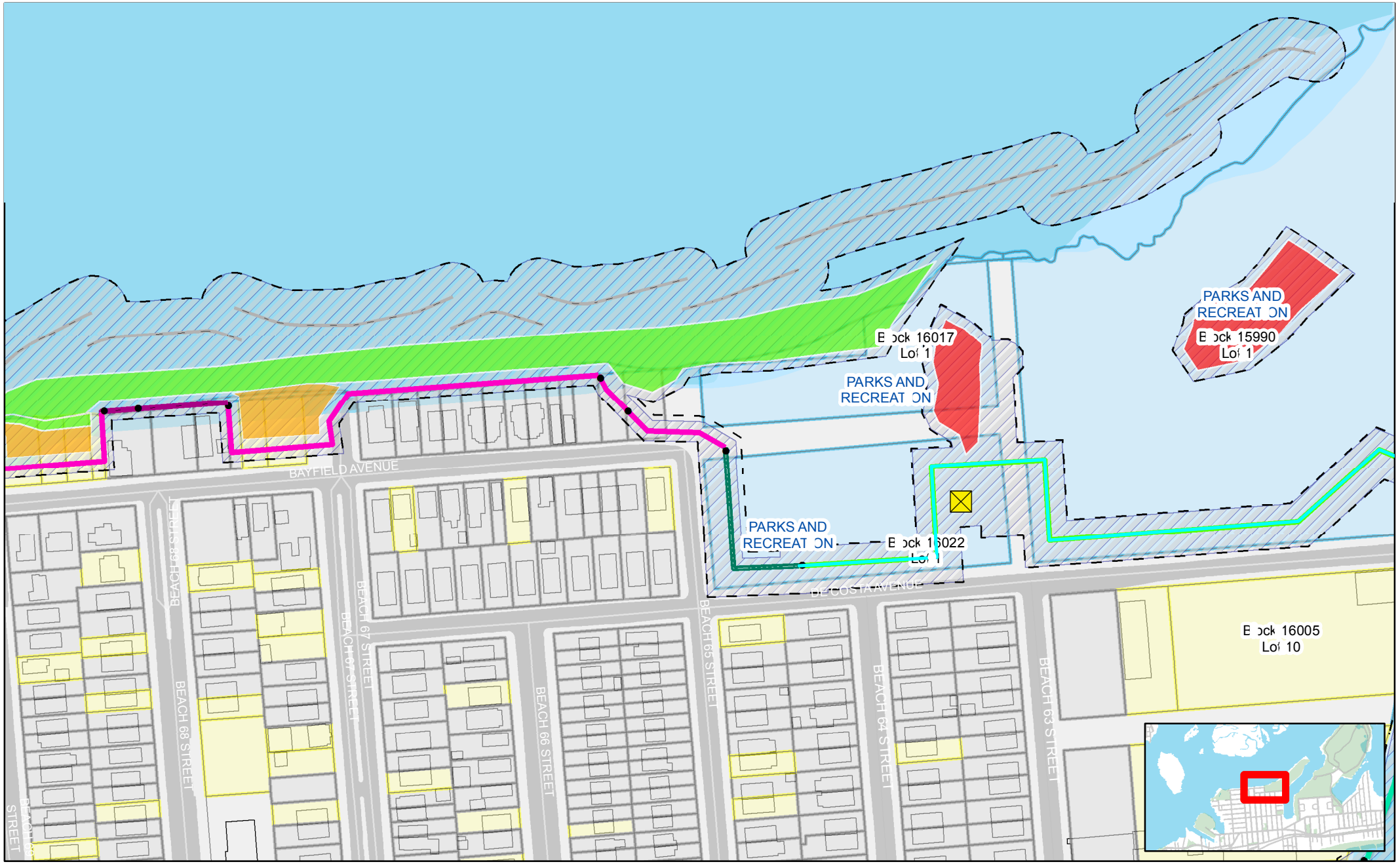
PLTQueens

OwnType

- City
- Private
- City Street
- Private Street; 6, V
- Work Area Easement
- Perpetual Easement

0 40 80 160 240 320 Feet

Arverne



Legend

N

Proposed Pump Station Locations

NNBF Gains Areas

Planting

- Canopy Tree
- Salt Meadow Hay
- Smooth Cordgrass

Project Alignments

HFFRR-Feature

- Rock Sill
- Low Berm
- Hybrid Berm
- Shallow Bulkhead
- Shallow Bulkhead Urban
- Revetment

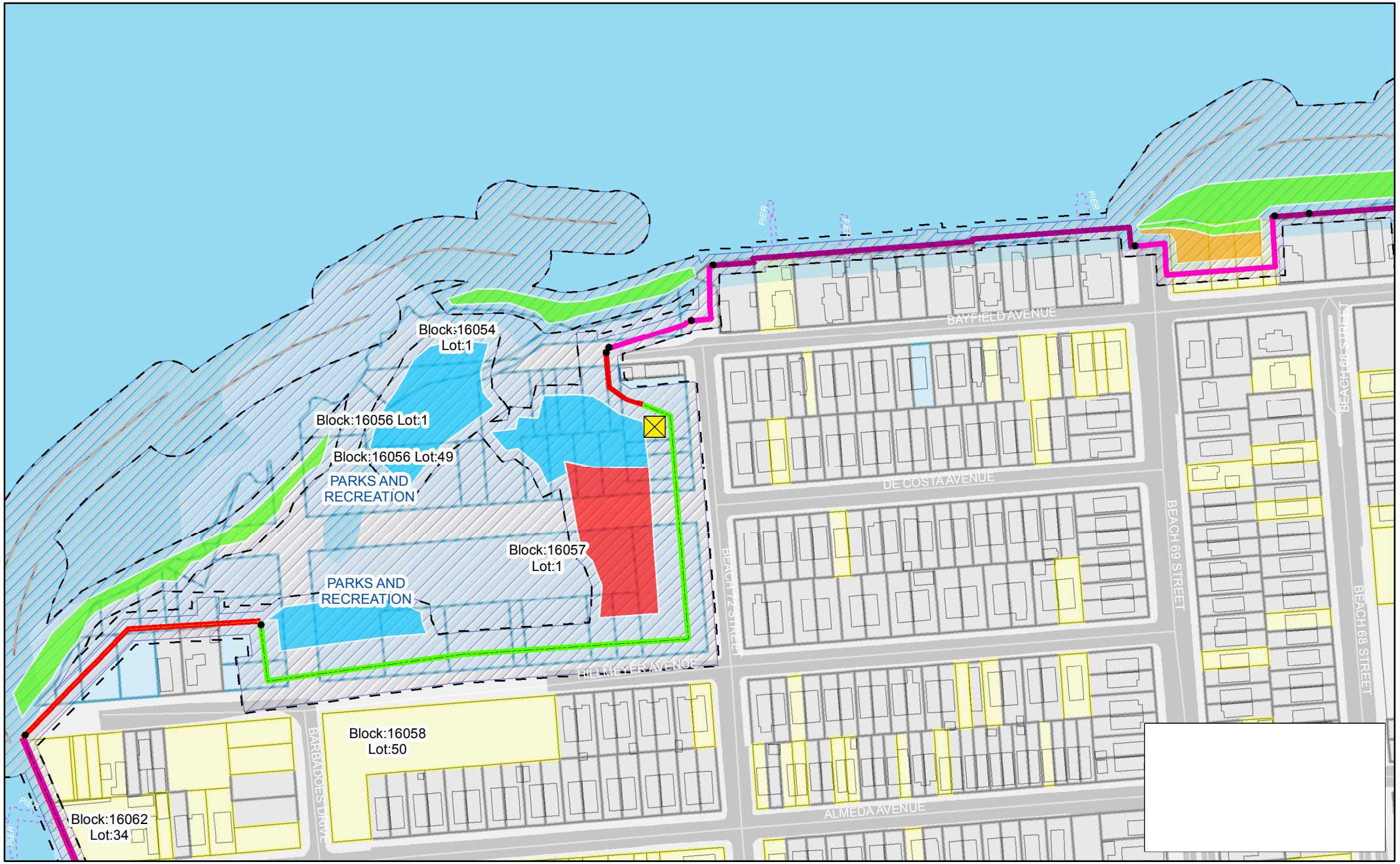
PLTQueens

OwnType

- City
- Private
- City Street
- Private Street; 6, V
- Work Area
- Perpetual Easement

0 40 80 160 240 320 Feet

Arverne



Legend

N

Proposed Pump Station Locations

NNBF Gains Areas (20180717)

Planting

- Canopy Tree
- Salt Meadow Hay
- Scrub-shrub
- Smooth Cordgrass

Project Alignments (v20180717)

HFFRR-Feature

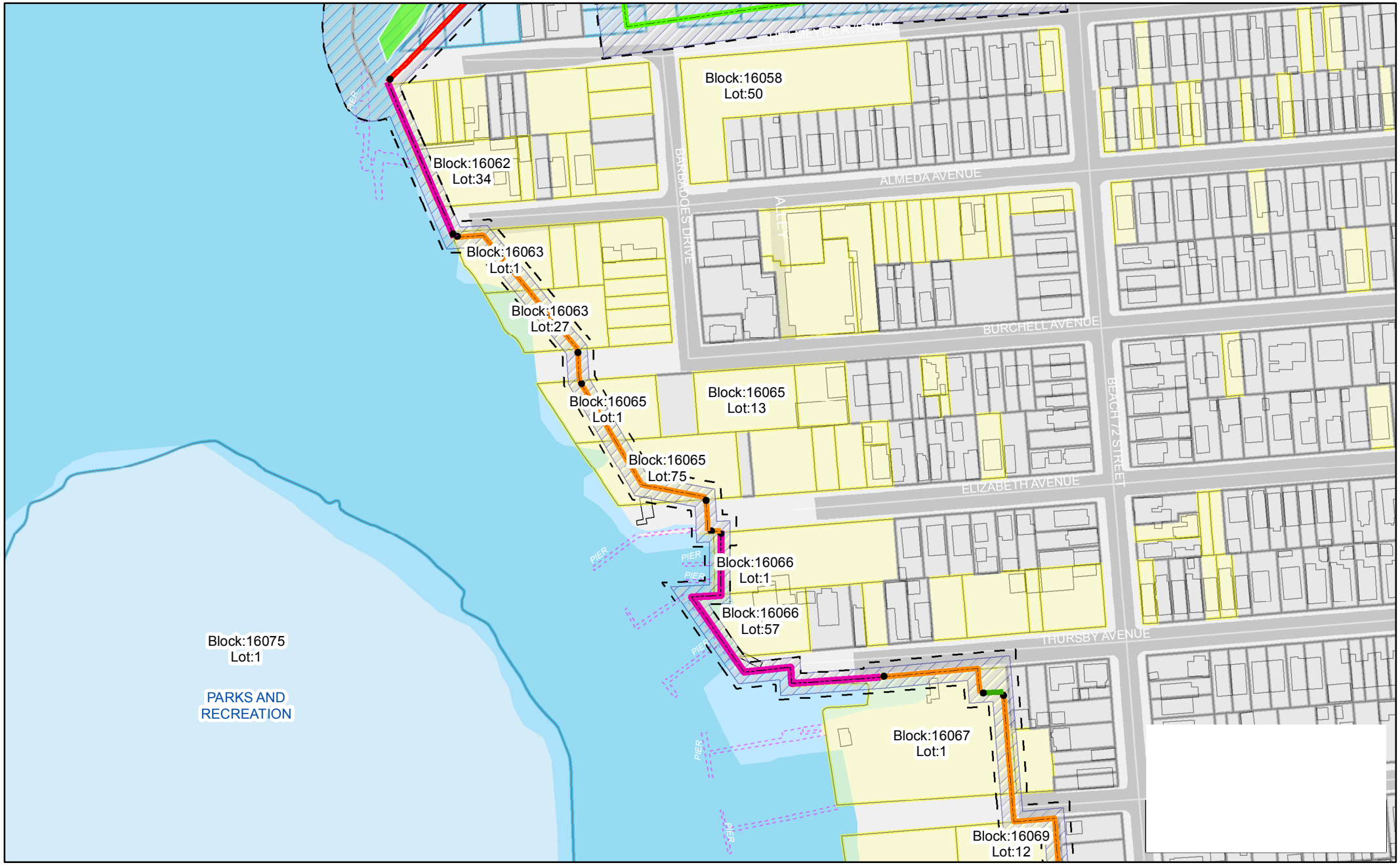
- Rock Sill
- Medium Floodwall
- High Floodwall
- Medium Berm
- Deep Bulkhead
- Shallow Bulkhead
- Shallow Bulkhead Urban

PLTQueens

OwnType

- City
- Private
- City Street
- Physical Non-Street Feature
- Alley
- Work Area Easement
- Perpetual Easement

0 40 80 160 240 320 Feet



Legend

NNBF Gains Areas (20180717)

Planting

- Smooth Cordgrass

Project Alignments (v20180717)

HFFRR-Feature

- Rock Sill
- Low Floodwall
- High Floodwall
- Medium Berm
- Deep Bulkhead
- Road Ramp

PLTQueens

OwnType

- City
- Private
- City Street
- Physical Non-Street Feature
- Alley
- Work Area Easement
- Perpetual Easement

N

0 40 80 160 240 320 Feet

Arverne

Legend

N

Project Alignments (v20180717)

HFFRR-Feature

- Low Floodwall
- Medium Floodwall
- Deep Bulkhead
- Vehicular Gate
- Road Ramp

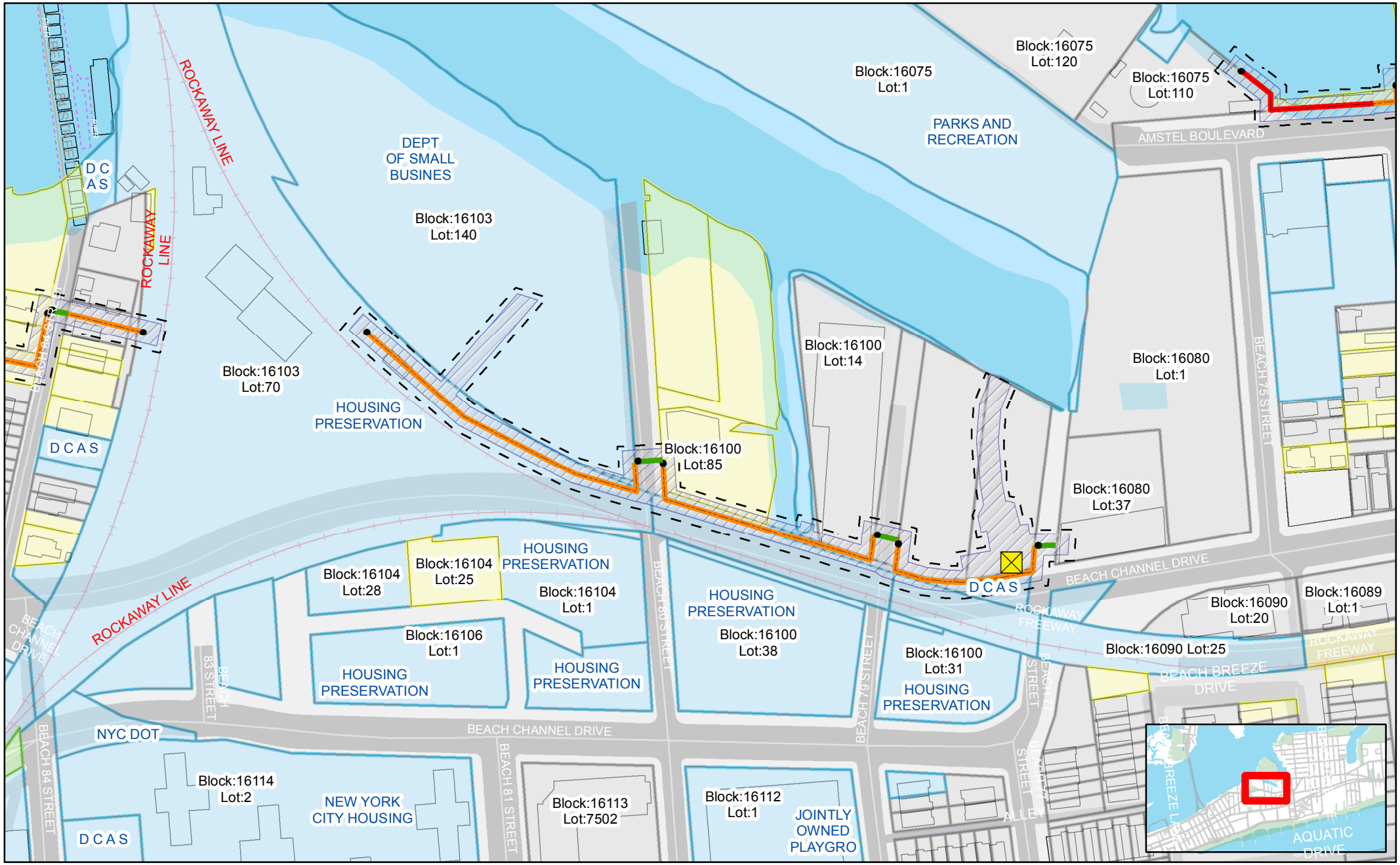
PLTQueens

OwnType

- City
- Private
- City Street
- Physical Non-Street Feature
- Work Area Easement
- Perpetual Easement

0 40 80 160 240 320 Feet

Hammels



Legend

Proposed Pump Station Locations

Project Alignments (v20180717)

HFFRR-Feature

- Low Floodwall
- Medium Floodwall
- Road Ramp

PLTQueens

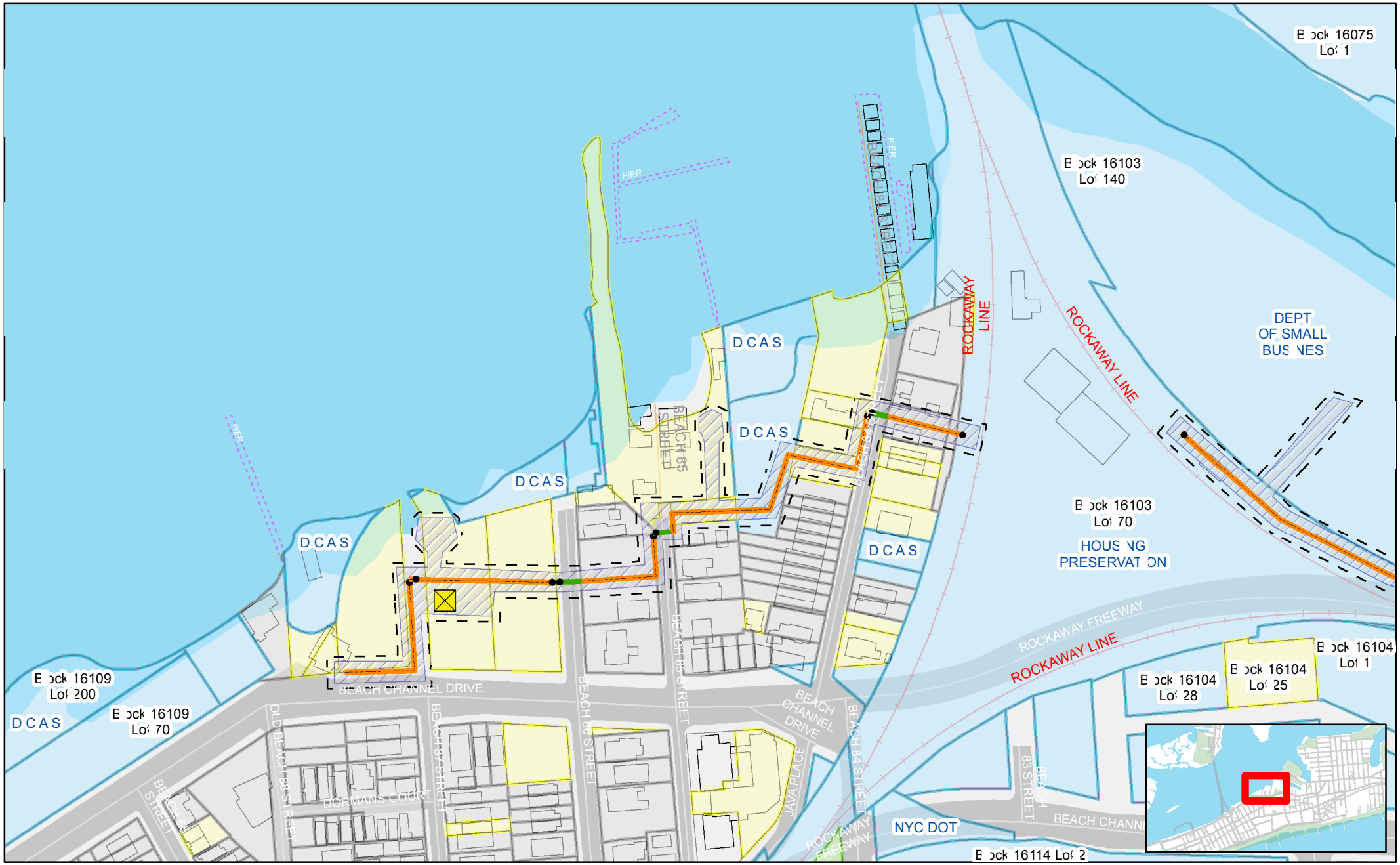
OwnType

- City
- Private
- State
- City Street
- Railroad Track
- Private Street; 6, V
- Physical Non-Street Feature
- Alley
- Addressable Path
- Work Area Easement
- Perpetual Easement

N

0 40 80 160 240 320 Feet

Hammels



Legend

Proposed Pump Station Locations

Project Alignments (v20180717)

HFFRR-Feature

- Low Floodwall
- Road Ramp

PLTQueens

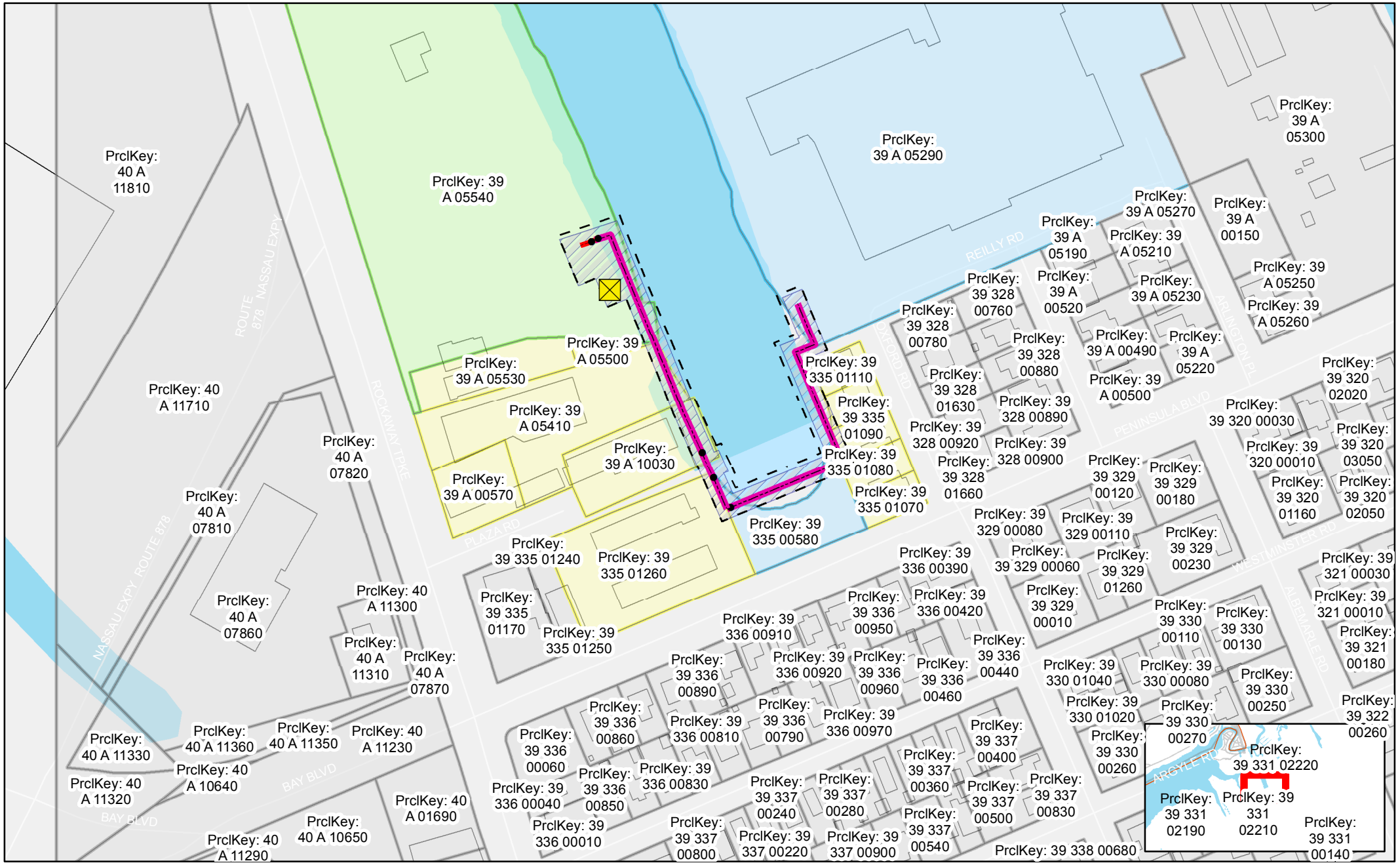
OwnType

- City
- Private
- State
- City Street
- Railroad Track
- Physical Non-Street Feature
- Addressable Path
- Work Area Easement
- Perpetual Easement

N

0 40 80 160 240 320 Feet

Cedarhurst-Lawrence



Legend

Proposed Pump Station Locations

Project Alignments

HFFRR-Feature

- Medium Floodwall
- Deep Bulkhead

Nassau County Streets

- Nassau County Streets
- Work Area Easement
- Perpetual Easement

N

0 40 80 160 240 320 Feet

US Army Corps of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix A2-C

Cost Engineering Screening Appendix

December 2018

TABLE OF CONTENTS

C.1 INTRODUCTION 4
C.2 PROJECT DESCRIPTION 5
2.1 Location 5
2.2 Feature Descriptions 5
C.3 HFFRRF FOR JAMAICA BAY COST FOR SCREENING 6
3.1 Introduction 6
3.2 Basis of Estimate 6
3.3 Phase 1 Project Costs 6
3.3.1 MII Cost Model 6
3.3.2 Feature Costs 7
3.3.3 Project Cost Items 8
3.3.4 Phase 1 Project Cost Summary 9
3.4 Phase 2 Projects 12
3.4.1 Introduction 12
3.4.2 Phase 2 Project Features Cost 12
3.4.3 HFFRRF Phase 2 Project Cost Summary 12

LIST OF TABLES

Table 3-1: Costs Per Linear Foot for Project Features 7
Table 3-2: Cost of Special Features 8
Table 3-3: Total Preliminary Project Cost for All Projects without inclusion of Natural and Nature Based Features—used for Preliminary Screening (*Does not include real estate costs) 10
Table 3-4: Preliminary Project Cost for All Projects with inclusion if Natural and Nature Based Features—used for Preliminary Screening (*Does not include real estate nor mitigation costs) 11
Table 3-5: Feature Costs 12
Table 3-6: Phase 2 Project Costs 13
Table 3-7: Total Project Cost for All Phase 2 Projects—used for Screening (*Does not include real estate costs) 13

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Reformulation Study

Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Appendix A2-C

Cost Engineering Screening Appendix

C.1 INTRODUCTION

This Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet Hurricane Sandy General Revaluation Report Cost Engineering Screening Appendix summarizes the cost engineering and analyses applied to evaluate and compare alternative features for each planning reach within the study area. There are two reaches within the study area: 1) the Atlantic Shorefront, 2) Jamaica Bay. Since each planning reach is exposed to different risk mechanisms two engineering appendices are included within this GRR/EIS: Appendix A1 - Shorefront Engineering and Design Appendix, and Appendix A2 - Jamaica Bay High Frequency Flood Risk Reduction Features Engineering and Design Appendix.

This Cost Engineering Screening Appendix provides an overview of the cost analyses supporting both the screening process for the High Frequency Flood Risk Reduction Features (HFFRRF) for Jamaica Bay and the shorefront alternatives.

The initial study was initially limited to the Atlantic Ocean Shoreline Planning Reach and was conducted as a legacy study. The engineering analyses were conducted to satisfy a more rigorous design level and the Atlantic Ocean shorefront summary engineering documents were written to satisfy those study requirements (USACE-NAN, 2016). The Jamaica Bay Planning Reach analysis was added following Hurricane Sandy and was conducted to broaden the recommended plan to the entire authorized study area and was conducted under SMART planning guidelines.

As a result of the Agency Decision Milestone, the storm surge barrier component of the Tentatively Selected Plan was moved into the New York and New Jersey Harbor and Tributaries Study for further study and possible recommendation. Without the barrier, the communities surrounding Jamaica Bay still experience substantial risk for coastal flooding. Therefore, the study team sought to identify stand-alone features that could complement a potential future storm surge barrier, but also be economically justified on their own. Residents in many parts of the Jamaica Bay side of the peninsula experience regular flooding due to rainfall events and high tides that occur frequently. Since the proposed barrier would not be closed at every high tide or rainfall event, there is an opportunity to recommend features to mitigate flood risk for high frequency flooding events where the proposed storm surge barrier would remain open yet inundation still occurs.

C.2 PROJECT DESCRIPTION

2.1 Location

Please refer to Figure 2-4 in the HFFRRF Engineering Appendix (Appendix A2) and Figure 1-1 of the Shorefront Engineering Appendix A1 for details relating to the project location.

2.2 Feature Descriptions

The high frequency flood risk reduction features are detailed in Section 4 of the Engineering Appendix (A2), including typical sections for all features. The alternative development options for the shorefront are detailed in Section 7 of the Shorefront Appendix (A1).

C.3 HFFRRF FOR JAMAICA BAY COST FOR SCREENING

3.1 Introduction

In support of the first round of screening of the HFFRRF projects, the economic benefits were analyzed to determine which projects had a net benefit. Benefits modeling is detailed in the Economics Appendix (Appendix B), and the costs are included below. The Benefit Cost Ratio (BCR) of each of the alternatives was calculated and the project characteristics were tabulated to facilitate screening.

3.2 Basis of Estimate

The initial costs were estimated on a per linear foot basis to allow for an easy comparison of the various features in different locations in Jamaica Bay. MCASESII (MII) software was utilized to estimate the costs of the various features and costs were estimated assuming stone was sourced from the NY / NJ area with local labor rates. Sheet pile costs from a comparable project were utilized, and NY DOT bid tabs were used where applicable. Blue Book Equipment rates were utilized for the equipment hourly rates, factoring in fuel usage and diesel prices of $3.18 / gal for the NYC area.

3.3 Phase 1 Project Costs

Cost estimates for the HFFRRF Phase 1 were developed in 2015 at a fourth quarter (4Q) 2015 price level for labor, material, and equipment using the MII files developed in support of the USACE-NAN. (2016) Appendix 2A. The prices were then escalated to 4Q 2017 using the Civil Works Construction Cost Index System (CWCCIS) for screening. The material quantities for the Features have been developed from the feature cross-sections shown in Section 4 of the Engineering Appendix (Appendix A-2). Labor rates for local union labor in Queens County was used based on published prevailing wage rates. Equipment rates were from Region 1 (Northeast) and nationally published Blue Book Rates.

To establish a total cost per project feature, the quantities per linear foot for each feature were calculated. For example, it was determined that for the revetment 0.70 cubic yards (CY) of concrete is required per linear foot of wall. Project costs were then calculated by multiplying the feature length by the feature type costs per foot and summing all features.

3.3.1 MII Cost Model

3.3.1.1 Work Breakdown Structure (WBS)

The cost estimates were developed according to the Civil Works Work Breakdown Structure (CWWBS) and have been broken down to the sub-feature level or detailed construction activity elements. All feature cost items included in the MII estimate are assumed to be in the Levees & Floodwalls (#11) CWWBS. It should be noted that Relocations are to be provided separately by

the USACE and would be in a separate WBS. Planning, Engineering and Design (PED) and Construction management costs were not included in the MII estimate detail, and were incorporated in the spreadsheet cost summary as a percentage of construction costs, so they would not impact the plan selection.

3.3.1.2 Contractor mark-ups

The contract mark-ups included 12% for Job Office Overhead (JOOH), 8% for Home Office Overhead (HOOH), 10% profit, and 0.66% Bond. These markups are consistent with the previous work completed for the USACE-NAN. (2016).

3.3.2 Feature Costs

For the various features that are part of the HFFRRF projects, the total cost per linear foot (LF) is tabulated in Table 3-1, costs are provided without contingency. Costs are inclusive of drainage features.

Table 3-1: Costs Per Linear Foot for Project Features

Feature	Cost
Revetment	$2,214
High Berm	$1,262
Low Berm	$495
Deep Bulkhead	$4,970
Shallow Bulkhead	$3,471
Deep Bulkhead (with developed upland considerations)	$9,956
Shallow Bulkhead (with developed upland considerations)	$8,415
Low Floodwall	$1,589
Medium Floodwall	$3,058
High Floodwall	$4,564
NNBF Type 1A – Shoreline Extension with Intertidal Marsh	$1,440
NNBF Type 1B – Shoreline Excavation for Phragmytes Removal with Intertidal Marsh	$1,581
NNBF Type 2A – Shoreline Extension with Intertidal and High Marsh	$1,645
NNBF Type 2B – Shoreline Excavation for Phragmytes Removal with Intertidal and High Marsh	$1,793

A couple of projects have special features that are specific to a particular project and not a typical section that could be used in multiple places. The cost for these special features are provided in the table below.

Table 3-2: Cost of Special Features

	Cost	Unit
Head of Bay Flood Gate	$301,305,000	Each
Shellbank Creek Flood Gate	$68,658,000	Each
Hawtree Basin Flood Gate	$64,105,000	Each
Vehicular Gate	$792,000	Each

3.3.3 Project Cost Items

In order to estimate the respective project costs, the following general approach was followed: Unit costs for material items such as steel, concrete, and fill were kept the same, with the same crews utilized as assumed in the USACE-NAN. (2016). Tasks were developed for new items such as different size sheet piles for some of the floodwalls and a task for hauling excavated materials offsite for disposal, however the crews (labor and equipment) used to complete the tasks were kept the same for consistency. The mobilization and demobilization was assigned to the contractor as an overhead cost so that it would be spread accordingly over the feature cost items. An additional mobilization and demobilization cost was included with the flood gates to account for the higher cost of marine work. Production rates from the previous estimate from Appendix A2 of the USACE-NAN. (2016) were used when applicable. Otherwise, production rates were estimated from similar project experience in the United States.

3.3.3.1 Planning, Engineering and Design (PED)

PED costs were estimated separately from the MII estimate. This includes permitting costs and final design of the features. 15% of construction costs was used for the PED costs for the initial screening, with updated PED costs estimated for the recommended plan. Separate PED costs were estimated for the shorefront and Jamaica Bay projects due to the different levels of PED required as a percentage of the project's construction values.

3.3.3.2 Construction Administration

Construction administration was also estimated separately from the MII and was estimated at 8% of construction costs. This cost was also updated for the recommended plan.

3.3.3.3 Lands and Damages

These costs are not included in MII or the cost estimates presented within this section at this time. Impacts will likely be similar between the difference features and not impact plan selection.

3.3.3.4 Relocations

These costs are not included in MII or the cost estimates presented within this section at this time. Impacts will likely be similar between the difference features and not impact plan selection.

3.3.3.5 Operation and Maintenance

The operation and maintenance costs were estimated using the same cost per linear foot, $19 / lf for passive measures and 0.50% for active measures, as utilized in Appendix A2 of the GRR report from August 2016.

3.3.3.6 Contingency

The project contingency was estimated at 40% for budgeting purposes. It was deemed appropriate by the USACE and project design team to use the 40% average contingency previously determined using the abbreviated risk analysis (ARA) process. The features included in this estimate are largely the same or of smaller magnitude than previously considered, so the contingency should be conservative, but applicable. A CSRA will be completed for the recommended plan using USACE guidelines.

3.3.3.7 Total Project Cost Calculation

The total project cost was developed in MII and summarized in Table 5-2 of the engineering appendix and in Table 3-3 below. PED, Construction Management, Lands & Damages, and Relocations were then added to the total, with contingency added to the subtotal of the costs. This cost is then escalated from 4Q 2015 to 4Q 2017. The cost is then converted to an annual cost to calculate the benefit to cost ratio for the projects and presented in the next section.

3.3.4 Phase 1 Project Cost Summary

Before the Phase 1 Project Costs are presented it is important to note the study described herein is in accordance with USACE's SMART Planning principles. The level of detail required to make planning decisions was still expected to grow over the course of the study, as the study team moved from a large array of alternatives to a select set of recommended project alternatives. The PDT made progressively detailed analyses for this smaller array of alternatives until finally identifying the recommended plan. The PDT reduces uncertainty with greater detail, but only when necessary to reduce unacceptable risk.

The initial phase 1 cost estimate included MII cost estimates of HFFRR-Features, but did not include details in the MII for some items including:

- Utilities
- Drainage
- Pump Stations

These items were not included as details had not been determined yet and it was assumed that they would not impact plan selection, as they would be similar in magnitude for all the features considered. A summary of the project cost calculated per the methodology described herein is provided Table 3-3.

Table 3-3: Total Preliminary Project Cost for All Projects without inclusion of Natural and Nature Based Features—used for Preliminary Screening. Total Project Cost (last column) includes escalation to Q4.2017 using CWCCIS (*Does not include real estate costs)

Project ID	Project Name	Perimeter Length (ft)	Initial Project Costs ($) Cost Code 11	PED Cost Code 30	Construction Administration Cost Code 31	Total Project Cost (2015 Q1 price level)	Contingency	Total Project Cost (Q4 2017 price level)
				15%	8%		40%	
1	Hammels	3,100	$9.6 M	$1.4 M	$0.8 M	$11.9 M	$4.9 M	$17.2 M
2	Arverne	12,300	$32.6 M	$4.9 M	$2.6 M	$40 M	$16.6 M	$58.1 M
3	Edgemere	6,300	$14.4 M	$2.2 M	$1.2 M	$17.8 M	$7.4 M	$25.8 M
4	Norton Basin	2,400	$7.3 M	$1.1 M	$0.6 M	$9 M	$3.7 M	$13 M
5	Bayswater Park	1,500	$0.7 M	$0.1 M	$0.1 M	$0.9 M	$0.4 M	$1.3 M
6	Motts Basin S	3,800	$12.3 M	$1.8 M	$1 M	$15.1 M	$6.3 M	$21.9 M
7	Motts Basin N	700	$1 M	$0.1 M	$0.1 M	$1.2 M	$0.5 M	$1.7 M
8	Inwood Harbor	2,700	$7.3 M	$1.1 M	$0.6 M	$9 M	$3.7 M	$13.1 M
9	Head of Bay Gate	3,000	$441.7 M	$66.2 M	$35.3 M	$543.2 M	$225.1 M	$787.9 M
10	Old Howard Beach	3,700	$145.4 M	$21.8 M	$11.6 M	$178.8 M	$74.1 M	$259.4 M
11	Canarsie	2,700	$4.7 M	$0.7 M	$0.4 M	$5.8 M	$2.4 M	$8.4 M
22	Lawrence-Cedarhurst	1,800	$4.7 M	$0.7 M	$0.4 M	$5.8 M	$2.4 M	$8.4 M
23	Meadowmere	6,700	$24.8 M	$3.7 M	$2 M	$30.6 M	$12.7 M	$44.3 M
24	Meadowmere N	4,800	$19.5 M	$2.9 M	$1.6 M	$24 M	$10 M	$34.8 M
25	Meadowmere E	1,600	$7.9 M	$1.2 M	$0.6 M	$9.7 M	$4 M	$14.1 M
26	Rosedale	1,900	$5.8 M	$0.9 M	$0.5 M	$7.1 M	$2.9 M	$10.3 M

Table 3-4: Preliminary Project Cost for All Projects with inclusion of Natural and Nature Based Features—used for Preliminary Screening (*Does not include real estate nor mitigation costs)

Project ID	Project Name	Perimeter Length (ft)	Initial Project Costs ($) Cost Code 11	PED Cost Code 30	Construction Administration Cost Code 31	Total Project Cost (2015 Q1 price level)	Contingency	Total Project Cost (Q4 2017 price level)
				15%	8%		40%	
2N	Arverne	12,300	$39 M	$5.9 M	$3.1 M	$48 M	$19.9 M	$69.6 M
3N	Edgemere	6,300	$19.2 M	$2.9 M	$1.5 M	$23.6 M	$9.8 M	$34.2 M
4N	Norton Basin	2,400	$11.6 M	$1.7 M	$0.9 M	$14.3 M	$5.9 M	$20.7 M
5N	Bayswater Park	1,500	$2.9 M	$0.4 M	$0.2 M	$3.6 M	$1.5 M	$5.2 M
6N	Motts Basin S	3,800	$14.5 M	$2.2 M	$1.2 M	$17.8 M	$7.4 M	$25.8 M
7N	Motts Basin N	700	$3.3 M	$0.5 M	$0.3 M	$4.1 M	$1.7 M	$5.9 M

3.4 Phase 2 Projects

3.4.1 Introduction

HFFRRF costs were further refined in Phase 2 to ultimately select the recommended plan. This included separating the rock sills and plantings out from the NNBFs, adding pump stations, addition of utility costs to each feature, as well as further design of the drainage systems, which were previously established on a per linear foot basis and are not quantified for each feature.

3.4.2 Phase 2 Project Features Cost

Table 3-5 below presents the updated feature costs with the refined quantities for the rock sills and drainage costs, as well as utilities.

Table 3-5: Feature Costs

Feature	Cost	Unit
Low Floodwall	$1,513.17	$/LF
Medium Floodwall	$2,455.58	$/LF
High Floodwall	$3,873.48	$/LF
Low Berm	$612.55	$/LF
Medium Berm	$ 857.97	$/LF
High Berm	$ 2,085.32	$/LF
Hybrid Berm	$4,036.12	$/LF
Shallow Bulkhead	$2,170.20	$/LF
Shallow Bulkhead Urban	$7,018.74	$/LF
Deep Bulkhead	$3,356.13	$/LF
Revetment	$2,879.85	$/LF
Rock Sill	$1,726.52	$/LF
Vehicular Gate	$797,530.47	$/EA
Road Ramp	$90,110.87	$/EA

3.4.3 HFFRRF Phase 2 Project Cost Summary

A total of four HFFRRF projects were delineated and refined during the second phase of the HFFRRF feasibility study as detailed in Table 6-1 of the Engineering Appendix. Each project consists of a single or multiple alignment(s), which in turn consist of one single or multiple HFFRR-Feature(s). A summary of project costs at the 2Q2018 price level by project are included in Table 3-6 and table 3-7 below.

Table 3-6: Phase 2 Project Costs

Project	Project Cost
Mid-Rockaway Backbay with NNBF (Summary of the three Project Areas)	$194 M
Motts Basin North	$ 2.6 M
Canarsie	$ 27.7 M
Cedarhurst - Lawrence	$13.6

Table 3-7: Total Project Cost for All Phase 2 Projects—used for Screening. Total Project Cost (last column) includes escalation to Q4.2017 using CWCCIS (*Does not include real estate costs)

Project ID	Project Name	Perimeter Length (ft)	Initial Project Costs ($) Cost Code 11	Pump Station Costs ($) Cost Code 13	PED Cost Code 30	Construction Admin. Cost Code 31	Total Project Cost (2017 Q4 price level)	Contingency	Total Project Cost (Q4 2017 price level)
					15%	8%		40%	
	Mid-Rockaway Backbay with NNBFs	21,700	$83.3 M	$29.4 M	$16.9 M	$9.0 M	$138.6 M	$55.4 M	$194.0 M
7	Motts Basin N	700	$1.5 M	$0 M	$0.2 M	$0.1 M	$1.9 M	$0.7 M	$2.6 M
11	Canarsie	2,700	$8.4 M	$7.7 M	$2.4 M	$1.3 M	$19.8 M	$7.9 M	$27.7 M
22	Lawrence-Cedarhurst	1,800	$4.3 M	$3.6 M	$1.2 M	$0.6 M	$9.7 M	$3.9 M	$13.6 M

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Sub Appendix A2-D: Phase 2 Wave Modeling for Design Basis Update

US Army Corps of Engineers

D. SUB-APPENDIX A2-D: PHASE 2 WAVE MODELING FOR DESIGN BASIS UPDATE

D.1 Wave Analysis Background

As part of Phase 1, design wave-heights at the HFFRRF project alignments were specified by applying the wave-height statistics derived from the USACE (2015) North Atlantic Comprehensive Coastal Study (NACCS) database.

The NACCS (2015) was conducted to provide information for computing the joint probability of coastal storm forcing parameters for the U.S. North Atlantic Coast, which is critical for effective flood risk management. As part of the NACCS, estimates of nearshore winds, waves, and water-levels, as well as the associated marginal and joint probabilities were evaluated. This was achieved by simulating a selected suite of tropical and extra-tropical storms to characterize the regional storm hazard. The modeling suite consisted of an offshore wave model (WAM) for simulation of deep-water waves, which were subsequently used to generate boundary conditions for a near-shore steady state wave model STWAVE. The STWAVE model for near-shore waves also allowed for simulation of local wind-generated waves, and was paired with the hydrodynamic circulation model ADCIRC to allow for dynamic interaction between surge and waves. While the ADCIRC model mesh extends across the western North Atlantic with approximately 3.1 million nodes, the nearshore wave model STWAVE is applied over ten domains from coastal Virginia to Maine, including one in the upper New York Bight area. A suite of 1150 storms including 100 extratropical events, and 1,050 synthetic tropical events were simulated for the NACCS production. The high-frequency outputs and statistical products from the modeling are publicly archived for a relatively small number of 18,000 'Save Points'.

The expected significant wave-heights for the 20% AEP (5-year RP) were extracted from NACCS at 137 Save Points along the perimeter of Jamaica Bay shown in Figure 3-1. The data from the save points was applied to all of Jamaica Bay using Natural Neighbor interpolation. Allowances were made for project features that are relatively sheltered or set back from the shoreline, and might thereby be less exposed to the bay, by assigning a minimum design wave-height of one (1) foot for such features.

D.2 Phase 2 Wave Analysis Refinement

As part of Phase 2, the expected wave-heights at the project features were updated to account for the wave transformation that might occur between the NACCS Save Point located within the Bay, and the individual project features located at the shoreline, using a 1-D wave model. In addition, the wave model was also applied to optimize the design of the Natural and Nature-Based Features (NNBFs), which are proposed to accompany select project features. The implementation of these updates is elaborated in the following sections.

Wave Model Setup

The Simulation of Waves Nearshore (SWAN) model (Booij et al, 1996) was used to simulate the transformation of waves along 1-D transects from boundary points within the Bay to the corresponding project alignment features. The bathymetric data for the modeling was derived from high-resolution (1/9 arc seconds or 10 feet) resolution topo-bathy Digital Elevation Models (DEMs) developed by NOAA, post- Hurricane Sandy in 2012. The map of the DEM in the Jamaica Bay Study Area is shown in Figure D-1.

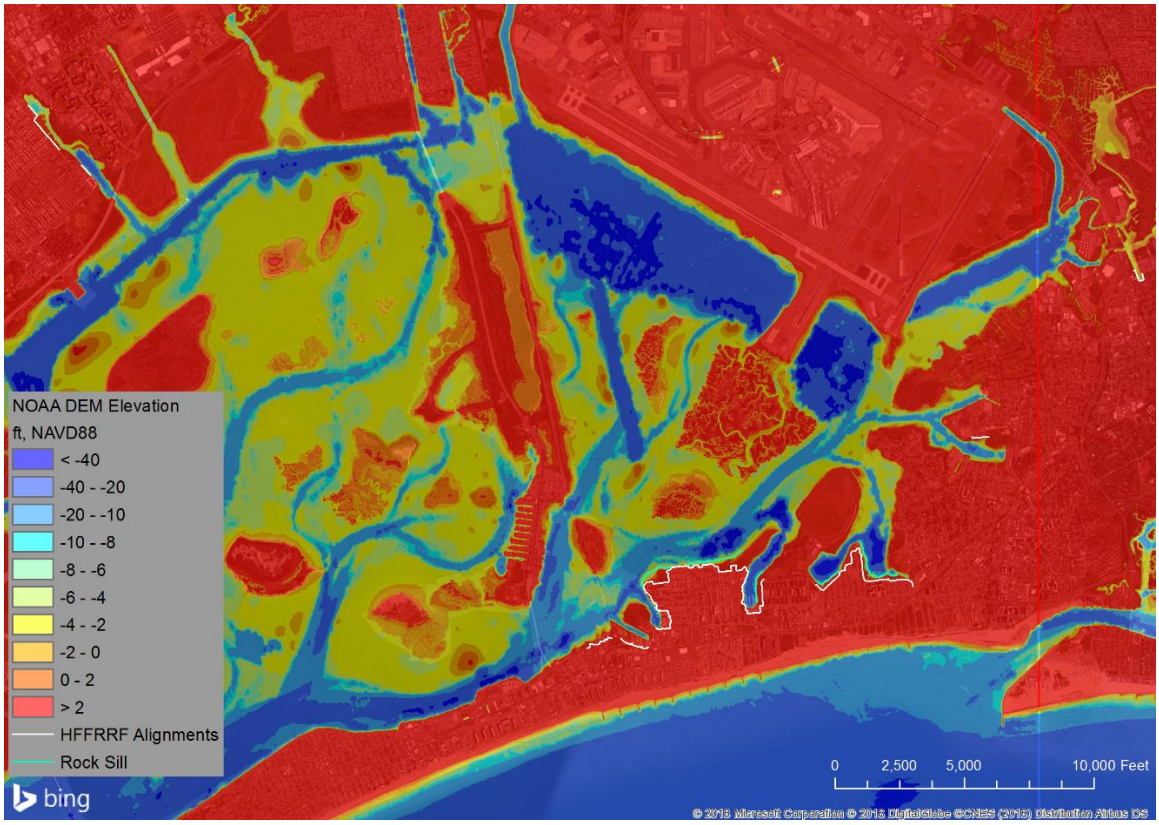


Figure D-1: NOAA High-resolution DEM in Jamaica Bay Study Area

Modeling wave-heights for project features with no NNBF

Based on the available resolution of NACCS wave statistics across the Bay, transects were drawn to model wave-transformation at several HFFRRF locations using the 20% AEP (5-year RP) wave-height as boundary condition. Figure D-2 shows these transect locations with respect to the HFFRRF alignments.

Boundary Point (NACCS)
HFFRRF Alignments
Rock Sill
Wave Model Transect
bing
0 875 1,750 3,500 Feet
© 2018 Microsoft Corporation © 2018 DigitalGlobe ©CNES (2018) Distribution Airbus DS

Boundary Point (NACCS)
HFFRRF Alignments
Rock Sill
Wave Model Transect
bing
0 875 1,750 3,500 Feet
© 2018 Microsoft Corporation © 2018 DigitalGlobe ©CNES (2018) Distribution Airbus DS

Figure D-2: 1-D wave model transect locations for refinement of Design Wave condition

At each of these transects, the bottom elevation profile was extracted from the DEM every 6 feet to specify the model bathymetry. A model still-water elevation corresponding to the respective 20% AEP (5-year RP) Still Water-Level plus the Sea Level Rise (SLR) corresponding to the USACE intermediate projection for 2068 was applied. A typical JONSWAP wave spectrum centered on the 5-year NACCS wave-height at the boundary point, and a corresponding peak wave-period according to typical fetch and depth limited wave growth (CERC, 1984) was assumed. The SWAN model was run in stationary mode, which means that the wave conditions within the 1-D model domain were allowed to evolve to a steady-state with the input conditions. Figure D-3 shows an overview of the model outputs with colored transects representing the magnitude of the simulated wave-heights. Profile of bottom elevation, water-level, and predicted wave-height at each of these transects identified in Figure D-2 is shown in Figure D-4 through Figure D-7.

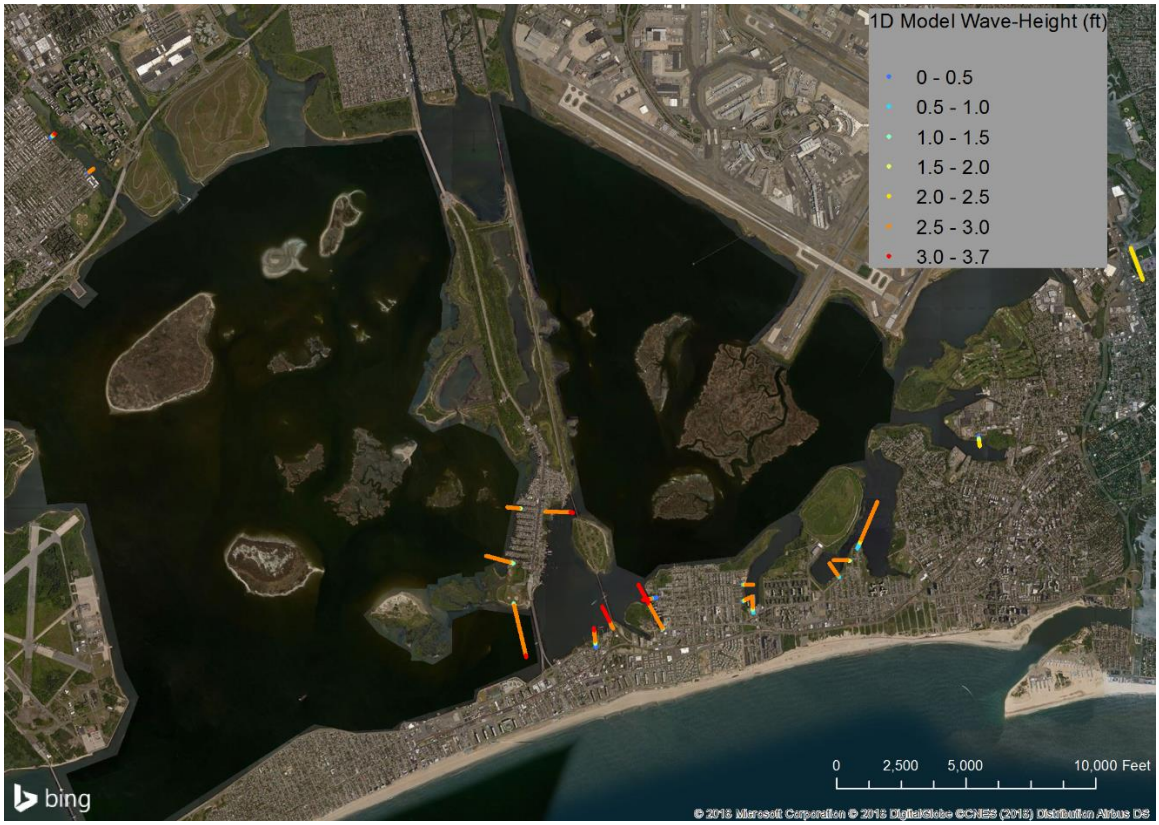


Figure D-3: Overview of wave model output showing predicted wave-heights

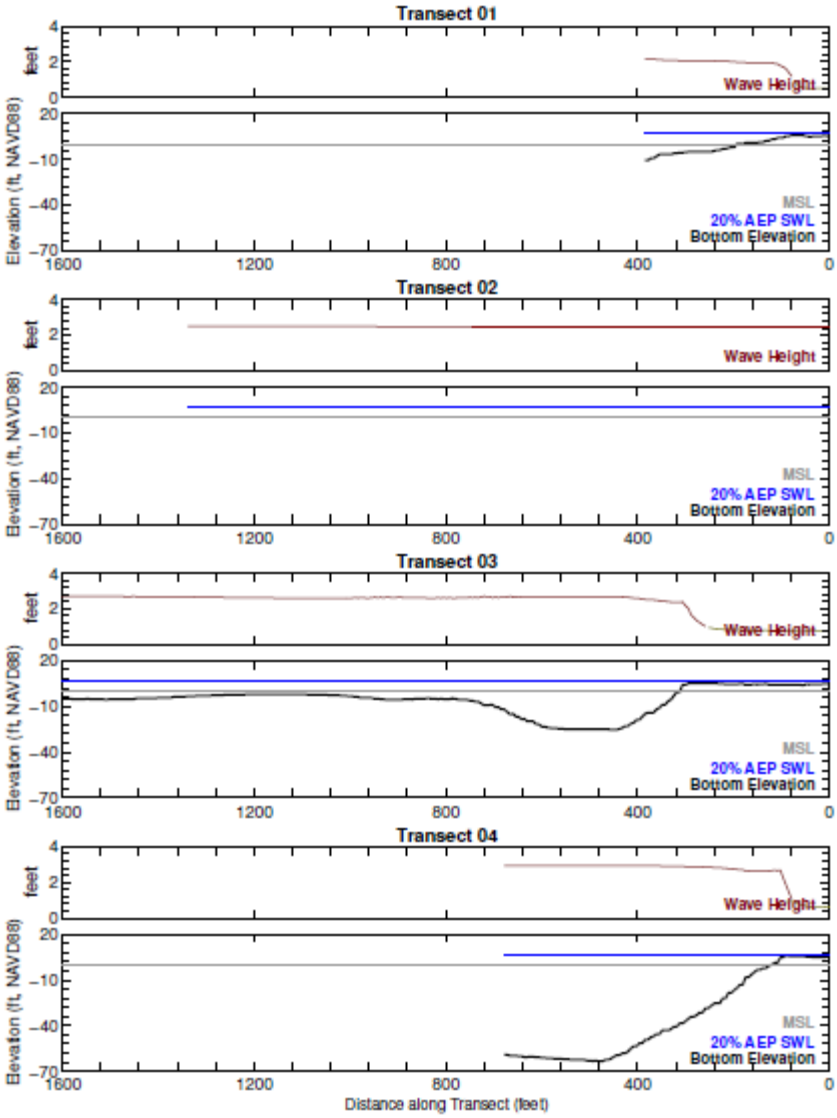


Figure D-4: Transect elevation profiles showing 1-D model wave-height transformation

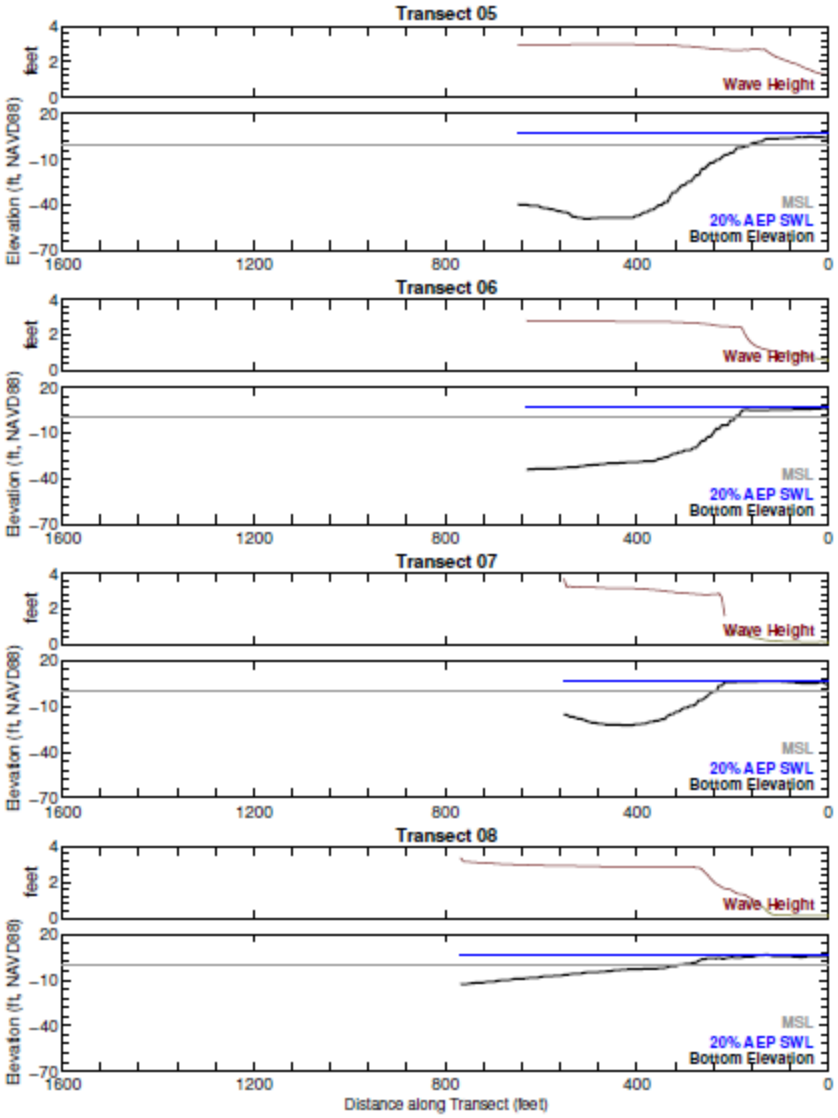


Figure D-5: Transect elevation profiles showing 1-D model wave-height transformation

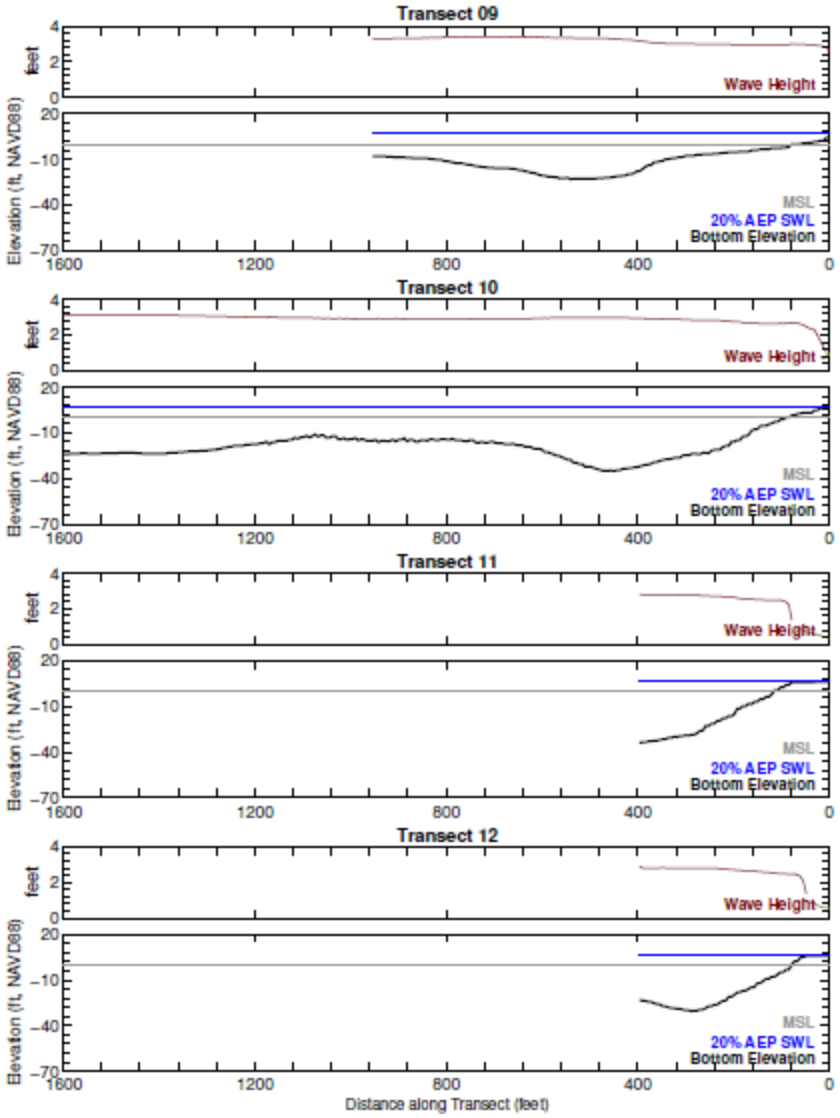


Figure D-6: Transect elevation profiles showing 1-D model wave-height transformation

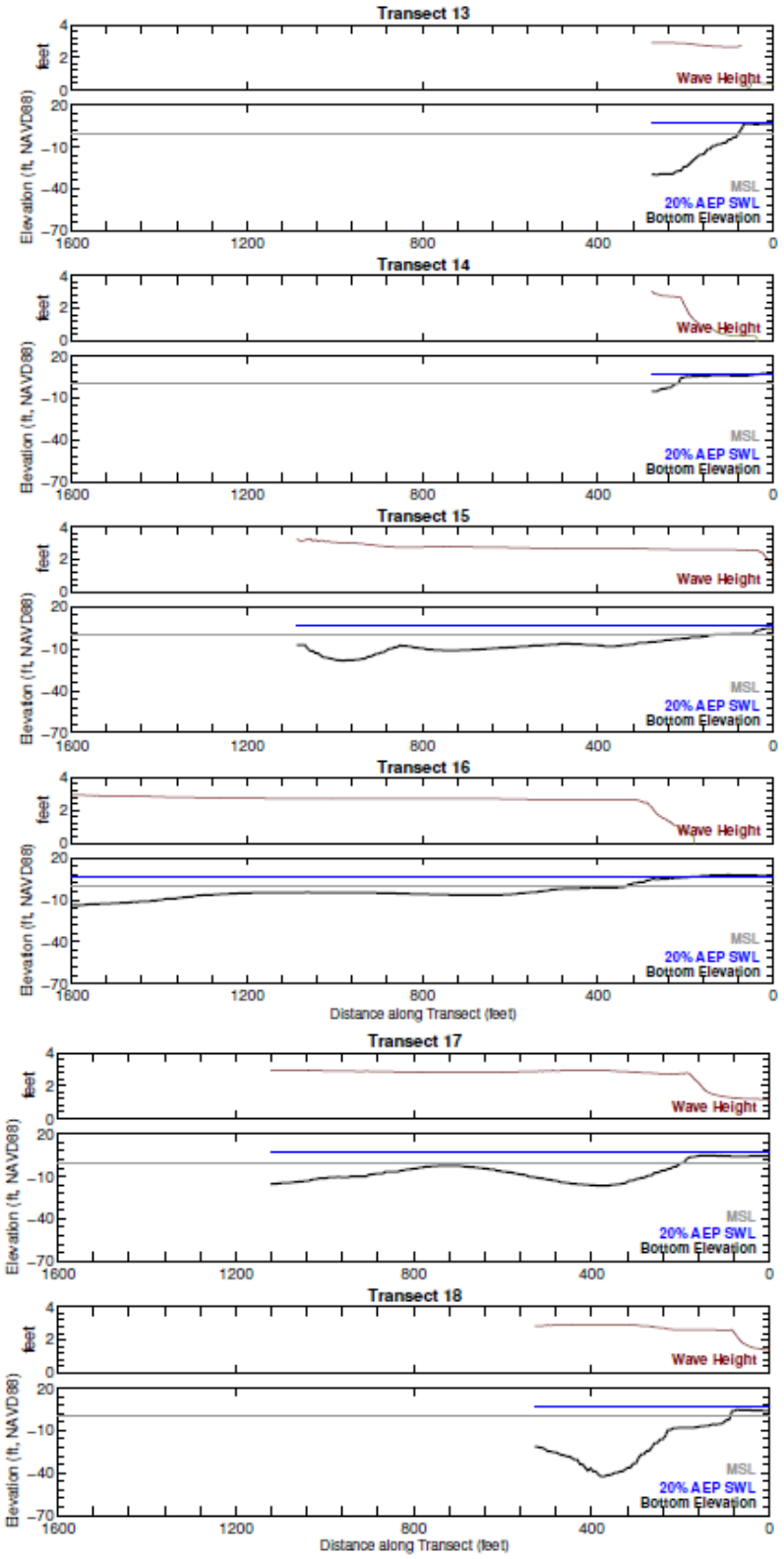


Figure D-7: Transect elevation profiles showing 1-D model wave-height transformation

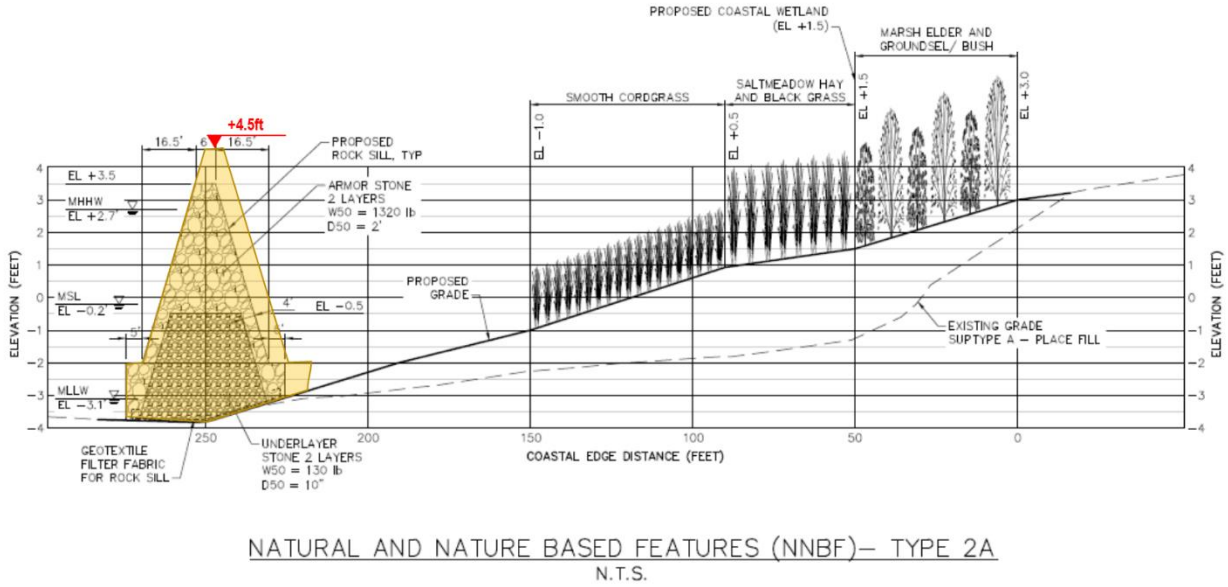
The design wave-height at each HFFRRF alignment was subsequently updated using the simulated wave-height at the feature from the nearest model transect. A map of the features denoting the updated wave-heights is shown in Figure D-8. The corresponding required freeboards for the features developed during Phase 2 of the HFFRRF screening were set using the overtopping criterion of one liter per second per meter.

Figure D-8: Updated wave-heights at HFFRRF alignments using 1-D wave model to transform NACCS data

D.3 Wave Model application to NNBF locations

Wave Analysis set-up and Schematization

The wave model was further applied to optimize the elevation of rock-sills that are part of the Natural and Nature Base Features with the goal of minimizing wave impacts on the wetland vegetation. Following the guidance in Miller et al, 2016, a target transmitted wave-height across the feature sills of half a foot or less under operational conditions was deemed necessary to protect the habitat on the leeward side of the sill. Figure D-9 shows a typical NNBF profile for the Jamaica Bay Study Area.



NATURAL AND NATURE BASED FEATURES (NNBF)– TYPE 2A
N.T.S.

Figure D-9: Typical NNBF section

The simulated model transects for the NNBF locations are shown in Figure D-10. The model bathymetry for each of these transects was specified at 1 foot resolution based on the NOAA DEM. The existing bottom profile from the DEM was adapted to include a rock sill at a base elevation of -2' NAVD88, a sill slope of 1 in 3, and a crest width of 6'. The NNBF area behind the sill was set at a 1 in 40 slope. Although it is recognized that the actual configuration of the NNBF rock sill and leeward wetlands and berm will vary once preliminary designs are completed, the focus of this analysis was on the transmitted wave-height. The transmitted wave-height is mainly a function of the incoming wave-height, the bay-side bathymetric profile and the crest geometry of the rock sill. As such the schematic representation of the landward profile was deemed acceptable for the feasibility study.

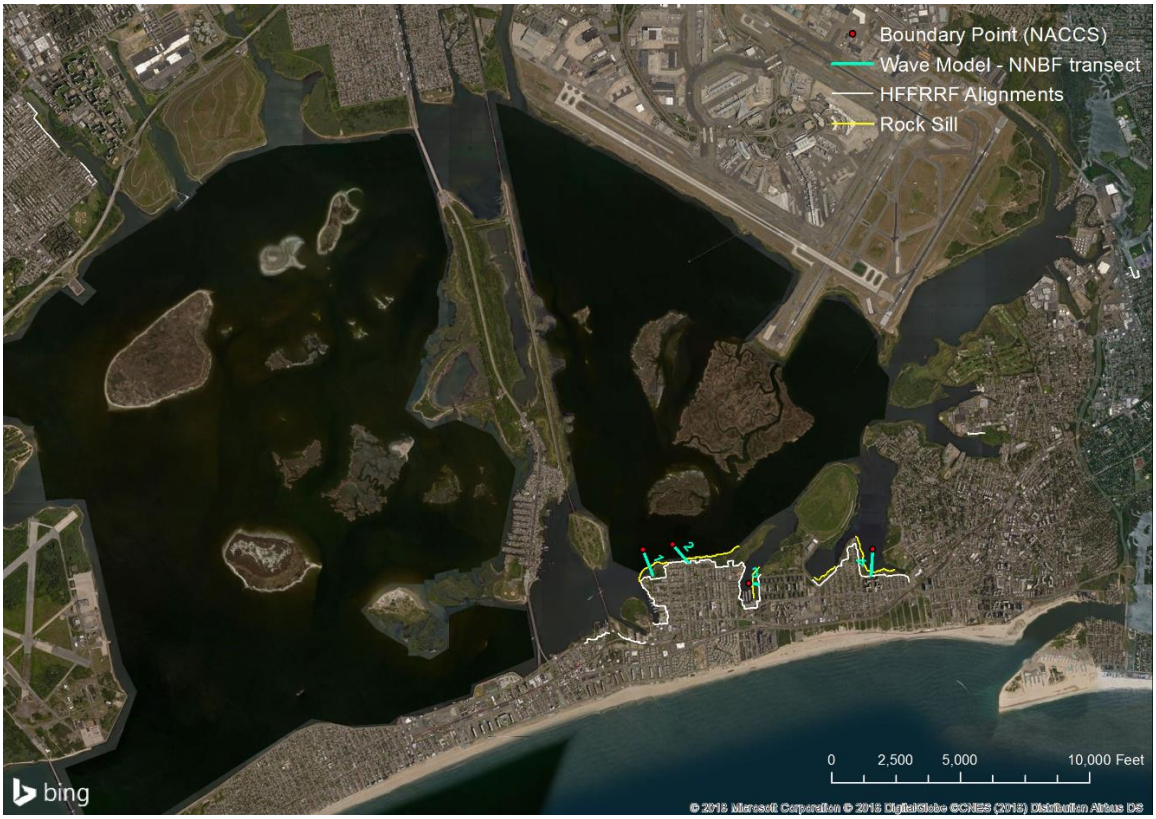


Figure D-10: Location of NNBF wave model transects

Several possible sill elevations as part of each NNBF were simulated in the wave model, using a 1, 2, and 5 year return period wave-height as boundary condition, to identify the lowest possible sill elevation providing the necessary sheltering from waves on the leeward side of the sill for each condition. A still water elevation with the same probability of occurrence as the wave-height was assumed for each scenario. Inclusion of expected future sea-level-rise scenarios was omitted since the created NNBFs were deemed most vulnerable to erosion in the near-term timeframe, following construction. For each scenario, the lowest sill crest elevation at which the predicted transmitted wave-height did not exceed the target height of 0.5 foot was identified.

Wave Modeling Results for NNBF Rock Sills

Table D-2 shows the modeled sill crest elevations meeting that requirement for each scenario at a typical transect location (Transect 1 at Arverne). The cumulative probability of occurrence of each scenario over a 1 or 2 year period is also shown. Applying the target wave-height of half a foot to a 2 year return period event yields a minimum sill-crest elevation of 4.5 feet. The 2 year return period scenario corresponds to a 39% chance of occurrence over 1 year, and 63% chance over 2 years. Using the same target transmitted wave-height on a 5 year return period event would yield

a minimum sill-crest elevation of 5.5 feet. The 5 year return period scenario corresponds to an 18% chance of occurrence over 1 year, and 33% chance over 2 years.

Table D-2: Summary of required sill-crest elevation to meet transmitted wave-height target for NNBFs under different scenarios

Inputs / Scenario			Sill-Crest Elevation with target Transmitted Wave Ht. of 0.5 ft		Cumulative Likelihood of Exceedance (%)	
Return Period (years)	Wave-Height at Boundary (ft)	Still Water Level (ft, NAVD88)	w.r.t NAVD88	w.r.t MHHW	Over 1 year	Over 2 years
1	2.53	3.61	3.5	0.8	63	86
2	2.72	4.56	4.5	1.8	39	63
5	2.90	5.74	5.5	2.8	18	33
10	3.04	6.83	6.5	3.8	10	18
20	3.18	7.77	7.5	4.8	5	10

Synopsis

Part of the wave analysis was to provide guidance on the elevation of the rock sill such that it is capable of protecting existing and newly established marsh during normal operational events and to minimize the cumulative impact of storms for a 1-2 year period. Following the guidance in Miller et al, 2016, this appendix describes sill height estimates using wave modeling analysis to protect the habitat during normal operational periods, keeping the transmitted wave-height at 0.5 feet or less except during extreme storms. Table D-2 shows sill height options for the wave climate in Jamaica Bay expressed in AEP terms. The higher the sill, the greater the protection, however, higher sills translate into greater costs and could increase visual nuisance.

It should further be stressed that the rock sill in combination with a healthy wetland habitat on the landward side will also provide wave protection (wave-height reduction) during the design conditions (20% AEP water level and waves) for the berm feature. I.e. the rock sill allows for a reduction in freeboard and lower crest elevation for the upland situated berm feature. Compared to the "without rock sill scenario" the freeboard reduction is approximately 1.5 feet for a rock sill with a 4.5 foot crest elevation.

The analyses documented herein demonstrates a 4.5 to 5.5 foot sill will be sufficient to achieve the target wave conditions for the NNBFs, which may only be expected to be exceeded at an acceptable average rate of once in two years.

If higher risk can be justified, for example by accepting some maintenance schedule for habitat repair, the sill height can be further optimized in PED. However for feasibility level design and

screening purposes it is recommended to set the rock sill crest elevation at an elevation of +4.5 feet NAVD88.

The predicted wave-heights across each model transect at the NNBF locations under future 20% AEP design conditions is shown in Figure D-11.

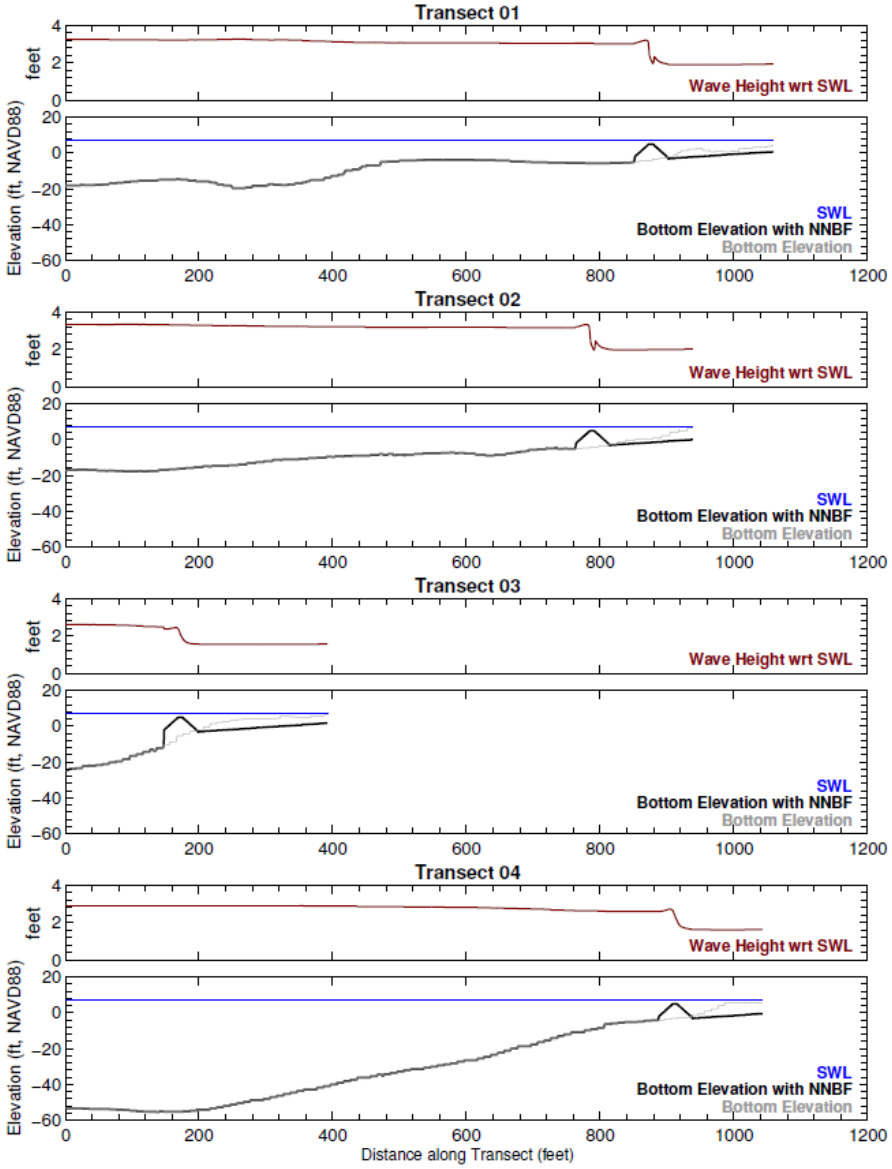


Figure D-11: 1-D model wave-height transformation across NNBFs

D.4 Conclusion

Assumptions and limitations of the modeling approach

The NACCS analysis forms the basis of the current study, as it is used to provide boundary conditions for the 1-D wave transformation to the shoreline features. The expected annual exceedance probabilities for different wave conditions within Jamaica Bay are therefore based on the NACCS analysis. However, the 1-D wave transformation model parameters were not calibrated or validated for lack of wave data at the shoreline. Additional sensitivity analysis to model parameters or more detailed analysis using a 2-D wave model could help further improve confidence in the model results.

Recommendations for PED phase

The wave transect modeling analysis was based on the bathymetric DEM from NOAA, which is a compilation of several data sources including some historical data. Since the estimated expected wave at the location of a feature depends on the bottom profile, additional data collection for the bay-side cross-shore profiles at the locations of the constructed features is recommended as part of any analysis during the PED phase. Other assumptions of lesser consequence on the estimated wave-height at feature or sill were made as part of the 1-D model. The model did not consider the friction effects due to any vegetation, especially as part of the NNBFs. A schematized representation of the NNBFs was used at this stage of analysis, which can be refined based on actual design during the PED phase.

US Army Corps of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Interior Drainage Sub-Appendix E for Appendix A2

Jamaica Bay High Frequency Flood Risk Reduction Features Engineering and Design Appendix

December 2018

TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 Scope 1

1.2 Climate Change 1

1.3 Study Locations 2

1.4 Source of Flooding 2

2 ANALYSIS OF HYDROLOGIC AND HYDRAULIC CONDITIONS 3

2.1 Basis of Interior Drainage Design 3

2.1.1 Rainfall and Storm Surge Correlation Analysis 3

2.1.2 Analysis Approach 4

2.1.3 Hydrologic Analysis 6

2.2 Hypothetical Storm Surge Data 6

2.3 Drainage Area Delineation 6

2.3.1 Delineation Methods 7

2.3.2 Hydraulic Analysis 7

2.4 Delineated Interior Drainage Basins 7

2.4.1 Mid-Rockaway Project Area 7

2.4.1.1 Hammels Drainage Basin 7

2.4.1.2 Arverne Drainage Basin 8

2.4.1.3 Edgemere Drainage Basin 8

2.4.2 Canarsie Project Area 8

2.4.3 Cedarhurst-Lawrence Project Area 8

2.4.4 Motts Basin North Project Area 8

2.5 Future Storm Drainage System 8

2.6 Development of Interior Inflow Runoff Hydrographs 9

2.6.1 Rainfall Data 9

2.6.2 NRCS Runoff Curve Numbers 10

2.6.3 Time of Concentration 11

2.6.4 NRCS Dimensionless Unit Hydrograph 13

2.7 Peak Inflows 13

3 DESIGN PROCEDURE 14

3.1 Interior Flood Control Simulation Models 14

4 INTERIOR DRAINAGE HYDRAULICS 15

4.1 Elevation/Storage Relationships 15

4.2 Potential Interior Drainage Facilities 15

4.2.1 Gravity Outlets 15
4.2.2 Ponding / Flood Storage 16
4.2.3 Pressure Outlets 16
4.2.4 Pumping 17
5 ECONOMIC ASSESSMENT 17
5.1 Conditions 17
5.2 Costs 18
5.2.1 First Construction Costs 18
5.2.2 Operation and Maintenance 18
5.3 Benefits 18
5.3.1 Interior Flood Damage 18
5.3.2 Annual Damage 18
5.3.3 Minimum Facility Damages 19
6 PLAN FORMULATION 19
6.1 Minimum Facility Concept 19
6.2 National Economic Development for Interior Drainage Facilities 20
6.3 Analysis of Alternative Plans 20
6.4 Preferred Plan 21
6.5 Interior Plan Formulation 21
6.5.1 Mid-Rockaway Project Area 22
6.5.1.1 Hammels Drainage Basin 22
6.5.1.2 Arverne Drainage Basin 25
6.5.1.3 Edgemere Drainage Basin 28
6.5.2 Canarsie Project Area 32
6.5.2.1 Minimum Facility 32
6.5.2.2 Alternative Plans 33
6.5.2.3 Preferred Plan 35
6.5.3 Cedarhurst-Lawrence Project Area 35
6.5.3.1 Minimum Facility 35
6.5.3.2 Alternative Plan 36
6.5.3.3 Preferred Plan 37
6.5.4 Motts Basin North Project Area 38
6.5.4.1 Minimum Facility 38
6.5.4.2 Alternative Plans 39
6.5.4.3 Preferred Plan 40

6.6 Preferred Plans for the Project Area 41
7 RESIDUAL FLOOD ANALYSIS 43
7.1 Line of Protection - Project Performance and Risk Analysis 44
7.2 Interior Drainage Residual Risk Analysis..... 47
7.2.1 Access and Egress Problems and Impacts to Public Services 48
7.2.2 Potential Loss of Life..... 48
7.2.3 Residual Flood Related Damages 48
8 SUMMARY OF INTERIOR DRAINAGE FINDINGS 49
9 REFERENCES..... 51

LIST OF TABLES

Table 2-1: Recommended Analysis Approach – Combination of Interior and Exterior Conditions 5
Table 2-2: Specific Frequency Hypothetical Point Rainfall Depths 10
Table 2-3: NRCS Runoff Curve Numbers 11
Table 2-4: HEC-HMS Model Subbasin Data 13
Table 2-5: Interior Drainage Peak Inflows 14
Table 5-1: Minimum Facility Damage – Mid-Rockaway 19
Table 5-2: Minimum Facility Damage – Canarsie, Cedarhurst-Lawrence, and Motts Basin North 19
Table 6-1: Interior Drainage Alternatives Evaluated 21
Table 6-2: Hammels: Minimum Facility Impacts 22
Table 6-3: Hammels: Minimum Facility Impacts – Upper Bound Condition 22
Table 6-4: Hammels: Alternatives Impacts 23
Table 6-5: Hammels: Alternatives Impacts – Upper Bound Condition 23
Table 6-6: Summary of Alternatives for Hammels Drainage Basin 24
Table 6-7: Preferred Plan Gravity Outlets for Hammels 24
Table 6-8: Arverne: Minimum Facility Impacts 25
Table 6-9: Arverne: Minimum Facility Impacts – Upper Bound Condition 26
Table 6-10: Arverne: Alternatives Impacts 26
Table 6-11: Arverne: Alternatives Impacts – Upper Bound Condition 27
Table 6-12: Summary of Alternatives Considered for Arverne 27
Table 6-13: Preferred Plan Gravity Outlets for Arverne 28
Table 6-14: Edgemere: Minimum Facility Impacts 29
Table 6-15: Edgemere: Minimum Facility Impacts – Upper Bound Condition 29
Table 6-16: Edgemere: Alternatives Impacts 30
Table 6-17: Edgemere: Alternatives Impacts – Upper Bound Condition 30
Table 6-18: Summary of Alternatives Considered for Edgemere 31
Table 6-19: Preferred Plan Gravity Outlets for Edgemere 31

Table 6-20: Canarsie: Minimum Facility Impacts 33
Table 6-21: Canarsie: Minimum Facility Impacts – Upper Bound Condition 33
Table 6-22: Canarsie: Alternatives Impacts 34
Table 6-23: Canarsie: Alternatives Impacts – Upper Bound Condition 34
Table 6-24: Summary of Alternatives Considered for Canarsie 34
Table 6-25: Cedarhurst-Lawrence: Minimum Facility Impacts 35
Table 6-26: Cedarhurst-Lawrence: Minimum Facility Impacts – Upper Bound Condition 36
Table 6-27: Cedarhurst-Lawrence: Alternative Impacts 37
Table 6-28: Cedarhurst-Lawrence: Alternative Impacts – Upper Bound Condition 37
Table 6-29: Summary of Alternative Considered for Cedarhurst-Lawrence 37
Table 6-30: Preferred Plan Gravity Outlets for Cedarhurst-Lawrence 38
Table 6-31: Motts Basin North: Minimum Facility Impacts 39
Table 6-32: Motts Basin North: Minimum Facility Impacts - Upper Bound Condition 39
Table 6-33: Motts Basin North: Alternative Impacts 40
Table 6-34: Motts Basin North: Alternative Impacts – Upper Bound Condition 40
Table 6-35: Summary of Alternative Considered for Motts Basin North 40
Table 6-36: Preferred Plan Gravity Outlet for Motts Basin North 41
Table 6-37: Summary of Preferred Plans for the Project Areas 42
Table 7-1: Base Year Peak Exterior Stillwater Elevations for Project Areas 43
Table 7-2: Base Year Peak Residual Interior Flood Stages for Project Areas 44
Table 7-3: Expected and Probabilistic Values of Structure/Contents Damage Reduced by Project 45
Table 7-4: Project Performance Analysis - Tentatively Selected Line of Protection 46
Table 7-5: Residual Flood Damage 48

ATTACHMENT 1 - LIST OF FIGURES

Figure 1-1: Study Area

Figure 2-1: Hypothetical Tides (Current Condition)

Figure 2-2: Hypothetical Tides (Future Condition)

Figure 2-3: Mid-Rockaway Drainage Subbasins Layout

Figure 2-4: Canarsie Drainage Subbasins Layout

Figure 2-5: Cedarhurst-Lawrence and Motts Basin North Drainage Subbasins Layout

Figure 2-6: HEC-HMS Model Schematic - Mid-Rockaway

Figure 2-7: HEC-HMS Model Schematic - Canarsie, Cedarhurst-Lawrence, and Motts Basin North

Figure 4-1: Elevation vs. Natural Storage Curves - Mid-Rockaway

Figure 4-2: Elevation vs. Natural Storage Curves - Canarsie, Cedarhurst-Lawrence, and Motts Basin North

Figure 6-1: Peak Stage vs. Frequency Curves - Hammels H1

Figure 6-2: Peak Stage vs. Frequency Curves - Hammels H2

Figure 6-3: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Hammels H1

Figure 6-4: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Hammels H2

Figure 6-5: Peak Stage vs. Frequency Curves - Arverne A1

Figure 6-6: Peak Stage vs. Frequency Curves - Arverne A2

Figure 6-7: Peak Stage vs. Frequency Curves - Arverne A3

Figure 6-8: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Arverne A1

Figure 6-9: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Arverne A2

Figure 6-10: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Arverne A3

Figure 6-11: Peak Stage vs. Frequency Curves - Edgemere E1

Figure 6-12: Peak Stage vs. Frequency Curves - Edgemere E2

Figure 6-13: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Edgemere E1

Figure 6-14: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Edgemere E2

Figure 6-15: Peak Stage vs. Frequency Curves - Cedarhurst-Lawrence L1

Figure 6-16: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Cedarhurst-Lawrence L1

Figure 6-17: Peak Stage vs. Frequency Curves - Motts Basin North M1

Figure 6-18: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Motts Basin North M1

Figure 7-1: Sample Interior Stage vs. Time Plot

Figure 7-2: Residual Flooding - Mid-Rockaway Hammels Subbasin H1

Figure 7-3: Residual Flooding - Mid-Rockaway Hammels Subbasin H2

Figure 7-4: Residual Flooding - Mid-Rockaway Arverne Subbasin A1

Figure 7-5: Residual Flooding - Mid-Rockaway Arverne Subbasin A2

Figure 7-6: Residual Flooding - Mid-Rockaway Arverne Subbasin A3

Figure 7-7: Residual Flooding - Mid-Rockaway Edgemere Subbasin E1

Figure 7-8: Residual Flooding - Mid-Rockaway Edgemere Subbasin E2

Figure 7-9: Residual Flooding - Cedarhurst-Lawrence Subbasin L1

Figure 7-10: Residual Flooding - Motts Basin North Subbasin M1

ATTACHMENT 2

Time of Concentration Calculations

ATTACHMENT 3

HEC-HMS Modeling Results by Subbasin

1 INTRODUCTION

1.1 Scope

This appendix documents the development and evaluation of interior drainage facilities associated with four locations that met the initial screening criteria for implementation of High Frequency Flood Risk Reduction Features (HFFRRF) within Jamaica Bay. The initial screening of potential HFFRRF compared the line of protection costs and benefits. Four locations were identified for continued analysis, including the development of interior drainage cost estimates and estimation of residual damages. In addition, this appendix documents the rationale for identifying the interior drainage facilities including storm sewer outfalls, gates, natural/excavated ponding areas, and pump stations to control precipitation runoff. The analysis herein represents the results of the interior drainage facilities formulation.

The appendix has been organized to provide the reader with a summary of the results of the hydrologic/hydraulic models, design and economic criteria, followed by an overview of the formulation process leading to the identified plans. The formulation effort incorporates an analysis of varying types and sizes of interior drainage facilities to determine a plan that provides significant net benefits while meeting the Minimum Facility design criteria.

1.2 Climate Change

In accordance with Corps of Engineers ECB 2016-25, "Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects", documentation of a qualitative response to the question "Is climate change relevant to the project goals or design?" is required. The primary feature of the interior drainage facilities for the Jamaica Bay HFFRRF is a combination of gravity storm sewer outlets with backflow prevention and pumping stations which provides protection against coastal storm events and inland flooding from heavy rainfalls. Potential changes in precipitation intensity might only be relevant to the interior drainage hydrology and would not be a significant risk to the primary features of this project.

Because the selected interior drainage plan consists of existing storm sewer outlets (i.e. substantially-sized box culverts), the possible impact of climate change on these interior facilities is fairly limited. The selected line of protection, with the selected interior drainage plan, will reduce the interior water surface elevations within the project area. Existing gravity outlets are unlike features such as interior levees or pump stations, which can result in sudden and catastrophic increases in flood depths once their design capacity is exceeded.

The actual amount of available storage within the project area is limited. The interior drainage facilities, like most Flood Risk Management Projects, are designed based upon a large and infrequent event and, as such, are designed with the appropriate allowances for risk and

uncertainty. Projected climate change impacts appear to be well within the normal range of hydrologic variability for Flood Risk Management Projects.

1.3 Study Locations

The overall study area lies in and around Jamaica Bay with a total of approximately 1,500 acres. The principal communities studied are the following: Canarsie in the Borough of Brooklyn; the Villages of Cedarhurst and Lawrence of Nassau County on the South Shore of Long Island; Motts Basin North; and the Mid-Rockaway area, including Hammels, Arverne and Edgemere, on the Rockaway Peninsula in the Borough of Queens in New York City.

1.4 Source of Flooding

Flooding in this area can result from either high storm surges in Jamaica Bay or interior precipitation runoff that cannot be conveyed to the bay through the existing interior drainage system.

The frequency of inland inundation will continue and increase as sea level is projected to rise. Relative sea level in the project area has been rising at an average of 0.014 feet per year. It is also anticipated that continued development and fill placement will occur within the floodplain. As new construction is elevated above the base interior flood elevation, the fill will reduce storage for interior runoff and may exacerbate interior flooding conditions during high intensity rainfall events.

2 ANALYSIS OF HYDROLOGIC AND HYDRAULIC CONDITIONS

The analysis and design of the Interior Drainage Plan is intended to supplement the Engineering and Design Plan, and manage the residual risks from flooding. The Recommended Engineering and Design Plan includes an improved coastal barrier system made up of levees, tide gates, floodwalls, and a buried seawall/armored levee for the project reach. With the introduction of these new flood management measures, the hydraulic characteristics between the with- and without-project conditions may change during tidal and interior runoff flooding events.

The main objective of implementing a new Coastal Storm Risk Management System is to reduce the risk associated with flooding and while the Recommended Engineering and Design Plan is expected to achieve this objective for high surge levels, interior drainage measures are needed in order to address residual flooding during high precipitation rainfall events. At a minimum, the Interior Drainage Plan must demonstrate that the Minimum Facility is met or that the local storm drainage system functions essentially as it would without the Engineering and Design Plan in place (EM 1110-2-1413). Supplemental interior drainage measures may be introduced to further improve the interior flooding conditions under the condition that the additional cost of incorporating the additional design features does not outweigh the additional benefit resulting from a reduction in flood related damages.

2.1 Basis of Interior Drainage Design

The analysis presented herein is based on the concepts and guidelines contained in EM 1110-2-1413 "Hydrologic Analysis of Interior Areas", dated 15 Jan 1987, ER 1105-2-100 “Planning Guidance Notebook”, dated 22 April 2000, ER 1105-2-101 “Risk Analysis for Flood Damage Reduction Studies”, dated 03 Jan 2006, and EM 1110-2-1417 “Flood Runoff Analysis”, dated 10 Jul 2013.

2.1.1 Rainfall and Storm Surge Correlation Analysis

For the with- and without-project conditions, the exterior flood stage (stillwater elevation within Jamaica Bay) is an important factor affecting the drainage of interior precipitation runoff. The exterior stage is controlled by the tide cycle and storm surge elevations during storm events. Inland, the interior surface runoff is conveyed out into the bay through the existing high ground via stormwater outfalls. In the without-project condition, these outfalls cease to operate when the exterior stage (tide/storm surge level) rises above the interior stage because they rely on gravity to facilitate the conveyance of surface runoff. Similarly, if a new coastal storm risk management structure is introduced (with-project condition) to reduce the risk of storm surge entering the study area, the proposed outfalls, under high exterior (tailwater) stage conditions, would still not be able to drain through gravity flow. Therefore, it is important to develop an understanding of whether there is a relationship between interior surface runoff and exterior tidal events in both the with- and without-project conditions.

To understand the relationship between the interior and exterior stage conditions, if any, a correlation analysis needed to be performed. In accordance with EM 1110-2-1413, the correlation analysis should include a data analysis of the correlation, dependence, and coincidence of the interior and exterior stage relationship. From the recent USACE's correlation analyses presented in the Feasibility Study for Fort Wadsworth to Oakwood Beach of the South Shore of Staten Island Coastal Storm Risk Management and the South River Project, we can expect that the storm surge in the Jamaica Bay does not correlate to the precipitation events, is lightly dependent upon precipitation events, and that its peak stage is unpredictable but could randomly coincide with peak interior discharges.

As demonstrated in the recent USACE's correlation analyses, most of the higher tide events occurred with little rainfall, and most high rainfall events occurred with normal tides. This relationship, along with the general wide scatter of precipitation amounts with a constant storm surge and vice versa indicates that there is no correlation between the surge events and precipitation. Therefore, it is not reasonable to say that we could predict one condition from the other based on these historic records.

2.1.2 Analysis Approach

The interior stage analysis was conducted for events with eight recurrence intervals: the 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, 250-year and 500-year frequency events. In order to develop a stage-frequency relationship, the interior events were routed against exterior tidal marigrams. For the most likely or expected flooding scenarios, the eight interior storm events were routed against a 2-year exterior tide, and a 2-year interior storm event was routed against all the exterior events. **Table 2-1** presents the different interior and exterior runs analyzed and the risk condition associated with each.

Table 2-1: Recommended Analysis Approach – Combination of Interior and Exterior Conditions

Varied Interior Condition		Varied Exterior Condition		Risk Condition
Interior Flow	Exterior Stage	Interior Flow	Exterior Stage	
2-year	Normal	N/A	N/A	Lower Bound
5-year	Normal	N/A	N/A	Lower Bound
10-year	Normal	N/A	N/A	Lower Bound
25-year	Normal	N/A	N/A	Lower Bound
50-year	Normal	N/A	N/A	Lower Bound
100-year	Normal	N/A	N/A	Lower Bound
250-year	Normal	N/A	N/A	Lower Bound
500-year	Normal	N/A	N/A	Lower Bound
2-year	2-year	2-year	2-year	Expected
5-year	2-year	2-year	5-year	Expected
10-year	2-year	2-year	10-year	Expected
25-year	2-year	2-year	10-year	Expected
50-year	2-year	2-year	10-year	Expected
100-year	2-year	2-year	10-year	Expected
250-year	2-year	2-year	10-year	Expected
500-year	2-year	2-year	10-year	Expected
2-year	2-year	2-year	2-year	Upper Bound
5-year	5-year	5-year	5-year	Upper Bound
10-year	10-year	10-year	10-year	Upper Bound
25-year	10-year	10-year	10-year	Upper Bound
50-year	10-year	10-year	10-year	Upper Bound
100-year	10-year	10-year	10-year	Upper Bound
250-year	10-year	10-year	10-year	Upper Bound
500-year	10-year	10-year	10-year	Upper Bound

As demonstrated in the Risk Condition column of **Table 2-1**, uncertainty was incorporated into the analysis by establishing lower and upper coincidental frequency bounds. For the lower bound, the interior storm events were routed against a normal exterior tidal condition and for the upper bound the interior events were routed against a 10-year external tide. The maximum water surface elevation of corresponding coincidental frequencies (e.g., 2-year interior and 10-year exterior, or 10-year interior and 2-year exterior) was identified as the most damaging flood level for the coincidental frequency. The three conditions: expected (design), lower bound, and upper bound were then incorporated into the economic analysis using a triangular probability distribution.

The Plan Formulation Section of this Sub-Appendix only presents the selected interior stage utilized in the economic comparison. Interior water surface elevations under all conditions demonstrated in **Table 2-1** are presented in **Attachment 3** of this Sub-Appendix.

2.1.3 Hydrologic Analysis

The HEC-HMS model, version 4.2.1, parameters are described in the subsequent sections of this appendix. Basic input parameters developed for the hydrologic models include: drainage area, rainfall generated for a series of hypothetical storm events (2 to 500-year recurrence intervals), runoff curve number, and time of concentration (Tc).

2.2 Hypothetical Storm Surge Data

For storm events, a storm hydrograph was developed to simulate surge levels during storm conditions. Two main assumptions were made to develop the storm hydrograph: (1) the peak elevation of the storm will occur at high tide; and (2) the duration of the storm is approximately 24 hours. Peak discharge hydrographs were developed for return periods from 2 to 500-years. Hypothetical tide marigrams (hydrographs) used in this study for the exterior stages for current and future conditions are plotted in **Figures 2-1** and **2-2**, respectively. Baseline conditions considered the current sea level, and future conditions considered a 1.1 feet rise in sea level and storm surge elevations (Intermediate sea level rise scenario). The storm surge duration was assumed to be 48 hours with four tide cycles. The storm surge data utilizes the stage frequency curves as described in **Appendix A2** (Engineering and Design Appendix).

The relationship between rainfall/runoff (including surface runoff flow) and storm surge is highly uncertain and may have a significant impact on interior stages. Uncertainty was incorporated into the analysis by routing the interior storm events against a normal exterior tidal condition to establish a lower bound of interior flood levels, and routing the interior events against a 10-year external storm surge conditions to establish a reasonable upper bound of interior flood levels. This methodology was then applied with a 2-year exterior surge level to create the expected interior flood levels.

2.3 Drainage Area Delineation

Interior drainage basins and subbasins were delineated in GIS utilizing publicly available LiDAR terrain data. For the Mid-Rockaway and Canarsie project areas, located within the City of New York, LiDAR data collected in the spring of 2010 was used. A Digital Elevation Model (DEM), which was was generated by interpolating the LiDAR ground points to create a one-foot resolution seamless surface, was downloaded for use. For the Cedarhurst-Lawrence project area, a three-meter DEM raster, produced by the State of New York by merging four separate datasets, was downloaded for use. For the Motts Basin North project area, a three-foot bare earth DEM, produced in November 2011 from the 2010 New York City LiDAR data, was used. One-foot

contours generated from the three DEMs along with aerial imagery from Web Mapping Service (WMS) 2016, Google Earth, and Bing Maps were used for subbasin delineation.

2.3.1 Delineation Methods

An interior drainage basin is defined, for the purpose of engineering analysis, to be a distinct drainage area which drains to one primary outlet location landward of the proposed line of protection alignment. The identification of such areas is complicated by the presence of man-made features such as storm sewers, which may divert flow into or out of a drainage area. In some cases, otherwise distinct and discrete interior areas have low-lying lands that may combine during low frequency storms because of the high pooling elevations that overtop the divide between drainage areas.

2.3.2 Hydraulic Analysis

Outlet structures, such as culverts and pipes running through the proposed line of protection were analyzed in the HEC-HMS model using inlet and outlet control analyses as described in Federal Highway Administration's Hydraulic Design Series No. 5 "Hydraulic Design of Highway Culverts" (HDS-5).

2.4 Delineated Interior Drainage Basins

The major interior drainage basins are named based on the neighborhoods through which the line of protection passes. The interior drainage subbasins used for the HEC-HMS analysis are depicted in **Figure 2-3** for the Mid-Rockaway project area, in **Figure 2-4** for the Canarsie project area, and in **Figure 2-5** for the Cedarhurst-Lawrence and Motts Basin North project areas.

2.4.1 Mid-Rockaway Project Area

The Mid-Rockaway project area is within the Rockaway Peninsula, in Queens County, New York. It covers approximately 1,130 acres and includes three interior drainage basins from west to east: Hammels, Arverne, and Edgemere. The drainage basins extend roughly from Beach 95th Street in the west and Beach 20th Street in the east. The following sections describe each of the Mid-Rockaway drainage basins in detail.

2.4.1.1 Hammels Drainage Basin

The Hammels drainage basin includes two subbasins, H1 and H2, covering approximately 104.5 acres and 139.0 acres, respectively. The Hammels drainage basin is almost fully developed, except for a few scattered grassy areas and is predominantly residential, with some commercial development.

2.4.1.2 Arverne Drainage Basin

The Arverne drainage basin has three subbasins A1, A2, and A3, covering approximately 72.5 acres, 139.5 acres, and 208.6 acres, respectively. The Arverne drainage basin is almost fully developed and predominantly residential, with a few, scattered undeveloped areas.

2.4.1.3 Edgemere Drainage Basin

The Edgemere drainage basin has two subbasins, E1 and E2, covering approximately 191.7 acres and 273.9 acres, respectively. The Edgemere drainage basin is almost fully developed and predominantly residential, except for a stretch of undeveloped, grassy area along the southern part of E1 and southwestern part of E2.

2.4.2 Canarsie Project Area

The Canarsie drainage basin is within Canarsie neighborhood of Brooklyn, New York in Kings County. It is located to the west of Fresh Creek and is roughly bounded by Flatlands Avenue, East 96th Street, and Seaview Avenue on the other three sides. It covers approximately 273 acres and is divided into three subbasins C1, C2, and C3 each covering approximately 119.7 acres, 69.3 acres, and 84.1 acres, respectively. There is an internal high area on either side of Avenue M, which defines a separation between subbasins C2 and C3. The Canarsie drainage basin is completely developed and predominantly residential, with some commercial development.

2.4.3 Cedarhurst-Lawrence Project Area

The Cedarhurst-Lawrence drainage basin is within Nassau County, between the villages of Lawrence and Cedarhurst. It is located immediately east of the Rockaway Turnpike, at the intersection with Peninsula Boulevard. It consists of a single subbasin L1, covering approximately 93.3 acres. The Cedarhurst-Lawrence drainage basin is fully developed and predominantly residential, with some commercial development.

2.4.4 Motts Basin North Project Area

The Motts Basin North area is within the village of Inwood, in Nassau County. It consists of a single subbasin M1, covering approximately 28.1 acres. It is fully developed and predominantly residential, with some commercial development and a wooded area in the southeastern part of M1.

2.5 Future Storm Drainage System

Numerous drainage improvement plans are currently proposed by the affected communties within the different HFFRRF project areas, which must be taken into consideration for this project:

- For the Mid-Rockaway project area, separation of combined sewer overflows (CSOs) from the flood risk reduction features being evaluated is required.
- In the Canarsie project area, the Governor's Office of Storm Recovery (GOSR) has a plan for Spring Creek, with many features similar to the ones being proposed for this project. However, it does not identify any significant upgrades to the interior drainage system.
- In the Cedarhurst-Lawrence project area, the New York State Department of Transportation (NYSDOT) is implementing a plan to elevate the Nassau Expressway to help alleviate flooding concerns. The proposed drainage improvements could eliminate the need for a line of protection in that area. In addition, it should be noted that, in the Village of Cedarhurst, GOSR has identified a pump station to improve drainage within the Village as part of the Five Towns Drainage Study. The pump station is proposed immediately to the east of the proposed line of protection and would not result in redundancy.

2.6 Development of Interior Inflow Runoff Hydrographs

HEC-HMS was used to model the interior runoff for a range of hypothetical rainfall frequencies and durations. Runoff curve numbers, routing reach travel times, lag times, and hydrograph combinations were used to define the interior basin response to the various hypothetical rainfall events. Each input parameter is described in more detail in the subsequent sections.

Generally, the capital letters used for Hydrologic Element identifications within the HEC-HMS models, have the following meanings:

SB = subbasin runoff computation; R = reservoir storage

The schematics shown in **Figures 2-6** and **Figure 2-7** represent the set-up of the interior flow HEC-HMS models for each of the interior drainage basins.

2.6.1 Rainfall Data

Specific frequency hypothetical point rainfall depths for a range of durations of and return periods were obtained from *National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 10, Version 2,* available online at https://hdsc.nws.noaa.gov/hdsc/pfds. Hypothetical point rainfall depths for the 1-year through 100-year storms for durations ranging from 5 min to 48 hours are shown in **Table 2-2**.

Table 2-2: Specific Frequency Hypothetical Point Rainfall Depths

Point Rainfall Depth (inches)								
Duration	Return Period (years)							
	2	5	10	25	50	100	200	500
5 min	0.438	0.556	0.654	0.788	0.892	0.996	1.13	1.31
15 min	0.730	0.927	1.09	1.31	1.49	1.66	1.88	2.18
1 hour	1.32	1.67	1.96	2.36	2.67	2.97	3.38	3.91
2 hours	1.71	2.15	2.51	3.00	3.38	3.77	4.26	4.92
3 hours	1.97	2.46	2.88	3.44	3.88	4.32	4.89	5.65
6 hours	2.43	3.07	3.60	4.34	4.90	5.46	6.22	7.23
12 hours	2.92	3.75	4.45	5.40	6.14	6.87	7.90	9.26
24 hours	3.38	4.42	5.29	6.48	7.39	8.31	9.62	11.4
48 hours	3.83	5.03	6.03	7.41	8.47	9.53	11.1	13.1

Data for the 24-hour storm duration were plotted on on a logarithmic scale and interpolated to project a point rainfall value for the 250-year storm. A 24-hour hypothetical storm was used to allow for HEC-HMS interior inflow routing for return periods of 2, 5, 10, 25, 50, 100, 250, and 500-years, against the exterior time-varying marigrams (astronomic tide plus storm surge) for a total duration of 48 hours.

To represent the variation in rainfall distribution in different regions of the United States, four synthetic 24-hour rainfall distributions (1, IA, II, and III) were developed by the NRCS from available National Weather Service data or local storm data. The project areas fall under the Type III rainfall.

2.6.2 NRCS Runoff Curve Numbers

The Natural Resources Conservation Service (NRCS) runoff curve number procedure as outlined in *NRCS Technical Release No. 55 (TR-55), Urban Hydrology For Small Watersheds* was used to define the rainfall-loss-excess (or runoff) behavior of the interior drainage subbasins in the HEC-HMS model. The runoff curve numbers (CN) relate total accumulated excess precipitation to total accumulated precipitation and are based on factors such as hydrologic soil group, land use, ground cover, quality of vegetative cover, and antecedent moisture conditions. Directly connected impervious areas for the subbasins were not specified separately, but accounted for by the curve numbers.

Soils data for the project areas were downloaded in GIS format from the Web Soil Survey developed and maintained by the NRCS (available online at https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx). The soils dataset also provides the Hydrologic Soil Group (HSG) rating for each soil type, with values of “A”, “B”, “C”, “D”, or a combination thereof. In case of a null value, the HSG was assumed to be “D”, to be conservative. For combinations such as “A/D”, “D” was assumed, to be conservative.

Land use for the interior drainage basins was assigned based on visually comparing aerial imagery from WMS 2016, Google Earth, and Bing Maps and assigning the areas to specific cateogries per the TR55 Urban Hydrology for Small Watersheds manual. For the Mid-Rockaway (Hammels, Arverne, and Edgemere), Canarsie, and Cedarhurst-Lawrence project areas, a majority of the drainage area falls under the category "Residential Districts, 1/8 acres or less". There are some scattered grassy, open spaces in Mid-Rockaway; these were included in the above residential districts category to account for future development. In the case of the Motts Basin North project area, three distinct land use categories were assigned: "Residential Districts, 1/8 acres or less", "Commercial and Business", and "Woods, good condition".

Following the guidance provided in TR-55, curve numbers were developed for this analysis based on the combined land use categories and hydrologic soil groups, as shown in **Table 2-3.** A composite curve number was estimated for each subbasin by computing an area-weighted average of curve numbers assigned within the subbasin.

Table 2-3: NRCS Runoff Curve Numbers

Land Use Categories	Hydrologic Soil Groups			
	A	B	C	D
Residential Districts, 1/8 acres or less	77	85	90	92
Commercial and Business	89	92	94	95
Woods, good condition	30	55	70	77

2.6.3 Time of Concentration

Time of concentration (Tc) for a watershed is the time taken for runoff to travel from the hydraulically most distant point of the watershed to the outlet point for the watershed. The longest hydraulic path for each subbasin was identified in ArcGIS. Tc was computed by summing travel times for consecutive components of the runoff conveyance system, which can typically be characterized into three types, per TR-55:

Sheet flow: Sheet flow refers to flow over plane surfaces, which usually occurs at the headwaters of a stream near the watershed boundary. A simplified version of the Manning's kinematic solution was used to compute travel time for sheet flow:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$$

where,

T_t = travel time, hours

n = Manning's roughness coefficients for sheet flow

L = sheet flow length, ft

P_2 = 2-year 24-hour rainfall, in

s = slope of land surface, ft/ft

Shallow Concentrated Flow: After the initial sheet flow, runoff usually transitions into shallow concentrated flow. The average velocity for shallow concentrated flow was estimated using:

$$V = 16.1345(s)^{0.5}, \text{ for unpaved areas}$$

$$V = 20.3282(s)^{0.5}, \text{ for paved areas}$$

where,

V = average velocity, ft/s

s = slope of hydraulic grade line or watercourse slope, ft/ft

Channel Flow: Channel flow is assumed to begin where channels can be identified based on available topographic data or aerial imagery. Average velocity for channel flow was determined using the Manning's equation, assuming bankfull elevation:

$$V = \frac{1.49(r)^{\frac{2}{3}}(s)^{\frac{1}{2}}}{n}$$

$$r = \frac{a}{p_w}$$

where,

V = average velocity, ft/s

r = hydraulic radius, ft

a = cross sectional flow area, ft^2

p_w = wetted perimeter, ft

s = slope of hydraulic grade line, ft/ft

n = Manning's roughness ceofficient for open channel flow

The travel times for the individual components of each subbasin were summed to obtain the time of concentration for the subbasin. The time of concentration calculations for all the subbasins are summarized in **Attachment 2** of this Sub-appendix.

2.6.4 NRCS Dimensionless Unit Hydrograph

The NRCS dimensionless unit hydrograph is based on a dimensionless table of discharge per unit area versus time, normalized to the peak discharge and time of concentration, respectively. The actual subbasin unit hydrograph is created within HEC-HMS, with the input of a specific drainage area and a lag time. The standard lag time for a basin is conceptually defined as the time from the center of mass of excess rainfall to the time of the peak discharge of the unit hydrograph. In general, lag time can be approximated as 0.6 times the time of concentration.

The shape of the unit hydrograph can be defined using two different graph types. Standard and Delmarva. The Standard Graph is generally applicable across the United States. The Delmarva Graph is applicable specifically to coastal plain areas of Delaware, Maryland, and Virigina. For this analysis, the Standard Graph was used.

For each of the subbasins modeled in HEC-HMS, **Table 2-4** summarizes three key modeling parameters: acreage, CN, and lag time.

Table 2-4: HEC-HMS Model Subbasin Data

Drainage Subbasin	Drainage Area (acres)	NRCS CN*	Lag Time (min)
Hammels H1	104.5	92	27
Hammels H2	139.0	91	19
Arverne A1	72.5	92	33
Arverne A2	139.5	92	36
Arverne A3	208.6	91	29
Edgemere E1	191.7	89	41
Edgemere E2	273.9	87	44
Canarsie C1	119.7	92	26
Canarsie C2	69.3	92	31
Canarsie C3	84.1	92	26
Cedarhurst-Lawrence L1	93.3	93	29
Motts Basin North M1	28.1	87	21

*The CN values shown are area-weighted values for each subbasin.

2.7 Peak Inflows

The peak interior drainage inflows for each of the subbasins are summarized in **Table 2-5** for return periods of 2, 5, 10, 25,50, 100, 250, and 500 years.

Table 2-5: Interior Drainage Peak Inflows

Interior Drainage Peak Inflows(cfs)								
Drainage Subbasin	Return Period							
	2-year	5-year	10-year	25-year	50-year	100-year	250-year	500-year
Hammels H1	145	199	244	306	353	400	491	557
Hammels H2	227	315	389	489	565	642	790	897
Arverne A1	90	123	152	190	219	248	305	346
Arverne A2	171	235	289	362	418	474	582	660
Arverne A3	278	387	478	601	695	789	972	1,104
Edgemere E1	195	277	346	439	511	582	721	822
Edgemere E2	248	360	454	584	682	782	974	1,113
Canarsie C1	165	227	279	348	401	455	559	634
Canarise C2	89	122	150	187	216	245	301	341
Canarsie C3	117	161	198	247	285	323	396	449
Cedarhurst-Lawrence L1	127	173	212	264	303	343	421	427
Motts Basin North M1	39	57	71	91	107	122	152	173

3 DESIGN PROCEDURE

As described in EM 1110-2-1413, "Hydrologic Analysis of Interior Areas", procedures for formulating and evaluating flood loss reduction measures for interior drainage basins are similar to planning procedures used in other types of investigations. The complexity of the process is dependent upon the nature of the study area, flood hazard, damage potential, and environmental and social factors. A comprehensive array of alternatives is formulated and evaluated through an iterative process until a final array of plans is developed. Data necessary to conduct the investigation includes basin hydrology, stage-frequency curves, hydraulic parameters of plan components, the annualized cost of construction and maintenance, and estimated residual damages. Using this data, with and without project benefits can be determined in order to identify the plan which maximizes net benefits.

3.1 Interior Flood Control Simulation Models

As discussed in Section 2, the hydrologic analysis program HEC-HMS was used to simulate the hydrologic response of the interior drainage basins and the operation of the drainage facilities. The program has some limitations in the modeling of existing storm sewer systems and natural flood storage area. It may, therefore underestimate outflow through the outlets through the line of protection and thereby overestimate interior water surface elevations by failing to account for runoff that may not accumulate in the natural flood storage area. This would be the case when

runoff passes directly into the bay when the head difference between tailwater elevation and the ground elevation behind the plan alignment is positive.

HEC-HMS computes both runoff and routes floods through interior drainage facilities taking into account variable tailwater conditions. This program was utilized to simulate the surface runoff response of the interior basins to precipitation while taking into account both the hydrologic and hydraulic components of these basins.

4 INTERIOR DRAINAGE HYDRAULICS

In addition to the development of hydrologic data, the analysis of interior drainage facilities required additional input to describe the physical and operational characteristics of the Minimum Facility and other alternatives. Input requirements consisted of potential storage volumes, and and pumping rates. HEC-HMS was utilized to evaluate the effects of existing or proposed hydraulic structures by routing interior fluvial flood events through the interior drainage basins. The hydraulic assumptions and criteria used to inform the models are described below.

4.1 Elevation/Storage Relationships

In order to evaluate the storage capacity behind the line of protection, elevation-storage relationships were developed. Using project mapping and commencing with the lowest elevation at the natural ponding site behind the line of protection, the planimetric area enveloped by a particular elevation was computed. For consecutive elevations, the average end-area method was used to compute the volume. The volumes between elevations were summed to generate an overall elevation-volume relationship for a particular ponding site. **Figure 4-1** is a plot of the elevation versus natural storage curves for the Mid-Rockaway project area that includes Hammels, Arverne, and Edgemere. **Figure 4-2** is a plot of the elevation versus natural storge curves for the Canarise, Cedarhurst-Lawrence, and Motts Basin North project areas.

4.2 Potential Interior Drainage Facilities

Potential interior drainage facilities (measures) are described below. No single measure is effective in all situations and typically no single measure is effective by itself. The most cost-effective approach to reducing interior flooding stages is likely to be a combination of measures.

4.2.1 Gravity Outlets

The driving head of runoff outflow from the protected areas is the elevation difference between two water surfaces; the elevation of runoff that is accumulated landward of the proposed alignment (headwater) and the elevation of the tidal surge seaward of the proposed alignment (tailwater).

There is no modeled backflow from the bay into natural flood storage areas because tide gates, which permit flow in only one direction, are assumed to be in place for the Minimum Facility as

well as all interior drainage alternatives. The program HEC-HMS would assume zero flow when tide level is higher than the interior headwater level.

Gravity outlets, typically the least expensive drainage measure, function best during the high rainfall coupled with low tide events, when there is sufficient head for gravity discharge. Gravity outlets also work well when the existing grade landward of the plan alignment is higher, again providing additional head. Conversely, gravity outlets are ineffective during high tide events when the tailwater elevations are higher than the interior elevations. During these events, outlets are effectively blocked and thus the gravity discharge is zero. Gravity outlets do not function well with large, low-lying natural flood storage areas such as freshwater wetlands, where even a moderate tide can prevent gravity discharge.

For this project, gravity outlets through the line of protection are a significant component of the hydraulic measures and considered part of the Minimum Facility scenario.

4.2.2 Ponding / Flood Storage

Ponding or flood storage can be an effective means for flood risk management. Runoff is stored in low-lying, non-damaging areas until the tidal surge (tailwater) drops sufficiently to permit gravity discharge. Ponding is most effective when runoff is first discharged through gravity outlets during low tailwater conditions, and then diverted into the pond as the gravity outlets become blocked. Directing all runoff into a pond will increase the size of the pond required. Excavating ponds to increase the runoff storage volume can be expensive, so natural flood storage areas should be used wherever possible, especially where development has already occurred or is expected to occur in low-lying areas.

Excavated ponds were considered for the project areas but were not found to be viable as the available storage was not sufficient to produce a significant difference in the interior flooding stages.

4.2.3 Pressure Outlets

If a significant portion of the drainage area is higher than the crest of the coastal storm risk management plan structure, it may be possible to divert the runoff from that higher area directly into the bay through pressure conduits. Typically, there must be sufficient head between the higher ground and the maximum tailwater to divert this runoff. Diversion effectively reduces the volume of runoff reaching the structure that would otherwise need to be handled by other means such as ponding or pumping. Pressurizing an existing gravity line by removing or sealing all of the lower catch basins is usually the most expensive method, so in some cases construction of a new pressure line may be justified.

Pressure outlets could be considered for subbasin E2 at the bottom of the steep slopes in the northeastern part of the subbasin. However, sufficient data is not available on the existing

stormwater system at this time to go forward with this approach. This can be reconsidered at a later phase of the design, when sufficient data is available.

4.2.4 Pumping

Pumping is usually the most expensive option in initial construction as well as operation and maintenance. Similar to pond excavation and pressure outlets, pumping is most effective during higher exterior stages when gravity outlets are blocked and there is insufficient natural flood storage area landward of the plan alignment. Pumping can be used to reduce the volume of a ponding area, or it can be used to handle the peak runoff. The construction of a pump station creates additional capital costs and also increases annual maintenance and operation costs. Capital expenditures affected by the addition of pump stations include mechanical equipment, associated housing, and any new outfalls. Increases in the cost of project operation and maintenance include power consumption, equipment operation, inspection and testing, maintenance and replacement.

Pumps typically have a minimum cycle time of about six starts per hour. To achieve this cycle time an adequate volume of surface runoff from the interior drainage basin must be stored and available whenever the pumping operation is initiated. The storage volume in cubic feet required between the lead pump-on and pump-off elevations is based on the following equation:

$$V = \frac{TQ_{pump}}{4}$$

where *V* is the volume in cubic feet, and Q_{pump} is the pump discharge rate in cubic feet per second, and T is the cycle time in seconds.

For this project, typically, each pump station has two pumps with one turning on at a flooding stage of 1 ft, NAVD88 and the other tunring on at 2 ft, NAVD88. In cases with three pumps, the third pump turns on at a flooding stage of 3ft, NAVD88. Once turned on, the pumps will remain on until the water level drops to below an elevation of -1 ft, NAVD88.

5 ECONOMIC ASSESSMENT

5.1 Conditions

Analysis of benefits and costs for formulation of interior drainage plans was conducted using the 2018 Federal discount rate of 2.75% applied over a 50-year period-of-analysis. Baseline conditions considered the current sea level and future conditions considered a 1.1 foot rise in sea level and storm surge elevations (Intermediate sea level rise scenario). The Recommended Plan was updated to reflect the 2019 discount rate.

5.2 Costs

Interior drainage consists of features required to maintain existing drainage and avoid induced flood-damage, and various interior drainage improvements that must be economically justified based on a comparison of benefits (reduction of Minimum Facility damages) and costs (annual cost above Minimum Facility costs). These costs consist of first construction costs, real estate costs, and annual operation and maintenance expenses. Interior drainage facility costs are based on incremental improvements and are additional to Minimum Facility features, which are considered part of the Recommended LOP Plan.

5.2.1 First Construction Costs

First construction costs for interior drainage facilities may include primary and secondary outlets, inlet and sluice gate structures, outlet gates, pump stations and new outfalls.

5.2.2 Operation and Maintenance

Annual costs attributed to the operation and maintenance of interior drainage facilities consist of, but are not limited to, labor charges for the inspection, care and cleaning of outlets and pump stations, as well as anticipated energy charges and annualized replacement costs.

5.3 Benefits

Flood damage reduction benefits for interior drainage facilities are calculated as the difference between the residual damages associated with the project with Minimum Facilities in place and the interior drainage alternative being evaluated.

5.3.1 Interior Flood Damage

The expected damage to each structure was calculated for the required range of flooding depths. These damages were then aggregated to determine composite stage versus damage relationships for each interior area.

5.3.2 Annual Damage

Annual damage was calculated using HEC-FDA Version 1.4.1 which applies Monte Carlo simulation techniques to compute the expected value of damage, while accounting for uncertainty in the value of key parameters such as structure value and elevation, damage as a percent of value at various stages, and hydrologic and hydraulic data such as stage-frequency relationships. The HEC-FDA model calculates the Average Annual Damages (AAD) for both the base and future conditions (with sea level change). Equivalent Annual Damages (EAD), which is the sum of the discounted value of the expected annual damage, was also calculated for the 50-year period-of-analysis.

5.3.3 Minimum Facility Damages

As noted above, the Minimum Facility becomes the starting point for evaluating interior drainage alternatives. The magnitude of these damages helps to guide decisions on the type and scale of interior flood risk management measures to consider. **Table 5-1** and **Table 5-2** provide a summary of the Minimum Facility AAD and EAD for each of the interior drainage subbasins.

Table 5-1: Minimum Facility Damage – Mid-Rockaway

Drainage Subbasins	Expected Annual Damage		Equivalent Annual Damage*
	Base Year	Future Year	
Hammels H1	$ 625,010	$ 1,305,130	$ 883,680
Hammels H2	$ 567,590	$ 936,910	$ 708,050
Arverne A1	$ 227,110	$ 409,860	$ 296,620
Arverne A2	$ 1,116,050	$ 1,452,560	$ 1,244,030
Arverne A3	$ 1,633,530	$ 2,796,050	$ 2,075,670
Edgemere E1	$ 1,188,750	$ 1,995,290	$ 1,495,500
Edgemere E2	$ 377,520	$ 797,130	$537,110

*2.75% Discount Rate

Table 5-2: Minimum Facility Damage – Canarsie, Cedarhurst-Lawrence, and Motts Basin North

Drainage Subbasins	Expected Annual Damage		Equivalent Annual Damage*
	Base Year	Future Year	
Canarsie C1	$ 1,052,900	$ 2,386,190	$ 1,559,990
Canarsie C2	$ 123,470	$ 343,680	$ 207,220
Canarsie C3	$ 317,220	$ 1,020,130	$ 584,560
Cedarhurst-Lawrence L1	$ 1,335,300	$ 3,107,130	$ 2,009,180
Motts Basin North M1	$ 60,170	$ 128,530	$ 86,170

*2.75% Discount Rate

6 PLAN FORMULATION

6.1 Minimum Facility Concept

As stated in EM 1110-2-1413, “Hydrologic Analysis of Interior Areas”, the design Minimum Facilities should provide interior flood relief such that during all exterior stages, residual flooding is not induced above the level that would occur without the Coastal Storm Risk Management System in place. This is the starting point from which all additional interior drainage alternatives can be evaluated. Additional interior drainage measures may be designed to further reduce interior water levels beyond the Minimum Facility. These additional interior facilities must be incrementally justified.

6.2 National Economic Development for Interior Drainage Facilities

The benefits accrued from interior drainage alternatives are attributable to the reduction in the residual flood damages that may have remained under the Minimum Facility condition. Finally, a preferred drainage alternative is selected based on meeting National Economic Development (NED) objectives.

The interior drainage facilities must be formulated to maximize NED benefits while meeting NED objectives to provide a complete, effective, efficient, and acceptable plan of protection.

- Completeness is defined in Engineering Regulation (ER) 1105 2 100 as,
  a. The extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities.
- Effectiveness is defined as,
  b. The extent to which the alternative plans contribute to achieve the planning objectives.
- Efficiency is defined as,
  c. The extent to which an alternative plan is the most cost effective means of achieving the objectives.
- Acceptability is defined as,
  d. The extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies.

6.3 Analysis of Alternative Plans

The Minimum Facility plan was the starting point from which alternative plans (herein called alternatives) were evaluated. The benefits accrued from alternatives are attributable to the reduction in the residual flood damages that would have remained under the Minimum Facility condition. For an alternative to be justified, it must be implementable and reasonably maximize benefits versus the additional cost required for its construction, operations and maintenance. Alternatives examined include the use of gravity outlets and pump stations. The following is a general description of several alternatives that were considered during the development of interior drainage facilities.

For the interior drainage measures described in Section 4.3, “Potential Interior Drainage Facilities”, no single measure could significantly lower the water surface elevation landward of the plan alignment. However, combinations of these measures can be effective in reducing

residual flooding. Alternatives consisting of combinations of measures are listed under **Section 6.5** Interior Plan Formulation.

Table 6-1 provides a list of the alternatives that were considered for each drainage subbasin.

Table 6-1: Interior Drainage Alternatives Evaluated

Drainage Subbasin	Minimum Facility	Pump Alternative 1	Pump Alternative 2
Hammels H1	Gravity Outlets	Gravity Outlets + 100 cfs Pump Station	N/A
Hammels H2	Gravity Outlets	Gravity Outlets + 160 cfs Pump Station	Gravity Outlets + 180 cfs Pump Station
Arverne A1	Gravity Outlets	Gravity Outlets + 70 cfs Pump Station	N/A
Arverne A2	Gravity Outlets	Gravity Outlets + 120 cfs Pump Station	Gravity Outlets + 180 cfs Pump Station
Arverne A3	Gravity Outlets	Gravity Outlets + 200 cfs Pump Station	Gravity Outlets + 300 cfs Pump Station
Edgemere E1	Gravity Outlets	Gravity Outlets + 140 cfs Pump Station	Gravity Outlets + 210 cfs Pump Station
Edgemere E2	Gravity Outlets	Gravity Outlets + 180 cfs Pump Station	Gravity Outlets + 120 cfs Pump Station
Canarsie C1	Gravity Outlets	Gravity Outlets + 70 cfs Pump Station	Gravity Outlets + 150 cfs Pump Station
Canarsie C2	Gravity Outlets	Gravity Outlets + 56 cfs Pump Station	N/A
Canarsie C3	Gravity Outlets	Gravity Outlets + 84 cfs Pump Station	N/A
Cedarhurst-Lawrence L1	Gravity Outlets	Gravity Outlets + 90 cfs Pump Station	N/A
Motts Basin North M1	Gravity Outlets	Gravity Outlets + 26 cfs Pump Station	N/A

6.4 Preferred Plan

The Preferred Plan is defined as the plan that maximizes net benefits over cost. As outlined within the description of Minimum Facility, the planning and development of interior drainage measures is performed independently from the Flood Risk Reduction line of protection features. Each interior drainage subbasin is analyzed to determine the preferred alternative based on the highest net benefits (benefits minus costs).

6.5 Interior Plan Formulation

The formulation of interior plans was an iterative process that considered a full range of measures for each drainage area. Only measures that are reasonably likely to meet the Minimum Facility or NED criteria discussed above were considered at any location.

6.5.1 Mid-Rockaway Project Area

The Mid-Rockaway project area covers approxiately 1,130 acres and includes three drainage basins: Hammels, Arverne, and Edgemere. The following sections describe the process of the interior drainage plan formualtion.

6.5.1.1 Hammels Drainage Basin

6.5.1.1.1 Minimum Facility

The Minimum Facility plan for the Hammels drainage basin consists of gravity outlets through the line of flood protection. Subbasin H1 was estimated to require 3 gravity outlets, including 2 existing outlets. Subbasin H2 was estimated to require 3 gravity outlets, including 1 existing outlet. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced, if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-2 provides a summary of the flood levels in the Hammels drainage basin for the Minimum Facility condition (based on a 2-year exterior storm). **Table 6-3** provides a similar summary under an Upper Bound condition.

Table 6-2: Hammels: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)	
	Subbasin H1	Subbasin H2
2-Year	4.76	5.06
5-Year	5.34	5.83
10-Year	5.47	6.06
25-Year	5.47	6.06

Table 6-3: Hammels: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)	
	Subbasin H1	Subbasin H2
2-Year	4.76	5.06
5-Year	5.53	6.00
10-Year	5.85	6.43
25-Year	6.03	6.59

The EAD for the Hammels drainage basin, with Minimum Facility measures in place, is estimated to be approximately $1,591,730.

6.5.1.1.2 Alternative Plans

The alternatives developed and analyzed for the Hammels drainage basin consist of pump stations, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump stations are not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump stations.

Pump Alternative 1 for Subbasin H1 consists of 3 gravity outlets (including 2 existing outlets) and a pump station with a total capacity of 100 cfs. Pump Alternatives 1 and 2 for Subbasin H2 consist of pump stations with a total capacity of 160 cfs and 180 cfs, respectively along with 3 gravity outlets (including 1 existing outlet).

Table 6-4 and **Table 6-5** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Hammels drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-4: Hammels: Alternatives Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin H1	Subbasin H2	
	Pump Alternative 1	Pump Alternative 1	Pump Alternative 2
2-Year	3.78	4.38	3.62
5-Year	4.49	4.77	4.71
10-Year	4.64	5.00	4.93
25-Year	4.80	5.27	5.21

Table 6-5: Hammels: Alternatives Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin H1	Subbasin H2	
	Pump Alternative 1	Pump Alternative 1	Pump Alternative 2
2-Year	3.78	4.38	3.62
5-Year	4.66	5.33	5.20
10-Year	4.99	5.63	5.54
25-Year	5.27	5.90	5.82

Table 6-6 provides a summary of the alternatives considered for subbasins in the Hammels drainage basin based on the Most Likely condition.

Table 6-6: Summary of Alternatives for Hammels Drainage Basin

Items	Subbasin H1	Subbasin H2	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative2*
Damage ($)	209,280	333,290	249,500
Benefits ($)	674,320	384,920	468,710
Pump Size (cfs)	100	160	180
Pump Cost ($)	4,688,500	5,561,900	6,200,666
Annualized Pump Cost ($)	173,670	206,020	229,680
Annual O&M Cost ($)	93,800	111,200	124,000
Total Annual Pump Cost ($)	267,470	317,220	353,680
Net Benefits ($)	406,850	67,700	115,030
Benefit to Cost Ratio	2.5	1.2	1.3

* denotes the Preferred Plan

6.5.1.1.3 Preferred Plan

Based on the evaluation of the interior water surface elevations and net benefits, a Preferred Plan was identified for each subbasin. Pump Alternative 1, with an estimated pump capacity of 100 cfs, is the Preferred Plan for Subbasin H1. The proposed pump station for Subbasin H1 would be located at the southern end of Hammels near Beach 87th Street. Pump Alternative 2, with an estimated pump capacity of 180 cfs, is the Preferred Plan for Subbasin H2. The proposed pump station for subbasin H2 would be located at the northern end of Hammels near Beach Channel Drive. It should be noted that the Preferred Plan includes additional gravity capacity that will operate when the pump station is not in operation. **Table 6-7** lists the gravity outlets for the Preferred Plan for the Hammels drainage basin. The capacity of each pump station and gravity outlet will be refined during the project design phase.

Table 6-7: Preferred Plan Gravity Outlets for Hammels

Subbasin	Gravity Outlets Description
H1	Existing Outlet ROC-656
H1	Proposed Outlet H1-1, approximately 70 feet east of Beach 85th Street
H1	Existing Outlet ROC-657
H2	Proposed Outlet H2-1, approximately 350 feet west of Beach 80th Street
H2	Proposed Outlet H2-2, approximately 100 feet west of Beach 79th Street
H2	Existing Outlet ROC-653

Note: Size and location of gravity outlets will be refined during the project design phase

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figures 6-1** and **6-2** are plots of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for subbasins H1 and H2, respectively. **Figures 6-3** and **6-4** show inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for subbasins H1 and H2, respectively. Residual flooding for the Hammels drainage subbasin is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for the Hammels drainage basin with the Preferred Plan in place is estimated to be approximately $458,780, which is a $1,132,950 reduction in annual damages compared to the Minimum Facility condition.

6.5.1.2 Arverne Drainage Basin

6.5.1.2.1 Minimum Facility

The Minimum Facility plan for the Arverne drainage basin consists of gravity outlets through the line of flood protection. Subbasin A1 was estimated to require 8 gravity outlets, including 5 existing outlets. Subbasin A2 was estimated to require 3 gravity outlets, all three being proposed. Subbasin A3 was estimated to require 5 gravity outlets, including 3 existing outlets. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced, if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-8 provides a summary of the most likely flood levels in the Arverne drainage basin for the Minimum Facility condition. **Table 6-9** provides a similar summary under an Upper Bound condition.

Table 6-8: Arverne: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin A1	Subbasin A2	Subbasin A3
2-Year	4.48	4.37	4.87
5-Year	4.79	4.56	5.71
10-Year	4.86	4.70	5.99
25-Year	4.86	4.86	5.99

Table 6-9: Arverne: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin A1	Subbasin A2	Subbasin A3
2-Year	4.48	4.37	4.87
5-Year	4.99	4.75	5.90
10-Year	5.24	4.98	6.37
25-Year	5.41	5.15	6.55

The EAD for the Arverne drainage basin, with Minimum Facility measures in place, is estimated to be approximately $3,616,320.

6.5.1.2.2 Alternative Plans

The alternatives developed and analyzed for the Arverne drainage basin consist of pump stations, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump stations are not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump stations.

Pump Alternative 1 for Subbasin A1 consists of 8 gravity outlets (including 5 existing outlets) and a pump station with a total capacity of about 70 cfs. Pump Alternatives 1 and 2 for Subbasin A2 consist of pump stations with a total capacity of about 120 cfs and 180 cfs, respectively along with 3 proposed gravity outlets. Pump Alternatives 1 and 2 for Subbasin A3 consist of pump stations with a total capacity of about 200 cfs and 300 cfs, respectively along with 5 gravity outlets (including 3 existing outlets).

Table 6-10 and **Table 6-11** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Arverne drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-10: Arverne: Alternatives Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)				
	Subbasin A1	Subbasin A2		Subbasin A3	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
2-Year	3.47	3.50	2.07	4.34	3.07
5-Year	4.09	3.94	3.47	4.64	4.39
10-Year	4.32	4.16	3.84	4.80	4.62
25-Year	4.44	4.36	4.15	5.04	4.83

Table 6-11: Arverne: Alternatives Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)				
	Subbasin A1	Subbasin A2		Subbasin A3	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
2-Year	3.47	3.50	2.07	4.34	3.07
5-Year	4.10	3.94	3.47	5.15	4.39
10-Year	4.37	4.18	3.84	5.52	5.02
25-Year	4.65	4.44	4.16	5.86	5.52

Table 6-12 provides a summary of the alternatives considered for subbasins in the Arverne drainage basin based on the Most Likely condition.

Table 6-12: Summary of Alternatives Considered for Arverne

Items	Subbasin A1	Subbasin A2		Subbasin A3	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
Damage ($)	103,810	491,420	213,570	952,840	566,400
Benefits ($)	192,810	752,610	1,030,460	1,122,830	1,509,270
Pump Size (cfs)	70	120	180	200	300
Pump Cost ($)	2,532,200	4,246,700	6,200,666	6,200,700	9,769,642
Annualized Pump Cost ($)	93,800	157,300	229,680	229,680	361,880
Annual O&M Cost ($)	50,600	84,900	124,000	124,000	195,400
Total Annual Pump Cost ($)	144,400	242,200	353,680	353,680	557,280
Net Benefits ($)	48,410	510,410	676,780	769,150	951,990
Benefit to Cost Ratio	1.3	3.1	2.9	3.2	2.7

* denotes the Preferred Plan

6.5.1.2.3 Preferred Plan

Based on the evaluation on the interior water surface elevations and net benefits, a Preferred Plan was identified for each subbasin. Pump Alternative 1, with an estimated pump capacity of 70 cfs, is the Preferred Plan for Subbasin A1. The proposed pump station for Subbasin A1 would be located adjacent to DE Costa Avenue, near Beach 72nd Street. Pump Alternative 2, with an estimated pump capacity of 180 cfs, is the Preferred Plan for Subbasin A2. The proposed pump station for Subbasin A2 would be located on DE Costa Avenue, near Beach 63rd Street. Pump Alternative 2, with an estimated pump capacity of 300 cfs, is the Preferred Plan for Subbasin A3. The proposed pump station for Subbasin A3 would be located south of Thursby Avenue. It should be noted that the Preferred Plan includes additional gravity capacity that will operate when the pump station is not in operation. **Table 6-13** lists the gravity outlets for the Preferred

Plan for the Arverne drainage basin. The capacity of each pump station and gravity outlet will be refined during the project design phase.

Table 6-13: Preferred Plan Gravity Outlets for Arverne

Subbasin	Gravity Outlets Description
A1	Existing Outlet ROC-633
A1	Existing Outlet ROC-634
A1	Existing Outlet TEMP40062
A1	Proposed Outlet A1-1, located at the end of Hillmyer Avenue
A1	Proposed Outlet A1-2, located adjacent to Hillmyer Avenue and Barbadoes Avenue
A1	Existing Outlet ROC-658
A1	Proposed Outlet A1-3, located 250 feet west of Beach 69th Street
A1	Existing Outlet ROC-659
A2	Proposed Outlet A2-1, located on Bayfield Avenue 150 feet west of Beach 65th Street
A2	Proposed Outlet A2-2, located at the east end of DE Costa Avenue
A2	Proposed Outlet A2-3, located at the east end of Burchell Road
A3	Existing Outlet, located at the east end of Thursby Avenue
A3	Existing Outlet ROC-636
A3	Proposed Outlet A3-1, located 250 north of Beach Channel Drive on 58th Street
A3	Existing Outlet ROC-635
A3	Proposed Outlet A3-2, located 50 feet south of Beach Channel Drive on 58th Street

Note: Size and location of gravity outlets will be refined during the project design phase

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figures 6-5, 6-6** and **6-7** are plots of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for subbasins A1, A2, and A3, respectively. **Figures 6-8, 6-9,** and **6-10** show inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for subbasins A1, A2, and A3, respectively. Residual flooding for the Arverne drainage basin is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for the Arverne drainage basin with the Preferred Plan in place is estimated to be approximately $883,740, which is a $2,732,580 reduction in annual damages compared to the Minimum Facility condition.

6.5.1.3 Edgemere Drainage Basin

6.5.1.3.1 Minimum Facility

The Minimum Facility plan for the Edgemere drainage basin consists of gravity outlets through the line of flood protection. Subbasin E1 was estimated to require 9 gravity outlets, including 2 existing outlets. Subbasin E2 was estimated to require 6 gravity outlets, including 1 existing outlet. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage

system. The existing outlet pipes will be replaced, if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-14 provides a summary of the most likely flood levels in the Edgemere drainage basin for the Minimum Facility condition. **Table 6-15** provides a similar summary under an Upper Bound condition.

Table 6-14: Edgemere: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)	
	Subbasin E1	Subbasin E2
2-Year	4.63	4.61
5-Year	5.18	5.36
10-Year	5.29	5.57
25-Year	5.29	5.57

Table 6-15: Edgemere: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)	
	Subbasin E1	Subbasin E2
2-Year	4.63	4.61
5-Year	5.33	5.53
10-Year	5.59	5.96
25-Year	5.73	6.14

The EAD for the Edgemere drainage basin, with Minimum Facility measures in place, is estimated to be approximately $2,032,610.

6.5.1.3.2 Alternative Plans

The alternatives developed and analyzed for the Edgemere drainage basin consist of pump stations, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump stations are not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump stations.

Pump Alternatives 1 and 2 for Subbasin E1 consist of pump stations with a total capacity of about 140 cfs and 210 cfs, respectively along with 9 gravity outlets (including 2 existing outlets). Pump Alternatives 1 and 2 for Subbasin E2 consist of pump stations with a total capacity of about 180 cfs and 120 cfs, respectively along with 6 gravity outlets (including 1 existing outlet).

Table 6-16 and **Table 6-17** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Edgemere drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-16: Edgemere: Alternatives Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)			
	Subbasin E1		Subbasin E2	
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 2
2-Year	4.36	3.10	4.04	4.37
5-Year	4.49	4.39	4.43	4.83
10-Year	4.55	4.49	4.53	4.83
25-Year	4.60	4.56	4.64	4.83

Table 6-17: Edgemere: Alternatives Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)			
	Subbasin E1		Subbasin E2	
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 2
2-Year	4.36	3.10	4.04	4.37
5-Year	4.88	4.54	5.01	5.22
10-Year	5.07	4.83	5.35	5.58
25-Year	5.28	5.08	5.66	5.81

Table 6-18 provides a summary of the alternatives considered for subbasins in the Edgemere drainage basin based on the Most Likely condition.

Table 6-18: Summary of Alternatives Considered for Edgemere

Items	Subbasin E1		Subbasin E2	
	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
Damage ($)	462,550	263,520	137,050	238,420
Benefits ($)	1,018,700	1,217,730	400,060	298,690
Pump Size (cfs)	140	210	180	120
Pump Cost ($)	4,910,600	7,135,270	6,200,700	4,246,738
Annualized Pump Cost ($)	181,890	264,300	229,680	157,300
Annual O&M Cost ($)	98,200	142,700	124,000	84,900
Total Annual Pump Cost ($)	280,090	407,000	353,680	242,200
Net Benefits ($)	738,610	810,730	46,380	56,490
Benefit to Cost Ratio	3.6	3.0	1.1	1.2

* denotes the Preferred Plan

6.5.1.3.3 Preferred Plan

Based on the evaluation of the interior water surface elevations and net benefits, a Preferred Plan was identified for each subbasin. Pump Alternative 2, with an estimated pump capacity of 210 cfs, is the Preferred Plan for Subbasin E1. Due to the length of the subbasin along the line of protection and the difficulty in draining all of runoff to a single location, two pump stations are proposed for Subbasin E1, with a combined capacity of about 210 cfs. One pump station would be located near Norton Avenue and Beach 49th Street and the other near Beach 43rd Street and Hough Place. Pump Alternative 2, with an estimated pump capacity of 120 cfs, is the Preferred Plan for Subbasin E2. The proposed pump station for Subbasin E2 would be located near Beach 38th Street. It should be noted that the Preferred Plan includes additional gravity capacity that will operate when the pump station is not in operation. **Table 6-19** lists the gravity outlets for the Preferred Plan for the Edgemere drainage basin. The capacity of each pump station and gravity outlet will be refined during the project design phase.

Table 6-19: Preferred Plan Gravity Outlets for Edgemere

Edgemere	Gravity Outlets Description
E1	Existing Outlet ROC-648
E1	Proposed Outlet E1-1, located on Norton Avenue between Beach 47th and 48th Streets
E1	Proposed Outlet E1-2, located on Norton Avenue between Beach 46th and 45th Streets
E1	Proposed Outlet E1-3, located on Beach 45th Street north of Hough Place
E1	Proposed Outlet E1-4, located on the north end of Beach 45th Street
E1	Proposed Outlet E1-5, located adjacent to Beach 43rd Street, 550 feet north of Hough Place
E1	Proposed Outlet E1-6, located adjacent to Beach 43rd Street, 500 feet north of Hough Place
E1	Existing Outlet ROC-637
E1	Proposed Outlet E1-7, located 700 feet north of Beach 40th Street

Edgemere	Gravity Outlets Description
E2	Existing Outlet ROC-638
E2	Proposed Outlet E2-1, located 50 feet east of Beach 37th Street
E2	Proposed Outlet E2-2, located 50 feet east of Beach 37th Street
E2	Proposed Outlet E2-3, located 50 feet east of Beach 36th Street
E2	Proposed Outlet E2-4, located 50 feet east of Beach 36th Street
E2	Proposed Outlet E2-5, located between Beach 36th Street and Beach 35th Street

Note: Size and location of gravity outlets will be refined during the project design phase

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figures 6-11** and **6-12** are plots of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for subbasins E1 and E2, respectively. **Figures 6-13** and **6-14** show inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for subbasins E1 and E2, respectively. Residual flooding for the Edgemere drainage basin is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for the Edgemere drainage basin with the Preferred Plan in place is estimated to be approximately $501,940, which is a $1,530,670 reduction in annual damages compared to the Minimum Facility condition.

6.5.2 Canarsie Project Area

6.5.2.1 Minimum Facility

The Minimum Facility plan for the Canarsie drainage basin consists of gravity outlets through the line of flood protection. Subbasin C1 was estimated to require 4 gravity outlets, Subbasin C2 was estimated to require 2 gravity outlets, and Subbasin C3 was estimated to require 5 gravity outlets. Each existing outlet will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-20 provides a summary of the most likely flood levels in the Canarsie drainage basin for the Minimum Facility condition. **Table 6-21** provides a similar summary under an Upper Bound condition.

Table 6-20: Canarsie: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin C1	Subbasin C2	Subbasin C3
2-Year	4.77	4.78	4.65
5-Year	5.96	5.98	5.85
10-Year	6.88	7.03	6.86
25-Year	6.88	7.03	6.86

Table 6-21: Canarsie: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin C1	Subbasin C2	Subbasin C3
2-Year	4.77	4.78	4.65
5-Year	6.11	6.17	5.88
10-Year	7.21	7.28	7.01
25-Year	7.38	7.43	7.08

The Equivalent Annual Damages (EAD) for the Canarsie project area, with Minimum Facility measures in place, is estimated to be approximately $2,351,770.

6.5.2.2 Alternative Plans

The alternatives developed and analyzed for the Canarsie drainage basin consist of pump stations, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump stations are not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump stations.

Pump Alternatives 1 and 2 for Subbasin C1 consist of pump stations with a total capacity of about 70 cfs and 150 cfs, respectively along with 4 gravity outlets. Pump Alternative 1 for Subbasin C2 consists of 2 gravity outlets and a pump station with a total capacity of about 56 cfs. Pump Alternative 1 for Subbasin C3 consists of 5 gravity outlets and a pump station with a total capacity of about 84 cfs.

Table 6-22 and **Table 6-23** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Canarsie drainage basin is provided in **Attachment 3** of this Sub-Appendix**.**

Table 6-22: Canarsie: Alternatives Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)			
	Subbasin C1		Subbasin C2	Subbasin C3
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 1
2-Year	4.63	2.92	4.58	4.55
5-Year	5.68	4.59	5.38	5.26
10-Year	5.96	4.69	6.55	5.42
25-Year	5.96	4.86	6.55	5.42

Table 6-23: Canarsie: Alternatives Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)			
	Subbasin C1		Subbasin C2	Subbasin C3
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 1
2-Year	4.63	2.92	4.58	4.55
5-Year	5.86	5.41	5.87	5.76
10-Year	6.80	6.09	6.93	6.66
25-Year	6.98	6.68	7.09	6.82

Table 6-24 provides a summary of the alternatives considered for subbasins in the Canarsie drainage basin based on the Most Likely condition.

Table 6-24: Summary of Alternatives Considered for Canarsie

Items	Subbasin C1		Subbasin C2	Subbasin C3
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 2
Damage ($)	976,550	360,580	108,760	222,760
Benefits ($)	583,440	1,199,410	98,460	361,800
Pump Size (cfs)	70	150	56	84
Pump Cost ($)	3,314,900	3,851,340	2,664,200	3,959,400
Annualized Pump Cost ($)	122,790	142,660	98,680	146,660
Annual O&M Cost ($)	66,300	77,000	53,300	79,200
Total Annual Pump Cost ($)	189,090	219,660	151,980	225,860
Net Benefits ($)	394,350	979,750	-53,520	135,940
Benefit to Cost Ratio	3.1	5.5	0.65	1.6

6.5.2.3 Preferred Plan

Based on the evaluation of the interior water surface elevation and net benefits, no interior drainage plan that would result in a HFFRRF with a BCR above 1.0 was identified. Accordingly, there is not a Preferred Drainage Plan identified for the Canarsie drainage basin. Even with the pumps and improved gravity outlet drainage system, flood elevations for a 50% AEP rainfall occurring with the design storm tide are only reduced between 0.1 and 0.2 feet. More information on the interior drainage analysis for Canarsie can be found in the HFFRRF Interior Drainage Appendix. Since residual flooding remains high for the Canarsie HFFRRF, NED benefits from the plan are not high enough to justify the federal investment, as will be discussed in Section 7, and the BCR drops below one.

6.5.3 Cedarhurst-Lawrence Project Area

6.5.3.1 Minimum Facility

The Minimum Facility plan for the Cedarhurst-Lawrence drainage basin consists of gravity outlets through the line of flood protection. Subbasin L1 was estimated to require 4 gravity outlets, including 3 existing outlets in the area where the bulkhead will be raised. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-25 provides a summary of the most likely flood levels in the Cedarhurst-Lawrence drainage basin for the Minimum Facility condition. **Table 6-26** provides a similar summary under an Upper Bound condition.

Table 6-25: Cedarhurst-Lawrence: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)
2-Year	4.65
5-Year	5.64
10-Year	5.90
25-Year	5.90

Table 6-26: Cedarhurst-Lawrence: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)
2-Year	4.65
5-Year	5.75
10-Year	6.25
25-Year	6.41

The EAD for the Cedarhurst-Lawrence project area, with Minimum Facility measures in place, is estimated to be approximately $586,110.

6.5.3.2 Alternative Plan

The alternative developed and analyzed for the Cedarhurst-Lawrence drainage basin consists of a pump station, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump station is not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump station.

Pump Alternative 1, the only alternative for Subbasin L1, consists of 4 gravity outlets (including 3 existing outlets) and a pump station with a total capacity of 90 cfs.

Table 6-27 and **Table 6-28** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Cedarhurst-Lawrence drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-27: Cedarhurst-Lawrence: Alternative Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)
	Pump Alternative 1
2-Year	4.48
5-Year	4.66
10-Year	4.67
25-Year	4.67

Table 6-28: Cedarhurst-Lawrence: Alternative Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)
	Pump Alternative 1
2-Year	4.48
5-Year	5.17
10-Year	5.43
25-Year	5.69

Table 6-29 provides a summary of the alternatives considered for subbasins in the Cedarhurst-Lawrence drainage basin based on the Most Likely condition.

Table 6-29: Summary of Alternative Considered for Cedarhurst-Lawrence

Items	Pump Alternative 1*
Damage ($)	642,780
Benefits ($)	1,366,400
Pump Size (cfs)	90
Pump Cost ($)	4,233,800
Annualized Pump Cost ($)	156,820
Annual O&M Cost ($)	84,700
Total Annual Pump Cost ($)	241,520
Net Benefits ($)	1,124,880
Benefit to Cost Ratio	5.7

* denotes the Preferred Plan

6.5.3.3 Preferred Plan

Based on the evaluation of the interior water surface elevations and net benefits, Pump Alternative 1, with an estimated pump capacity of 90 cfs, is the Preferred Plan for the Cedarhurst-Lawrence drainage basin. The proposed pump station for L1 would be located approximately 260 feet north of Plaza Road. It should be noted that the Preferred Plan includes additional gravity capacity that will operate when the pump station is not in operation.

Table 6-30 lists the gravity outlets for the Preferred Plan for the Cedarhurst-Lawrence drainage basin. The capacity of each pump station and gravity outlet will be refined during the project design phase.

Table 6-30: Preferred Plan Gravity Outlets for Cedarhurst-Lawrence

Subbasin	Gravity Outlet Description
L1	Existing Outlet
L1	Existing (recently constructed) culvert, located approximately 100 feet north of Peninsula Boulevard and 150 feet west of Oxford Road
L1	Existing (recently constructed) culvert, located approximately 100 feet north of Peninsula Boulevard and 200 feet west of Oxford Road
L1	Proposed Outlet L-1, located approximately 250 feet from Peninsula Boulevard

Note: Size and location of gravity outlets will be refined during the project design phase

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figure 6-15** is a plot of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for subbasin L1. **Figure 6-16** shows inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for subbasin L1. Residual flooding for the Cedarhurst-Lawrence drainage basin is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for the Cedarhurst-Lawrence drainage basin with the Preferred Plan in place is estimated to be approximately $642,780, which is a $1,366,390 reduction in annual damages compared to the Minimum Facility condition.

6.5.4 Motts Basin North Project Area

6.5.4.1 Minimum Facility

The Minimum Facility plan for the Motts Basin North drainage basin consists of gravity outlets through the line of flood protection. The Motts Basin North subbasin M1 was estimated to require 1 gravity outlet, which is existing. The existing outlet will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipe will be replaced if the design phase indicates it is necessary due to the condition of the pipe or a need for additional capacity. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with inlets that will be connected to the existing drainage outlet.

Table 6-31 provides a summary of the most likely flood levels in the Motts Basin North drainage basin for the Minimum Facility condition. Table 6-32 provides a similar summary under an Upper Bound condition.

Table 6-31: Motts Basin North: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)
2-Year	4.73
5-Year	5.56
10-Year	5.70
25-Year	5.70

Table 6-32: Motts Basin North: Minimum Facility Impacts - Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)
2-Year	4.73
5-Year	5.71
10-Year	6.11
25-Year	6.30

The EAD for the Motts Basin North drainage basin, with Minimum Facility measures in place, is estimated to be approximately $86,170.

6.5.4.2 Alternative Plans

The alternative developed and analyzed for the Motts Basin North drainage basin consists of a pump station, in addition to the gravity outlet that was described as part of the Minimum Facility. The gravity outlet will operate when the pump station is not in operation. When the gravity outlet is blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump station.

Pump Alternative 1, the only alternative for Subbasin M1, consists of one existing gravity outlet and a pump station with a total capacity of 26 cfs.

Table 6-33 and **Table 6-34** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Motts Basin North drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-33: Motts Basin North: Alternative Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)
	Pump Alternative 1
2-Year	4.56
5-Year	4.72
10-Year	4.76
25-Year	4.92

Table 6-34: Motts Basin North: Alternative Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)
	Pump Alternative 1
2-Year	4.56
5-Year	5.16
10-Year	5.40
25-Year	5.66

Table 6-35 provides a summary of the alternatives considered for subbasins in the Motts Basin North drainage basin based on the Most Likely condition.

Table 6-35: Summary of Alternative Considered for Motts Basin North

Items	Pump Alternative 1
Damage ($)	28,710
Benefits ($)	57,460
Pump Size (cfs)	26
Pump Cost ($)	1,249,200
Annualized Pump Cost ($)	46,270
Annual O&M Cost ($)	25,000
Total Annual Pump Cost ($)	71,270
Net Benefits ($)	-13,810
Benefit to Cost Ratio	0.8

6.5.4.3 Preferred Plan

Based on the evaluation of the interior water surface elevations and net benefits, the Minimum Facility is the Preferred Plan for the Motts Basin North project area. Pump Alternative 1 was found to have a negative net benefit and hence was eliminated from further consideration. The Preferred Plan for the Motts Basin North project (which is the Minimum Facility) consists of one gravity outlet as shown in **Table 6-36**. The capacity of the gravity outlet will be refined during the project design phase.

Table 6-36: Preferred Plan Gravity Outlet for Motts Basin North

Subbasin	Gravity Outlets Description
M1	Existing Outlet

Note: Size and location of gravity outlets will be defined during the project design phase.

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figure 6-17** is a plot of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for Subbasin M1. **Figure 6-18** shows inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for Subbasin M1. Residual flooding for the Motts Basin North drainage basin for the Preferred Plan (which is the Minimum Facility condition) is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for Motts Basin North project area with the Preferred Plan in place (i.e., the Minimum Facility condition) is estimated to be approximately $86,170.

6.6 Preferred Plans for the Project Area

In the previous section, within each interior drainage subbasin, the economics for a series of alternative interior drainage measures were evaluated to determine the alternative providing the highest level of net benefits to the project, which was identified as the Preferred Plan. The Preferred Plan for each subbasin and associated costs and net benefits are presented in **Table 6-37**.

Table 6-37: Summary of Preferred Plans for the Project Areas

Project Area	Preferred Plans[1]	First Cost	O&M Cost[2]	Total Annual Cost[3]	Annual Benefits	Net Benefits
Hammels	H1 - 100 cfs pump H2 - 180 cfs pump	$10,889,000	$218,000	$621,200	$1,143,000	$521,800
Arverne	A1 - 70 cfs pump A2 - 180 cfs pump A3 - 300 cfs pump	$18,503,000	$370,000	$1,055,400	$2,732,600	$1,677,200
Edgemere	E1 - 210 cfs pump E2 - 120 cfs pump	$11,382,000	$227,600	$649,200	$1,516,400	$867,200
Cedarhurst-Lawrence	L1 - 90 cfs pump	$4,233,800	$84,700	$241,500	$1,366,400	$1,124,880
Motts Basin North	M1 - Minimum Facility	N/A	N/A	N/A	N/A	N/A
	Totals	**$45,007,800**	**$900,300**	**$2,567,300**	**$6,758,400**	**$4,191,080**

50-year period-of-analysis, 2.75% Federal Discout Rate, October 2017 price level

[1]Preferred Plans with a pump station also include gravity outlets

[2]Includes IDC and O&M Costs

[3]Includes Annualized Replacement Costs (See Cost Appendix)

7 RESIDUAL FLOOD ANALYSIS

The Preferred Plan is designed to reduce the risk from exterior coastal surge and either maintain or reduce the risk from interior residual flooding. Residual flooding, by definition, is the flooding that still occurs with the Preferred Plan in place. For the base year 20-year peak coastal surge, the flood stage exceeds the design elevation of the Preferred Plan, which is designed to a stillwater design of 6.8 to 8.0 feet NAVD88, depending on the individual project area. The overtopping in this case will create flood levels throughout the study area equivalent to the without-project condition.

The base year exterior flood stages from published FEMA coastal modeling studies are presented in **Table 7-1** and the residual peak flood stages from the Interior Drainage Analysis for the Most Likely Condition are presented in **Table 7-2**.

The residual peak interior flood stages are the expected flood conditions from the Interior Drainage Analysis. From the analysis it was found that the risk condition can increase or decrease according to the relationship between the interior and exterior stages. This phenomenon is characterized by three separate likelihoods or combinations of interior/exterior events: the lower bound, expected (most likely), or upper bound condition. For this study, the expected condition is used as the analysis condition for recording with project damage reduction. Due to uncertainty in precipitation intensity and duration, and the correlation with exterior surge stages, a worse flooding condition could occur (upper bound condition).

Table 7-1: Base Year Peak Exterior Stillwater Elevations for Project Areas

Project Area	Peak Exterior Stillwater Elevations, Base Year (feet, NAVD88)				
	20-year	50-year	100-year	200-year	500-year
Hammels	7.9	9.1	10.0	11.0	12.3
Arverne	7.8	9.0	10.0	11.0	12.3
Edgemere	7.8	9.0	9.9	10.9	12.2
Motts Basin North	7.7	8.9	9.9	10.8	12.1
Cedarhurst-Lawrence	7.8	9.0	9.9	10.9	12.2
Canarsie	8.1	9.7	10.8	11.9	13.6

Source: FEMA

Table 7-2: Base Year Peak Residual Interior Flood Stages for Project Areas

Drainage Subbasin	Peak Residual Interior Flood Stages, Most Likely Condition (feet, NAVD88)		
	2-year Storm	5-year Storm	10-year Storm
Hammels H1	3.78	4.49	4.64
Hammels H2	3.62	4.71	4.93
Arverne A1	3.47	4.09	4.32
Arverne A2	2.07	3.47	3.84
Arverne A3	3.07	4.39	4.62
Edgemere E1	3.10	4.39	4.49
Edgemere E2	4.37	4.83	4.83
Cedarhurst-Lawrence L1	4.48	4.66	4.67
Motts Basin North M1	4.73	5.56	5.70

Notes:
1. The peak residual flood stages shown assume no overtopping of the line of protection.
2. For all subbasins, the residual flood stages shown correspond to the Preferred Plan, typically a pump alternative with gravity outlets. Motts Basin North is the only area for which Minimum Facility is the Preferred Plan.

7.1 Line of Protection - Project Performance and Risk Analysis

The Line of Protection will be the first line of defense against surge and wave action experienced during high frequency coastal storm events. However, lower frequency coastal events that have a storm surge which exceeds the Preferred Plan Line of Protection stillwater design heights would overtop the LOP and cause extensive damages to structures in the study area, and life-safety risks.

ER 1105-2-101, "Risk Analysis for Flood Damage Reduction Studies (USACE, January 3, 2006) stipulates that the risk analysis for a flood protection project should quantify the performance of the plan and evaluate the residual risk, including the consequences of exceedance of the project's capacity. The guidance specifically stipulates, along with the basic economic performance of a project, the engineering performance of the project is to be reported in terms of:

- The annual exceedance probability
- The long-term risk of exceedance
- The conditional non-exceedance probability

The overall economic performance of the selected line of protection plan has been computed by HEC-FDA and the results are presented in **Table 7-3**.

Table 7-3: Expected and Probabilistic Values of Structure/Contents Damage Reduced by Project

Project Area	Equivalent Annual Damage (Line of Protection Only)			Probability that Damage Reduced Exceeds the Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Hammels	$6,865,000	$5,315,000	$1,550,000	$1,067,000	$1,477,000	$1,991,000
Arverne	$23,069,000	$17,132,000	$5,937,000	$5,181,000	$5,968,000	$6,678,000
Edgemere	$14,447,000	$12,059,000	$1,388,000	$1,096,000	$1,365,000	$1,656000
Motts Basin North	$701,000	$478,000	$223,000	$194,000	$222,000	$252,000
Cedarhurst-Lawrence	$12,503,000	$6,755,000	$5,748,000	$4,863,000	$5,697,000	$6,617,000
Canarsie	$4,424,000	$3,557,000	$867,000	$805,000	$875,000	$939,000

The annual exceedance probability of a project is the likelihood that a target stage is exceeded by flood waters in any year and can be considered as an indication of the level of risk management provided by the Preferred Plan. The target stage is the point at which significant damage is incurred in the with-project condition, significant damage elevation being defined as the stage at which non-nominal damages begin to occur within each interior drainage basin

The target stage for each reach was used in HEC-FDA to calculate the base year median and expected annual exceedance probability for the Preferred Plan. The median value reflects the basic as-designed performance of the plan without the application of uncertainty to the basic discharge-frequency and stage-discharge functions, while the expected value is computed from the results of the Monte Carlo simulations which take into account uncertainty in hydrologic/hydraulic functions and project features such as diversion structures. Hence the difference between the two is an indication of the uncertainty associated with the project performance.

The long-term risk of exceedance is the probability that the design stage will be exceeded at least once in the specified durations of 10, 30, and 50 years, and the conditional non-exceedance probability measures the likelihood that the project will not be exceeded by a specified hydrologic event. For this analysis, the base year conditional non-exceedance probability has been computed for each alternative for the 10%, 4%, 2%, 1%, 0.4% and 0.2% annual chance exceedance events (10-, 25-, 50-, 100-, 250- and 500-year floods). These indicators of project performance and residual risk for the Preferred Plan are presented in **Table 7-4**.

Table 7-4: Project Performance Analysis - Tentatively Selected Line of Protection

Performance and Reliability Criteria		Hammels	Arverne	Edgemere	Canarsie	Cedarhurst-Lawrence	Motts Basin North
Annual Exceedance Probability of Target Stage	Median	10%	10%	10%	8%	5%	7%
	Expected	11%	11%	10%	8%	5%	7%
Long Term Exceedance Probability	10 Years	67%	67%	66%	56%	42%	51%
	30 Years	96%	96%	96%	92%	80%	88%
	50 Years	100%	100%	100%	98%	93%	98%
Conditional Non-Exceedance Probability	10%	46%	46%	48%	73%	90%	83%
	4%	5%	5%	5%	17%	43%	24%
	2%	1%	1%	1%	4%	19%	8%
	1%	1%	1%	1%	2%	8%	4%
	0.4%	1%	1%	0%	0%	1%	0%
	0.2%	0%	0%	0%	0%	2%	0%

7.2 Interior Drainage Residual Risk Analysis

For storm events where the Line of Protection stillwater design level is not exceeded, there are still residual flood risks from precipitation-runoff in the interior drainage basins landward of the Line of Protection. As part of the Preferred Plan, interior drainage measures are to be implemented so as to ensure that the high frequency flood risk reduction projects do not induce flooding as mandated by the criteria of the Minimum Facility, but also to be studied as to discover where additional measures may be implemented to increase the Net Benefits of the Preferred Plan.

Local flooding of roadways and some structural damages will occur around the 2- to 5-year storm event even with the high frequency flood risk reduction projects in place. As defined in **Section 7.1**, significant damage elevation is defined as the stage at which non-nominal damages begin to occur within each interior drainage basin. By setting significant damage elevations, it is possible to quantify different important flooding characteristics other than just the peak flood stage, such as the warning time, the rate of rise of floodwaters, and the duration of inundation.

- The start point for the warning time of impending inundation begins at the inflection point on the stage storage curve where the instantaneous change in stage begins to accelerate. In effect, this point in time is when the increase in exterior tide level begins blocking outflow through the stormwater outfalls and the stormwater conveyance system reaches full capacity. Prior to this point in time, there is only a steady and slight change in interior flood stages during an extended period of initial rainfall. The end value for the warning time function is the time when the interior stage equals the established significant damage elevation. Typically, the more severe the event, the shorter the warning time.
- The rate of rise for storm events, measures the rate of change in flood levels per minute. The rate is an average speed value from the time the flood stage first reaches the significant damage elevation until it reaches the peak flood stage.
- Duration of flooding refers to the amount of time during which the flood stage is above the significant damage elevation. In this case, the duration of flooding is controlled by the tide, which blocks the outfalls when the exterior stage is increased above the elevation of the outfall.

Figure 7-1 is a sample stage-time plot, which presents a visual interpretation of warning time, rate of rise, and flooding duration. The significant damage elevation set to 1.44 feet NAVD88.

Other important considerations to quantify flooding characteristics are the number of structures that will experience flood related damage in the with-project conditions and the remaining possibility for loss of life.

7.2.1 Access and Egress Problems and Impacts to Public Services

For more frequent rainfall events, local residents may still experience some local road closures and access issues. For events that produce higher rainfall and or coastal surge, some significant local thoroughfares can be expected to experience some level of inundation. The Preferred Plan does not reduce the risk of flooding from coastal surges with an annual probability of less than 20%, and some more severe events will cause extensive road closures and inundation of public facilities in the project areas. An overlay of the residual flooding extents on aerial imagery is presented in **Figures 7-2** through **7-10**, for each of the subbasins with an identified Preferred Plan.

7.2.2 Potential Loss of Life

The implementation of the Preferred Plan will not eliminate the potential for loss of life. The Preferred Plan will reduce the risk of flooding from high frequency storm surges in Jamaica Bay reaching the structures in the individual project areas and will therefore reduce the risk to residents of those areas. Instead of high velocity overtopping flows from the coast, the interior drainage basins will experience pools of water in low-lying areas from surface run-off. Interior Drainage flooding is predicted to have waters that rise over two feet per hour in some areas, which may generate life safety risks in addition to those created by the depth of flooding alone.

7.2.3 Residual Flood Related Damages

There are a number of structures within the study area that remain at risk of being inundated following project implementation. The with-project equivalent annual residual damages are presented in **Table 7-5**.

Table 7-5: Residual Flood Damage

Drainage Area	Equivalent Annual Damage
Hammels	$458,780
Arverne	$883,740
Edgemere	$501,940
Canarsie	$692,100
Cedarhurst-Lawrence	$642,780
Motts Basin North	$86,170
Total With Project Damage	**$2,671,980**

8 SUMMARY OF INTERIOR DRAINAGE FINDINGS

The LOP Alternative recommended in the NED Plan will be the first line of defense against significant coastal surge and wave action. However, implementation of the LOP will impact interior runoff resulting in residual damage that must be addressed with additional interior drainage features. Due to the limited availability of storage, this primarily includes pump alternatives to lower the interior water surface elevations in the project area.

Based on the evaluation of the Alternative Plans for each of the subbasins, below is a summary of the interior drainage study findings:

- Hammels Drainage Basin of the Mid-Rockaway Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The EAD with Minimum Facility measures in place is estimated to be approximately $1,591,730. Pump Alternative 1 for Subbasin H1 and Pump Alternative 2 for Subbasin H2, which includes 100cfs and 180 cfs pumping stations, respectively, and 3 additional proposed outlets, were identified as the Preferred Plan. The residual EAD with the Preferred Plan in place is estimated to be approximately $458,780, which is a $1,132,950 reduction in annual damages compared to the Minimum Facility condition.
- Arverne Drainage Basin of the Mid-Rockaway Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The EAD with Minimum Facility measures in place is estimated to be approximately $3,616,320. Pump Alternative 1 (70 cfs) for Subbasin A1, Pump Alternative 2 for Subbasin A2 (180 cfs), Pump Alternative 2 for Subbasin A3 (300 cfs), and 8 additional proposed outlets were identified as the Preferred Plan. The residual EAD with the Preferred Plan in place is estimated to be approximately $883,740, which is a $2,732,580 reduction in annual damages compared to the Minimum Facility condition.
- Edgemere Drainage Basin of the Mid-Rockaway Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The EAD with Minimum Facility measures in place is estimated to be approximately $2,032,610. Pump Alternative 2 (210 cfs) for Subbasin E1, Pump Alternative 2 for Subbasin E2 (120 cfs), and 12 additional proposed outlets were identified as the Preferred Plan. The residual EAD with the Preferred Plan in place is estimated to be approximately $501,940, which is a $1,530,670 reduction in annual damages compared to the Minimum Facility condition.
- Canarsie Project Area: Based on the evaluation of the interior water surface elevation and net benefits, no interior drainage plan that would result in a HFFRRF with a BCR above 1.0 was identified. Accordingly, there is not a Preferred Drainage Plan identified for the Canarsie drainage basin. Even with the pumps and improved gravity

outlet drainage system, flood elevations for a 50% AEP rainfall occurring with the design storm tide are only reduced between 0.1 and 0.2 feet. Since residual flooding remains high for the Canarsie HFFRRF, NED benefits from the plan are not high enough to justify the federal investment and the BCR drops below one.

- Cedarhurst-Lawrence Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The EAD with Minimum Facility measures in place is estimated to be approximately $2,009,180. Pump Alternative 1 and one additional proposed outlet were identified as the Preferred Plan. The residual EAD with the Preferred Plan in place is estimated to be approximately $642,780, which is a $1,366,390 reduction in annual damages compared to the Minimum Facility condition.
- Motts Basin North Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The residual EAD with Minimum Facility measures in place is estimated to be approximately $86,170. Pump Alternative 1 was found to have a negative net benefit and hence was eliminated from further consideration. The Minimum Facility is selected as the Preferred Plan.

9 REFERENCES

Federal Highway Administration's Hydraulic Design Series No. 5 "Hydraulic Design of Highway Culverts" (HDS-5). Third Edition. (2012). U.S. Department of Transportation.

National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 10, Version 2, (https://hdsc.nws.noaa.gov/hdsc/pfds).

NRCS Technical Release No. 55 (TR-55), Urban Hydrology for Small Watersheds. (1986). United States Department of Agriculture.

NRCS Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx).

U.S. Army Corps of Engineers. (1987). Hydrologic Analysis of Interior Areas (EM 1110-2-1413). Washington, D.C.: Department of the Army.

U.S. Army Corps of Engineers. (2000). Planning Guidance Notebook (ER 1105-2-100). Washington, D.C.: Department of the Army.

U.S. Army Corps of Engineers. (2006). Risk Analysis for Flood Damage Reduction Studies (ER 1105-2-101). Washington, D.C.: Department of the Army.

U.S. Army Corps of Engineers. (2013). Flood Runoff Analysis (EM 1110-2-14170). Washington, D.C.: Department of the Army.

U.S. Army Corps of Engineers. (2016). Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects (ECB 2016-25). Washington, D.C.: Department of the Army.

Interior Drainage Sub-Appendix E

Attachment 1: Figures

Figure 1-1: Study Area

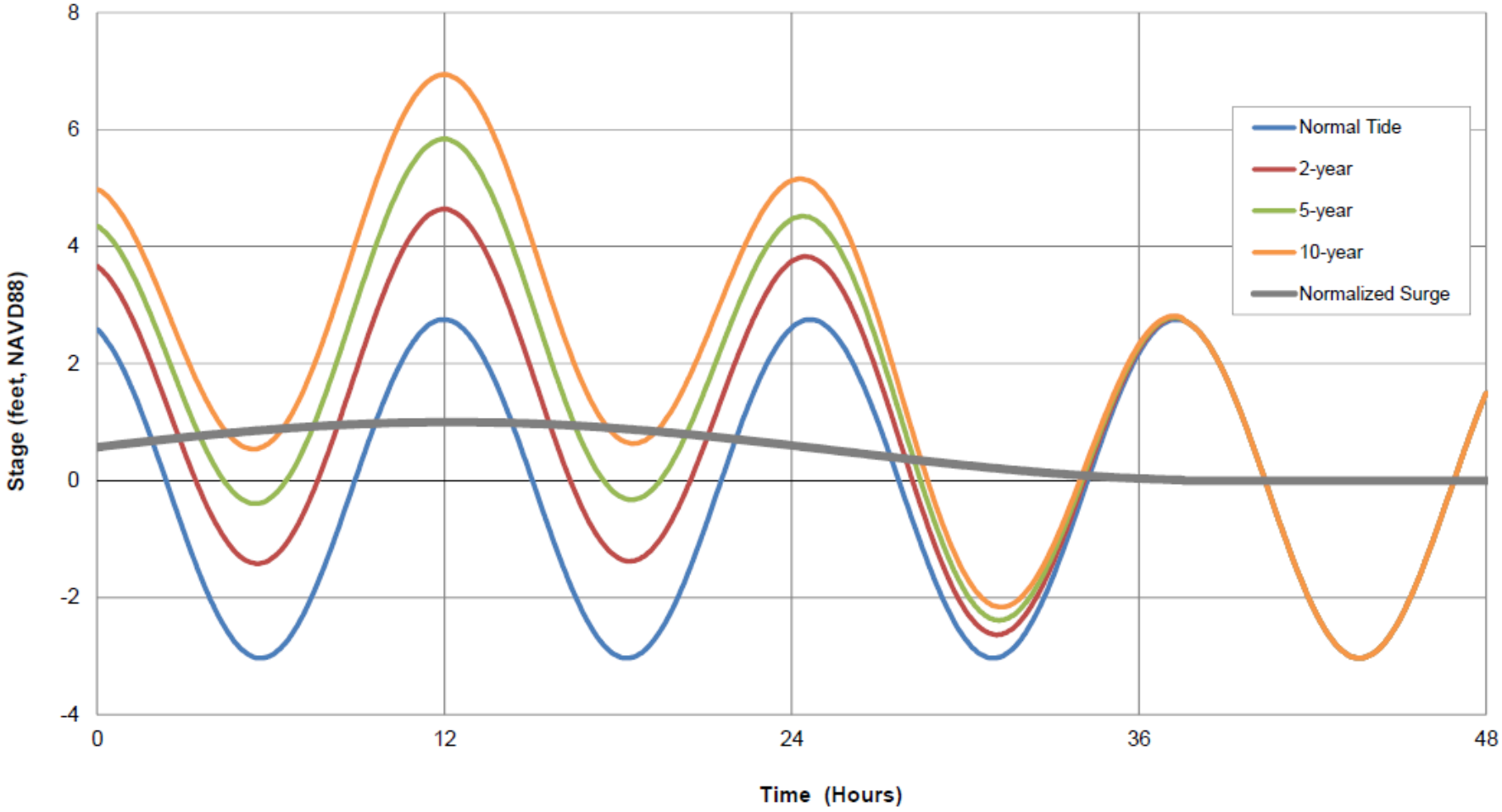


Figure 2-1: Hypothetical Tides (Current Condition)

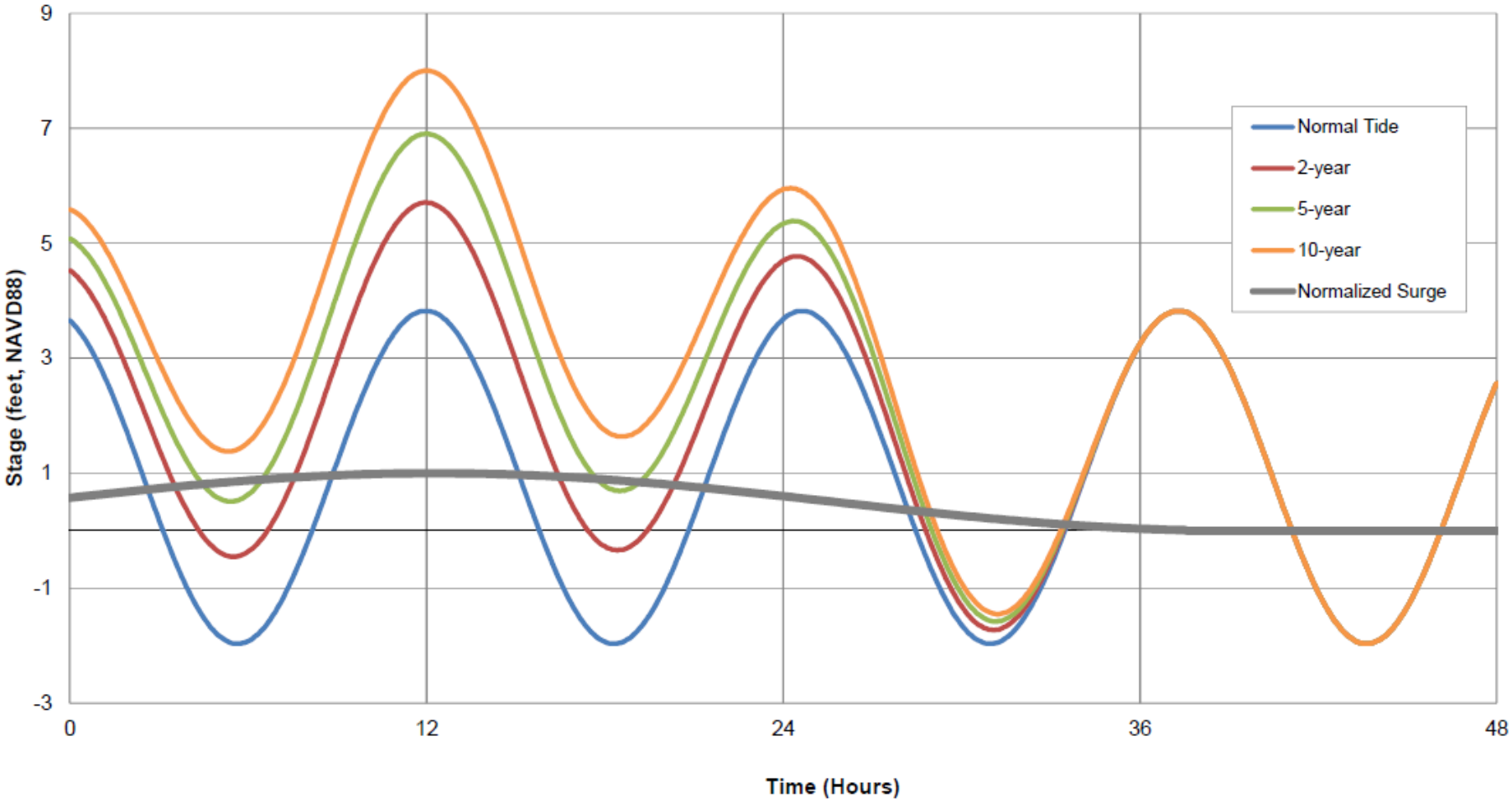


Figure 2-2: Hypothetical Tides (Future Condition)

Figure 2-3: Mid-Rockaway Drainage Subbasins Layout

Figure 2-4: Canarsie Drainage Subbasins Layout

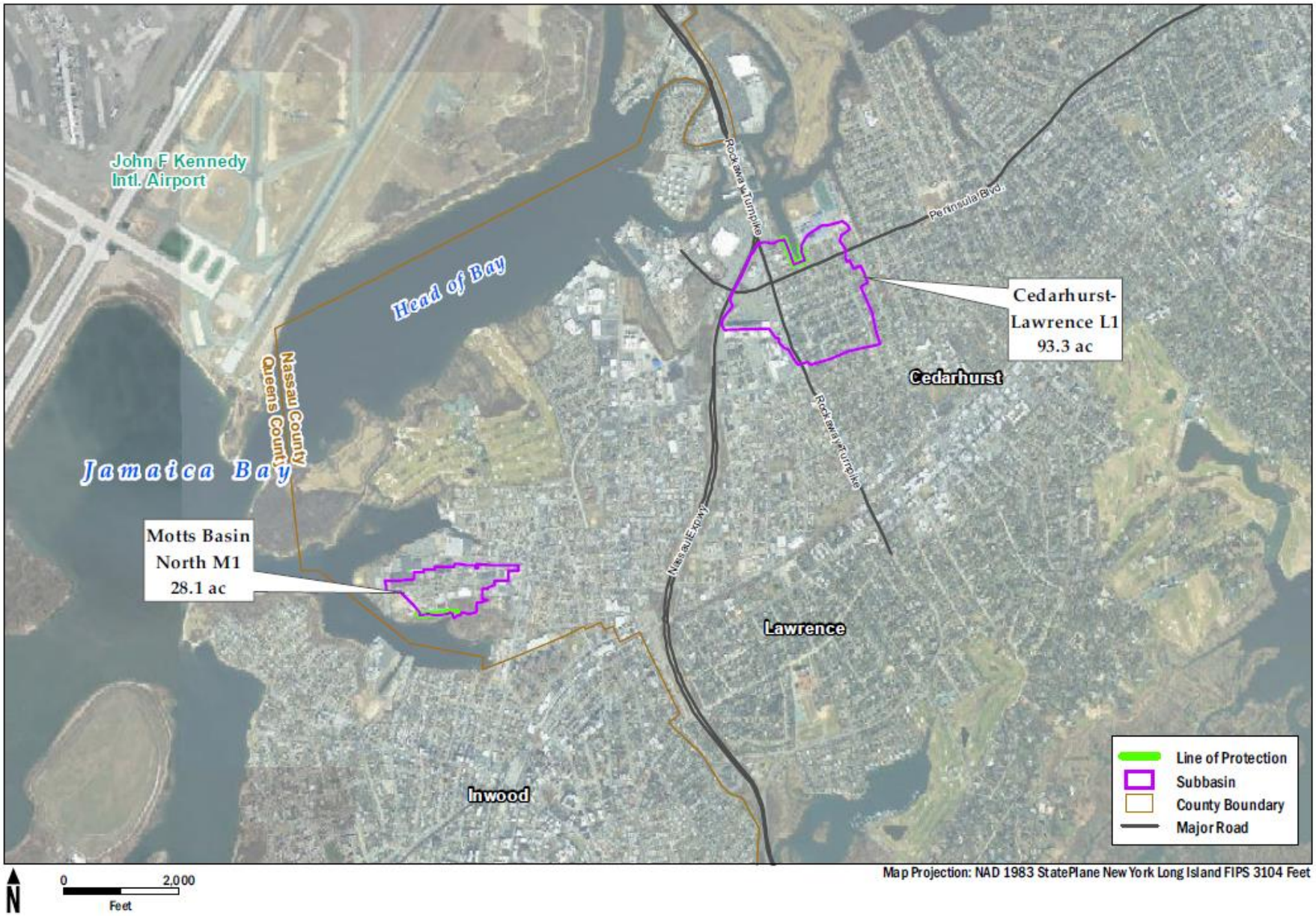


Figure 2-5: Cedarhurst-Lawrence and Motts Basin North Drainage Subbasins Layout

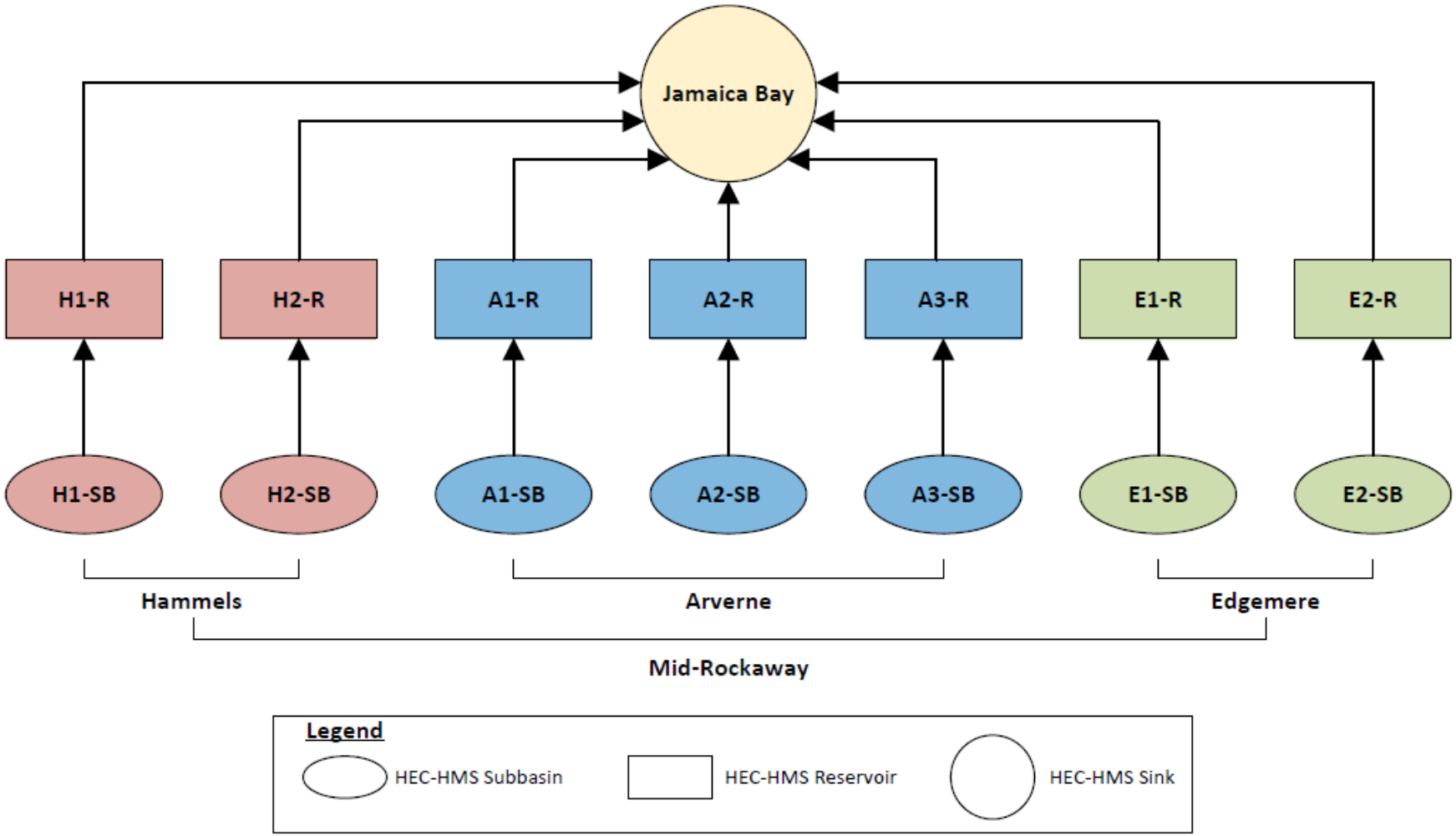


Figure 2-6: HEC-HMS Model Schematic - Mid-Rockaway

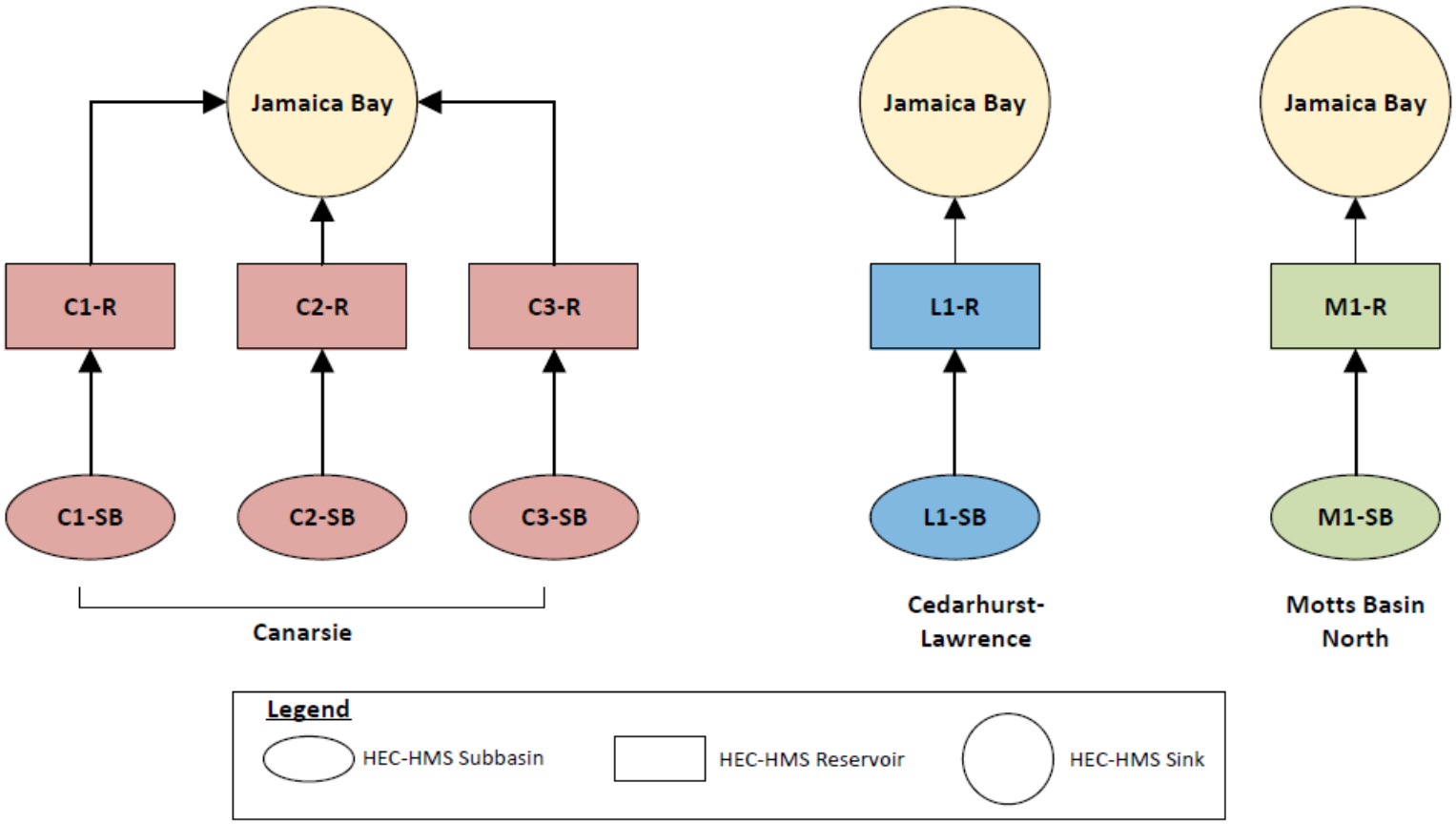


Figure 2-7: HEC-HMS Model Schematic - Canarsie, Cedarhurst-Lawrence, and Motts Basin North

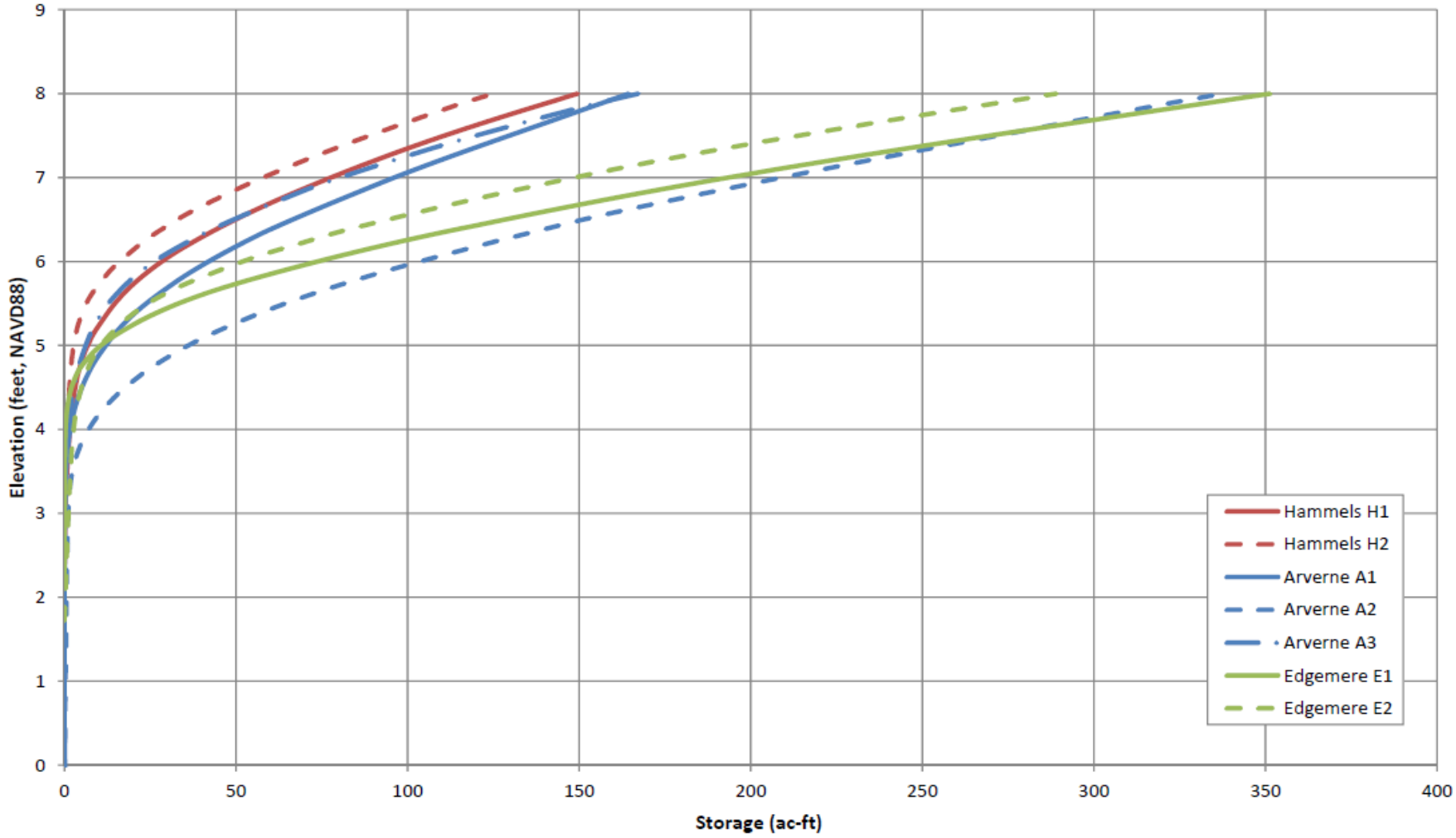


Figure 4-1: Elevation vs. Natural Storage Curves - Mid-Rockaway

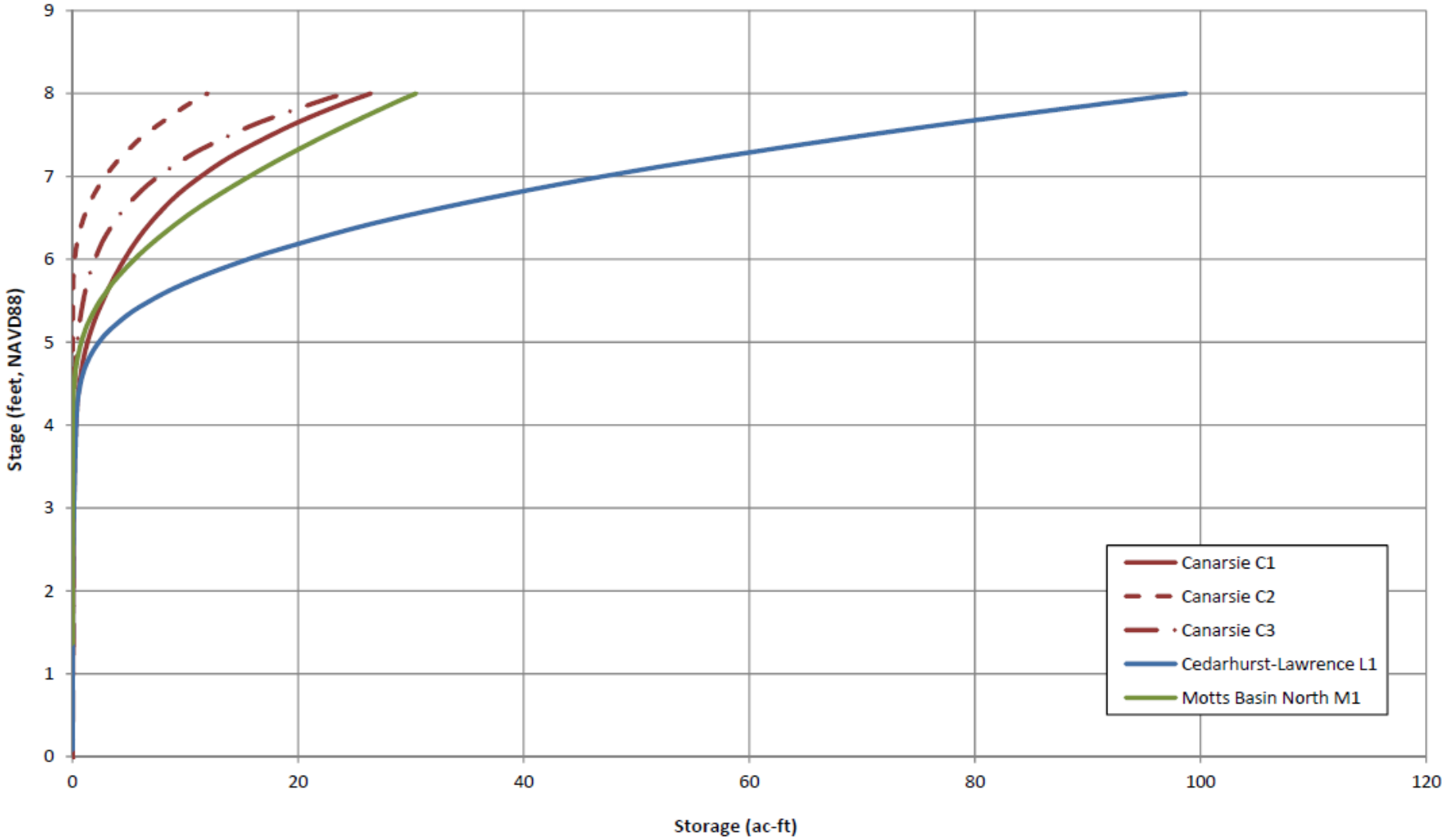


Figure 4-2: Elevation vs. Natural Storage Curves - Canarsie, Cedarhurst-Lawrence, and Motts Basin North

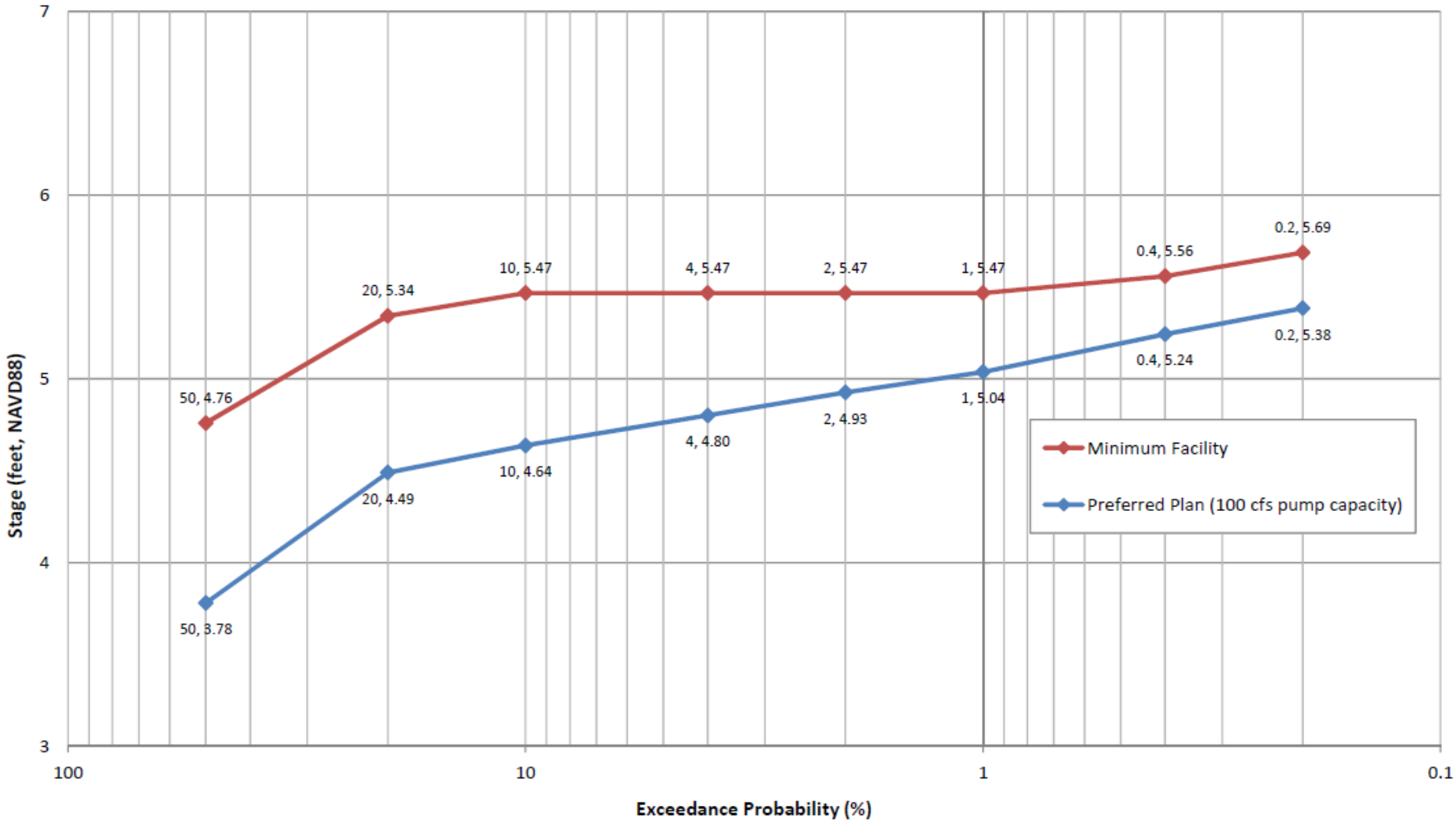


Figure 6-1: Peak Stage vs. Frequency Curves - Hammels H1

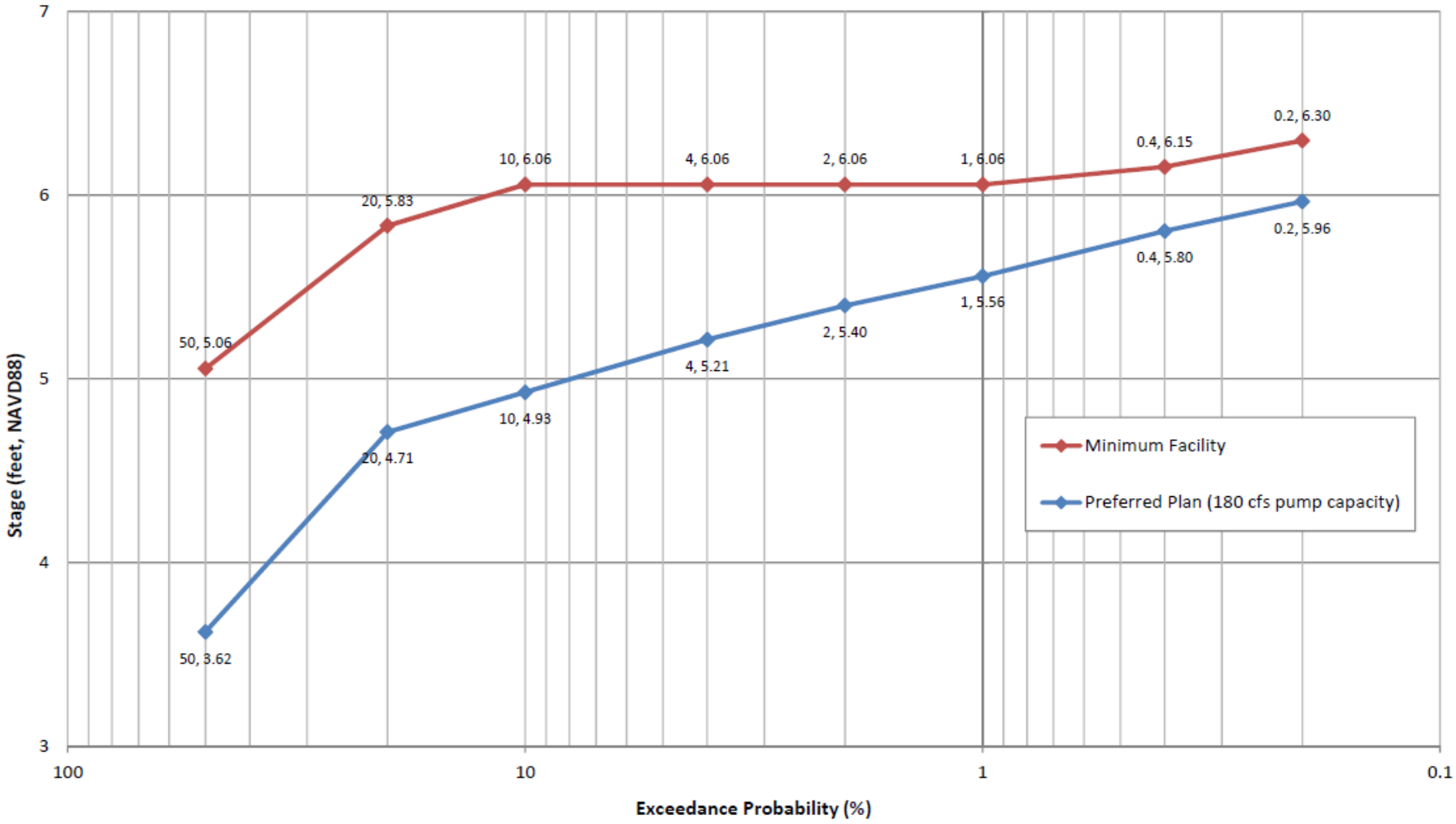
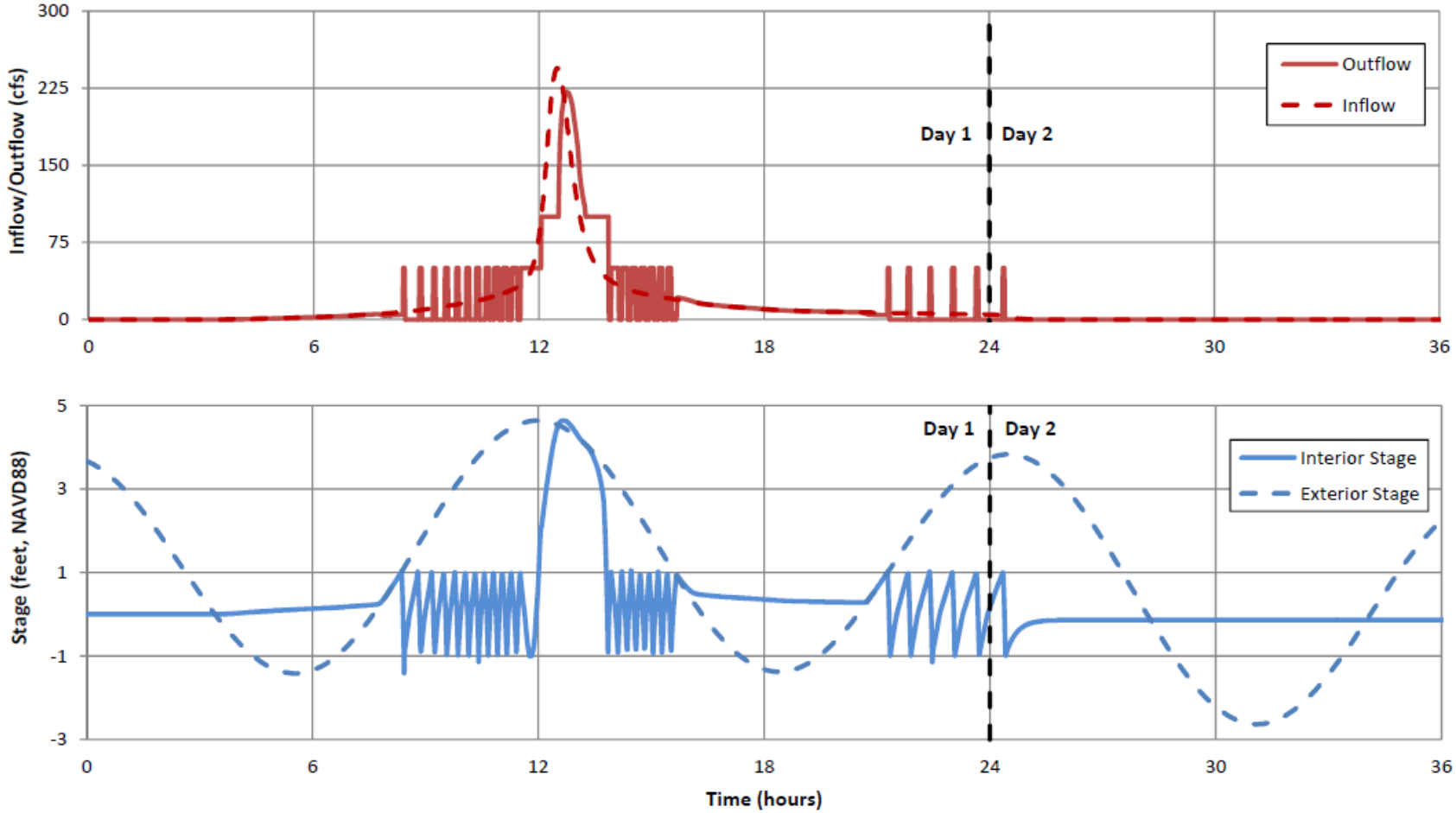
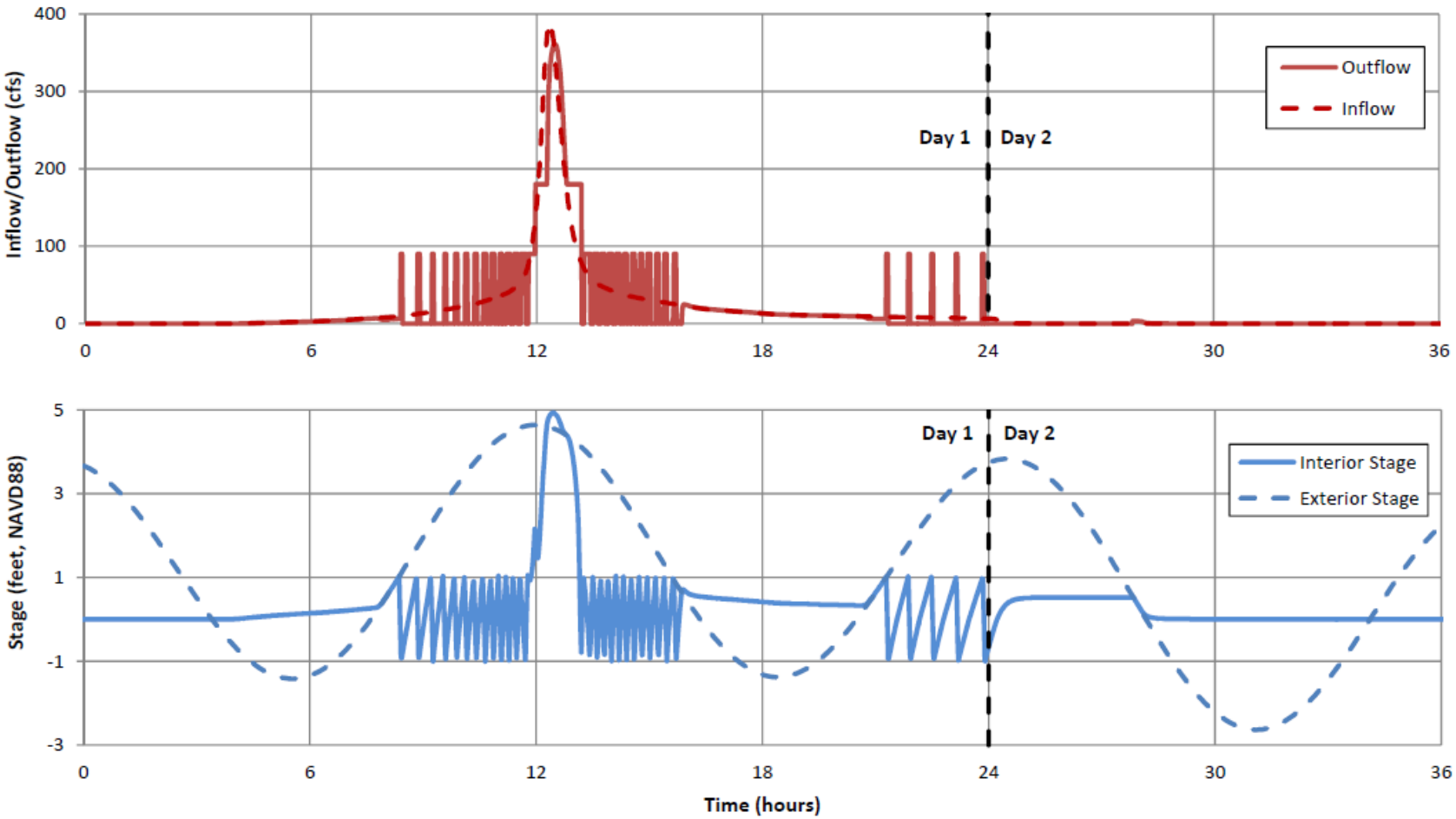


Figure 6-2: Peak Stage vs. Frequency Curves - Hammels H2



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Hammels Subbasin H1, Preferred Plan (100 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-3: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Hammels H1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Hammels Subbasin H2, Preferred Plan (180 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-4: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Hammels H2

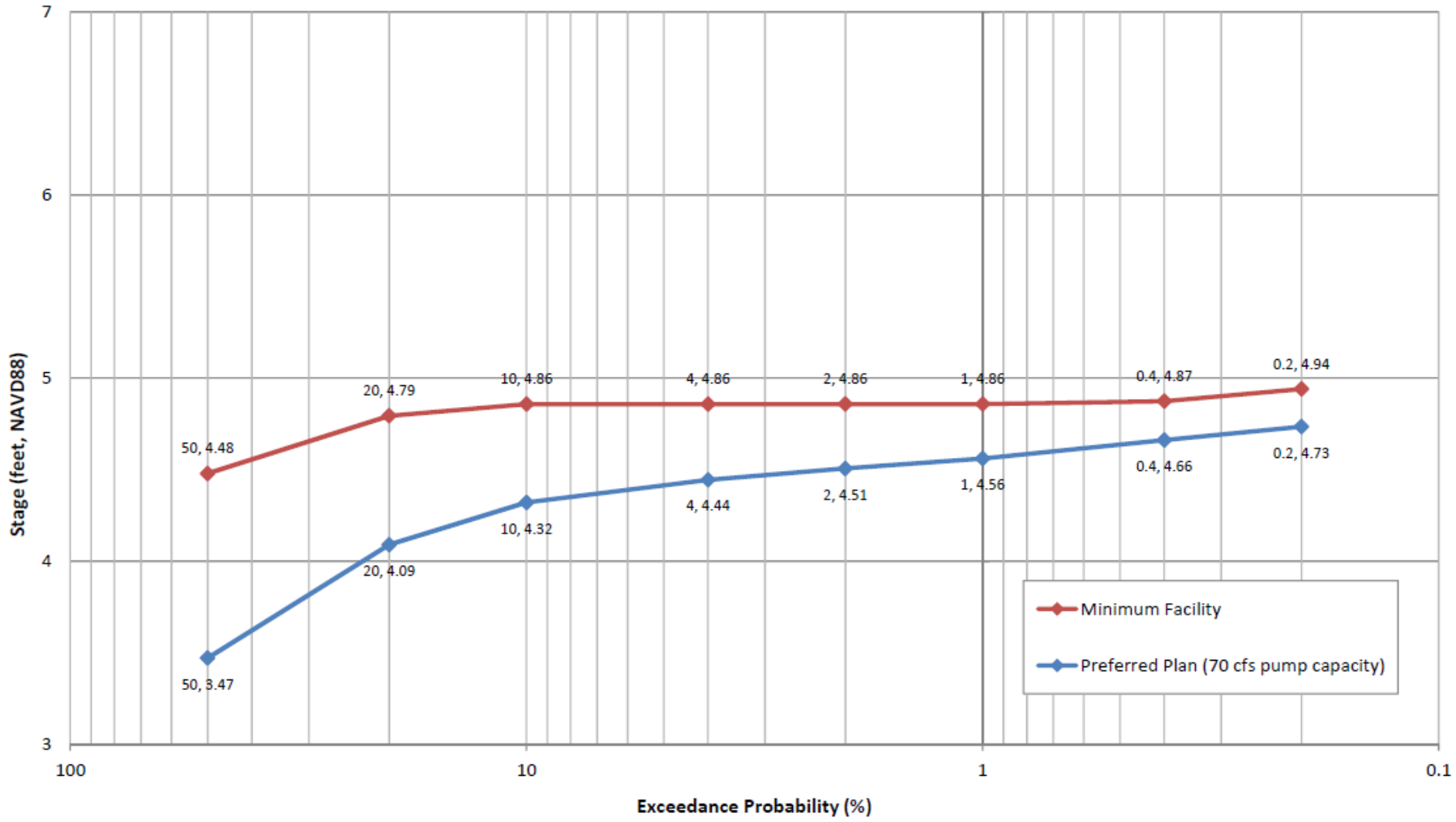


Figure 6-5: Peak Stage vs. Frequency Curves - Arverne A1

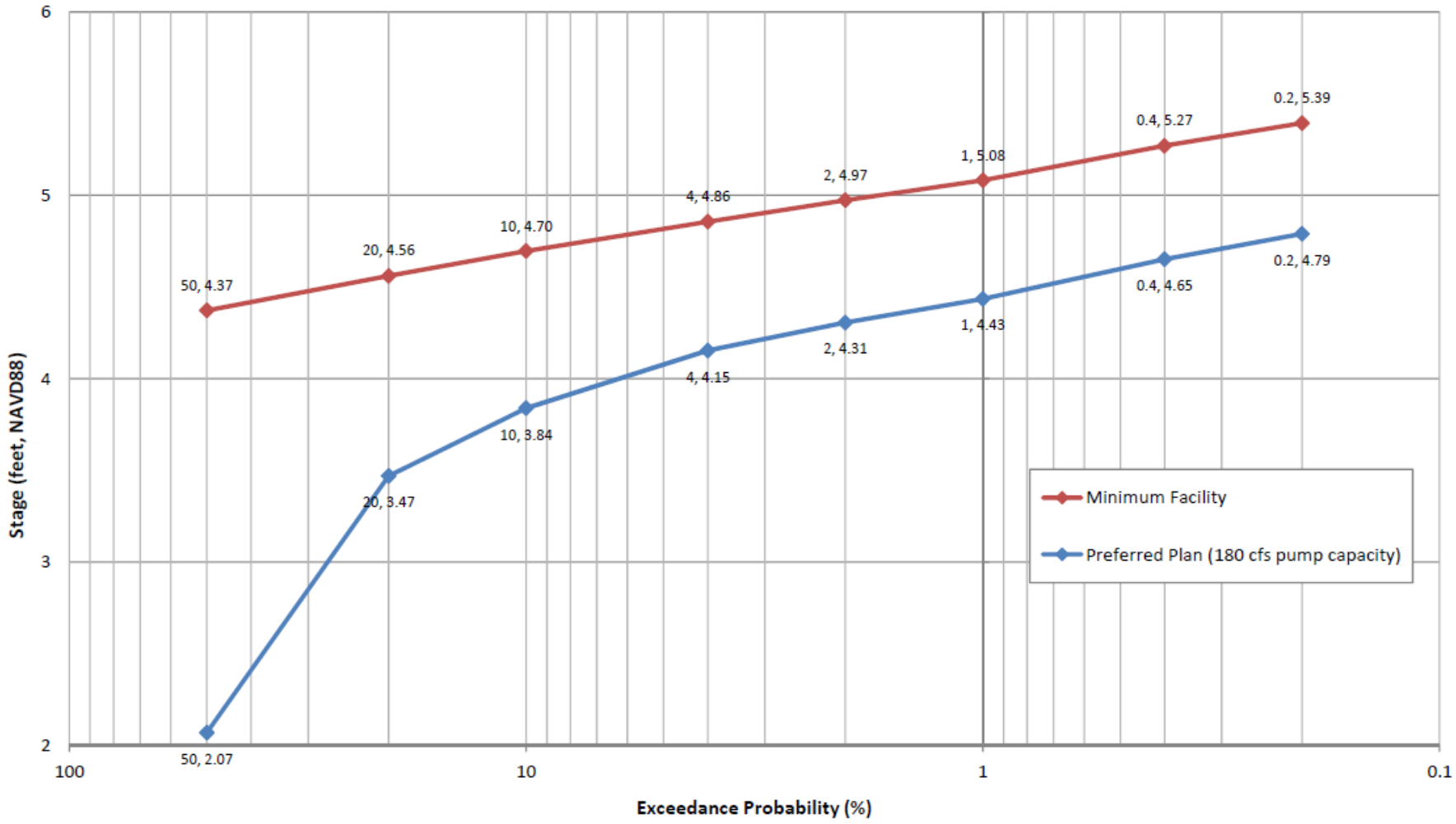


Figure 6-6: Peak Stage vs. Frequency Curves - Arverne A2

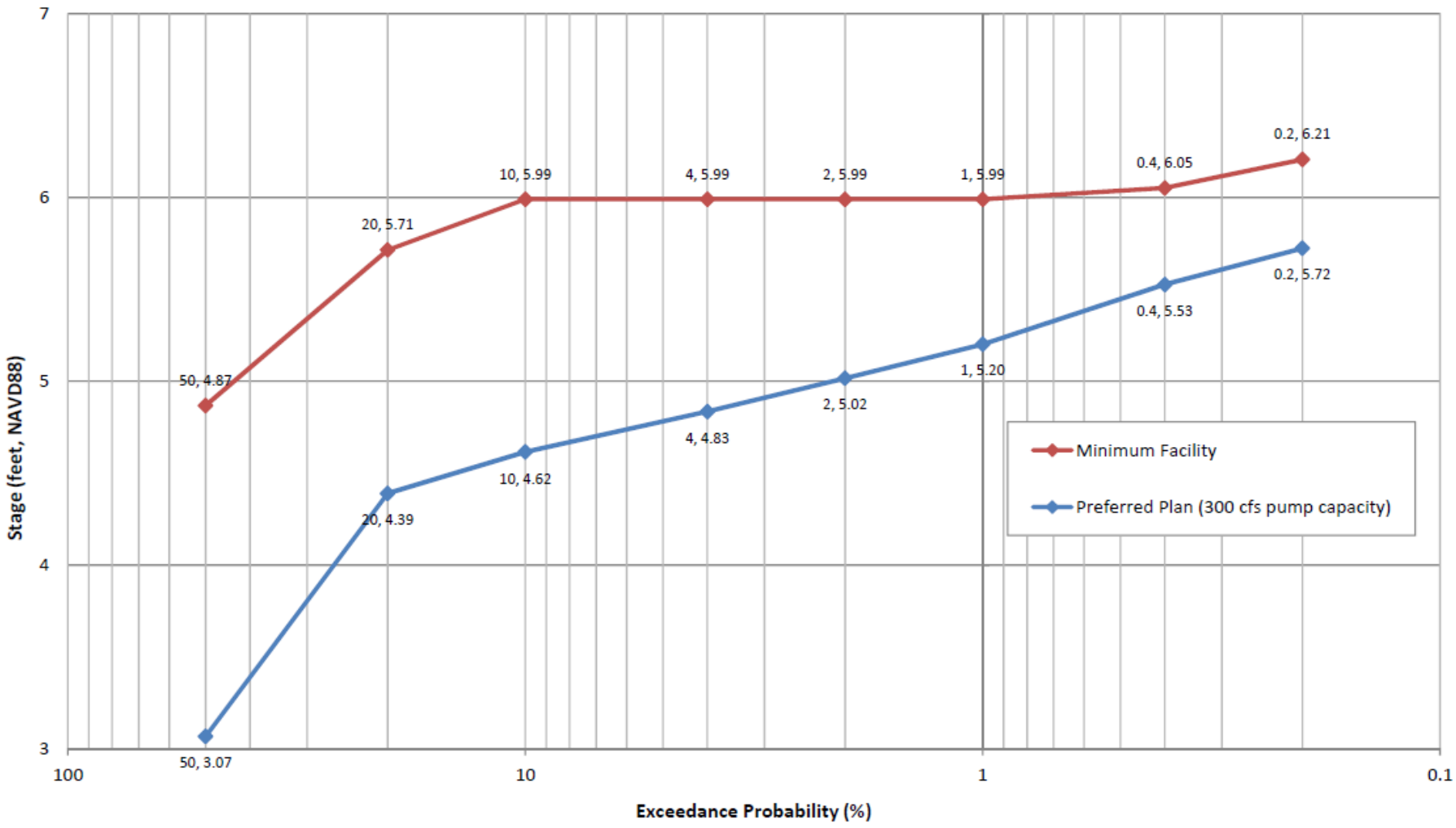
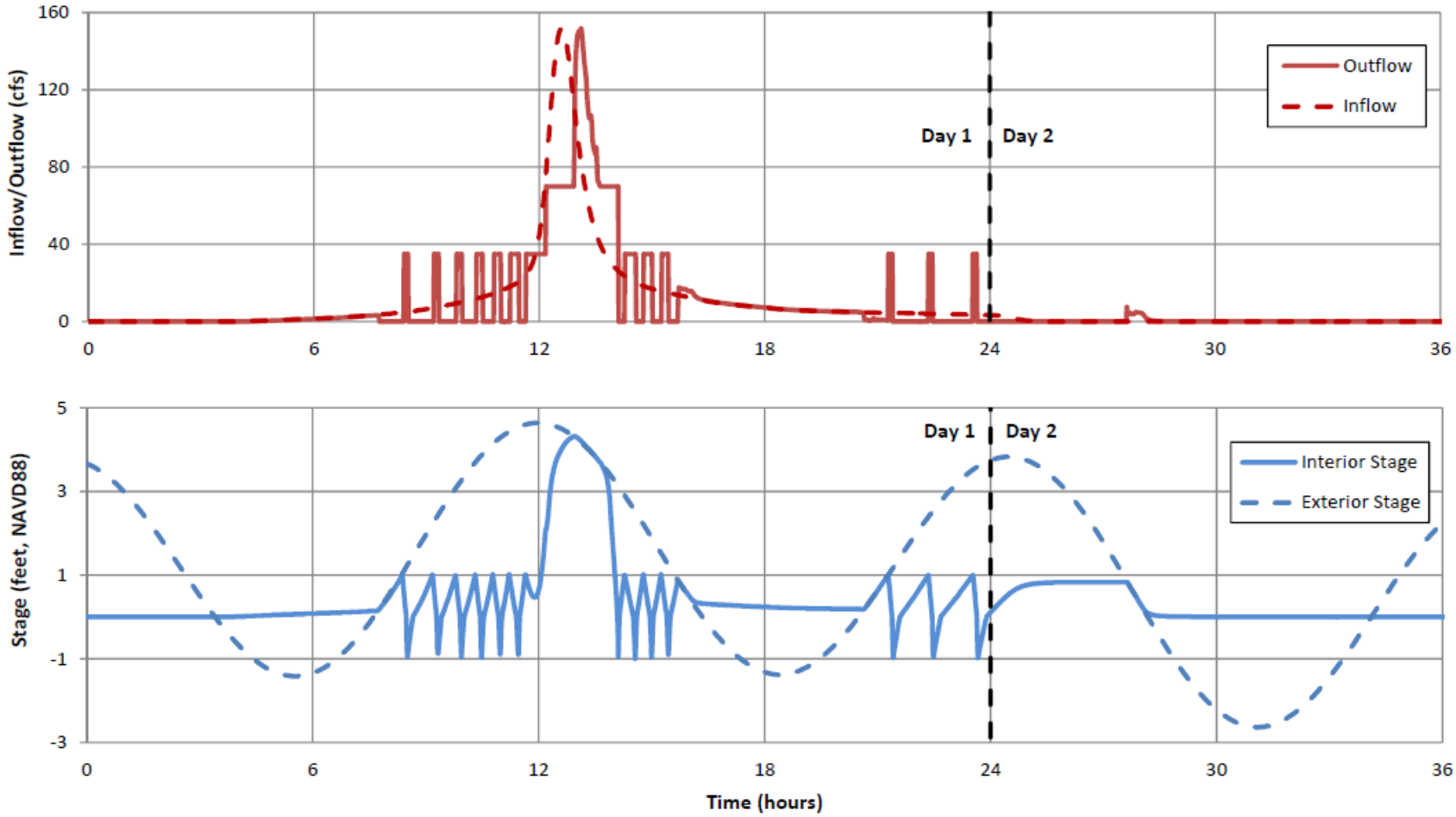
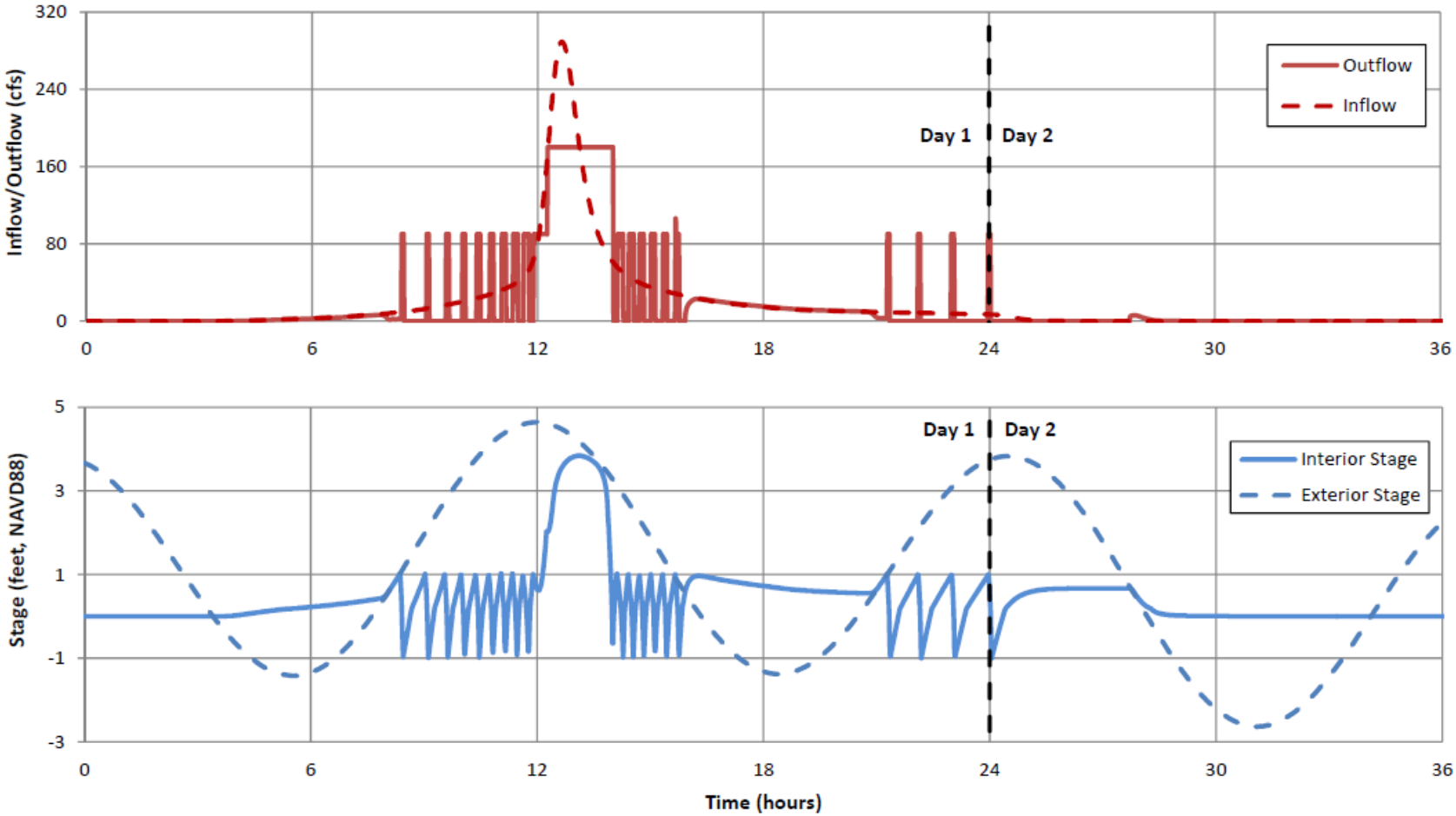


Figure 6-7: Peak Stage vs. Frequency Curves - Arverne A3



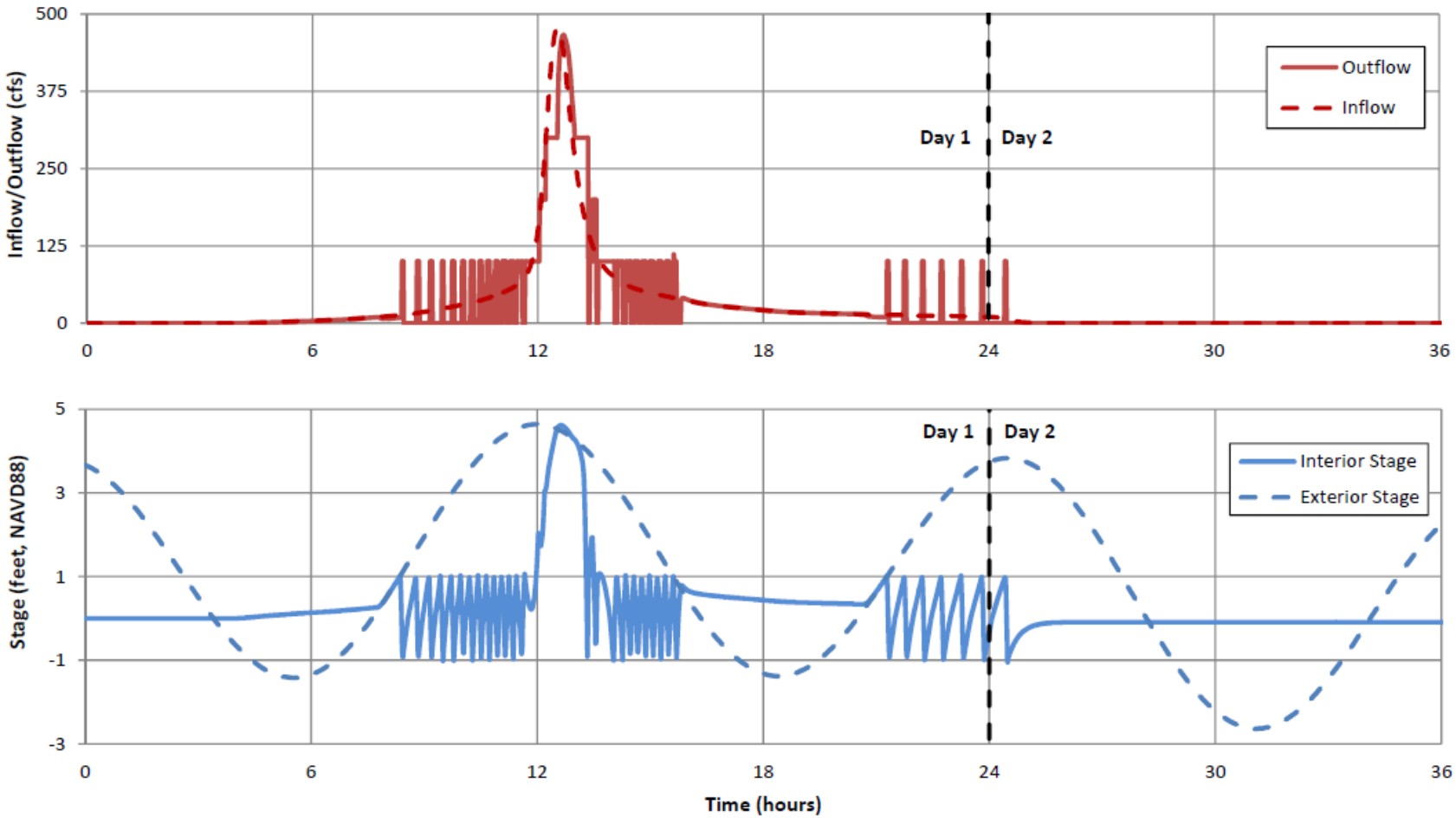
Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Arverne Subbasin A1, Preferred Plan (70 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-8: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Arverne A1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Arverne Subbasin A2, Preferred Plan (180 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-9: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Arverne A2



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Arverne Subbasin A3, Preferred Plan (300 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-10: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Arverne A3

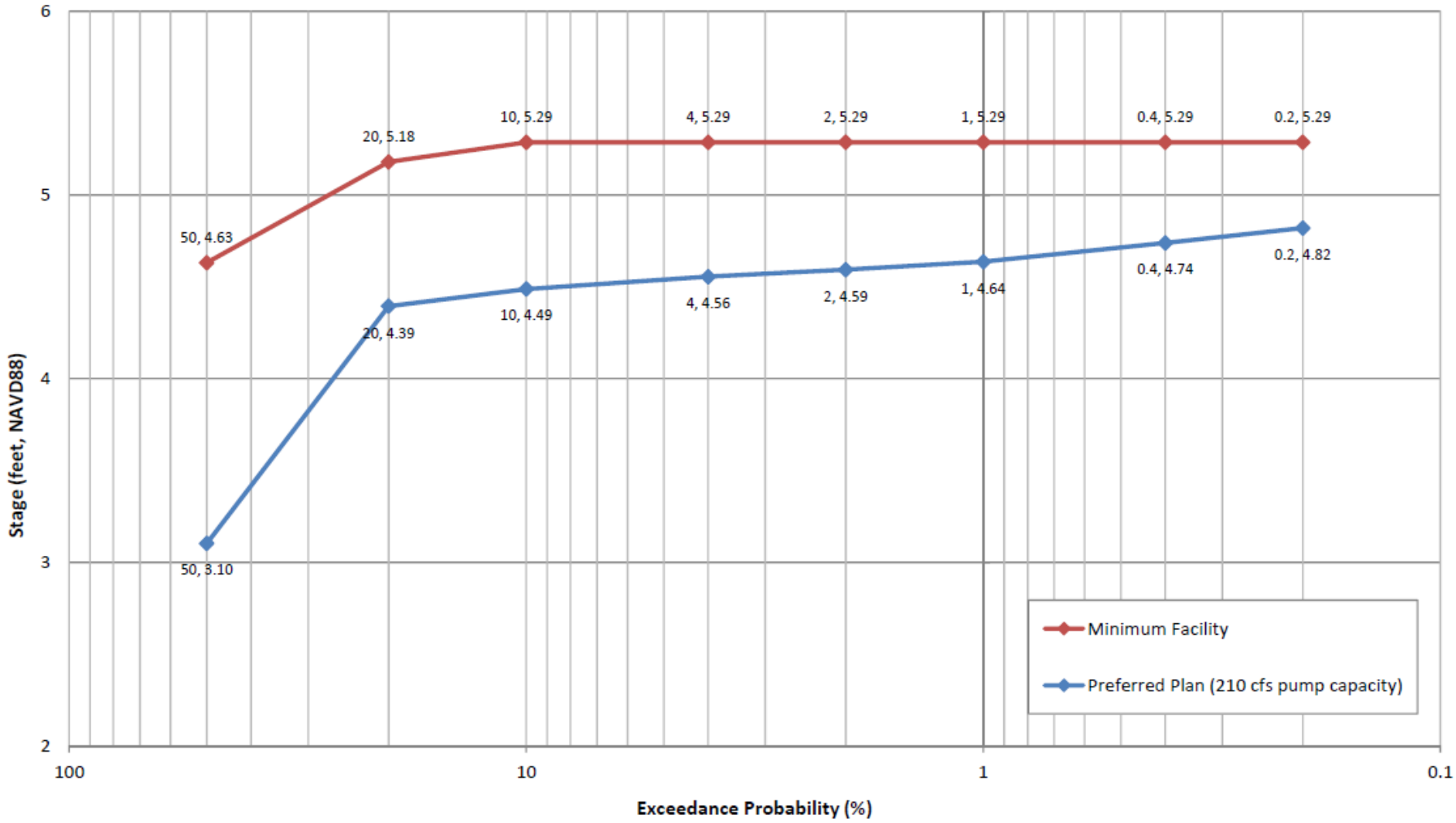


Figure 6-11: Peak Stage vs. Frequency Curves - Edgemere E1

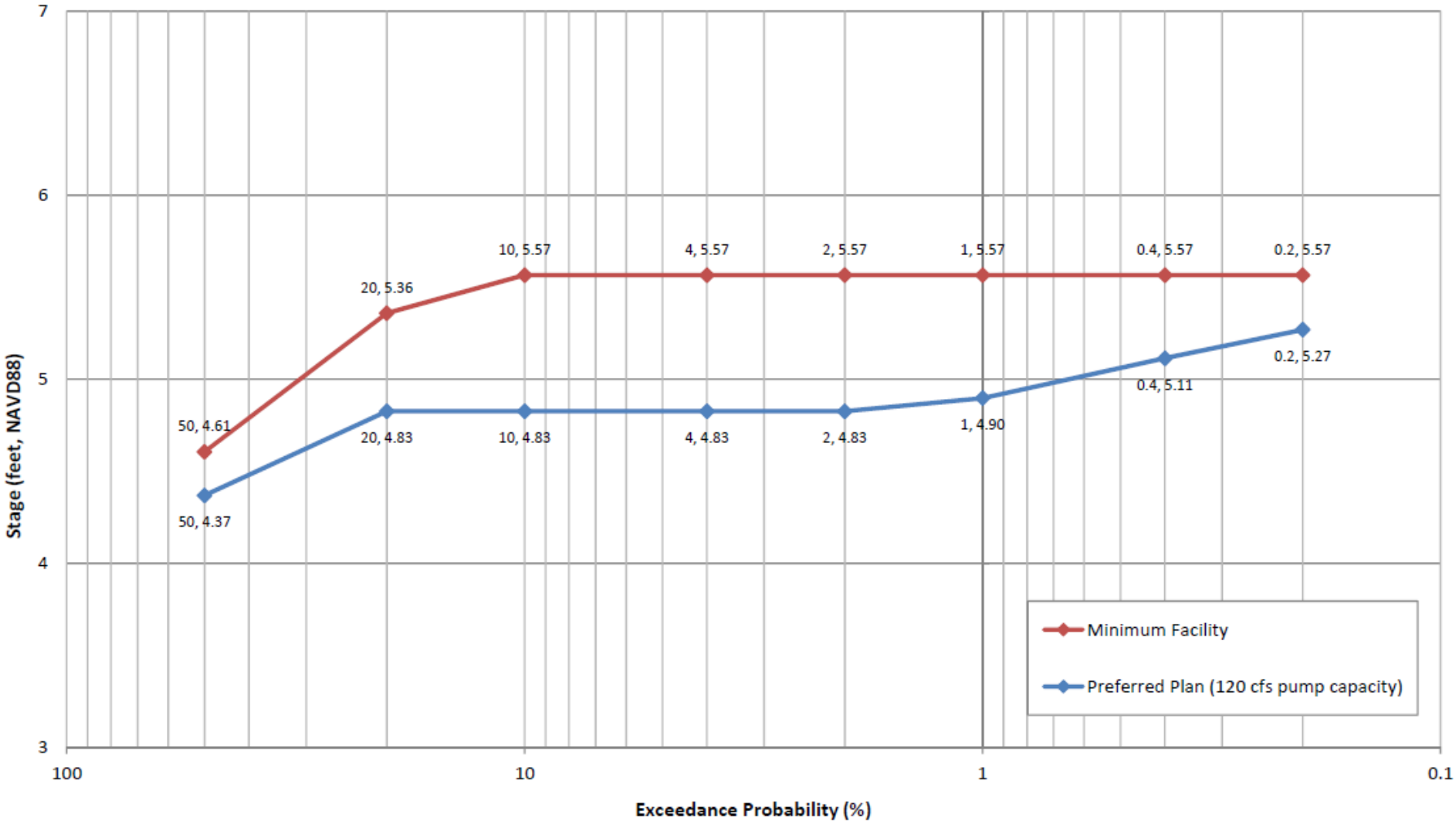
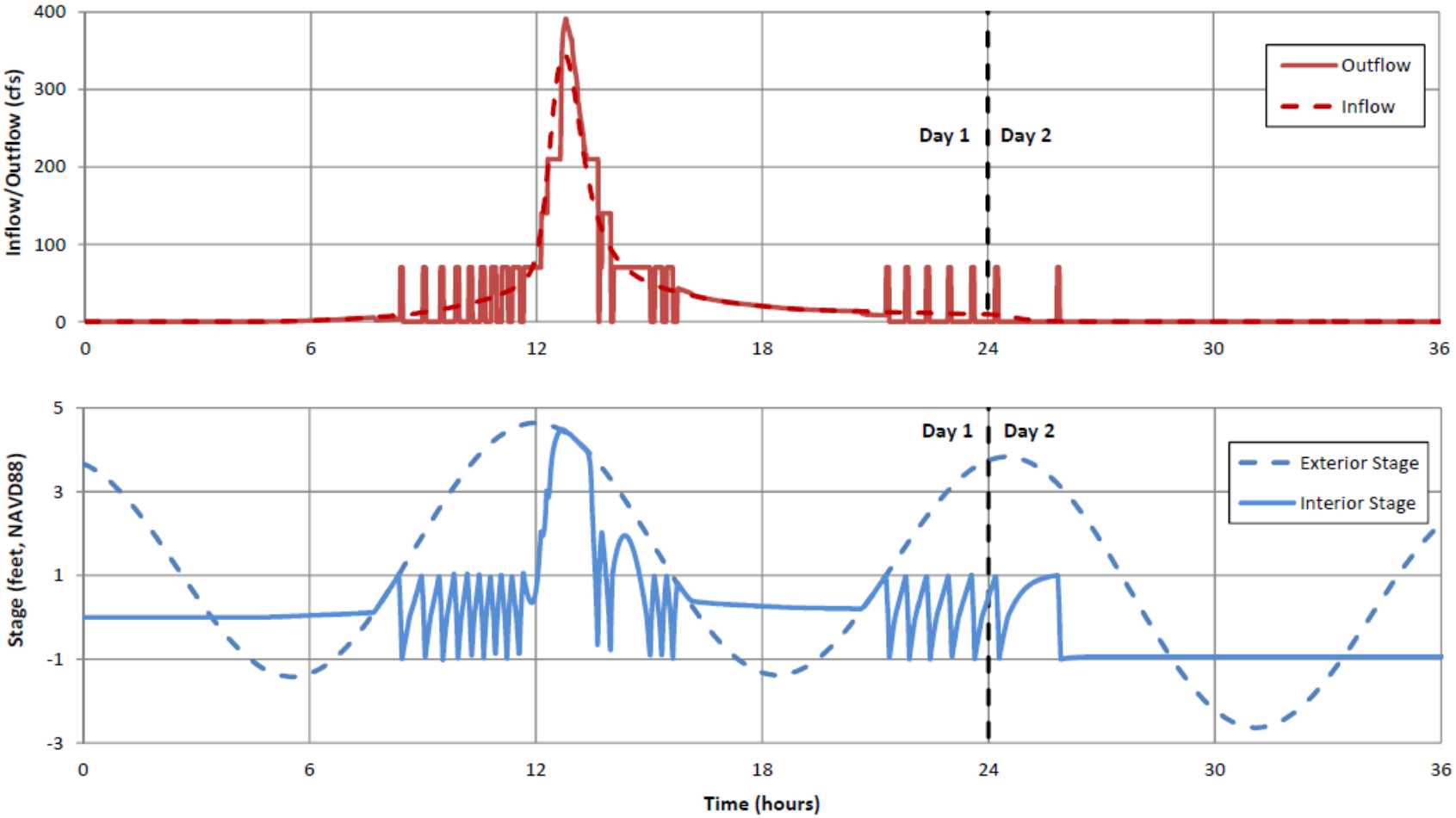
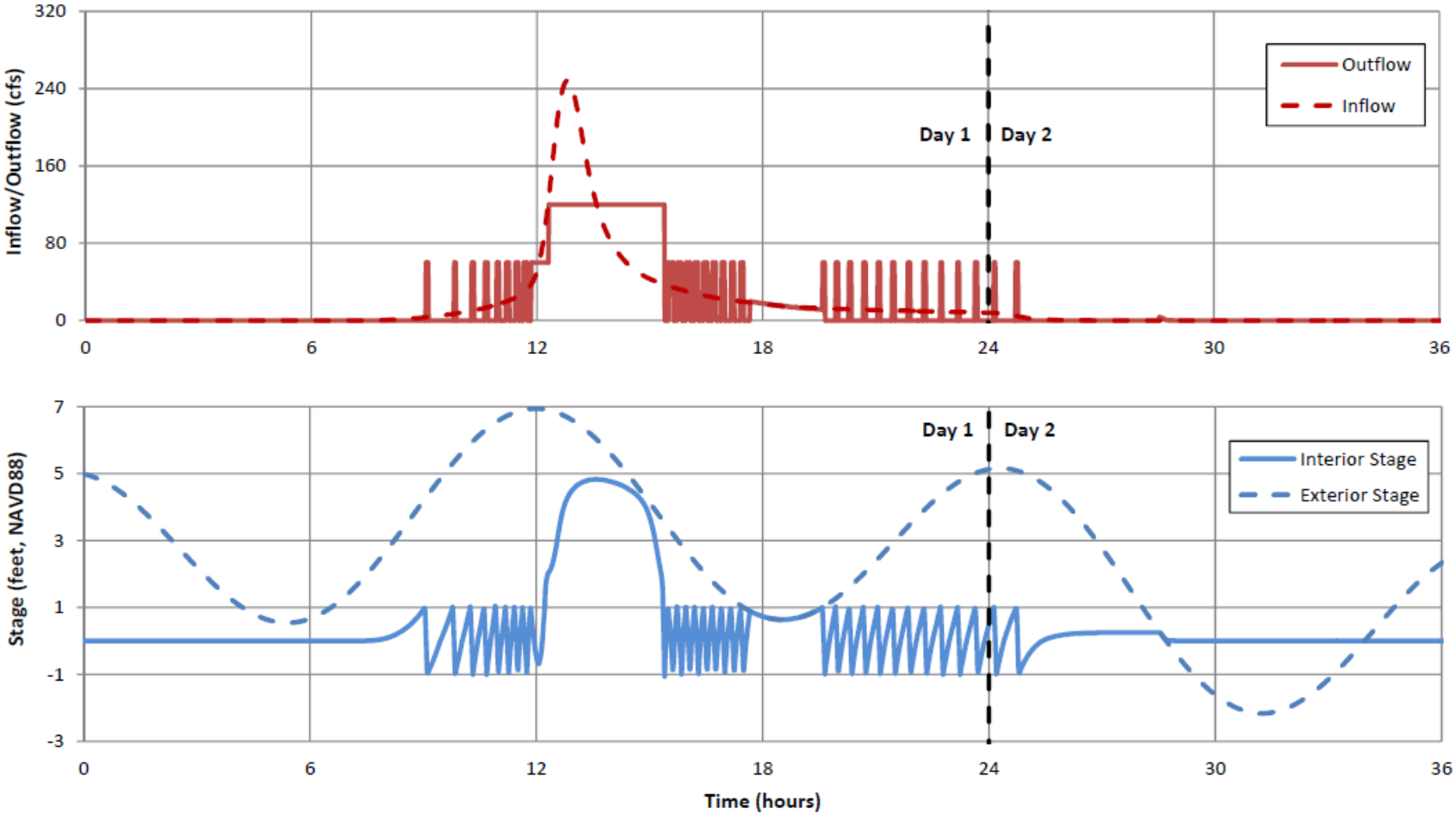


Figure 6-12: Peak Stage vs. Frequency Curves - Edgemere E2



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Edgemere Subbasin E1, Preferred Plan (210 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-13: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Edgemere E1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Edgemere Subbasin E2, Preferred Plan (120 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-14: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Edgemere E2

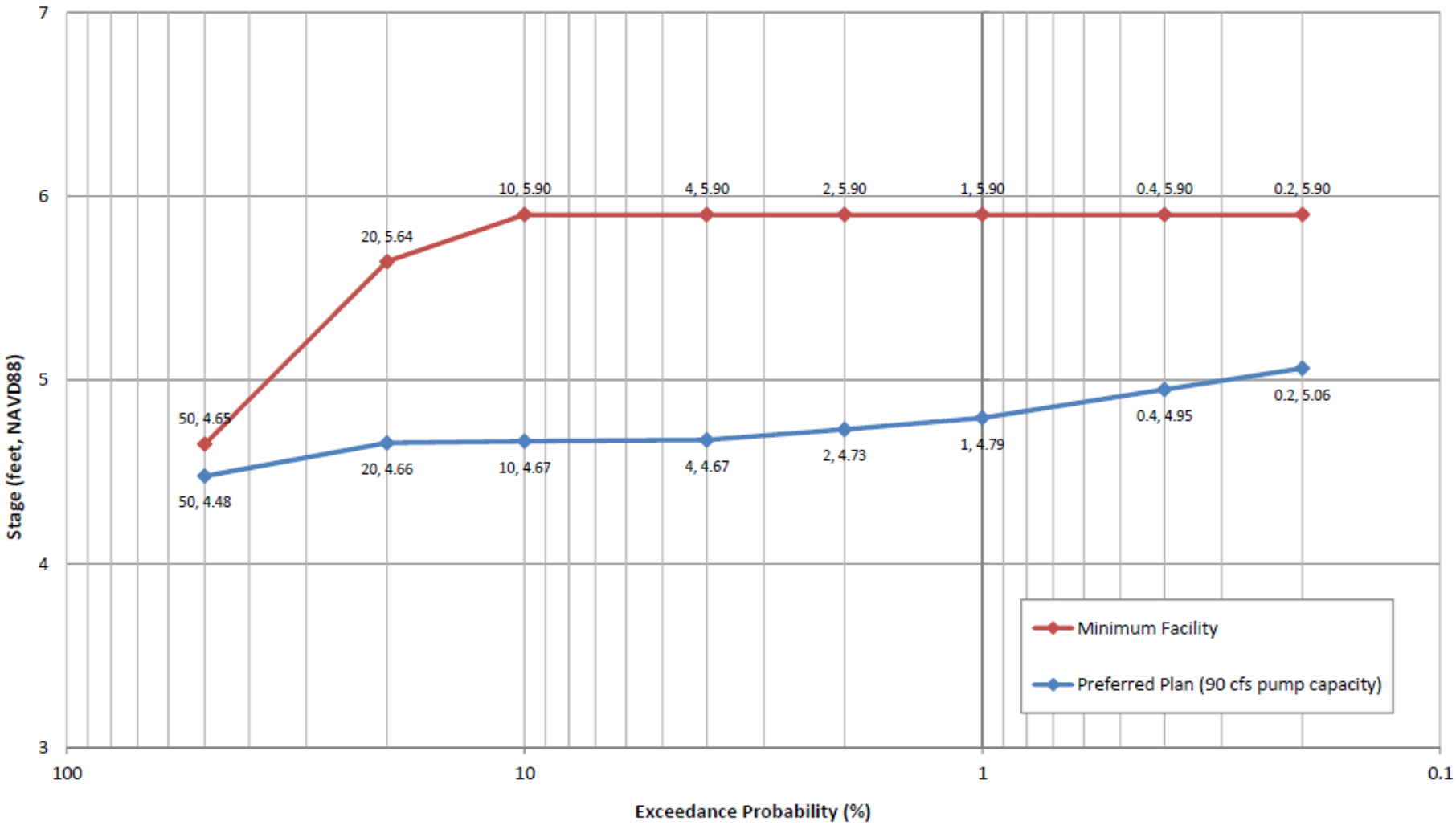
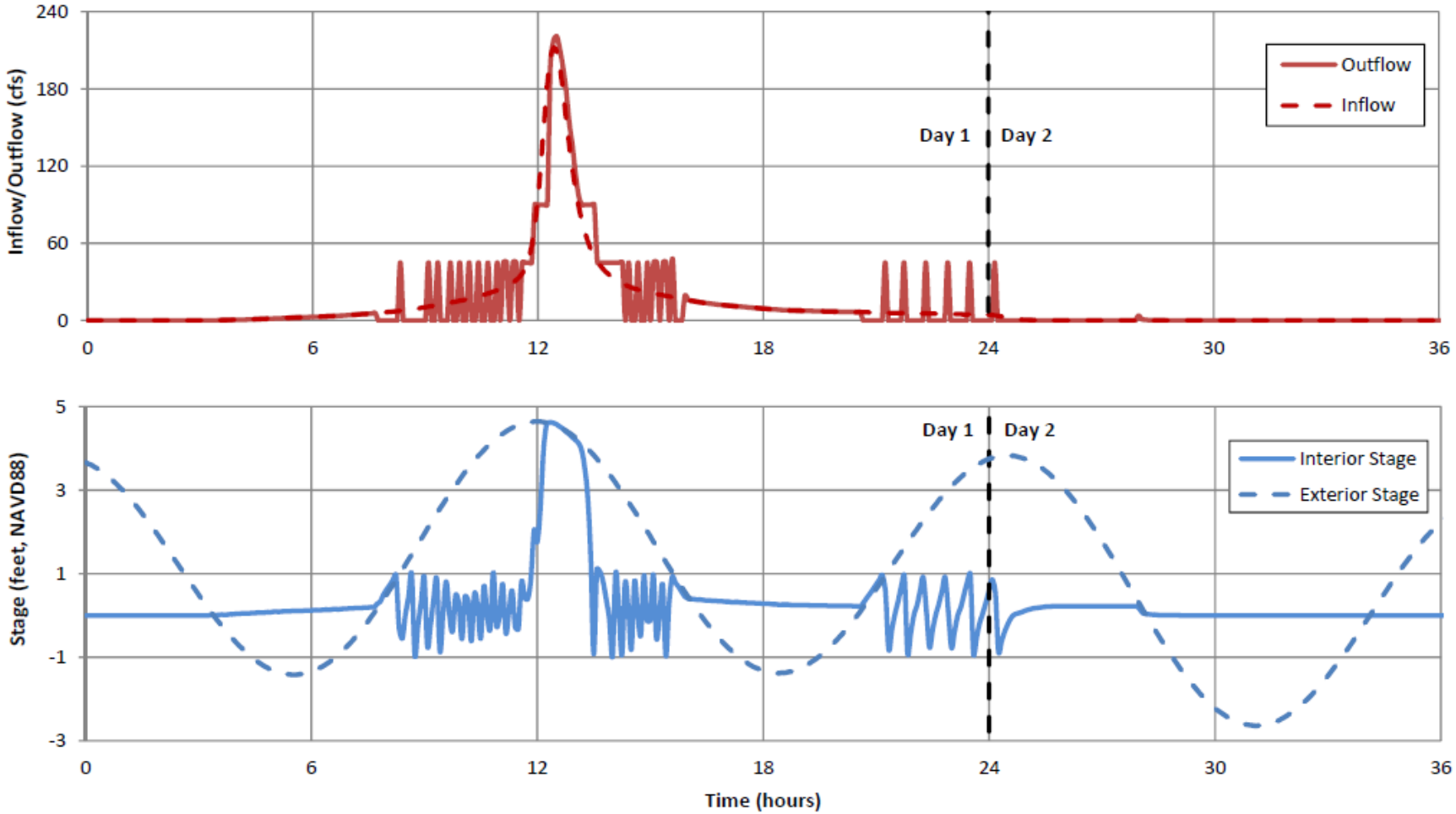


Figure 6-15: Peak Stage vs. Frequency Curves - Cedarhurst-Lawrence L1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Cedarhurst-Lawrence Subbasin L1, Preferred Plan (90 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-16: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Cedarhurst-Lawrence L1

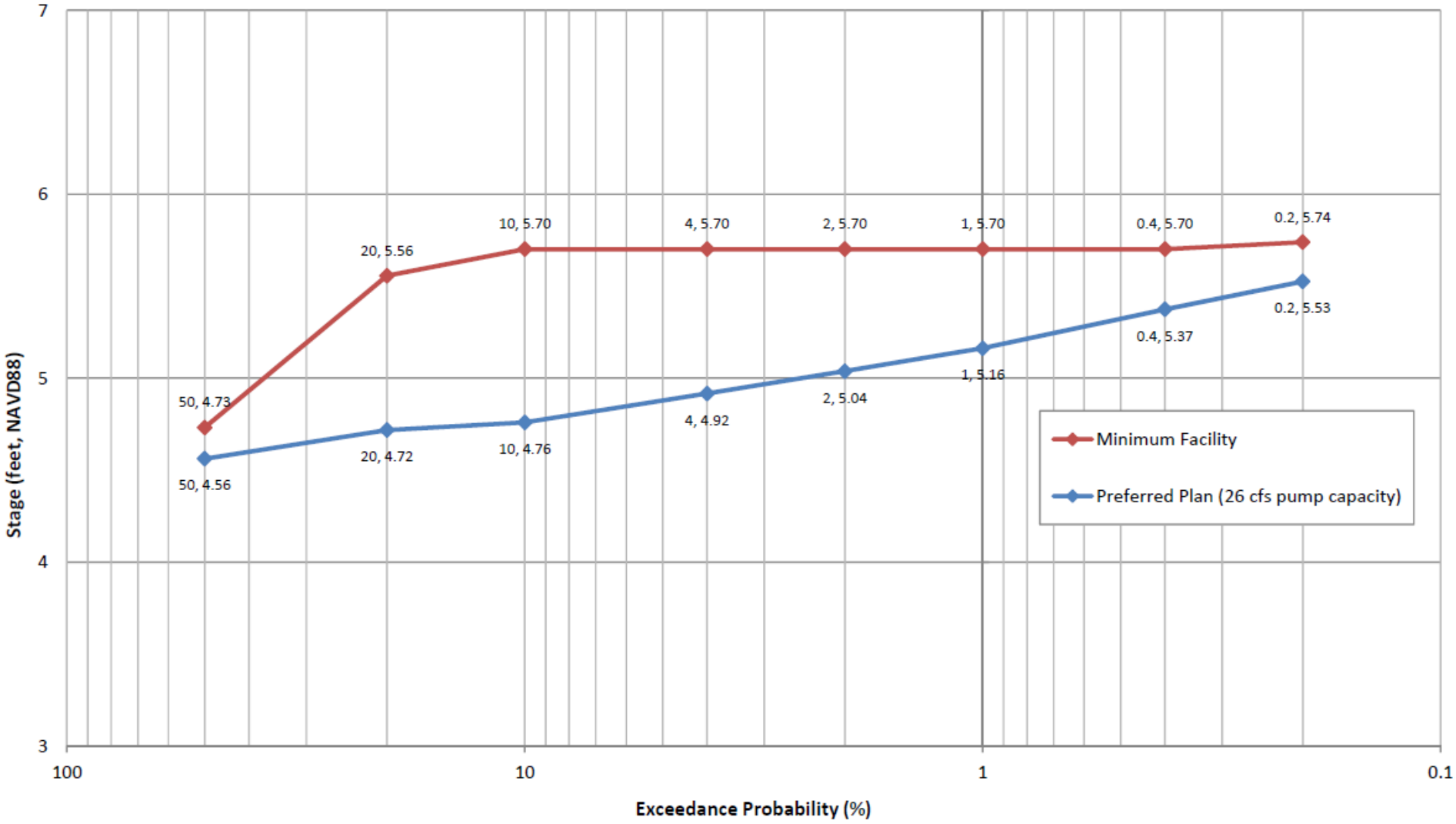
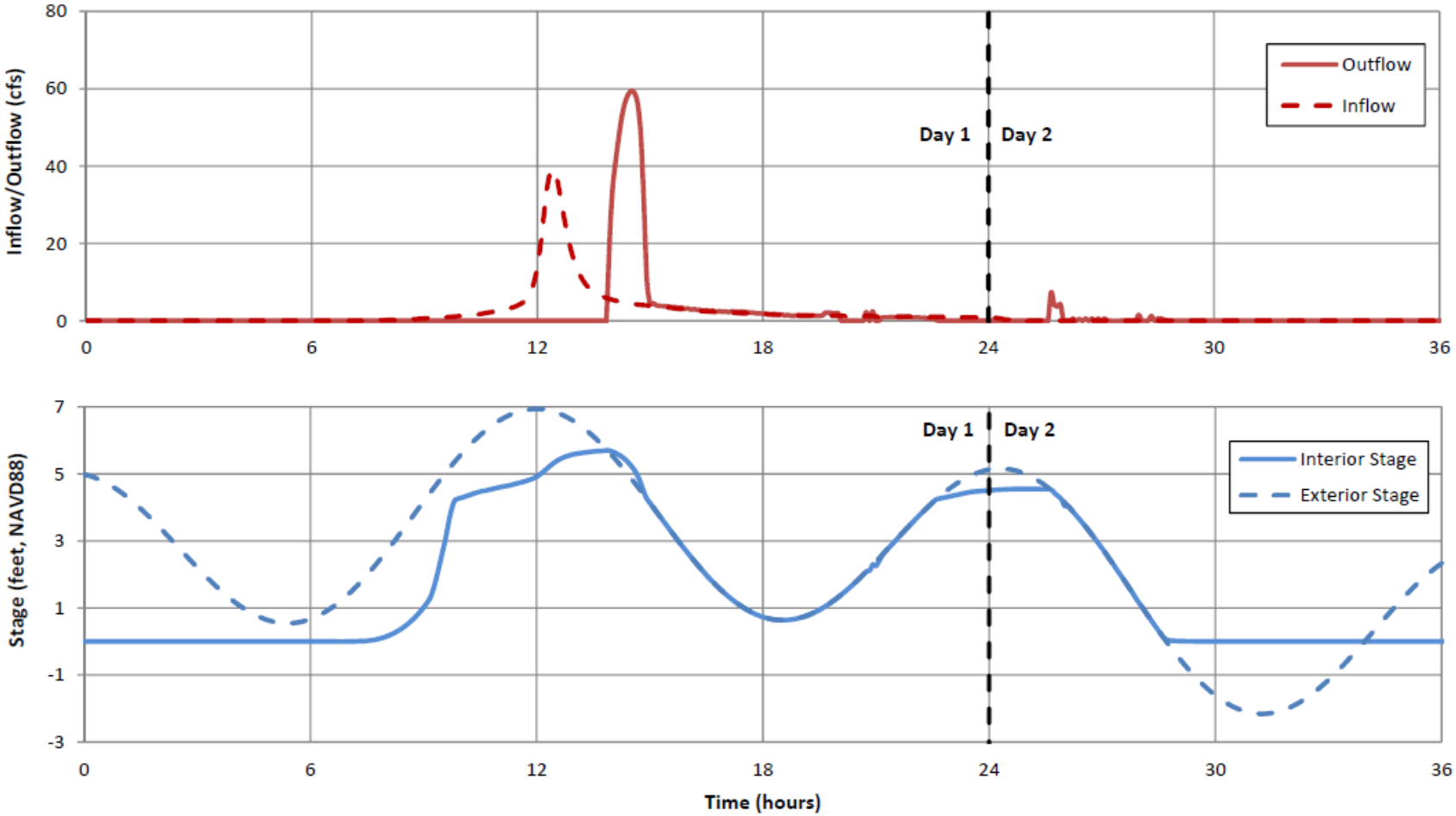


Figure 6-17: Peak Stage vs. Frequency Curves - Motts Basin North M1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Motts Subbasin M1, Preferred Plan (Minimum Facility), Most Likely Maximum Interior Stage (2-year storm, 10-year tide)

Figure 6-18: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Motts Basin North M1

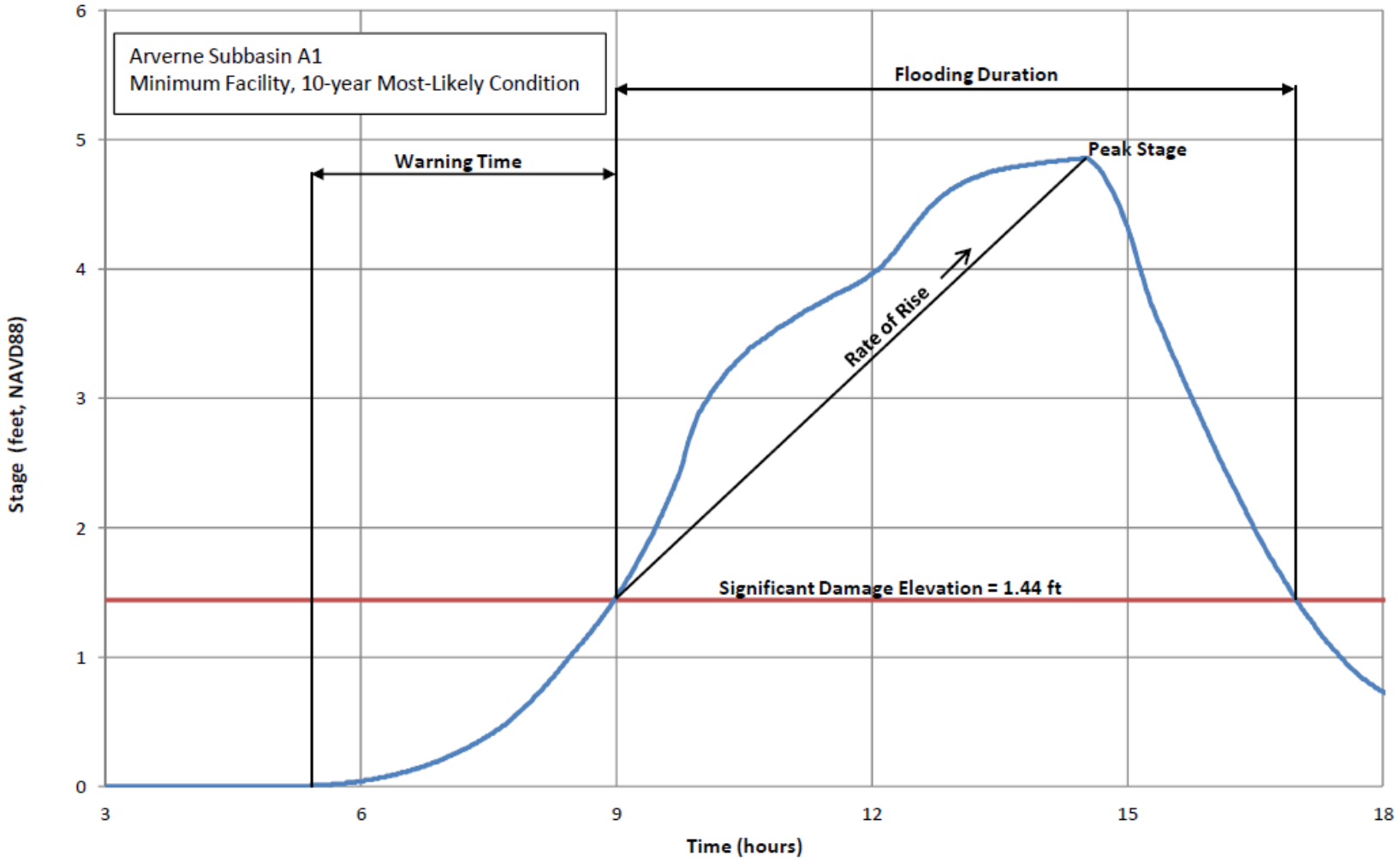


Figure 7-1: Sample Interior Stage vs. Time Plot

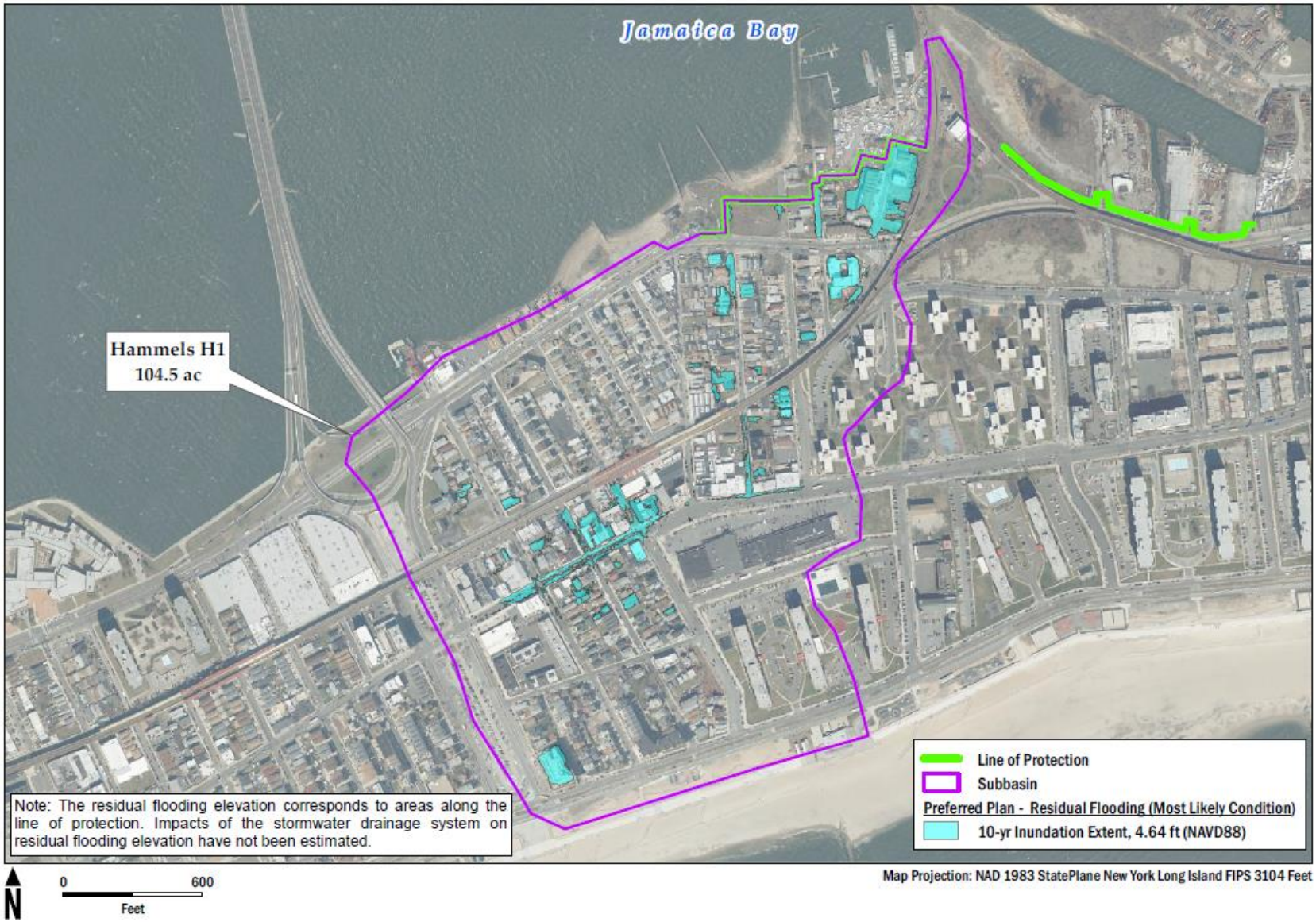


Figure 7-2: Residual Flooding - Mid-Rockaway Hammels Subbasin H1

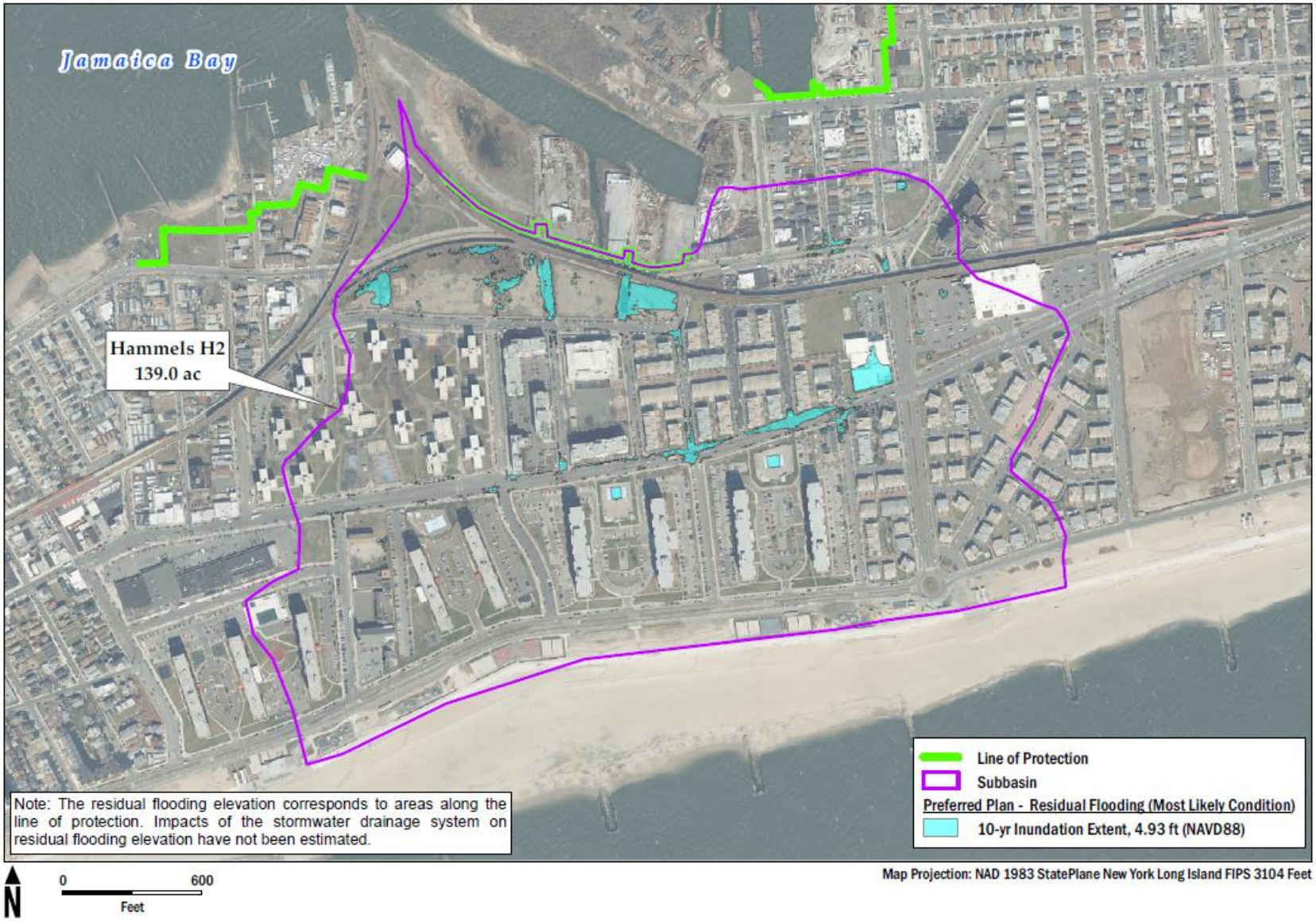


Figure 7-3: Residual Flooding - Mid-Rockaway Hammels Subbasin H2

Figure 7-4: Residual Flooding - Mid-Rockaway Arverne Subbasin A1

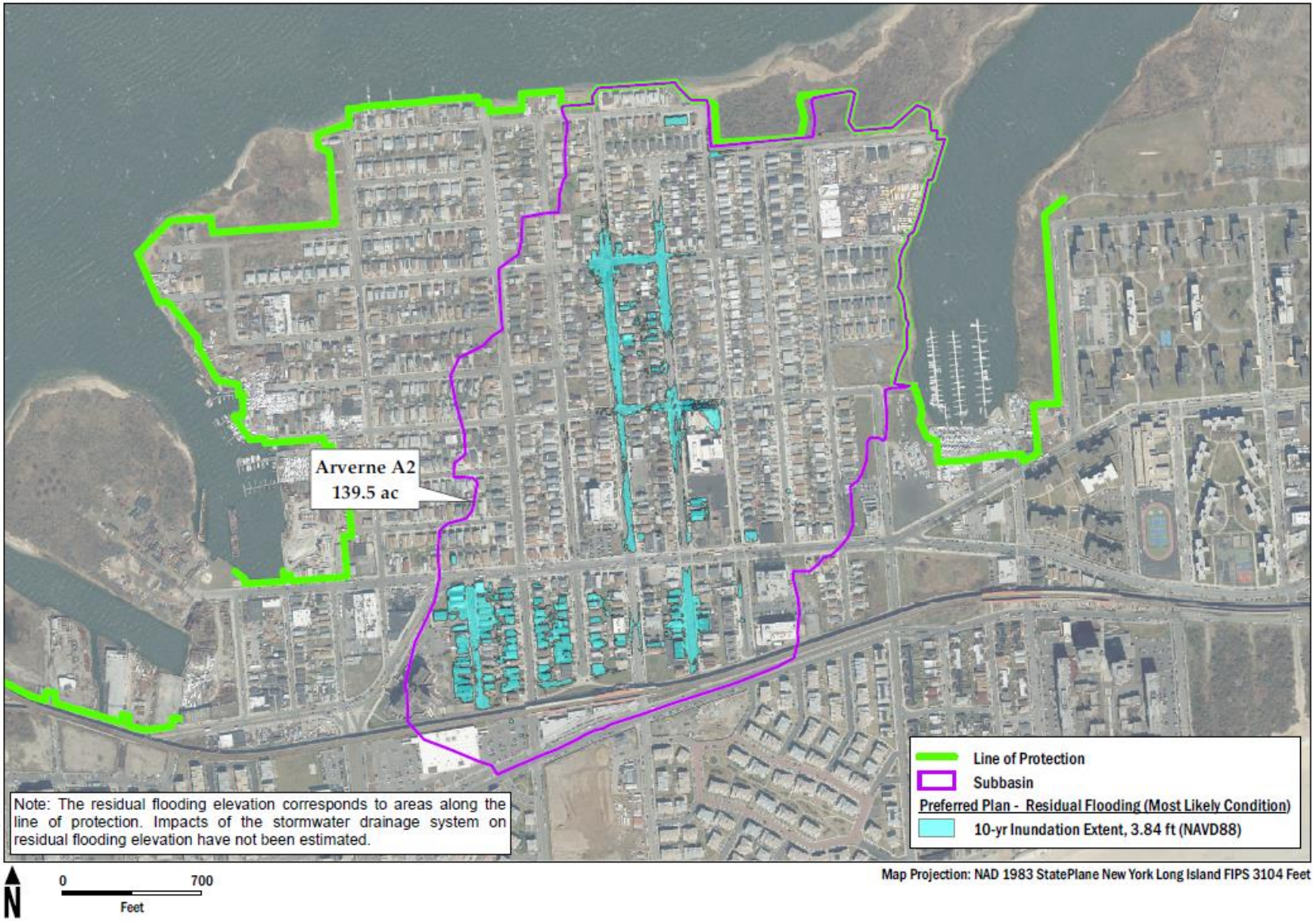


Figure 7-5: Residual Flooding - Mid-Rockaway Arverne Subbasin A2

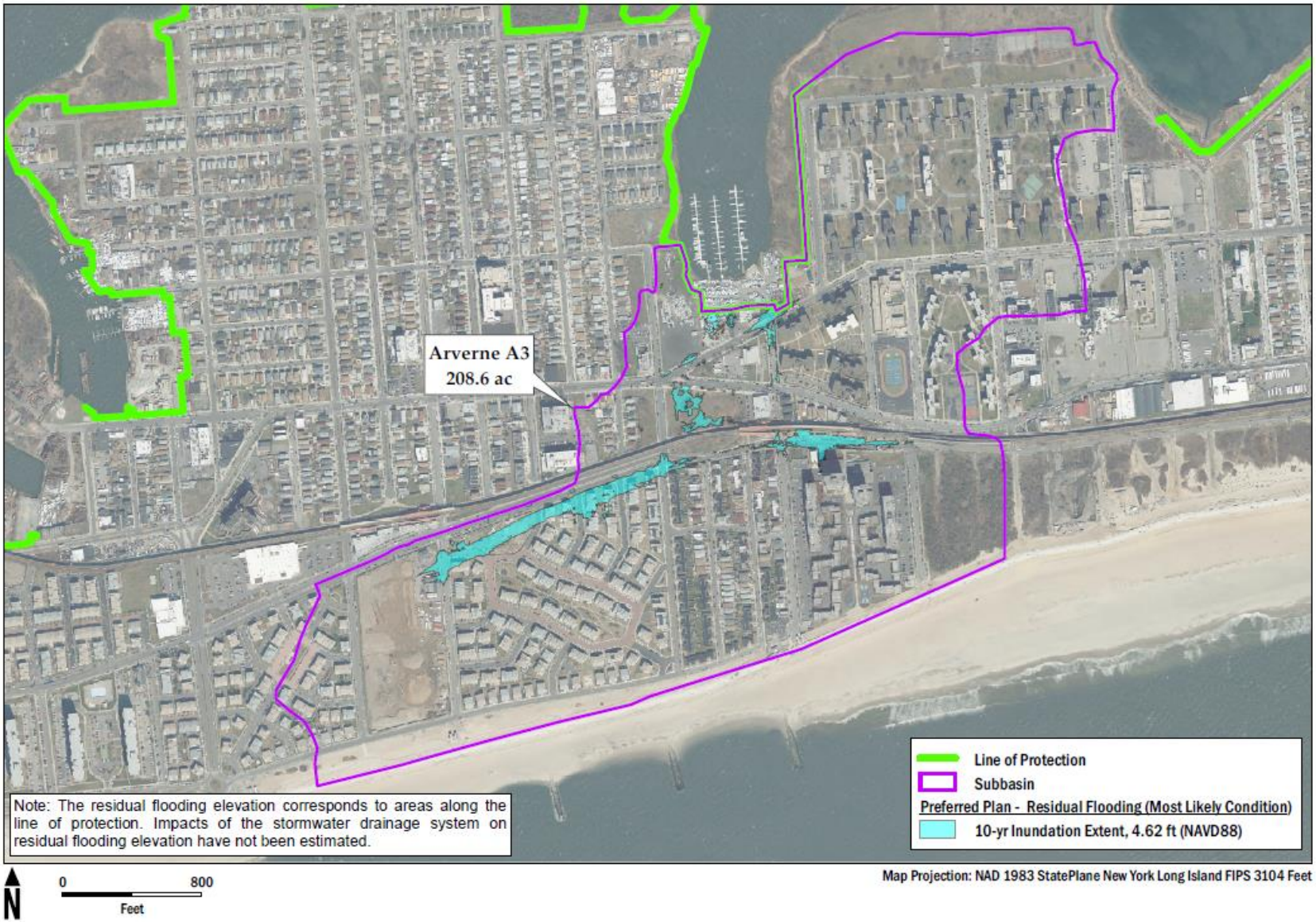


Figure 7-6: Residual Flooding - Mid-Rockaway Arverne Subbasin A3

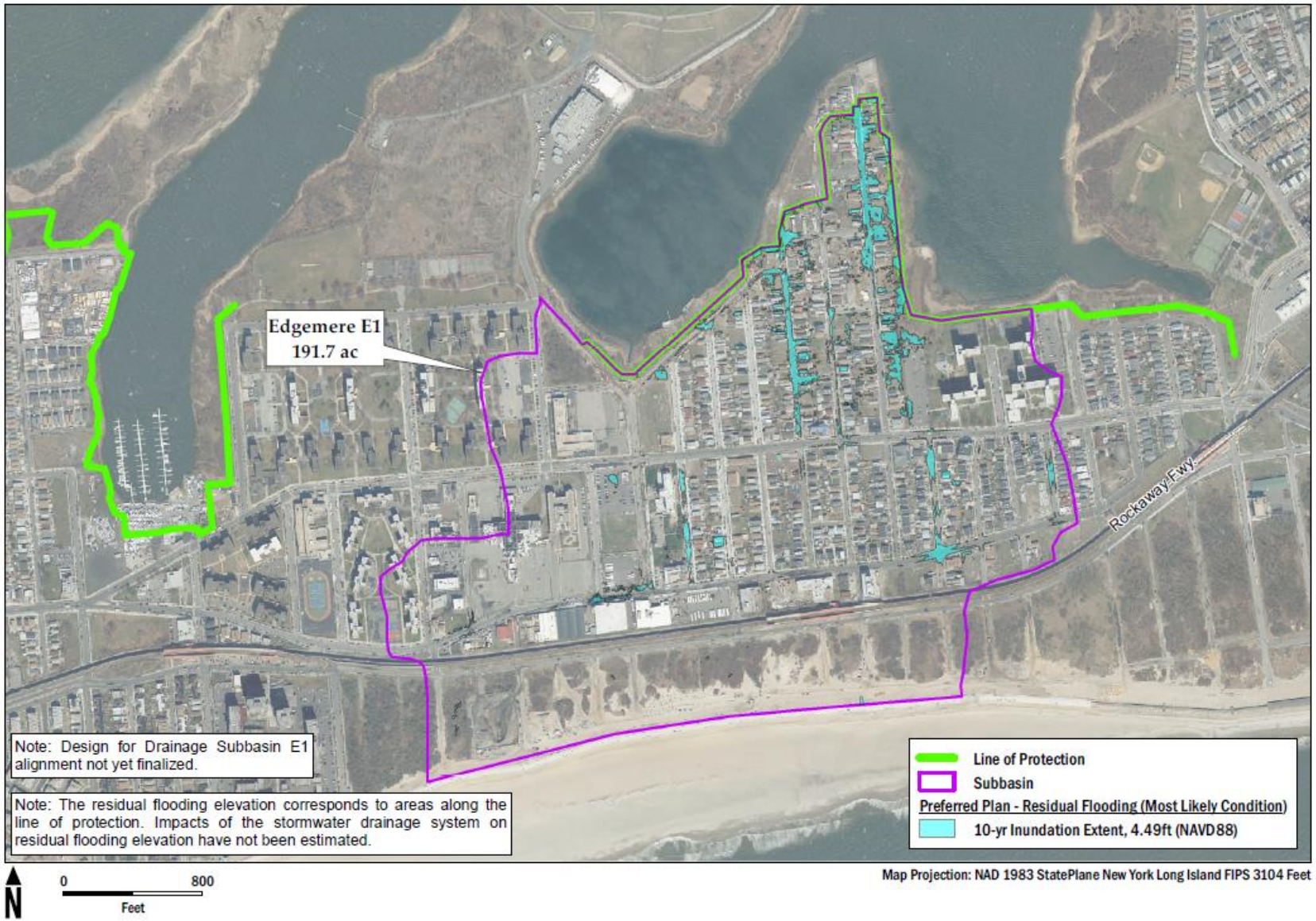


Figure 7-7: Residual Flooding - Mid-Rockaway Edgemere Subbasin E1

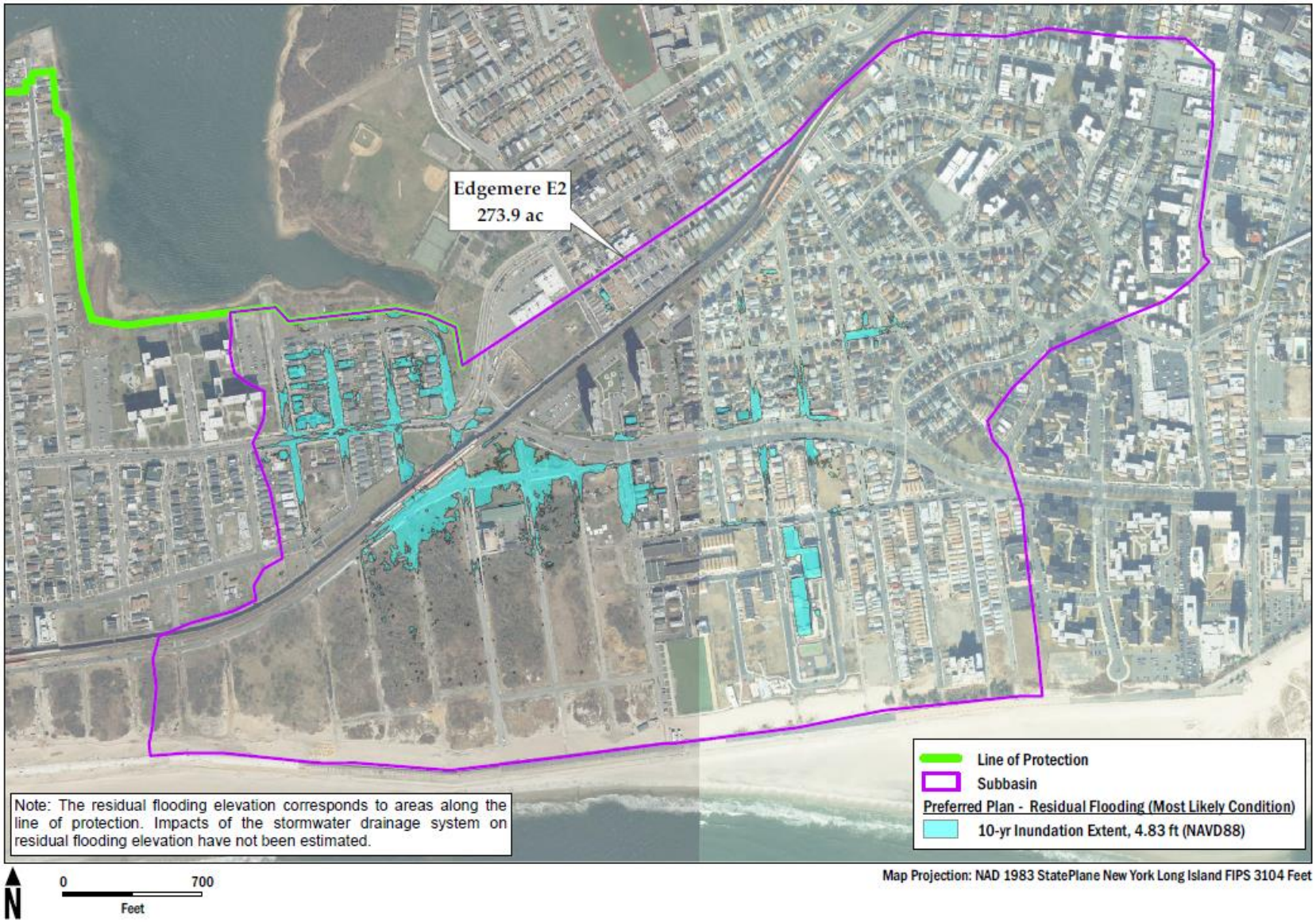


Figure 7-8: Residual Flooding - Mid-Rockaway Edgemere Subbasin E2

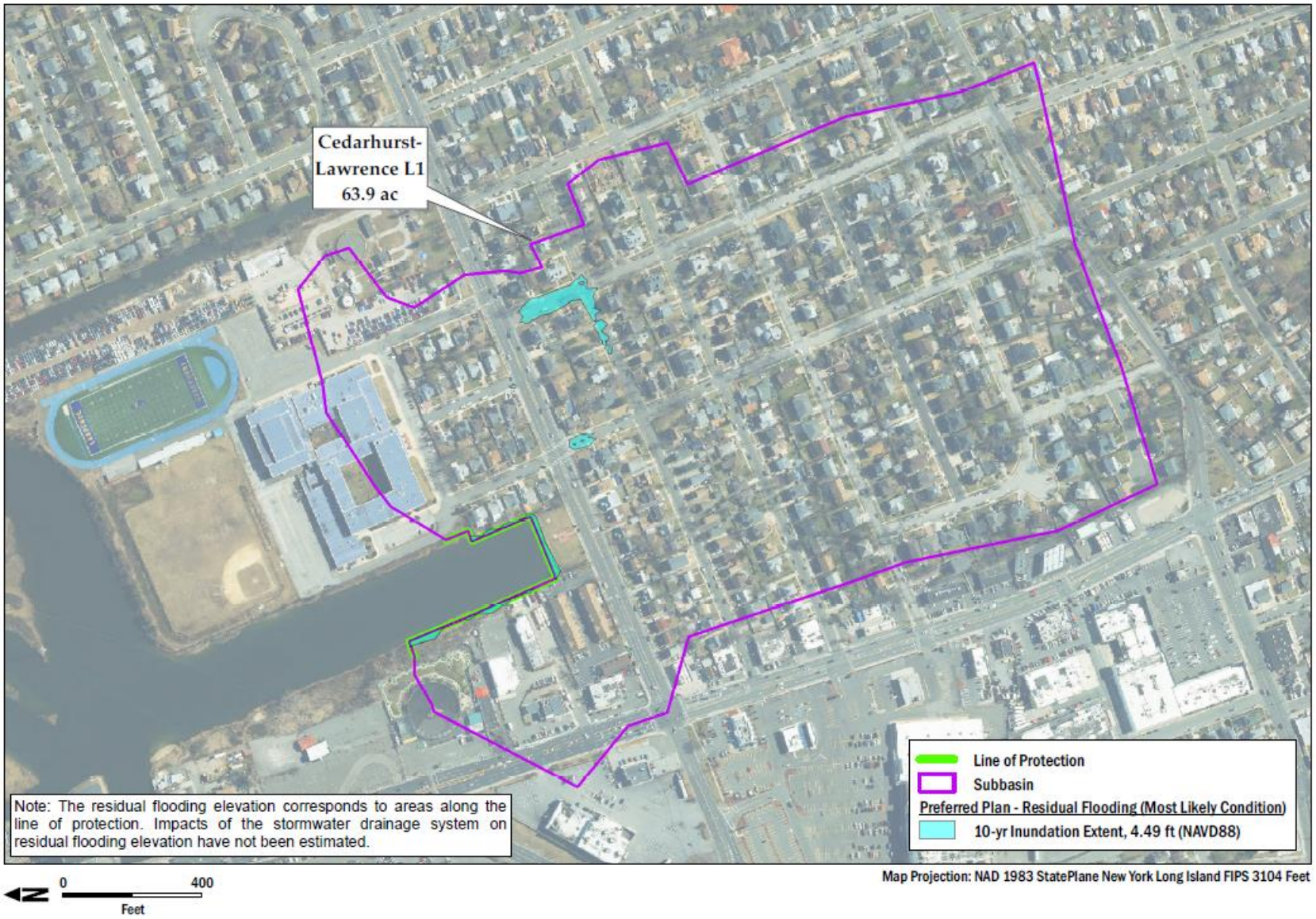


Figure 7-9: Residual Flooding - Cedarhurst-Lawrence Subbasin L1

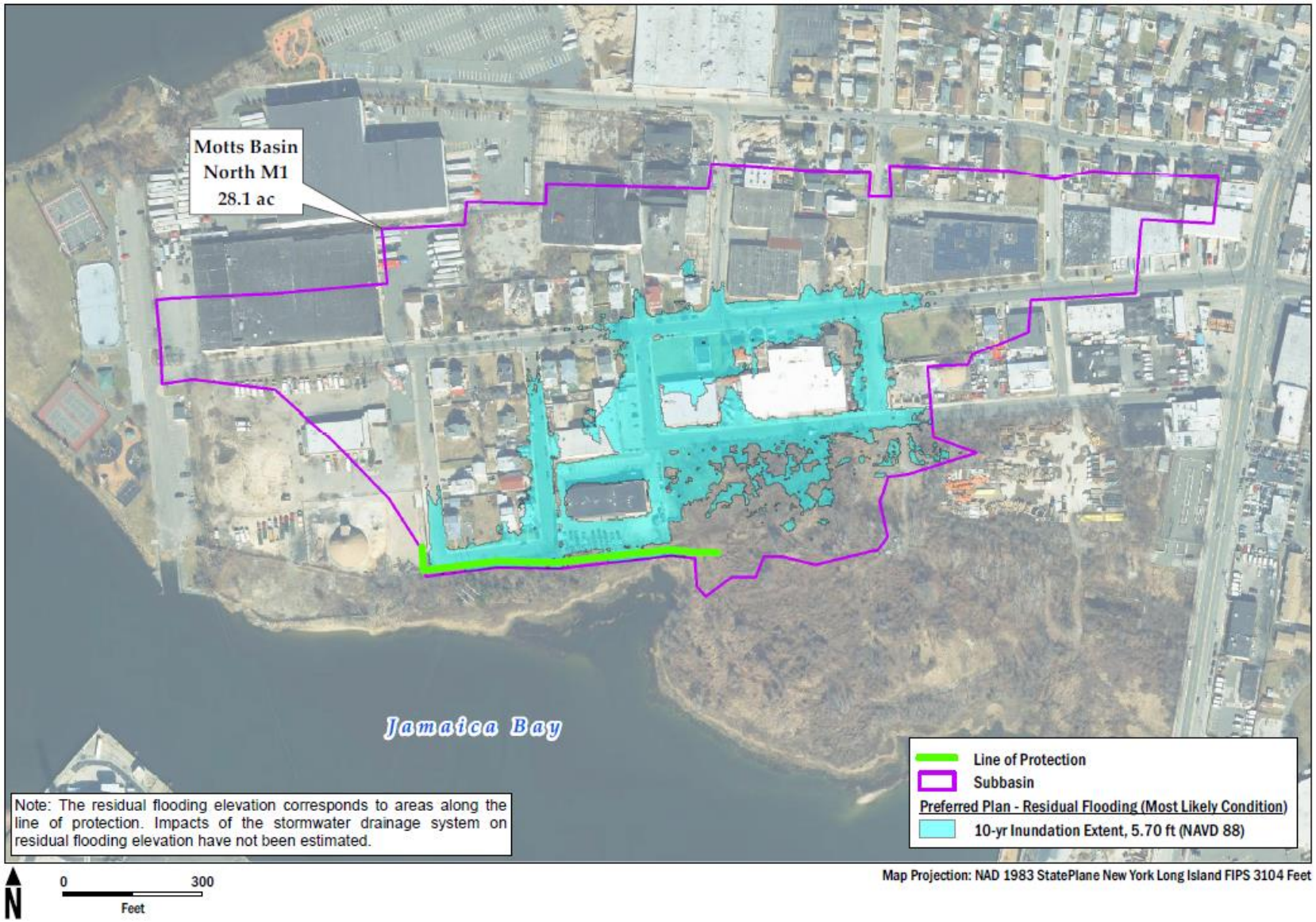


Figure 7-10: Residual Flooding - Motts Basin North Subbasin M1

Interior Drainage Sub-Appendix E

Attachment 2: Time of Concentration Calculations

Subbasin Name: H1		
Location: Hammels, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		Smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.005
Travel time, T_1	**hr**	**0.03**
$T = 0.007(nL)^{0.8}$	**min**	**2.05**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	277.4
Watercourse slope, s	ft/ft	0.003
Average velocity, V	ft/s	1.1
Unpaved $V = 16.1345 (s)^{0.5}$		
Paved $V = 20.3282 (s)^{0.5}$		
Travel time, T2	**hr**	**0.07**
	min	**4.20**
Channel Flow		
Cross Sectional Flow area, A	sq ft	10
Wetted perimeter, p_w	ft	40.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.002
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	3808.6
Velocity, V	ft/s	1.64
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.65**
	min	**38.73**
Subbasin Time of concentration, Tc	**min**	**44.98**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**27**
$T_{lag} = 0.6 T_c$		

Subbasin Name: H2		
Location: Hammels, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.014
Travel time, T_1	**hr**	**0.02**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**1.36**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	109.8
Watercourse slope, s	ft/ft	0.013
Average velocity, V	ft/s	2.3
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.01**
	min	**0.80**
Channel Flow		
Cross Sectional Flow area, A	sq ft	7.5
Wetted perimeter, p_w	ft	30.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.002
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	2962.8
Velocity, V	ft/s	1.63
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.50**
	min	**30.21**
Subbasin Time of concentration, Tc	**min**	**32.36**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**19**
$T_{lag} = 0.6 T_c$		

Subbasin Name: A1		
Location: Arvene, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.094
Travel time, T_1	**hr**	**0.01**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**0.63**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	159.2
Watercourse slope, s	ft/ft	0.008
Average velocity, V	ft/s	1.8
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.02**
	min	**1.47**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.001
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	3647
Velocity, V	ft/s	1.14
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.89**
	min	**53.16**
Subbasin Time of concentration, Tc	**min**	**55.27**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**33**
$T_{lag} = 0.6 T_c$		

Subbasin Name: A2		
Location: Arvene, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.002
Travel time, T_1	**hr**	**0.05**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**2.96**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	236.6
Watercourse slope, s	ft/ft	0.01
Average velocity, V	ft/s	2
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.03**
	min	**1.97**
Channel Flow		
Cross Sectional Flow area, A	sq ft	7.5
Wetted perimeter, p_w	ft	30.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.001
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	3813.5
Velocity, V	ft/s	1.16
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.92**
	min	**54.99**
Subbasin Time of concentration, Tc	**min**	**59.92**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**36**
$T_{lag} = 0.6 T_c$		

Subbasin Name: A3		
Location: Arvene, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.034
Travel time, T_1	**hr**	**0.02**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**0.95**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	163.3
Watercourse slope, s	ft/ft	0.021
Average velocity, V	ft/s	2.9
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.02**
	min	**0.94**
Channel Flow		
Cross Sectional Flow area, A	sq ft	7.5
Wetted perimeter, p_w	ft	30.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.002
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	4476.7
Velocity, V	ft/s	1.63
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.76**
	min	**45.64**
Subbasin Time of concentration, Tc	**min**	**47.54**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**29**
$T_{lag} = 0.6 T_c$		

Subbasin Name: E1		
Location: Edgemere Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.027
Travel time, T_1	**hr**	**0.02**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**1.05**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	650.2
Watercourse slope, s	ft/ft	0.008
Average velocity, V	ft/s	1.8
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.10**
	min	**6.02**
Channel Flow		
Cross Sectional Flow area, A	sq ft	5
Wetted perimeter, p_w	ft	20.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.001
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	4262.1
Velocity, V	ft/s	1.15
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**1.03**
	min	**61.79**
Subbasin Time of concentration, Tc	**min**	**68.86**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**41**
$T_{lag} = 0.6 T_c$		

Subbasin Name: E2		
Location: Edgemere, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.003
Travel time, T_1	**hr**	**0.04**
$T = 0.007(nL)^{0.8}$	**min**	**2.52**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	211.8
Watercourse slope, s	ft/ft	0.008
Average velocity, V	ft/s	1.8
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.03**
	min	**1.96**
Channel Flow Segment 1		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.017
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	1100
Velocity, V	ft/s	4.71
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.06**
	min	**3.89**
Channel Flow Segment 2		
Cross Sectional Flow area, A	sq ft	10
Wetted perimeter, p_w	ft	40.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.001
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	4523.9
Velocity, V	ft/s	1.16
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**1.08**
	min	**65.05**
Subbasin Time of concentration, Tc	**min**	**73.42**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**44**
$T_{lag} = 0.6 T_c$		

Subbasin Name: C1		
Location: Canarsie, Brooklyn, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.024
Travel time, T_1	**hr**	**0.15**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**8.86**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	1735
Watercourse slope, s	ft/ft	0.004
Average velocity, V	ft/s	1.3
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.37**
	min	**22.24**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.004
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	1735
Velocity, V	ft/s	2.29
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.21**
	min	**12.65**
Subbasin Time of concentration, Tc	**min**	**43.75**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**26.25**
$T_{lag} = 0.6 T_c$		

Subbasin Name: C2		
Location: Canarsie, Brooklyn, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.022
Travel time, T_1	**hr**	**0.15**
$T = 0.007(nL)^{0.8}$	**min**	**9.18**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	2075
Watercourse slope, s	ft/ft	0.004
Average velocity, V	ft/s	1.3
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.44**
	min	**26.60**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.004
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	2075
Velocity, V	ft/s	2.29
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.25**
	min	**15.12**
Subbasin Time of concentration, Tc	**min**	**50.90**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**30.54**
$T_{lag} = 0.6 T_c$		

Subbasin Name: C3		
Location: Canarsie, Brooklyn, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.032
Travel time, T_1	**hr**	**0.13**
$T = 0.007(nL)^{0.8}$	**min**	**7.90**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	1475
Watercourse slope, s	ft/ft	0.003
Average velocity, V	ft/s	1.1
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.37**
	min	**22.35**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.003
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	1475
Velocity, V	ft/s	1.98
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.21**
	min	**12.41**
Subbasin Time of concentration, Tc	**min**	**42.66**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**25.60**
$T_{lag} = 0.6T_c$		

Subbasin Name: L1		
Location: Cedarhurst-Lawrence, Nassau County, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.00383
Travel time, T_1	**hr**	**0.31**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**18.47**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	1150
Watercourse slope, s	ft/ft	0.00265
Average velocity, V	ft/s	1
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.32**
	min	**19.17**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.00265
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	1150
Velocity, V	ft/s	1.86
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.17**
	min	**10.30**
Subbasin Time of concentration, Tc	**min**	**47.93**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**28.76**
$T_{lag} = 0.6T_c$		

Subbasin Name: M1		
Location: Motts Basin North, Nassau County, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.01
Travel time, T_1	**hr**	**0.21**
$T = 0.007(nL)^{0.8}$	**min**	**12.58**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	1620
Watercourse slope, s	ft/ft	0.0037
Average velocity, V	ft/s	1.2
Unpaved $V = 16.1345 (s)^{0.5}$		
Paved $V = 20.3282 (s)^{0.5}$		
Travel time, T2	**hr**	**0.38**
	min	**22.50**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.0037
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	0
Velocity, V	ft/s	2.20
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.00**
	min	**0.00**
Subbasin Time of concentration, Tc	**min**	**35.08**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**21.05**
$T_{lag} = 0.6 T_c$		

Interior Drainage Sub-Appendix E

Attachment 3: HEC-HMS Modeling Results by Subbasin

Mid-Rockaway Hammels - Minimum Facility, Present Tides													
Subbasin H1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.94	145	2.75							2.94	145	Low
5 yr	Normal	Present	3.16	199	2.75							3.16	199	Low
10 yr	Normal	Present	3.40	244	2.75							3.40	244	Low
25 yr	Normal	Present	3.75	306	2.75							3.75	306	Low
50 yr	Normal	Present	4.03	353	2.75							4.03	353	Low
100 yr	Normal	Present	4.30	400	2.75							4.30	400	Low
250 yr	Normal	Present	4.72	491	2.75							4.72	491	Low
500 yr	Normal	Present	4.95	557	2.75							4.95	557	Low
2 yr	2 yr	Present	4.76	145	4.64	2 yr	2 yr	Present	4.76	145	4.64	4.76	145	Likely
5 yr	2 yr	Present	4.90	199	4.64	2 yr	5 yr	Present	5.34	145	5.94	5.34	199	Likely
10 yr	2 yr	Present	5.01	244	4.64	2 yr	10 yr	Present	5.47	145	6.94	5.47	244	Likely
25 yr	2 yr	Present	5.16	306	4.64	2 yr	10yr	Present	5.47	145	6.94	5.47	306	Likely
50 yr	2 yr	Present	5.26	353	4.64	2 yr	10yr	Present	5.47	145	6.94	5.47	353	Likely
100 yr	2 yr	Present	5.36	400	4.64	2 yr	10yr	Present	5.47	145	6.94	5.47	400	Likely
250 yr	2 yr	Present	5.56	491	4.64	2 yr	10yr	Present	5.47	145	6.94	5.56	491	Likely
500 yr	2 yr	Present	5.69	557	4.64	2 yr	10yr	Present	5.47	145	6.94	5.69	557	Likely
2 yr	2 yr	Present	4.76	145	4.64	2yr	2 yr	Present	4.76	145	4.64	4.76	145	High
5 yr	5 yr	Present	5.53	199	5.94	5 yr	5 yr	Present	5.53	199	5.94	5.53	199	High
10 yr	10 yr	Present	5.85	244	6.94	10 yr	10 yr	Present	5.85	244	6.94	5.85	244	High
25 yr	10 yr	Present	6.03	306	6.94	10 yr	10yr	Present	5.85	244	6.94	6.03	306	High
50 yr	10 yr	Present	6.14	353	6.94	10 yr	10yr	Present	5.85	244	6.94	6.14	353	High
100 yr	10 yr	Present	6.24	400	6.94	10 yr	10yr	Present	5.85	244	6.94	6.24	400	High
250 yr	10 yr	Present	6.41	491	6.94	10 yr	10yr	Present	5.85	244	6.94	6.41	491	High
500 yr	10 yr	Present	6.51	557	6.94	10 yr	10yr	Present	5.85	244	6.94	6.51	557	High

Mid-Rockaway Hammels - Pump Alternative 1, Present Tides													
Subbasin H1, 100 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.72	145	2.75							2.72	145	Low
5 yr	Normal	Present	2.80	199	2.75							2.80	199	Low
10 yr	Normal	Present	2.93	244	2.75							2.93	244	Low
25 yr	Normal	Present	3.19	306	2.75							3.19	306	Low
50 yr	Normal	Present	3.43	353	2.75							3.43	353	Low
100 yr	Normal	Present	3.69	400	2.75							3.69	400	Low
250 yr	Normal	Present	4.21	491	2.75							4.21	491	Low
500 yr	Normal	Present	4.55	557	2.75							4.55	557	Low
2 yr	2 yr	Present	3.78	145	4.64	2 yr	2 yr	Present	3.78	145	4.64	3.78	145	Likely
5 yr	2 yr	Present	4.49	199	4.64	2 yr	5 yr	Present	3.79	145	5.84	4.49	199	Likely
10 yr	2 yr	Present	4.64	244	4.64	2 yr	10 yr	Present	3.80	145	6.94	4.64	244	Likely
25 yr	2 yr	Present	4.80	306	4.64	2 yr	10yr	Present	3.80	145	6.94	4.80	306	Likely
50 yr	2 yr	Present	4.93	353	4.64	2 yr	10yr	Present	3.80	145	6.94	4.93	353	Likely
100 yr	2 yr	Present	5.04	400	4.64	2 yr	10yr	Present	3.80	145	6.94	5.04	400	Likely
250 yr	2 yr	Present	5.24	491	4.64	2 yr	10yr	Present	3.80	145	6.94	5.24	491	Likely
500 yr	2 yr	Present	5.38	557	4.64	2 yr	10yr	Present	3.80	145	6.94	5.38	557	Likely
2 yr	2 yr	Present	3.78	145	4.64	2yr	2 yr	Present	3.78	145	4.64	3.78	145	High
5 yr	5 yr	Present	4.66	199	5.84	5 yr	5 yr	Present	4.66	199	5.84	4.66	199	High
10 yr	10 yr	Present	4.99	244	6.94	10 yr	10 yr	Present	4.99	244	6.94	4.99	244	High
25 yr	10 yr	Present	5.27	306	6.94	10 yr	10yr	Present	4.99	244	6.94	5.27	306	High
50 yr	10 yr	Present	5.46	353	6.94	10 yr	10yr	Present	4.99	244	6.94	5.46	353	High
100 yr	10 yr	Present	5.62	400	6.94	10 yr	10yr	Present	4.99	244	6.94	5.62	400	High
250 yr	10 yr	Present	5.88	491	6.94	10 yr	10yr	Present	4.99	244	6.94	5.88	491	High
500 yr	10 yr	Present	6.03	557	6.94	10 yr	10yr	Present	4.99	244	6.94	6.03	557	High

Mid-Rockaway Hammels - Minimum Facility, Future Tides													
Subbasin H1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	4.00	145	3.82							4.00	145	Low
5 yr	Normal	Future	4.19	199	3.82							4.19	199	Low
10 yr	Normal	Future	4.37	244	3.82							4.37	244	Low
25 yr	Normal	Future	4.62	306	3.82							4.62	306	Low
50 yr	Normal	Future	4.78	353	3.82							4.78	353	Low
100 yr	Normal	Future	4.94	400	3.82							4.94	400	Low
250 yr	Normal	Future	5.18	491	3.82							5.18	491	Low
500 yr	Normal	Future	5.33	557	3.82							5.33	557	Low
2 yr	2 yr	Future	5.31	145	5.71	2 yr	2 yr	Future	5.31	145	5.71	5.31	145	Likely
5 yr	2 yr	Future	5.49	199	5.71	2 yr	5 yr	Future	5.47	145	6.91	5.49	199	Likely
10 yr	2 yr	Future	5.61	244	5.71	2 yr	10 yr	Future	5.52	145	8.00	5.61	244	Likely
25 yr	2 yr	Future	5.74	306	5.71	2 yr	10yr	Future	5.52	145	8.00	5.74	306	Likely
50 yr	2 yr	Future	5.84	353	5.71	2 yr	10yr	Future	5.52	145	8.00	5.84	353	Likely
100 yr	2 yr	Future	5.93	400	5.71	2 yr	10yr	Future	5.52	145	8.00	5.93	400	Likely
250 yr	2 yr	Future	6.09	491	5.71	2 yr	10yr	Future	5.52	145	8.00	6.09	491	Likely
500 yr	2 yr	Future	6.19	557	5.71	2 yr	10yr	Future	5.52	145	8.00	6.19	557	Likely
2 yr	2 yr	Future	5.31	145	5.71	2yr	2 yr	Future	5.31	145	5.71	5.31	145	High
5 yr	5 yr	Future	5.70	199	6.91	5 yr	5 yr	Future	5.70	199	6.91	5.70	199	High
10 yr	10 yr	Future	5.92	244	8.00	10 yr	10 yr	Future	5.92	244	8.00	5.92	244	High
25 yr	10 yr	Future	6.11	306	8.00	10 yr	10yr	Future	5.92	244	8.00	6.11	306	High
50 yr	10 yr	Future	6.23	353	8.00	10 yr	10yr	Future	5.92	244	8.00	6.23	353	High
100 yr	10 yr	Future	6.34	400	8.00	10 yr	10yr	Future	5.92	244	8.00	6.34	400	High
250 yr	10 yr	Future	6.54	491	8.00	10 yr	10yr	Future	5.92	244	8.00	6.54	491	High
500 yr	10 yr	Future	6.67	557	8.00	10 yr	10yr	Future	5.92	244	8.00	6.67	557	High

Mid-Rockaway Hammels - Pump Alternative 1, Future Tides													
Subbasin H1, 100 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.67	145	3.82							3.67	145	Low
5 yr	Normal	Present	3.84	199	3.82							3.84	199	Low
10 yr	Normal	Present	3.98	244	3.82							3.98	244	Low
25 yr	Normal	Present	4.19	306	3.82							4.19	306	Low
50 yr	Normal	Present	4.37	353	3.82							4.37	353	Low
100 yr	Normal	Present	4.56	400	3.82							4.56	400	Low
250 yr	Normal	Present	4.87	491	3.82							4.87	491	Low
500 yr	Normal	Present	5.05	557	3.82							5.05	557	Low
2 yr	2 yr	Present	3.80	145	5.71	2 yr	2 yr	Present	3.80	145	5.71	3.80	145	Likely
5 yr	2 yr	Present	4.65	199	5.71	2 yr	5 yr	Present	3.80	145	6.91	4.65	199	Likely
10 yr	2 yr	Present	4.98	244	5.71	2 yr	10 yr	Present	3.80	145	8.00	4.98	244	Likely
25 yr	2 yr	Present	5.27	306	5.71	2 yr	10yr	Present	3.80	145	8.00	5.27	306	Likely
50 yr	2 yr	Present	5.41	353	5.71	2 yr	10yr	Present	3.80	145	8.00	5.41	353	Likely
100 yr	2 yr	Present	5.51	400	5.71	2 yr	10yr	Present	3.80	145	8.00	5.51	400	Likely
250 yr	2 yr	Present	5.68	491	5.71	2 yr	10yr	Present	3.80	145	8.00	5.68	491	Likely
500 yr	2 yr	Present	5.78	557	5.71	2 yr	10yr	Present	3.80	145	8.00	5.78	557	Likely
2 yr	2 yr	Present	3.80	145	5.71	2yr	2 yr	Present	3.80	145	5.71	3.80	145	High
5 yr	5 yr	Present	4.66	199	6.91	5 yr	5 yr	Present	4.66	199	6.91	4.66	199	High
10 yr	10 yr	Present	4.98	244	8.00	10 yr	10 yr	Present	4.98	244	8.00	4.98	244	High
25 yr	10 yr	Present	5.27	306	8.00	10 yr	10yr	Present	4.98	244	8.00	5.27	306	High
50 yr	10 yr	Present	5.46	353	8.00	10 yr	10yr	Present	4.98	244	8.00	5.46	353	High
100 yr	10 yr	Present	5.62	400	8.00	10 yr	10yr	Present	4.98	244	8.00	5.62	400	High
250 yr	10 yr	Present	5.88	491	8.00	10 yr	10yr	Present	4.98	244	8.00	5.88	491	High
500 yr	10 yr	Present	6.03	557	8.00	10 yr	10yr	Present	4.98	244	8.00	6.03	557	High

Mid-Rockaway Hammels - Minimum Facility, Present Tides													
Subbasin H2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.29	227	2.75							3.29	227	Low
5 yr	Normal	Present	3.80	315	2.75							3.80	315	Low
10 yr	Normal	Present	4.28	389	2.75							4.28	389	Low
25 yr	Normal	Present	4.88	489	2.75							4.88	489	Low
50 yr	Normal	Present	5.18	565	2.75							5.18	565	Low
100 yr	Normal	Present	5.41	642	2.75							5.41	642	Low
250 yr	Normal	Present	5.72	790	2.75							5.72	790	Low
500 yr	Normal	Present	5.90	897	2.75							5.90	897	Low
2 yr	2 yr	Present	5.06	227	4.64	2 yr	2 yr	Present	5.06	227	4.64	5.06	227	Likely
5 yr	2 yr	Present	5.30	315	4.64	2 yr	5 yr	Present	5.83	227	5.94	5.83	315	Likely
10 yr	2 yr	Present	5.48	389	4.64	2 yr	10 yr	Present	6.06	227	6.94	6.06	389	Likely
25 yr	2 yr	Present	5.68	489	4.64	2 yr	10yr	Present	6.06	227	6.94	6.06	489	Likely
50 yr	2 yr	Present	5.81	565	4.64	2 yr	10yr	Present	6.06	227	6.94	6.06	565	Likely
100 yr	2 yr	Present	5.94	642	4.64	2 yr	10yr	Present	6.06	227	6.94	6.06	642	Likely
250 yr	2 yr	Present	6.15	790	4.64	2 yr	10yr	Present	6.06	227	6.94	6.15	790	Likely
500 yr	2 yr	Present	6.30	897	4.64	2 yr	10yr	Present	6.06	227	6.94	6.30	897	Likely
2 yr	2 yr	Present	5.06	227	4.64	2yr	2 yr	Present	5.06	227	4.64	5.06	227	High
5 yr	5 yr	Present	6.00	315	5.94	5 yr	5 yr	Present	6.00	315	5.94	6.00	315	High
10 yr	10 yr	Present	6.43	389	6.94	10 yr	10 yr	Present	6.43	389	6.94	6.43	389	High
25 yr	10 yr	Present	6.59	489	6.94	10 yr	10yr	Present	6.43	389	6.94	6.59	489	High
50 yr	10 yr	Present	6.69	565	6.94	10 yr	10yr	Present	6.43	389	6.94	6.69	565	High
100 yr	10 yr	Present	6.78	642	6.94	10 yr	10yr	Present	6.43	389	6.94	6.78	642	High
250 yr	10 yr	Present	6.96	790	6.94	10 yr	10yr	Present	6.43	389	6.94	6.96	790	High
500 yr	10 yr	Present	7.07	897	6.94	10 yr	10yr	Present	6.43	389	6.94	7.07	897	High

Mid-Rockaway Hammels - Pump Alternative 1, Present Tides													
Subbasin H2, 160 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	227	2.75							2.76	227	Low
5 yr	Normal	Present	2.98	315	2.75							2.98	315	Low
10 yr	Normal	Present	3.29	389	2.75							3.29	389	Low
25 yr	Normal	Present	3.85	489	2.75							3.85	489	Low
50 yr	Normal	Present	4.34	565	2.75							4.34	565	Low
100 yr	Normal	Present	4.78	642	2.75							4.78	642	Low
250 yr	Normal	Present	5.32	790	2.75							5.32	790	Low
500 yr	Normal	Present	5.57	897	2.75							5.57	897	Low
2 yr	2 yr	Present	4.38	227	4.64	2 yr	2 yr	Present	4.38	227	4.64	4.38	227	Likely
5 yr	2 yr	Present	4.77	315	4.64	2 yr	5 yr	Present	4.34	227	5.84	4.77	315	Likely
10 yr	2 yr	Present	5.00	389	4.64	2 yr	10 yr	Present	4.34	227	6.94	5.00	389	Likely
25 yr	2 yr	Present	5.27	489	4.64	2 yr	10yr	Present	4.34	227	6.94	5.27	489	Likely
50 yr	2 yr	Present	5.45	565	4.64	2 yr	10yr	Present	4.34	227	6.94	5.45	565	Likely
100 yr	2 yr	Present	5.60	642	4.64	2 yr	10yr	Present	4.34	227	6.94	5.60	642	Likely
250 yr	2 yr	Present	5.84	790	4.64	2 yr	10yr	Present	4.34	227	6.94	5.84	790	Likely
500 yr	2 yr	Present	6.00	897	4.64	2 yr	10yr	Present	4.34	227	6.94	6.00	897	Likely
2 yr	2 yr	Present	4.38	227	4.64	2yr	2 yr	Present	4.38	227	4.64	4.38	227	High
5 yr	5 yr	Present	5.33	315	5.84	5 yr	5 yr	Present	5.33	315	5.84	5.33	315	High
10 yr	10 yr	Present	5.63	389	6.94	10 yr	10 yr	Present	5.63	389	6.94	5.63	389	High
25 yr	10 yr	Present	5.90	489	6.94	10 yr	10yr	Present	5.63	389	6.94	5.90	489	High
50 yr	10 yr	Present	6.05	565	6.94	10 yr	10yr	Present	5.63	389	6.94	6.05	565	High
100 yr	10 yr	Present	6.21	642	6.94	10 yr	10yr	Present	5.63	389	6.94	6.21	642	High
250 yr	10 yr	Present	6.45	790	6.94	10 yr	10yr	Present	5.63	389	6.94	6.45	790	High
500 yr	10 yr	Present	6.60	897	6.94	10 yr	10yr	Present	5.63	389	6.94	6.60	897	High

Mid-Rockaway Hammels - Pump Alternative 2, Present Tides													
Subbasin H2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.74	227	2.75							2.74	227	Low
5 yr	Normal	Present	2.92	315	2.75							2.92	315	Low
10 yr	Normal	Present	3.19	389	2.75							3.19	389	Low
25 yr	Normal	Present	3.72	489	2.75							3.72	489	Low
50 yr	Normal	Present	4.21	565	2.75							4.21	565	Low
100 yr	Normal	Present	4.67	642	2.75							4.67	642	Low
250 yr	Normal	Present	5.27	790	2.75							5.27	790	Low
500 yr	Normal	Present	5.53	897	2.75							5.53	897	Low
2 yr	2 yr	Present	3.62	227	4.64	2 yr	2 yr	Present	3.62	227	4.64	3.62	227	Likely
5 yr	2 yr	Present	4.71	315	4.64	2 yr	5 yr	Present	3.67	227	5.84	4.71	315	Likely
10 yr	2 yr	Present	4.93	389	4.64	2 yr	10 yr	Present	3.72	227	6.94	4.93	389	Likely
25 yr	2 yr	Present	5.21	489	4.64	2 yr	10yr	Present	3.72	227	6.94	5.21	489	Likely
50 yr	2 yr	Present	5.40	565	4.64	2 yr	10yr	Present	3.72	227	6.94	5.40	565	Likely
100 yr	2 yr	Present	5.56	642	4.64	2 yr	10yr	Present	3.72	227	6.94	5.56	642	Likely
250 yr	2 yr	Present	5.80	790	4.64	2 yr	10yr	Present	3.72	227	6.94	5.80	790	Likely
500 yr	2 yr	Present	5.96	897	4.64	2 yr	10yr	Present	3.72	227	6.94	5.96	897	Likely
2 yr	2 yr	Present	3.62	227	4.64	2 yr	2 yr	Present	3.62	227	4.64	3.62	227	High
5 yr	5 yr	Present	5.20	315	5.84	5 yr	5 yr	Present	5.20	315	5.84	5.20	315	High
10 yr	10 yr	Present	5.54	389	6.94	10 yr	10 yr	Present	5.54	389	6.94	5.54	389	High
25 yr	10 yr	Present	5.82	489	6.94	10 yr	10yr	Present	5.54	389	6.94	5.82	489	High
50 yr	10 yr	Present	5.99	565	6.94	10 yr	10yr	Present	5.54	389	6.94	5.99	565	High
100 yr	10 yr	Present	6.15	642	6.94	10 yr	10yr	Present	5.54	389	6.94	6.15	642	High
250 yr	10 yr	Present	6.40	790	6.94	10 yr	10yr	Present	5.54	389	6.94	6.40	790	High
500 yr	10 yr	Present	6.55	897	6.94	10 yr	10yr	Present	5.54	389	6.94	6.55	897	High

Mid-Rockaway Hammels - Minimum Facility, Future Tides													
Subbasin H2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	4.33	227	3.82							4.33	227	Low
5 yr	Normal	Future	4.75	315	3.82							4.75	315	Low
10 yr	Normal	Future	5.06	389	3.82							5.06	389	Low
25 yr	Normal	Future	5.37	489	3.82							5.37	489	Low
50 yr	Normal	Future	5.55	565	3.82							5.55	565	Low
100 yr	Normal	Future	5.70	642	3.82							5.70	642	Low
250 yr	Normal	Future	5.95	790	3.82							5.95	790	Low
500 yr	Normal	Future	6.10	897	3.82							6.10	897	Low
2 yr	2 yr	Future	5.78	227	5.71	2 yr	2 yr	Future	5.78	227	5.71	5.78	227	Likely
5 yr	2 yr	Future	5.95	315	5.71	2 yr	5 yr	Future	6.06	227	6.91	6.06	315	Likely
10 yr	2 yr	Future	6.06	389	5.71	2 yr	10 yr	Future	6.12	227	8.00	6.12	389	Likely
25 yr	2 yr	Future	6.21	489	5.71	2 yr	10yr	Future	6.12	227	8.00	6.21	489	Likely
50 yr	2 yr	Future	6.31	565	5.71	2 yr	10yr	Future	6.12	227	8.00	6.31	565	Likely
100 yr	2 yr	Future	6.41	642	5.71	2 yr	10yr	Future	6.12	227	8.00	6.41	642	Likely
250 yr	2 yr	Future	6.58	790	5.71	2 yr	10yr	Future	6.12	227	8.00	6.58	790	Likely
500 yr	2 yr	Future	6.68	897	5.71	2 yr	10yr	Future	6.12	227	8.00	6.68	897	Likely
2 yr	2 yr	Future	5.78	227	5.71	2yr	2 yr	Future	5.78	227	5.71	5.78	227	High
5 yr	5 yr	Future	6.28	315	6.91	5 yr	5 yr	Future	6.28	315	6.91	6.28	315	High
10 yr	10 yr	Future	6.52	389	8.00	10 yr	10 yr	Future	6.52	389	8.00	6.52	389	High
25 yr	10 yr	Future	6.71	489	8.00	10 yr	10yr	Future	6.52	389	8.00	6.71	489	High
50 yr	10 yr	Future	6.83	565	8.00	10 yr	10yr	Future	6.52	389	8.00	6.83	565	High
100 yr	10 yr	Future	6.95	642	8.00	10 yr	10yr	Future	6.52	389	8.00	6.95	642	High
250 yr	10 yr	Future	7.15	790	8.00	10 yr	10yr	Future	6.52	389	8.00	7.15	790	High
500 yr	10 yr	Future	7.29	897	8.00	10 yr	10yr	Future	6.52	389	8.00	7.29	897	High

Mid-Rockaway Hammels - Pump Alternative 1, Future Tides													
Subbasin H2, 160 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.80	227	3.82							3.80	227	Low
5 yr	Normal	Present	4.04	315	3.82							4.04	315	Low
10 yr	Normal	Present	4.32	389	3.82							4.32	389	Low
25 yr	Normal	Present	4.77	489	3.82							4.77	489	Low
50 yr	Normal	Present	5.08	565	3.82							5.08	565	Low
100 yr	Normal	Present	5.30	642	3.82							5.30	642	Low
250 yr	Normal	Present	5.62	790	3.82							5.62	790	Low
500 yr	Normal	Present	5.80	897	3.82							5.80	897	Low
2 yr	2 yr	Present	4.42	227	5.71	2 yr	2 yr	Present	4.42	227	5.71	4.42	227	Likely
5 yr	2 yr	Present	5.34	315	5.71	2 yr	5 yr	Present	4.34	227	6.91	5.34	315	Likely
10 yr	2 yr	Present	5.58	389	5.71	2 yr	10 yr	Present	4.34	227	8.00	5.58	389	Likely
25 yr	2 yr	Present	5.75	489	5.71	2 yr	10yr	Present	4.34	227	8.00	5.75	489	Likely
50 yr	2 yr	Present	5.86	565	5.71	2 yr	10yr	Present	4.34	227	8.00	5.86	565	Likely
100 yr	2 yr	Present	5.97	642	5.71	2 yr	10yr	Present	4.34	227	8.00	5.97	642	Likely
250 yr	2 yr	Present	6.16	790	5.71	2 yr	10yr	Present	4.34	227	8.00	6.16	790	Likely
500 yr	2 yr	Present	6.29	897	5.71	2 yr	10yr	Present	4.34	227	8.00	6.29	897	Likely
2 yr	2 yr	Present	4.42	227	5.71	2yr	2 yr	Present	4.42	227	5.71	4.42	227	High
5 yr	5 yr	Present	5.34	315	6.91	5 yr	5 yr	Present	5.34	315	6.91	5.34	315	High
10 yr	10 yr	Present	5.63	389	8.00	10 yr	10 yr	Present	5.63	389	8.00	5.63	389	High
25 yr	10 yr	Present	5.89	489	8.00	10 yr	10yr	Present	5.63	389	8.00	5.89	489	High
50 yr	10 yr	Present	6.05	565	8.00	10 yr	10yr	Present	5.63	389	8.00	6.05	565	High
100 yr	10 yr	Present	6.21	642	8.00	10 yr	10yr	Present	5.63	389	8.00	6.21	642	High
250 yr	10 yr	Present	6.45	790	8.00	10 yr	10yr	Present	5.63	389	8.00	6.45	790	High
500 yr	10 yr	Present	6.62	897	8.00	10 yr	10yr	Present	5.63	389	8.00	6.62	897	High

Mid-Rockaway Hammels - Pump Alternative 2, Future Tides													
Subbasin H2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.73	227	3.82							3.73	227	Low
5 yr	Normal	Future	3.97	315	3.82							3.97	315	Low
10 yr	Normal	Future	4.24	389	3.82							4.24	389	Low
25 yr	Normal	Future	4.68	489	3.82							4.68	489	Low
50 yr	Normal	Future	5.00	565	3.82							5.00	565	Low
100 yr	Normal	Future	5.24	642	3.82							5.24	642	Low
250 yr	Normal	Future	5.58	790	3.82							5.58	790	Low
500 yr	Normal	Future	5.76	897	3.82							5.76	897	Low
2 yr	2 yr	Future	3.68	227	5.71	2 yr	2 yr	Future	3.68	227	5.71	3.68	227	Likely
5 yr	2 yr	Future	5.19	315	5.71	2 yr	5 yr	Future	3.72	227	6.91	5.19	315	Likely
10 yr	2 yr	Future	5.53	389	5.71	2 yr	10 yr	Future	3.72	227	8.00	5.53	389	Likely
25 yr	2 yr	Future	5.71	489	5.71	2 yr	10yr	Future	3.72	227	8.00	5.71	489	Likely
50 yr	2 yr	Future	5.82	565	5.71	2 yr	10yr	Future	3.72	227	8.00	5.82	565	Likely
100 yr	2 yr	Future	5.93	642	5.71	2 yr	10yr	Future	3.72	227	8.00	5.93	642	Likely
250 yr	2 yr	Future	6.12	790	5.71	2 yr	10yr	Future	3.72	227	8.00	6.12	790	Likely
500 yr	2 yr	Future	6.26	897	5.71	2 yr	10yr	Future	3.72	227	8.00	6.26	897	Likely
2 yr	2 yr	Future	3.68	227	5.71	2 yr	2 yr	Future	3.68	227	5.71	3.68	227	High
5 yr	5 yr	Future	5.19	315	6.91	5 yr	5 yr	Future	5.19	315	6.91	5.19	315	High
10 yr	10 yr	Future	5.55	389	8.00	10 yr	10 yr	Future	5.55	389	8.00	5.55	389	High
25 yr	10 yr	Future	5.82	489	8.00	10 yr	10yr	Future	5.55	389	8.00	5.82	489	High
50 yr	10 yr	Future	5.99	565	8.00	10 yr	10yr	Future	5.55	389	8.00	5.99	565	High
100 yr	10 yr	Future	6.15	642	8.00	10 yr	10yr	Future	5.55	389	8.00	6.15	642	High
250 yr	10 yr	Future	6.40	790	8.00	10 yr	10yr	Future	5.55	389	8.00	6.40	790	High
500 yr	10 yr	Future	6.56	897	8.00	10 yr	10yr	Future	5.55	389	8.00	6.56	897	High

Mid-Rockaway Arverne - Minimum Facility, Present Tides													
Subbasin A1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	90	2.75							2.76	90	Low
5 yr	Normal	Present	2.76	123	2.75							2.76	123	Low
10 yr	Normal	Present	2.79	152	2.75							2.79	152	Low
25 yr	Normal	Present	2.85	190	2.75							2.85	190	Low
50 yr	Normal	Present	2.91	219	2.75							2.91	219	Low
100 yr	Normal	Present	2.98	248	2.75							2.98	248	Low
250 yr	Normal	Present	3.15	305	2.75							3.15	305	Low
500 yr	Normal	Present	3.29	346	2.75							3.29	346	Low
2 yr	2 yr	Present	4.48	90	4.64	2 yr	2 yr	Present	4.48	90	4.64	4.48	90	Likely
5 yr	2 yr	Present	4.57	123	4.64	2 yr	5 yr	Present	4.79	90	5.84	4.79	123	Likely
10 yr	2 yr	Present	4.62	152	4.64	2 yr	10 yr	Present	4.86	90	6.94	4.86	152	Likely
25 yr	2 yr	Present	4.68	190	4.64	2 yr	10yr	Present	4.86	90	6.94	4.86	190	Likely
50 yr	2 yr	Present	4.73	219	4.64	2 yr	10yr	Present	4.86	90	6.94	4.86	219	Likely
100 yr	2 yr	Present	4.78	248	4.64	2 yr	10yr	Present	4.86	90	6.94	4.86	248	Likely
250 yr	2 yr	Present	4.87	305	4.64	2 yr	10yr	Present	4.86	90	6.94	4.87	305	Likely
500 yr	2 yr	Present	4.94	346	4.64	2 yr	10yr	Present	4.86	90	6.94	4.94	346	Likely
2 yr	2 yr	Present	4.48	90	4.64	2yr	2 yr	Present	4.48	90	4.64	4.48	90	High
5 yr	5 yr	Present	4.99	123	5.84	5 yr	5 yr	Present	4.99	123	5.84	4.99	123	High
10 yr	10 yr	Present	5.24	152	6.94	10 yr	10 yr	Present	5.24	152	6.94	5.24	152	High
25 yr	10 yr	Present	5.41	190	6.94	10 yr	10yr	Present	5.24	152	6.94	5.41	190	High
50 yr	10 yr	Present	5.51	219	6.94	10 yr	10yr	Present	5.24	152	6.94	5.51	219	High
100 yr	10 yr	Present	5.61	248	6.94	10 yr	10yr	Present	5.24	152	6.94	5.61	248	High
250 yr	10 yr	Present	5.78	305	6.94	10 yr	10yr	Present	5.24	152	6.94	5.78	305	High
500 yr	10 yr	Present	5.89	346	6.94	10 yr	10yr	Present	5.24	152	6.94	5.89	346	High

Mid-Rockaway Arverne - Pump Alternative 1, Present Tides													
Subbasin A1, 70 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.66	90	2.75							2.66	90	Low
5 yr	Normal	Present	2.70	123	2.75							2.70	123	Low
10 yr	Normal	Present	2.74	152	2.75							2.74	152	Low
25 yr	Normal	Present	2.75	190	2.75							2.75	190	Low
50 yr	Normal	Present	2.78	219	2.75							2.78	219	Low
100 yr	Normal	Present	2.82	248	2.75							2.82	248	Low
250 yr	Normal	Present	2.94	305	2.75							2.94	305	Low
500 yr	Normal	Present	3.05	346	2.75							3.05	346	Low
2 yr	2 yr	Present	3.47	90	4.64	2 yr	2 yr	Present	3.47	90	4.64	3.47	90	Likely
5 yr	2 yr	Present	4.09	123	4.64	2 yr	5 yr	Present	3.45	90	5.84	4.09	123	Likely
10 yr	2 yr	Present	4.32	152	4.64	2 yr	10 yr	Present	3.46	90	6.94	4.32	152	Likely
25 yr	2 yr	Present	4.44	190	4.64	2 yr	10yr	Present	3.46	90	6.94	4.44	190	Likely
50 yr	2 yr	Present	4.51	219	4.64	2 yr	10yr	Present	3.46	90	6.94	4.51	219	Likely
100 yr	2 yr	Present	4.56	248	4.64	2 yr	10yr	Present	3.46	90	6.94	4.56	248	Likely
250 yr	2 yr	Present	4.66	305	4.64	2 yr	10yr	Present	3.46	90	6.94	4.66	305	Likely
500 yr	2 yr	Present	4.73	346	4.64	2 yr	10yr	Present	3.46	90	6.94	4.73	346	Likely
2 yr	2 yr	Present	3.47	90	4.64	2yr	2 yr	Present	3.47	90	4.64	3.47	90	High
5 yr	5 yr	Present	4.10	123	5.84	5 yr	5 yr	Present	4.10	123	5.84	4.10	123	High
10 yr	10 yr	Present	4.37	152	6.94	10 yr	10 yr	Present	4.37	152	6.94	4.37	152	High
25 yr	10 yr	Present	4.65	190	6.94	10 yr	10yr	Present	4.37	152	6.94	4.65	190	High
50 yr	10 yr	Present	4.82	219	6.94	10 yr	10yr	Present	4.37	152	6.94	4.82	219	High
100 yr	10 yr	Present	4.96	248	6.94	10 yr	10yr	Present	4.37	152	6.94	4.96	248	High
250 yr	10 yr	Present	5.21	305	6.94	10 yr	10yr	Present	4.37	152	6.94	5.21	305	High
500 yr	10 yr	Present	5.35	346	6.94	10 yr	10yr	Present	4.37	152	6.94	5.35	346	High

Mid-Rockaway Arverne - Minimum Facility, Future Tides													
Subbasin A1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.83	90	3.82							3.83	90	Low
5 yr	Normal	Future	3.83	123	3.82							3.83	123	Low
10 yr	Normal	Future	3.86	152	3.82							3.86	152	Low
25 yr	Normal	Future	3.91	190	3.82							3.91	190	Low
50 yr	Normal	Future	3.97	219	3.82							3.97	219	Low
100 yr	Normal	Future	4.03	248	3.82							4.03	248	Low
250 yr	Normal	Future	4.16	305	3.82							4.16	305	Low
500 yr	Normal	Future	4.26	346	3.82							4.26	346	Low
2 yr	2 yr	Future	4.78	90	5.71	2 yr	2 yr	Future	4.78	90	5.71	4.78	90	Likely
5 yr	2 yr	Future	4.98	123	5.71	2 yr	5 yr	Future	4.86	90	6.91	4.98	123	Likely
10 yr	2 yr	Future	5.10	152	5.71	2 yr	10 yr	Future	4.90	90	8.00	5.10	152	Likely
25 yr	2 yr	Future	5.23	190	5.71	2 yr	10yr	Future	4.90	90	8.00	5.23	190	Likely
50 yr	2 yr	Future	5.32	219	5.71	2 yr	10yr	Future	4.90	90	8.00	5.32	219	Likely
100 yr	2 yr	Future	5.39	248	5.71	2 yr	10yr	Future	4.90	90	8.00	5.39	248	Likely
250 yr	2 yr	Future	5.50	305	5.71	2 yr	10yr	Future	4.90	90	8.00	5.50	305	Likely
500 yr	2 yr	Future	5.58	346	5.71	2 yr	10yr	Future	4.90	90	8.00	5.58	346	Likely
2 yr	2 yr	Future	4.78	90	5.71	2yr	2 yr	Future	4.78	90	5.71	4.78	90	High
5 yr	5 yr	Future	5.08	123	6.91	5 yr	5 yr	Future	5.08	123	6.91	5.08	123	High
10 yr	10 yr	Future	5.28	152	8.00	10 yr	10 yr	Future	5.28	152	8.00	5.28	152	High
25 yr	10 yr	Future	5.47	190	8.00	10 yr	10yr	Future	5.28	152	8.00	5.47	190	High
50 yr	10 yr	Future	5.58	219	8.00	10 yr	10yr	Future	5.28	152	8.00	5.58	219	High
100 yr	10 yr	Future	5.68	248	8.00	10 yr	10yr	Future	5.28	152	8.00	5.68	248	High
250 yr	10 yr	Future	5.87	305	8.00	10 yr	10yr	Future	5.28	152	8.00	5.87	305	High
500 yr	10 yr	Future	5.99	346	8.00	10 yr	10yr	Future	5.28	152	8.00	5.99	346	High

Mid-Rockaway Arverne - Pump Alternative 1, Future Tides													
Subbasin A1, 70 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.48	90	3.82							3.48	90	Low
5 yr	Normal	Future	3.71	123	3.82							3.71	123	Low
10 yr	Normal	Future	3.76	152	3.82							3.76	152	Low
25 yr	Normal	Future	3.81	190	3.82							3.81	190	Low
50 yr	Normal	Future	3.84	219	3.82							3.84	219	Low
100 yr	Normal	Future	3.89	248	3.82							3.89	248	Low
250 yr	Normal	Future	3.99	305	3.82							3.99	305	Low
500 yr	Normal	Future	4.08	346	3.82							4.08	346	Low
2 yr	2 yr	Future	3.45	90	5.71	2 yr	2 yr	Future	3.45	90	5.71	3.45	90	Likely
5 yr	2 yr	Future	4.10	123	5.71	2 yr	5 yr	Future	3.46	90	6.91	4.10	123	Likely
10 yr	2 yr	Future	4.38	152	5.71	2 yr	10 yr	Future	3.46	90	8.00	4.38	152	Likely
25 yr	2 yr	Future	4.65	190	5.71	2 yr	10yr	Future	3.46	90	8.00	4.65	190	Likely
50 yr	2 yr	Future	4.82	219	5.71	2 yr	10yr	Future	3.46	90	8.00	4.82	219	Likely
100 yr	2 yr	Future	4.96	248	5.71	2 yr	10yr	Future	3.46	90	8.00	4.96	248	Likely
250 yr	2 yr	Future	5.16	305	5.71	2 yr	10yr	Future	3.46	90	8.00	5.16	305	Likely
500 yr	2 yr	Future	5.26	346	5.71	2 yr	10yr	Future	3.46	90	8.00	5.26	346	Likely
2 yr	2 yr	Future	3.45	90	5.71	2yr	2 yr	Future	3.45	90	5.71	3.45	90	High
5 yr	5 yr	Future	4.10	123	6.91	5 yr	5 yr	Future	4.10	123	6.91	4.10	123	High
10 yr	10 yr	Future	4.37	152	8.00	10 yr	10 yr	Future	4.37	152	8.00	4.37	152	High
25 yr	10 yr	Future	4.64	190	8.00	10 yr	10yr	Future	4.37	152	8.00	4.64	190	High
50 yr	10 yr	Future	4.82	219	8.00	10 yr	10yr	Future	4.37	152	8.00	4.82	219	High
100 yr	10 yr	Future	4.96	248	8.00	10 yr	10yr	Future	4.37	152	8.00	4.96	248	High
250 yr	10 yr	Future	5.21	305	8.00	10 yr	10yr	Future	4.37	152	8.00	5.21	305	High
500 yr	10 yr	Future	5.35	346	8.00	10 yr	10yr	Future	4.37	152	8.00	5.35	346	High

Mid-Rockaway Arverne - Minimum Facility, Present Tides													
Subbasin A2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.53	171	2.75							3.53	171	Low
5 yr	Normal	Present	3.83	235	2.75							3.83	235	Low
10 yr	Normal	Present	4.03	289	2.75							4.03	289	Low
25 yr	Normal	Present	4.26	362	2.75							4.26	362	Low
50 yr	Normal	Present	4.41	418	2.75							4.41	418	Low
100 yr	Normal	Present	4.55	474	2.75							4.55	474	Low
250 yr	Normal	Present	4.78	582	2.75							4.78	582	Low
500 yr	Normal	Present	4.93	660	2.75							4.93	660	Low
2 yr	2 yr	Present	4.37	171	4.64	2 yr	2 yr	Present	4.37	171	4.64	4.37	171	Likely
5 yr	2 yr	Present	4.56	235	4.64	2 yr	5 yr	Present	4.53	171	5.84	4.56	235	Likely
10 yr	2 yr	Present	4.70	289	4.64	2 yr	10 yr	Present	4.59	171	6.94	4.70	289	Likely
25 yr	2 yr	Present	4.86	362	4.64	2 yr	10yr	Present	4.59	171	6.94	4.86	362	Likely
50 yr	2 yr	Present	4.97	418	4.64	2 yr	10yr	Present	4.59	171	6.94	4.97	418	Likely
100 yr	2 yr	Present	5.08	474	4.64	2 yr	10yr	Present	4.59	171	6.94	5.08	474	Likely
250 yr	2 yr	Present	5.27	582	4.64	2 yr	10yr	Present	4.59	171	6.94	5.27	582	Likely
500 yr	2 yr	Present	5.39	660	4.64	2 yr	10yr	Present	4.59	171	6.94	5.39	660	Likely
2 yr	2 yr	Present	4.37	171	4.64	2yr	2 yr	Present	4.37	171	4.64	4.37	171	High
5 yr	5 yr	Present	4.75	235	5.84	5 yr	5 yr	Present	4.75	235	5.84	4.75	235	High
10 yr	10 yr	Present	4.98	289	6.94	10 yr	10 yr	Present	4.98	289	6.94	4.98	289	High
25 yr	10 yr	Present	5.15	362	6.94	10 yr	10yr	Present	4.98	289	6.94	5.15	362	High
50 yr	10 yr	Present	5.27	418	6.94	10 yr	10yr	Present	4.98	289	6.94	5.27	418	High
100 yr	10 yr	Present	5.38	474	6.94	10 yr	10yr	Present	4.98	289	6.94	5.38	474	High
250 yr	10 yr	Present	5.58	582	6.94	10 yr	10yr	Present	4.98	289	6.94	5.58	582	High
500 yr	10 yr	Present	5.70	660	6.94	10 yr	10yr	Present	4.98	289	6.94	5.70	660	High

Mid-Rockaway Arverne - Pump Alternative 1, Present Tides													
Subbasin A2, 120 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.73	171	2.75							2.73	171	Low
5 yr	Normal	Present	3.13	235	2.75							3.13	235	Low
10 yr	Normal	Present	3.47	289	2.75							3.47	289	Low
25 yr	Normal	Present	3.79	362	2.75							3.79	362	Low
50 yr	Normal	Present	3.98	418	2.75							3.98	418	Low
100 yr	Normal	Present	4.15	474	2.75							4.15	474	Low
250 yr	Normal	Present	4.43	582	2.75							4.43	582	Low
500 yr	Normal	Present	4.60	660	2.75							4.60	660	Low
2 yr	2 yr	Present	3.50	171	4.64	2 yr	2 yr	Present	3.50	171	4.64	3.50	171	Likely
5 yr	2 yr	Present	3.94	235	4.64	2 yr	5 yr	Present	3.50	171	5.84	3.94	235	Likely
10 yr	2 yr	Present	4.16	289	4.64	2 yr	10 yr	Present	3.50	171	6.94	4.16	289	Likely
25 yr	2 yr	Present	4.36	362	4.64	2 yr	10yr	Present	3.50	171	6.94	4.36	362	Likely
50 yr	2 yr	Present	4.49	418	4.64	2 yr	10yr	Present	3.50	171	6.94	4.49	418	Likely
100 yr	2 yr	Present	4.60	474	4.64	2 yr	10yr	Present	3.50	171	6.94	4.60	474	Likely
250 yr	2 yr	Present	4.80	582	4.64	2 yr	10yr	Present	3.50	171	6.94	4.80	582	Likely
500 yr	2 yr	Present	4.93	660	4.64	2 yr	10yr	Present	3.50	171	6.94	4.93	660	Likely
2 yr	2 yr	Present	3.50	171	4.64	2yr	2 yr	Present	3.50	171	4.64	3.50	171	High
5 yr	5 yr	Present	3.94	235	5.84	5 yr	5 yr	Present	3.94	235	5.84	3.94	235	High
10 yr	10 yr	Present	4.18	289	6.94	10 yr	10 yr	Present	4.18	289	6.94	4.18	289	High
25 yr	10 yr	Present	4.44	362	6.94	10 yr	10yr	Present	4.18	289	6.94	4.44	362	High
50 yr	10 yr	Present	4.60	418	6.94	10 yr	10yr	Present	4.18	289	6.94	4.60	418	High
100 yr	10 yr	Present	4.75	474	6.94	10 yr	10yr	Present	4.18	289	6.94	4.75	474	High
250 yr	10 yr	Present	4.99	582	6.94	10 yr	10yr	Present	4.18	289	6.94	4.99	582	High
500 yr	10 yr	Present	5.14	660	6.94	10 yr	10yr	Present	4.18	289	6.94	5.14	660	High

Mid-Rockaway Arverne - Pump Alternative 2, Present Tides													
Subbasin A2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.04	171	2.75							2.04	171	Low
5 yr	Normal	Present	2.74	235	2.75							2.74	235	Low
10 yr	Normal	Present	3.07	289	2.75							3.07	289	Low
25 yr	Normal	Present	3.52	362	2.75							3.52	362	Low
50 yr	Normal	Present	3.75	418	2.75							3.75	418	Low
100 yr	Normal	Present	3.94	474	2.75							3.94	474	Low
250 yr	Normal	Present	4.25	582	2.75							4.25	582	Low
500 yr	Normal	Present	4.44	660	2.75							4.44	660	Low
2 yr	2 yr	Present	2.07	171	4.64	2 yr	2 yr	Present	2.07	171	4.64	2.07	171	Likely
5 yr	2 yr	Present	3.47	235	4.64	2 yr	5 yr	Present	2.06	171	5.84	3.47	235	Likely
10 yr	2 yr	Present	3.84	289	4.64	2 yr	10 yr	Present	2.04	171	6.94	3.84	289	Likely
25 yr	2 yr	Present	4.15	362	4.64	2 yr	10yr	Present	2.04	171	6.94	4.15	362	Likely
50 yr	2 yr	Present	4.31	418	4.64	2 yr	10yr	Present	2.04	171	6.94	4.31	418	Likely
100 yr	2 yr	Present	4.43	474	4.64	2 yr	10yr	Present	2.04	171	6.94	4.43	474	Likely
250 yr	2 yr	Present	4.65	582	4.64	2 yr	10yr	Present	2.04	171	6.94	4.65	582	Likely
500 yr	2 yr	Present	4.79	660	4.64	2 yr	10yr	Present	2.04	171	6.94	4.79	660	Likely
2 yr	2 yr	Present	2.07	171	4.64	2yr	2 yr	Present	2.07	171	4.64	2.07	171	High
5 yr	5 yr	Present	3.47	235	5.84	5 yr	5 yr	Present	3.47	235	5.84	3.47	235	High
10 yr	10 yr	Present	3.84	289	6.94	10 yr	10 yr	Present	3.84	289	6.94	3.84	289	High
25 yr	10 yr	Present	4.16	362	6.94	10 yr	10yr	Present	3.84	289	6.94	4.16	362	High
50 yr	10 yr	Present	4.35	418	6.94	10 yr	10yr	Present	3.84	289	6.94	4.35	418	High
100 yr	10 yr	Present	4.51	474	6.94	10 yr	10yr	Present	3.84	289	6.94	4.51	474	High
250 yr	10 yr	Present	4.78	582	6.94	10 yr	10yr	Present	3.84	289	6.94	4.78	582	High
500 yr	10 yr	Present	4.94	660	6.94	10 yr	10yr	Present	3.84	289	6.94	4.94	660	High

Mid-Rockaway Arverne - Minimum Facility, Future Tides													
Subbasin A2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	4.11	171	3.82							4.11	171	Low
5 yr	Normal	Future	4.31	235	3.82							4.31	235	Low
10 yr	Normal	Future	4.45	289	3.82							4.45	289	Low
25 yr	Normal	Future	4.62	362	3.82							4.62	362	Low
50 yr	Normal	Future	4.73	418	3.82							4.73	418	Low
100 yr	Normal	Future	4.84	474	3.82							4.84	474	Low
250 yr	Normal	Future	5.04	582	3.82							5.04	582	Low
500 yr	Normal	Future	5.16	660	3.82							5.16	660	Low
2 yr	2 yr	Future	4.53	171	5.71	2 yr	2 yr	Future	4.53	171	5.71	4.53	171	Likely
5 yr	2 yr	Future	4.74	235	5.71	2 yr	5 yr	Future	4.59	171	6.91	4.74	235	Likely
10 yr	2 yr	Future	4.87	289	5.71	2 yr	10 yr	Future	4.63	171	8.00	4.87	289	Likely
25 yr	2 yr	Future	5.05	362	5.71	2 yr	10yr	Future	4.63	171	8.00	5.05	362	Likely
50 yr	2 yr	Future	5.15	418	5.71	2 yr	10yr	Future	4.63	171	8.00	5.15	418	Likely
100 yr	2 yr	Future	5.25	474	5.71	2 yr	10yr	Future	4.63	171	8.00	5.25	474	Likely
250 yr	2 yr	Future	5.44	582	5.71	2 yr	10yr	Future	4.63	171	8.00	5.44	582	Likely
500 yr	2 yr	Future	5.56	660	5.71	2 yr	10yr	Future	4.63	171	8.00	5.56	660	Likely
2 yr	2 yr	Future	4.53	171	5.71	2yr	2 yr	Future	4.53	171	5.71	4.53	171	High
5 yr	5 yr	Future	4.82	235	6.91	5 yr	5 yr	Future	4.82	235	6.91	4.82	235	High
10 yr	10 yr	Future	5.03	289	8.00	10 yr	10 yr	Future	5.03	289	8.00	5.03	289	High
25 yr	10 yr	Future	5.21	362	8.00	10 yr	10yr	Future	5.03	289	8.00	5.21	362	High
50 yr	10 yr	Future	5.34	418	8.00	10 yr	10yr	Future	5.03	289	8.00	5.34	418	High
100 yr	10 yr	Future	5.45	474	8.00	10 yr	10yr	Future	5.03	289	8.00	5.45	474	High
250 yr	10 yr	Future	5.65	582	8.00	10 yr	10yr	Future	5.03	289	8.00	5.65	582	High
500 yr	10 yr	Future	5.78	660	8.00	10 yr	10yr	Future	5.03	289	8.00	5.78	660	High

Mid-Rockaway Arverne - Pump Alternative 1, Future Tides													
Subbasin A2, 120 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.48	171	3.82							3.48	171	Low
5 yr	Normal	Future	3.76	235	3.82							3.76	235	Low
10 yr	Normal	Future	3.93	289	3.82							3.93	289	Low
25 yr	Normal	Future	4.15	362	3.82							4.15	362	Low
50 yr	Normal	Future	4.29	418	3.82							4.29	418	Low
100 yr	Normal	Future	4.42	474	3.82							4.42	474	Low
250 yr	Normal	Future	4.64	582	3.82							4.64	582	Low
500 yr	Normal	Future	4.79	660	3.82							4.79	660	Low
2 yr	2 yr	Future	3.50	171	5.71	2 yr	2 yr	Future	3.50	171	5.71	3.50	171	Likely
5 yr	2 yr	Future	3.94	235	5.71	2 yr	5 yr	Future	3.50	171	6.91	3.94	235	Likely
10 yr	2 yr	Future	4.18	289	5.71	2 yr	10 yr	Future	3.50	171	8.00	4.18	289	Likely
25 yr	2 yr	Future	4.44	362	5.71	2 yr	10yr	Future	3.50	171	8.00	4.44	362	Likely
50 yr	2 yr	Future	4.60	418	5.71	2 yr	10yr	Future	3.50	171	8.00	4.60	418	Likely
100 yr	2 yr	Future	4.75	474	5.71	2 yr	10yr	Future	3.50	171	8.00	4.75	474	Likely
250 yr	2 yr	Future	4.96	582	5.71	2 yr	10yr	Future	3.50	171	8.00	4.96	582	Likely
500 yr	2 yr	Future	5.09	660	5.71	2 yr	10yr	Future	3.50	171	8.00	5.09	660	Likely
2 yr	2 yr	Future	3.50	171	5.71	2yr	2 yr	Future	3.50	171	5.71	3.50	171	High
5 yr	5 yr	Future	3.93	235	6.91	5 yr	5 yr	Future	3.93	235	6.91	3.93	235	High
10 yr	10 yr	Future	4.18	289	8.00	10 yr	10 yr	Future	4.18	289	8.00	4.18	289	High
25 yr	10 yr	Future	4.44	362	8.00	10 yr	10yr	Future	4.18	289	8.00	4.44	362	High
50 yr	10 yr	Future	4.60	418	8.00	10 yr	10yr	Future	4.18	289	8.00	4.60	418	High
100 yr	10 yr	Future	4.75	474	8.00	10 yr	10yr	Future	4.18	289	8.00	4.75	474	High
250 yr	10 yr	Future	4.99	582	8.00	10 yr	10yr	Future	4.18	289	8.00	4.99	582	High
500 yr	10 yr	Future	5.14	660	8.00	10 yr	10yr	Future	4.18	289	8.00	5.14	660	High

Mid-Rockaway Arverne - Pump Alternative 2, Future Tides													
Subbasin A2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	2.00	171	3.82							2.00	171	Low
5 yr	Normal	Future	3.47	235	3.82							3.47	235	Low
10 yr	Normal	Future	3.71	289	3.82							3.71	289	Low
25 yr	Normal	Future	3.94	362	3.82							3.94	362	Low
50 yr	Normal	Future	4.09	418	3.82							4.09	418	Low
100 yr	Normal	Future	4.24	474	3.82							4.24	474	Low
250 yr	Normal	Future	4.49	582	3.82							4.49	582	Low
500 yr	Normal	Future	4.79	660	3.82							4.79	660	Low
2 yr	2 yr	Future	2.00	171	5.71	2 yr	2 yr	Future	2.00	171	5.71	2.00	171	Likely
5 yr	2 yr	Future	3.47	235	5.71	2 yr	5 yr	Future	2.04	171	6.91	3.47	235	Likely
10 yr	2 yr	Future	3.84	289	5.71	2 yr	10 yr	Future	2.04	171	8.00	3.84	289	Likely
25 yr	2 yr	Future	4.16	362	5.71	2 yr	10yr	Future	2.04	171	8.00	4.16	362	Likely
50 yr	2 yr	Future	4.35	418	5.71	2 yr	10yr	Future	2.04	171	8.00	4.35	418	Likely
100 yr	2 yr	Future	4.51	474	5.71	2 yr	10yr	Future	2.04	171	8.00	4.51	474	Likely
250 yr	2 yr	Future	4.78	582	5.71	2 yr	10yr	Future	2.04	171	8.00	4.78	582	Likely
500 yr	2 yr	Future	4.93	660	5.71	2 yr	10yr	Future	2.04	171	8.00	4.93	660	Likely
2 yr	2 yr	Future	2.00	171	5.71	2yr	2 yr	Future	2.00	171	5.71	2.00	171	High
5 yr	5 yr	Future	3.47	235	6.91	5 yr	5 yr	Future	3.47	235	6.91	3.47	235	High
10 yr	10 yr	Future	3.84	289	8.00	10 yr	10 yr	Future	3.84	289	8.00	3.84	289	High
25 yr	10 yr	Future	4.16	362	8.00	10 yr	10yr	Future	3.84	289	8.00	4.16	362	High
50 yr	10 yr	Future	4.35	418	8.00	10 yr	10yr	Future	3.84	289	8.00	4.35	418	High
100 yr	10 yr	Future	4.51	474	8.00	10 yr	10yr	Future	3.84	289	8.00	4.51	474	High
250 yr	10 yr	Future	4.78	582	8.00	10 yr	10yr	Future	3.84	289	8.00	4.78	582	High
500 yr	10 yr	Future	4.94	660	8.00	10 yr	10yr	Future	3.84	289	8.00	4.94	660	High

Mid-Rockaway Arverne - Minimum Facility, Present Tides													
Subbasin A3 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.05	278	2.75							3.05	278	Low
5 yr	Normal	Present	3.41	387	2.75							3.41	387	Low
10 yr	Normal	Present	3.76	478	2.75							3.76	478	Low
25 yr	Normal	Present	4.27	601	2.75							4.27	601	Low
50 yr	Normal	Present	4.63	695	2.75							4.63	695	Low
100 yr	Normal	Present	4.92	789	2.75							4.92	789	Low
250 yr	Normal	Present	5.39	972	2.75							5.39	972	Low
500 yr	Normal	Present	5.64	1104	2.75							5.64	1104	Low
2 yr	2 yr	Present	4.87	278	4.64	2 yr	2 yr	Present	4.87	278	4.64	4.87	278	Likely
5 yr	2 yr	Present	5.09	387	4.64	2 yr	5 yr	Present	5.71	278	5.84	5.71	387	Likely
10 yr	2 yr	Present	5.27	478	4.64	2 yr	10 yr	Present	5.99	278	6.94	5.99	478	Likely
25 yr	2 yr	Present	5.51	601	4.64	2 yr	10yr	Present	5.99	278	6.94	5.99	601	Likely
50 yr	2 yr	Present	5.66	695	4.64	2 yr	10yr	Present	5.99	278	6.94	5.99	695	Likely
100 yr	2 yr	Present	5.81	789	4.64	2 yr	10yr	Present	5.99	278	6.94	5.99	789	Likely
250 yr	2 yr	Present	6.05	972	4.64	2 yr	10yr	Present	5.99	278	6.94	6.05	972	Likely
500 yr	2 yr	Present	6.21	1104	4.64	2 yr	10yr	Present	5.99	278	6.94	6.21	1104	Likely
2 yr	2 yr	Present	4.87	278	4.64	2yr	2 yr	Present	4.87	278	4.64	4.87	278	High
5 yr	5 yr	Present	5.90	387	5.84	5 yr	5 yr	Present	5.90	387	5.84	5.90	387	High
10 yr	10 yr	Present	6.37	478	6.94	10 yr	10 yr	Present	6.37	478	6.94	6.37	478	High
25 yr	10 yr	Present	6.55	601	6.94	10 yr	10yr	Present	6.37	478	6.94	6.55	601	High
50 yr	10 yr	Present	6.67	695	6.94	10 yr	10yr	Present	6.37	478	6.94	6.67	695	High
100 yr	10 yr	Present	6.78	789	6.94	10 yr	10yr	Present	6.37	478	6.94	6.78	789	High
250 yr	10 yr	Present	6.99	972	6.94	10 yr	10yr	Present	6.37	478	6.94	6.99	972	High
500 yr	10 yr	Present	7.12	1104	6.94	10 yr	10yr	Present	6.37	478	6.94	7.12	1104	High

Mid-Rockaway Arverne - Pump Alternative 1, Present Tides													
Subbasin A3, 200 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.71	278	2.75							2.71	278	Low
5 yr	Normal	Present	2.84	387	2.75							2.84	387	Low
10 yr	Normal	Present	3.05	478	2.75							3.05	478	Low
25 yr	Normal	Present	3.46	601	2.75							3.46	601	Low
50 yr	Normal	Present	3.81	695	2.75							3.81	695	Low
100 yr	Normal	Present	4.19	789	2.75							4.19	789	Low
250 yr	Normal	Present	4.83	972	2.75							4.83	972	Low
500 yr	Normal	Present	5.19	1104	2.75							5.19	1104	Low
2 yr	2 yr	Present	4.34	278	4.64	2 yr	2 yr	Present	4.34	278	4.64	4.34	278	Likely
5 yr	2 yr	Present	4.64	387	4.64	2 yr	5 yr	Present	4.32	278	5.84	4.64	387	Likely
10 yr	2 yr	Present	4.80	478	4.64	2 yr	10 yr	Present	4.31	278	6.94	4.80	478	Likely
25 yr	2 yr	Present	5.04	601	4.64	2 yr	10yr	Present	4.31	278	6.94	5.04	601	Likely
50 yr	2 yr	Present	5.23	695	4.64	2 yr	10yr	Present	4.31	278	6.94	5.23	695	Likely
100 yr	2 yr	Present	5.40	789	4.64	2 yr	10yr	Present	4.31	278	6.94	5.40	789	Likely
250 yr	2 yr	Present	5.70	972	4.64	2 yr	10yr	Present	4.31	278	6.94	5.70	972	Likely
500 yr	2 yr	Present	5.89	1104	4.64	2 yr	10yr	Present	4.31	278	6.94	5.89	1104	Likely
2 yr	2 yr	Present	4.34	278	4.64	2yr	2 yr	Present	4.34	278	4.64	4.34	278	High
5 yr	5 yr	Present	5.15	387	5.84	5 yr	5 yr	Present	5.15	387	5.84	5.15	387	High
10 yr	10 yr	Present	5.52	478	6.94	10 yr	10 yr	Present	5.52	478	6.94	5.52	478	High
25 yr	10 yr	Present	5.86	601	6.94	10 yr	10yr	Present	5.52	478	6.94	5.86	601	High
50 yr	10 yr	Present	6.06	695	6.94	10 yr	10yr	Present	5.52	478	6.94	6.06	695	High
100 yr	10 yr	Present	6.22	789	6.94	10 yr	10yr	Present	5.52	478	6.94	6.22	789	High
250 yr	10 yr	Present	6.47	972	6.94	10 yr	10yr	Present	5.52	478	6.94	6.47	972	High
500 yr	10 yr	Present	6.60	1104	6.94	10 yr	10yr	Present	5.52	478	6.94	6.60	1104	High

Mid-Rockaway Arverne - Pump Alternative 2, Present Tides													
Subbasin A3, 300 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.71	278	2.75							2.71	278	Low
5 yr	Normal	Present	2.84	387	2.75							2.84	387	Low
10 yr	Normal	Present	3.01	478	2.75							3.01	478	Low
25 yr	Normal	Present	3.11	601	2.75							3.11	601	Low
50 yr	Normal	Present	3.43	695	2.75							3.43	695	Low
100 yr	Normal	Present	3.78	789	2.75							3.78	789	Low
250 yr	Normal	Present	4.48	972	2.75							4.48	972	Low
500 yr	Normal	Present	4.90	1104	2.75							4.90	1104	Low
2 yr	2 yr	Present	3.07	278	4.64	2 yr	2 yr	Present	3.07	278	4.64	3.07	278	Likely
5 yr	2 yr	Present	4.39	387	4.64	2 yr	5 yr	Present	3.10	278	5.84	4.39	387	Likely
10 yr	2 yr	Present	4.62	478	4.64	2 yr	10 yr	Present	3.05	278	6.94	4.62	478	Likely
25 yr	2 yr	Present	4.83	601	4.64	2 yr	10yr	Present	3.05	278	6.94	4.83	601	Likely
50 yr	2 yr	Present	5.02	695	4.64	2 yr	10yr	Present	3.05	278	6.94	5.02	695	Likely
100 yr	2 yr	Present	5.20	789	4.64	2 yr	10yr	Present	3.05	278	6.94	5.20	789	Likely
250 yr	2 yr	Present	5.53	972	4.64	2 yr	10yr	Present	3.05	278	6.94	5.53	972	Likely
500 yr	2 yr	Present	5.72	1104	4.64	2 yr	10yr	Present	3.05	278	6.94	5.72	1104	Likely
2 yr	2 yr	Present	3.07	278	4.64	2yr	2 yr	Present	3.07	278	4.64	3.07	278	High
5 yr	5 yr	Present	4.39	387	5.84	5 yr	5 yr	Present	4.39	387	5.84	4.39	387	High
10 yr	10 yr	Present	5.02	478	6.94	10 yr	10 yr	Present	5.02	478	6.94	5.02	478	High
25 yr	10 yr	Present	5.52	601	6.94	10 yr	10yr	Present	5.02	478	6.94	5.52	601	High
50 yr	10 yr	Present	5.77	695	6.94	10 yr	10yr	Present	5.02	478	6.94	5.77	695	High
100 yr	10 yr	Present	5.97	789	6.94	10 yr	10yr	Present	5.02	478	6.94	5.97	789	High
250 yr	10 yr	Present	6.28	972	6.94	10 yr	10yr	Present	5.02	478	6.94	6.28	972	High
500 yr	10 yr	Present	6.46	1104	6.94	10 yr	10yr	Present	5.02	478	6.94	6.46	1104	High

Mid-Rockaway Arverne - Minimum Facility, Future Tides													
Subbasin A3 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	4.10	278	3.82							4.10	278	Low
5 yr	Normal	Future	4.39	387	3.82							4.39	387	Low
10 yr	Normal	Future	4.66	478	3.82							4.66	478	Low
25 yr	Normal	Future	4.99	601	3.82							4.99	601	Low
50 yr	Normal	Future	5.23	695	3.82							5.23	695	Low
100 yr	Normal	Future	5.43	789	3.82							5.43	789	Low
250 yr	Normal	Future	5.75	972	3.82							5.75	972	Low
500 yr	Normal	Future	5.95	1104	3.82							5.95	1104	Low
2 yr	2 yr	Future	5.66	278	5.71	2 yr	2 yr	Future	5.66	278	5.71	5.66	278	Likely
5 yr	2 yr	Future	5.84	387	5.71	2 yr	5 yr	Future	5.99	278	6.91	5.99	387	Likely
10 yr	2 yr	Future	5.97	478	5.71	2 yr	10 yr	Future	6.06	278	8.00	6.06	478	Likely
25 yr	2 yr	Future	6.14	601	5.71	2 yr	10yr	Future	6.06	278	8.00	6.14	601	Likely
50 yr	2 yr	Future	6.25	695	5.71	2 yr	10yr	Future	6.06	278	8.00	6.25	695	Likely
100 yr	2 yr	Future	6.36	789	5.71	2 yr	10yr	Future	6.06	278	8.00	6.36	789	Likely
250 yr	2 yr	Future	6.55	972	5.71	2 yr	10yr	Future	6.06	278	8.00	6.55	972	Likely
500 yr	2 yr	Future	6.68	1104	5.71	2 yr	10yr	Future	6.06	278	8.00	6.68	1104	Likely
2 yr	2 yr	Future	5.66	278	5.71	2yr	2 yr	Future	5.66	278	5.71	5.66	278	High
5 yr	5 yr	Future	6.22	387	6.91	5 yr	5 yr	Future	6.22	387	6.91	6.22	387	High
10 yr	10 yr	Future	6.50	478	8.00	10 yr	10 yr	Future	6.50	478	8.00	6.50	478	High
25 yr	10 yr	Future	6.72	601	8.00	10 yr	10yr	Future	6.50	478	8.00	6.72	601	High
50 yr	10 yr	Future	6.86	695	8.00	10 yr	10yr	Future	6.50	478	8.00	6.86	695	High
100 yr	10 yr	Future	7.00	789	8.00	10 yr	10yr	Future	6.50	478	8.00	7.00	789	High
250 yr	10 yr	Future	7.22	972	8.00	10 yr	10yr	Future	6.50	478	8.00	7.22	972	High
500 yr	10 yr	Future	7.37	1104	8.00	10 yr	10yr	Future	6.50	478	8.00	7.37	1104	High

Mid-Rockaway Arverne - Pump Alternative 1, Future Tides													
Subbasin A3, 200 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.75	278	3.82							3.75	278	Low
5 yr	Normal	Future	3.90	387	3.82							3.90	387	Low
10 yr	Normal	Future	4.09	478	3.82							4.09	478	Low
25 yr	Normal	Future	4.41	601	3.82							4.41	601	Low
50 yr	Normal	Future	4.68	695	3.82							4.68	695	Low
100 yr	Normal	Future	4.92	789	3.82							4.92	789	Low
250 yr	Normal	Future	5.34	972	3.82							5.34	972	Low
500 yr	Normal	Future	5.58	1104	3.82							5.58	1104	Low
2 yr	2 yr	Future	4.31	278	5.71	2 yr	2 yr	Future	4.31	278	5.71	4.31	278	Likely
5 yr	2 yr	Future	5.15	387	5.71	2 yr	5 yr	Future	4.31	278	6.91	5.15	387	Likely
10 yr	2 yr	Future	5.45	478	5.71	2 yr	10 yr	Future	4.31	278	8.00	5.45	478	Likely
25 yr	2 yr	Future	5.65	601	5.71	2 yr	10yr	Future	4.31	278	8.00	5.65	601	Likely
50 yr	2 yr	Future	5.77	695	5.71	2 yr	10yr	Future	4.31	278	8.00	5.77	695	Likely
100 yr	2 yr	Future	5.89	789	5.71	2 yr	10yr	Future	4.31	278	8.00	5.89	789	Likely
250 yr	2 yr	Future	6.11	972	5.71	2 yr	10yr	Future	4.31	278	8.00	6.11	972	Likely
500 yr	2 yr	Future	6.25	1104	5.71	2 yr	10yr	Future	4.31	278	8.00	6.25	1104	Likely
2 yr	2 yr	Future	4.31	278	5.71	2yr	2 yr	Future	4.31	278	5.71	4.31	278	High
5 yr	5 yr	Future	5.14	387	6.91	5 yr	5 yr	Future	5.14	387	6.91	5.14	387	High
10 yr	10 yr	Future	5.52	478	8.00	10 yr	10 yr	Future	5.52	478	8.00	5.52	478	High
25 yr	10 yr	Future	5.86	601	8.00	10 yr	10yr	Future	5.52	478	8.00	5.86	601	High
50 yr	10 yr	Future	6.06	695	8.00	10 yr	10yr	Future	5.52	478	8.00	6.06	695	High
100 yr	10 yr	Future	6.22	789	8.00	10 yr	10yr	Future	5.52	478	8.00	6.22	789	High
250 yr	10 yr	Future	6.52	972	8.00	10 yr	10yr	Future	5.52	478	8.00	6.52	972	High
500 yr	10 yr	Future	6.71	1104	8.00	10 yr	10yr	Future	5.52	478	8.00	6.71	1104	High

Mid-Rockaway Arverne - Pump Alternative 2, Future Tides													
Subbasin A3, 300 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.02	278	3.82							3.02	278	Low
5 yr	Normal	Future	3.77	387	3.82							3.77	387	Low
10 yr	Normal	Future	3.88	478	3.82							3.88	478	Low
25 yr	Normal	Future	4.14	601	3.82							4.14	601	Low
50 yr	Normal	Future	4.39	695	3.82							4.39	695	Low
100 yr	Normal	Future	4.65	789	3.82							4.65	789	Low
250 yr	Normal	Future	5.11	972	3.82							5.11	972	Low
500 yr	Normal	Future	5.58	1104	3.82							5.58	1104	Low
2 yr	2 yr	Future	3.02	278	5.71	2 yr	2 yr	Future	3.02	278	5.71	3.02	278	Likely
5 yr	2 yr	Future	4.39	387	5.71	2 yr	5 yr	Future	3.05	278	6.91	4.39	387	Likely
10 yr	2 yr	Future	5.02	478	5.71	2 yr	10 yr	Future	3.05	278	8.00	5.02	478	Likely
25 yr	2 yr	Future	5.47	601	5.71	2 yr	10yr	Future	3.05	278	8.00	5.47	601	Likely
50 yr	2 yr	Future	5.61	695	5.71	2 yr	10yr	Future	3.05	278	8.00	5.61	695	Likely
100 yr	2 yr	Future	5.74	789	5.71	2 yr	10yr	Future	3.05	278	8.00	5.74	789	Likely
250 yr	2 yr	Future	5.97	972	5.71	2 yr	10yr	Future	3.05	278	8.00	5.97	972	Likely
500 yr	2 yr	Future	6.11	1104	5.71	2 yr	10yr	Future	3.05	278	8.00	6.11	1104	Likely
2 yr	2 yr	Future	3.02	278	5.71	2yr	2 yr	Future	3.02	278	5.71	3.02	278	High
5 yr	5 yr	Future	4.39	387	6.91	5 yr	5 yr	Future	4.39	387	6.91	4.39	387	High
10 yr	10 yr	Future	5.02	478	8.00	10 yr	10 yr	Future	5.02	478	8.00	5.02	478	High
25 yr	10 yr	Future	5.52	601	8.00	10 yr	10yr	Future	5.02	478	8.00	5.52	601	High
50 yr	10 yr	Future	5.77	695	8.00	10 yr	10yr	Future	5.02	478	8.00	5.77	695	High
100 yr	10 yr	Future	5.97	789	8.00	10 yr	10yr	Future	5.02	478	8.00	5.97	789	High
250 yr	10 yr	Future	6.28	972	8.00	10 yr	10yr	Future	5.02	478	8.00	6.28	972	High
500 yr	10 yr	Future	6.48	1104	8.00	10 yr	10yr	Future	5.02	478	8.00	6.48	1104	High

Mid-Rockaway Edgemere - Minimum Facility, Present Tides													
Subbasin E1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.75	195	2.75							2.75	195	Low
5 yr	Normal	Present	2.76	277	2.75							2.76	277	Low
10 yr	Normal	Present	2.77	346	2.75							2.77	346	Low
25 yr	Normal	Present	2.83	439	2.75							2.83	439	Low
50 yr	Normal	Present	2.89	511	2.75							2.89	511	Low
100 yr	Normal	Present	2.97	582	2.75							2.97	582	Low
250 yr	Normal	Present	3.18	721	2.75							3.18	721	Low
500 yr	Normal	Present	3.35	822	2.75							3.35	822	Low
2 yr	2 yr	Present	4.63	195	4.64	2 yr	2 yr	Present	4.63	195	4.64	4.63	195	Likely
5 yr	2 yr	Present	4.65	277	4.64	2 yr	5 yr	Present	5.18	195	5.84	5.18	277	Likely
10 yr	2 yr	Present	4.65	346	4.64	2 yr	10 yr	Present	5.29	195	6.94	5.29	346	Likely
25 yr	2 yr	Present	4.70	439	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	439	Likely
50 yr	2 yr	Present	4.75	511	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	511	Likely
100 yr	2 yr	Present	4.81	582	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	582	Likely
250 yr	2 yr	Present	4.94	721	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	721	Likely
500 yr	2 yr	Present	5.03	822	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	822	Likely
2 yr	2 yr	Present	4.63	195	4.64	2 yr	2 yr	Present	4.63	195	4.64	4.63	195	High
5 yr	5 yr	Present	5.33	277	5.84	5 yr	5 yr	Present	5.33	277	5.84	5.33	277	High
10 yr	10 yr	Present	5.59	346	6.94	10 yr	10 yr	Present	5.59	346	6.94	5.59	346	High
25 yr	10 yr	Present	5.73	439	6.94	10 yr	10yr	Present	5.59	346	6.94	5.73	439	High
50 yr	10 yr	Present	5.82	511	6.94	10 yr	10yr	Present	5.59	346	6.94	5.82	511	High
100 yr	10 yr	Present	5.90	582	6.94	10 yr	10yr	Present	5.59	346	6.94	5.90	582	High
250 yr	10 yr	Present	6.05	721	6.94	10 yr	10yr	Present	5.59	346	6.94	6.05	721	High
500 yr	10 yr	Present	6.15	822	6.94	10 yr	10yr	Present	5.59	346	6.94	6.15	822	High

Mid-Rockaway Edgemere - Pump Alternative 1, Present Tides													
Subbasin E1, 140 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.65	195	2.75							2.65	195	Low
5 yr	Normal	Present	2.70	277	2.75							2.70	277	Low
10 yr	Normal	Present	2.73	346	2.75							2.73	346	Low
25 yr	Normal	Present	2.74	439	2.75							2.74	439	Low
50 yr	Normal	Present	2.77	511	2.75							2.77	511	Low
100 yr	Normal	Present	2.82	582	2.75							2.82	582	Low
250 yr	Normal	Present	2.97	721	2.75							2.97	721	Low
500 yr	Normal	Present	3.11	822	2.75							3.11	822	Low
2 yr	2 yr	Present	4.36	195	4.64	2 yr	2 yr	Present	4.36	195	4.64	4.36	195	Likely
5 yr	2 yr	Present	4.49	277	4.64	2 yr	5 yr	Present	4.48	195	5.84	4.49	277	Likely
10 yr	2 yr	Present	4.55	346	4.64	2 yr	10 yr	Present	4.48	195	6.94	4.55	346	Likely
25 yr	2 yr	Present	4.60	439	4.64	2 yr	10yr	Present	4.48	195	6.94	4.60	439	Likely
50 yr	2 yr	Present	4.64	511	4.64	2 yr	10yr	Present	4.48	195	6.94	4.64	511	Likely
100 yr	2 yr	Present	4.69	582	4.64	2 yr	10yr	Present	4.48	195	6.94	4.69	582	Likely
250 yr	2 yr	Present	4.80	721	4.64	2 yr	10yr	Present	4.48	195	6.94	4.80	721	Likely
500 yr	2 yr	Present	4.89	822	4.64	2 yr	10yr	Present	4.48	195	6.94	4.89	822	Likely
2 yr	2 yr	Present	4.36	195	4.64	2 yr	2 yr	Present	4.36	195	4.64	4.36	195	High
5 yr	5 yr	Present	4.88	277	5.84	5 yr	5 yr	Present	4.88	277	5.84	4.88	277	High
10 yr	10 yr	Present	5.07	346	6.94	10 yr	10 yr	Present	5.07	346	6.94	5.07	346	High
25 yr	10 yr	Present	5.28	439	6.94	10 yr	10yr	Present	5.07	346	6.94	5.28	439	High
50 yr	10 yr	Present	5.41	511	6.94	10 yr	10yr	Present	5.07	346	6.94	5.41	511	High
100 yr	10 yr	Present	5.53	582	6.94	10 yr	10yr	Present	5.07	346	6.94	5.53	582	High
250 yr	10 yr	Present	5.72	721	6.94	10 yr	10yr	Present	5.07	346	6.94	5.72	721	High
500 yr	10 yr	Present	5.83	822	6.94	10 yr	10yr	Present	5.07	346	6.94	5.83	822	High

Mid-Rockaway Edgemere - Pump Alternative 2, Present Tides													
Subbasin E1, 210 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.65	195	2.75							2.65	195	Low
5 yr	Normal	Present	2.70	277	2.75							2.70	277	Low
10 yr	Normal	Present	2.73	346	2.75							2.73	346	Low
25 yr	Normal	Present	2.74	439	2.75							2.74	439	Low
50 yr	Normal	Present	2.77	511	2.75							2.77	511	Low
100 yr	Normal	Present	2.82	582	2.75							2.82	582	Low
250 yr	Normal	Present	2.97	721	2.75							2.97	721	Low
500 yr	Normal	Present	3.01	822	2.75							3.01	822	Low
2 yr	2 yr	Present	3.10	195	4.64	2 yr	2 yr	Present	3.10	195	4.64	3.10	195	Likely
5 yr	2 yr	Present	4.39	277	4.64	2 yr	5 yr	Present	3.04	195	5.84	4.39	277	Likely
10 yr	2 yr	Present	4.49	346	4.64	2 yr	10 yr	Present	3.04	195	6.94	4.49	346	Likely
25 yr	2 yr	Present	4.56	439	4.64	2 yr	10yr	Present	3.04	195	6.94	4.56	439	Likely
50 yr	2 yr	Present	4.59	511	4.64	2 yr	10yr	Present	3.04	195	6.94	4.59	511	Likely
100 yr	2 yr	Present	4.64	582	4.64	2 yr	10yr	Present	3.04	195	6.94	4.64	582	Likely
250 yr	2 yr	Present	4.74	721	4.64	2 yr	10yr	Present	3.04	195	6.94	4.74	721	Likely
500 yr	2 yr	Present	4.82	822	4.64	2 yr	10yr	Present	3.04	195	6.94	4.82	822	Likely
2 yr	2 yr	Present	3.10	195	4.64	2 yr	2 yr	Present	3.10	195	4.64	3.10	195	High
5 yr	5 yr	Present	4.54	277	5.84	5 yr	5 yr	Present	4.54	277	5.84	4.54	277	High
10 yr	10 yr	Present	4.83	346	6.94	10 yr	10 yr	Present	4.83	346	6.94	4.83	346	High
25 yr	10 yr	Present	5.08	439	6.94	10 yr	10yr	Present	4.83	346	6.94	5.08	439	High
50 yr	10 yr	Present	5.22	511	6.94	10 yr	10yr	Present	4.83	346	6.94	5.22	511	High
100 yr	10 yr	Present	5.36	582	6.94	10 yr	10yr	Present	4.83	346	6.94	5.36	582	High
250 yr	10 yr	Present	5.58	721	6.94	10 yr	10yr	Present	4.83	346	6.94	5.58	721	High
500 yr	10 yr	Present	5.71	822	6.94	10 yr	10yr	Present	4.83	346	6.94	5.71	822	High

Mid-Rockaway Edgemere - Minimum Facility, Future Tides													
Subbasin E1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.82	195	3.82							3.82	195	Low
5 yr	Normal	Future	3.83	277	3.82							3.83	277	Low
10 yr	Normal	Future	3.84	346	3.82							3.84	346	Low
25 yr	Normal	Future	3.90	439	3.82							3.90	439	Low
50 yr	Normal	Future	3.97	511	3.82							3.97	511	Low
100 yr	Normal	Future	4.05	582	3.82							4.05	582	Low
250 yr	Normal	Future	4.24	721	3.82							4.24	721	Low
500 yr	Normal	Future	4.39	822	3.82							4.39	822	Low
2 yr	2 yr	Future	5.16	195	5.71	2 yr	2 yr	Future	5.16	195	5.71	5.16	195	Likely
5 yr	2 yr	Future	5.29	277	5.71	2 yr	5 yr	Future	5.29	195	6.91	5.29	277	Likely
10 yr	2 yr	Future	5.37	346	5.71	2 yr	10 yr	Future	5.33	195	8.00	5.37	346	Likely
25 yr	2 yr	Future	5.46	439	5.71	2 yr	10yr	Future	5.33	195	8.00	5.46	439	Likely
50 yr	2 yr	Future	5.53	511	5.71	2 yr	10yr	Future	5.33	195	8.00	5.53	511	Likely
100 yr	2 yr	Future	5.59	582	5.71	2 yr	10yr	Future	5.33	195	8.00	5.59	582	Likely
250 yr	2 yr	Future	5.69	721	5.71	2 yr	10yr	Future	5.33	195	8.00	5.69	721	Likely
500 yr	2 yr	Future	5.76	822	5.71	2 yr	10yr	Future	5.33	195	8.00	5.76	822	Likely
2 yr	2 yr	Future	5.16	195	5.71	2 yr	2 yr	Future	5.16	195	5.71	5.16	195	High
5 yr	5 yr	Future	5.47	277	6.91	5 yr	5 yr	Future	5.47	277	6.91	5.47	277	High
10 yr	10 yr	Future	5.65	346	8.00	10 yr	10 yr	Future	5.65	346	8.00	5.65	346	High
25 yr	10 yr	Future	5.80	439	8.00	10 yr	10yr	Future	5.65	346	8.00	5.80	439	High
50 yr	10 yr	Future	5.90	511	8.00	10 yr	10yr	Future	5.65	346	8.00	5.90	511	High
100 yr	10 yr	Future	6.00	582	8.00	10 yr	10yr	Future	5.65	346	8.00	6.00	582	High
250 yr	10 yr	Future	6.18	721	8.00	10 yr	10yr	Future	5.65	346	8.00	6.18	721	High
500 yr	10 yr	Future	6.29	822	8.00	10 yr	10yr	Future	5.65	346	8.00	6.29	822	High

Mid-Rockaway Edgemere - Pump Alternative 1, Future Tides													
Subbasin E1, 140 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.69	195	3.82							3.69	195	Low
5 yr	Normal	Future	3.76	277	3.82							3.76	277	Low
10 yr	Normal	Future	3.79	346	3.82							3.79	346	Low
25 yr	Normal	Future	3.81	439	3.82							3.81	439	Low
50 yr	Normal	Future	3.84	511	3.82							3.84	511	Low
100 yr	Normal	Future	3.89	582	3.82							3.89	582	Low
250 yr	Normal	Future	4.04	721	3.82							4.04	721	Low
500 yr	Normal	Future	4.18	822	3.82							4.18	822	Low
2 yr	2 yr	Future	4.48	195	5.71	2 yr	2 yr	Future	4.48	195	5.71	4.48	195	Likely
5 yr	2 yr	Future	4.88	277	5.71	2 yr	5 yr	Future	4.48	195	6.91	4.88	277	Likely
10 yr	2 yr	Future	5.05	346	5.71	2 yr	10 yr	Future	4.48	195	8.00	5.05	346	Likely
25 yr	2 yr	Future	5.20	439	5.71	2 yr	10yr	Future	4.48	195	8.00	5.20	439	Likely
50 yr	2 yr	Future	5.28	511	5.71	2 yr	10yr	Future	4.48	195	8.00	5.28	511	Likely
100 yr	2 yr	Future	5.35	582	5.71	2 yr	10yr	Future	4.48	195	8.00	5.35	582	Likely
250 yr	2 yr	Future	5.46	721	5.71	2 yr	10yr	Future	4.48	195	8.00	5.46	721	Likely
500 yr	2 yr	Future	5.54	822	5.71	2 yr	10yr	Future	4.48	195	8.00	5.54	822	Likely
2 yr	2 yr	Future	4.48	195	5.71	2 yr	2 yr	Future	4.48	195	5.71	4.48	195	High
5 yr	5 yr	Future	4.87	277	6.91	5 yr	5 yr	Future	4.87	277	6.91	4.87	277	High
10 yr	10 yr	Future	5.07	346	8.00	10 yr	10 yr	Future	5.07	346	8.00	5.07	346	High
25 yr	10 yr	Future	5.28	439	8.00	10 yr	10yr	Future	5.07	346	8.00	5.28	439	High
50 yr	10 yr	Future	5.41	511	8.00	10 yr	10yr	Future	5.07	346	8.00	5.41	511	High
100 yr	10 yr	Future	5.53	582	8.00	10 yr	10yr	Future	5.07	346	8.00	5.53	582	High
250 yr	10 yr	Future	5.74	721	8.00	10 yr	10yr	Future	5.07	346	8.00	5.74	721	High
500 yr	10 yr	Future	5.87	822	8.00	10 yr	10yr	Future	5.07	346	8.00	5.87	822	High

Mid-Rockaway Edgemere - Pump Alternative 2, Future Tides													
Subbasin E1, 210 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	2.95	248	3.82							2.95	248	Low
5 yr	Normal	Future	3.72	360	3.82							3.72	360	Low
10 yr	Normal	Future	3.76	454	3.82							3.76	454	Low
25 yr	Normal	Future	3.78	584	3.82							3.78	584	Low
50 yr	Normal	Future	3.80	682	3.82							3.80	682	Low
100 yr	Normal	Future	3.83	782	3.82							3.83	782	Low
250 yr	Normal	Future	3.96	974	3.82							3.96	974	Low
500 yr	Normal	Future	4.08	1113	3.82							4.08	1113	Low
2 yr	2 yr	Future	3.04	248	5.71	2 yr	2 yr	Future	3.04	248	5.71	3.04	248	Likely
5 yr	2 yr	Future	4.54	360	5.71	2 yr	5 yr	Future	3.04	248	6.91	4.54	360	Likely
10 yr	2 yr	Future	4.83	454	5.71	2 yr	10 yr	Future	3.04	248	8.00	4.83	454	Likely
25 yr	2 yr	Future	5.07	584	5.71	2 yr	10yr	Future	3.04	248	8.00	5.07	584	Likely
50 yr	2 yr	Future	5.18	682	5.71	2 yr	10yr	Future	3.04	248	8.00	5.18	682	Likely
100 yr	2 yr	Future	5.27	782	5.71	2 yr	10yr	Future	3.04	248	8.00	5.27	782	Likely
250 yr	2 yr	Future	5.40	974	5.71	2 yr	10yr	Future	3.04	248	8.00	5.40	974	Likely
500 yr	2 yr	Future	5.47	1113	5.71	2 yr	10yr	Future	3.04	248	8.00	5.47	1113	Likely
2 yr	2 yr	Future	3.04	248	5.71	2 yr	2 yr	Future	3.04	248	5.71	3.04	248	High
5 yr	5 yr	Future	4.54	360	6.91	5 yr	5 yr	Future	4.54	360	6.91	4.54	360	High
10 yr	10 yr	Future	4.83	454	8.00	10 yr	10 yr	Future	4.83	454	8.00	4.83	454	High
25 yr	10 yr	Future	5.08	584	8.00	10 yr	10yr	Future	4.83	454	8.00	5.08	584	High
50 yr	10 yr	Future	5.22	682	8.00	10 yr	10yr	Future	4.83	454	8.00	5.22	682	High
100 yr	10 yr	Future	5.36	782	8.00	10 yr	10yr	Future	4.83	454	8.00	5.36	782	High
250 yr	10 yr	Future	5.58	974	8.00	10 yr	10yr	Future	4.83	454	8.00	5.58	974	High
500 yr	10 yr	Future	5.72	1113	8.00	10 yr	10yr	Future	4.83	454	8.00	5.72	1113	High

Mid-Rockaway Edgemere - Minimum Facility, Present Tides													
Subbasin E2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	248	2.75							2.76	248	Low
5 yr	Normal	Present	2.76	360	2.75							2.76	360	Low
10 yr	Normal	Present	2.82	454	2.75							2.82	454	Low
25 yr	Normal	Present	2.97	584	2.75							2.97	584	Low
50 yr	Normal	Present	3.12	682	2.75							3.12	682	Low
100 yr	Normal	Present	3.28	782	2.75							3.28	782	Low
250 yr	Normal	Present	3.68	974	2.75							3.68	974	Low
500 yr	Normal	Present	4.01	1113	2.75							4.01	1113	Low
2 yr	2 yr	Present	4.61	248	4.64	2 yr	2 yr	Present	4.61	248	4.64	4.61	248	Likely
5 yr	2 yr	Present	4.65	360	4.64	2 yr	5 yr	Present	5.36	248	5.84	5.36	360	Likely
10 yr	2 yr	Present	4.70	454	4.64	2 yr	10 yr	Present	5.57	248	6.94	5.57	454	Likely
25 yr	2 yr	Present	4.83	584	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	584	Likely
50 yr	2 yr	Present	4.93	682	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	682	Likely
100 yr	2 yr	Present	5.04	782	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	782	Likely
250 yr	2 yr	Present	5.26	974	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	974	Likely
500 yr	2 yr	Present	5.41	1113	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	1113	Likely
2 yr	2 yr	Present	4.61	248	4.64	2 yr	2 yr	Present	4.61	248	4.64	4.61	248	High
5 yr	5 yr	Present	5.53	360	5.84	5 yr	5 yr	Present	5.53	360	5.84	5.53	360	High
10 yr	10 yr	Present	5.96	454	6.94	10 yr	10 yr	Present	5.96	454	6.94	5.96	454	High
25 yr	10 yr	Present	6.14	584	6.94	10 yr	10yr	Present	5.96	454	6.94	6.14	584	High
50 yr	10 yr	Present	6.25	682	6.94	10 yr	10yr	Present	5.96	454	6.94	6.25	682	High
100 yr	10 yr	Present	6.35	782	6.94	10 yr	10yr	Present	5.96	454	6.94	6.35	782	High
250 yr	10 yr	Present	6.52	974	6.94	10 yr	10yr	Present	5.96	454	6.94	6.52	974	High
500 yr	10 yr	Present	6.63	1113	6.94	10 yr	10yr	Present	5.96	454	6.94	6.63	1113	High

Mid-Rockaway Edgemere - Pump Alternative 1, Present Tides													
Subbasin E2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.58	248	2.75							2.58	248	Low
5 yr	Normal	Present	2.68	360	2.75							2.68	360	Low
10 yr	Normal	Present	2.71	454	2.75							2.71	454	Low
25 yr	Normal	Present	2.77	584	2.75							2.77	584	Low
50 yr	Normal	Present	2.87	682	2.75							2.87	682	Low
100 yr	Normal	Present	2.99	782	2.75							2.99	782	Low
250 yr	Normal	Present	3.30	974	2.75							3.30	974	Low
500 yr	Normal	Present	3.58	1113	2.75							3.58	1113	Low
2 yr	2 yr	Present	4.04	248	4.64	2 yr	2 yr	Present	4.04	248	4.64	4.04	248	Likely
5 yr	2 yr	Present	4.43	360	4.64	2 yr	5 yr	Present	4.04	248	5.84	4.43	360	Likely
10 yr	2 yr	Present	4.53	454	4.64	2 yr	10 yr	Present	4.04	248	6.94	4.53	454	Likely
25 yr	2 yr	Present	4.64	584	4.64	2 yr	10yr	Present	4.04	248	6.94	4.64	584	Likely
50 yr	2 yr	Present	4.73	682	4.64	2 yr	10yr	Present	4.04	248	6.94	4.73	682	Likely
100 yr	2 yr	Present	4.83	782	4.64	2 yr	10yr	Present	4.04	248	6.94	4.83	782	Likely
250 yr	2 yr	Present	5.04	974	4.64	2 yr	10yr	Present	4.04	248	6.94	5.04	974	Likely
500 yr	2 yr	Present	5.20	1113	4.64	2 yr	10yr	Present	4.04	248	6.94	5.20	1113	Likely
2 yr	2 yr	Present	4.04	248	4.64	2 yr	2 yr	Present	4.04	248	4.64	4.04	248	High
5 yr	5 yr	Present	5.01	360	5.84	5 yr	5 yr	Present	5.01	360	5.84	5.01	360	High
10 yr	10 yr	Present	5.35	454	6.94	10 yr	10 yr	Present	5.35	454	6.94	5.35	454	High
25 yr	10 yr	Present	5.66	584	6.94	10 yr	10yr	Present	5.35	454	6.94	5.66	584	High
50 yr	10 yr	Present	5.83	682	6.94	10 yr	10yr	Present	5.35	454	6.94	5.83	682	High
100 yr	10 yr	Present	5.95	782	6.94	10 yr	10yr	Present	5.35	454	6.94	5.95	782	High
250 yr	10 yr	Present	6.17	974	6.94	10 yr	10yr	Present	5.35	454	6.94	6.17	974	High
500 yr	10 yr	Present	6.29	1113	6.94	10 yr	10yr	Present	5.35	454	6.94	6.29	1113	High

Mid-Rockaway Edgemere - Pump Alternative 2, Present Tides													
Subbasin E2, 120 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.66	248	2.75							2.66	248	Low
5 yr	Normal	Present	2.72	360	2.75							2.72	360	Low
10 yr	Normal	Present	2.74	454	2.75							2.74	454	Low
25 yr	Normal	Present	2.83	584	2.75							2.83	584	Low
50 yr	Normal	Present	2.94	682	2.75							2.94	682	Low
100 yr	Normal	Present	3.08	782	2.75							3.08	782	Low
250 yr	Normal	Present	3.42	974	2.75							3.42	974	Low
500 yr	Normal	Present	3.72	1113	2.75							3.72	1113	Low
2 yr	2 yr	Present	4.37	248	4.64	2 yr	2 yr	Present	4.37	248	4.64	4.37	248	Likely
5 yr	2 yr	Present	4.51	360	4.64	2 yr	5 yr	Present	4.83	248	5.84	4.83	360	Likely
10 yr	2 yr	Present	4.59	454	4.64	2 yr	10 yr	Present	4.83	248	6.94	4.83	454	Likely
25 yr	2 yr	Present	4.70	584	4.64	2 yr	10yr	Present	4.83	248	6.94	4.83	584	Likely
50 yr	2 yr	Present	4.79	682	4.64	2 yr	10yr	Present	4.83	248	6.94	4.83	682	Likely
100 yr	2 yr	Present	4.90	782	4.64	2 yr	10yr	Present	4.83	248	6.94	4.90	782	Likely
250 yr	2 yr	Present	5.11	974	4.64	2 yr	10yr	Present	4.83	248	6.94	5.11	974	Likely
500 yr	2 yr	Present	5.27	1113	4.64	2 yr	10yr	Present	4.83	248	6.94	5.27	1113	Likely
2 yr	2 yr	Present	4.37	248	4.64	2 yr	2 yr	Present	4.37	248	4.64	4.37	248	High
5 yr	5 yr	Present	5.22	360	5.84	5 yr	5 yr	Present	5.22	360	5.84	5.22	360	High
10 yr	10 yr	Present	5.58	454	6.94	10 yr	10 yr	Present	5.58	454	6.94	5.58	454	High
25 yr	10 yr	Present	5.81	584	6.94	10 yr	10yr	Present	5.58	454	6.94	5.81	584	High
50 yr	10 yr	Present	5.94	682	6.94	10 yr	10yr	Present	5.58	454	6.94	5.94	682	High
100 yr	10 yr	Present	6.07	782	6.94	10 yr	10yr	Present	5.58	454	6.94	6.07	782	High
250 yr	10 yr	Present	6.26	974	6.94	10 yr	10yr	Present	5.58	454	6.94	6.26	974	High
500 yr	10 yr	Present	6.39	1113	6.94	10 yr	10yr	Present	5.58	454	6.94	6.39	1113	High

Mid-Rockaway Edgemere - Minimum Facility, Future Tides													
Subbasin E2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.82	248	3.82							3.82	248	Low
5 yr	Normal	Future	3.83	360	3.82							3.83	360	Low
10 yr	Normal	Future	3.90	454	3.82							3.90	454	Low
25 yr	Normal	Future	4.04	584	3.82							4.04	584	Low
50 yr	Normal	Future	4.18	682	3.82							4.18	682	Low
100 yr	Normal	Future	4.33	782	3.82							4.33	782	Low
250 yr	Normal	Future	4.66	974	3.82							4.66	974	Low
500 yr	Normal	Future	4.88	1113	3.82							4.88	1113	Low
2 yr	2 yr	Future	5.31	248	5.71	2 yr	2 yr	Future	5.31	248	5.71	5.31	248	Likely
5 yr	2 yr	Future	5.47	360	5.71	2 yr	5 yr	Future	5.56	248	6.91	5.56	360	Likely
10 yr	2 yr	Future	5.58	454	5.71	2 yr	10 yr	Future	5.64	248	8.00	5.64	454	Likely
25 yr	2 yr	Future	5.70	584	5.71	2 yr	10yr	Future	5.64	248	8.00	5.70	584	Likely
50 yr	2 yr	Future	5.79	682	5.71	2 yr	10yr	Future	5.64	248	8.00	5.79	682	Likely
100 yr	2 yr	Future	5.86	782	5.71	2 yr	10yr	Future	5.64	248	8.00	5.86	782	Likely
250 yr	2 yr	Future	6.02	974	5.71	2 yr	10yr	Future	5.64	248	8.00	6.02	974	Likely
500 yr	2 yr	Future	6.13	1113	5.71	2 yr	10yr	Future	5.64	248	8.00	6.13	1113	Likely
2 yr	2 yr	Future	5.31	248	5.71	2 yr	2 yr	Future	5.31	248	5.71	5.31	248	High
5 yr	5 yr	Future	5.80	360	6.91	5 yr	5 yr	Future	5.80	360	6.91	5.80	360	High
10 yr	10 yr	Future	6.07	454	8.00	10 yr	10 yr	Future	6.07	454	8.00	6.07	454	High
25 yr	10 yr	Future	6.28	584	8.00	10 yr	10yr	Future	6.07	454	8.00	6.28	584	High
50 yr	10 yr	Future	6.41	682	8.00	10 yr	10yr	Future	6.07	454	8.00	6.41	682	High
100 yr	10 yr	Future	6.54	782	8.00	10 yr	10yr	Future	6.07	454	8.00	6.54	782	High
250 yr	10 yr	Future	6.76	974	8.00	10 yr	10yr	Future	6.07	454	8.00	6.76	974	High
500 yr	10 yr	Future	6.89	1113	8.00	10 yr	10yr	Future	6.07	454	8.00	6.77	1113	High

Mid-Rockaway Edgemere - Pump Alternative 1, Future Tides													
Subbasin E2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.54	248	3.82							3.54	248	Low
5 yr	Normal	Future	3.71	360	3.82							3.71	360	Low
10 yr	Normal	Future	3.77	454	3.82							3.77	454	Low
25 yr	Normal	Future	3.85	584	3.82							3.85	584	Low
50 yr	Normal	Future	3.94	682	3.82							3.94	682	Low
100 yr	Normal	Future	4.06	782	3.82							4.06	782	Low
250 yr	Normal	Future	4.35	974	3.82							4.35	974	Low
500 yr	Normal	Future	4.58	1113	3.82							4.58	1113	Low
2 yr	2 yr	Future	4.04	248	5.71	2 yr	2 yr	Future	4.04	248	5.71	4.04	248	Likely
5 yr	2 yr	Future	5.00	360	5.71	2 yr	5 yr	Future	4.04	248	6.91	5.00	360	Likely
10 yr	2 yr	Future	5.22	454	5.71	2 yr	10 yr	Future	4.04	248	8.00	5.22	454	Likely
25 yr	2 yr	Future	5.39	584	5.71	2 yr	10yr	Future	4.04	248	8.00	5.39	584	Likely
50 yr	2 yr	Future	5.48	682	5.71	2 yr	10yr	Future	4.04	248	8.00	5.48	682	Likely
100 yr	2 yr	Future	5.57	782	5.71	2 yr	10yr	Future	4.04	248	8.00	5.57	782	Likely
250 yr	2 yr	Future	5.73	974	5.71	2 yr	10yr	Future	4.04	248	8.00	5.73	974	Likely
500 yr	2 yr	Future	5.83	1113	5.71	2 yr	10yr	Future	4.04	248	8.00	5.83	1113	Likely
2 yr	2 yr	Future	4.04	248	5.71	2 yr	2 yr	Future	4.04	248	5.71	4.04	248	High
5 yr	5 yr	Future	5.01	360	6.91	5 yr	5 yr	Future	5.01	360	6.91	5.01	360	High
10 yr	10 yr	Future	5.35	454	8.00	10 yr	10 yr	Future	5.35	454	8.00	5.35	454	High
25 yr	10 yr	Future	5.66	584	8.00	10 yr	10yr	Future	5.35	454	8.00	5.66	584	High
50 yr	10 yr	Future	5.84	682	8.00	10 yr	10yr	Future	5.35	454	8.00	5.84	682	High
100 yr	10 yr	Future	6.00	782	8.00	10 yr	10yr	Future	5.35	454	8.00	6.00	782	High
250 yr	10 yr	Future	6.28	974	8.00	10 yr	10yr	Future	5.35	454	8.00	6.28	974	High
500 yr	10 yr	Future	6.45	1113	8.00	10 yr	10yr	Future	5.35	454	8.00	6.45	1113	High

Mid-Rockaway Edgemere - Pump Alternative 2, Future Tides													
Subbasin E2, 120 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.68	248	3.82							3.68	248	Low
5 yr	Normal	Future	3.76	360	3.82							3.76	360	Low
10 yr	Normal	Future	3.81	454	3.82							3.81	454	Low
25 yr	Normal	Future	3.90	584	3.82							3.90	584	Low
50 yr	Normal	Future	4.01	682	3.82							4.01	682	Low
100 yr	Normal	Future	4.14	782	3.82							4.14	782	Low
250 yr	Normal	Future	4.45	974	3.82							4.45	974	Low
500 yr	Normal	Future	4.68	1113	3.82							4.68	1113	Low
2 yr	2 yr	Future	4.83	248	5.71	2 yr	2 yr	Future	4.83	248	5.71	4.83	248	Likely
5 yr	2 yr	Future	5.19	360	5.71	2 yr	5 yr	Future	4.83	248	6.91	5.19	360	Likely
10 yr	2 yr	Future	5.33	454	5.71	2 yr	10 yr	Future	4.83	248	8.00	5.33	454	Likely
25 yr	2 yr	Future	5.47	584	5.71	2 yr	10yr	Future	4.83	248	8.00	5.47	584	Likely
50 yr	2 yr	Future	5.55	682	5.71	2 yr	10yr	Future	4.83	248	8.00	5.55	682	Likely
100 yr	2 yr	Future	5.64	782	5.71	2 yr	10yr	Future	4.83	248	8.00	5.64	782	Likely
250 yr	2 yr	Future	5.80	974	5.71	2 yr	10yr	Future	4.83	248	8.00	5.80	974	Likely
500 yr	2 yr	Future	5.91	1113	5.71	2 yr	10yr	Future	4.83	248	8.00	5.91	1113	Likely
2 yr	2 yr	Future	4.83	248	5.71	2 yr	2 yr	Future	4.83	248	5.71	4.83	248	High
5 yr	5 yr	Future	5.32	360	6.91	5 yr	5 yr	Future	5.32	360	6.91	5.32	360	High
10 yr	10 yr	Future	5.59	454	8.00	10 yr	10 yr	Future	5.59	454	8.00	5.59	454	High
25 yr	10 yr	Future	5.84	584	8.00	10 yr	10yr	Future	5.59	454	8.00	5.84	584	High
50 yr	10 yr	Future	6.02	682	8.00	10 yr	10yr	Future	5.59	454	8.00	6.02	682	High
100 yr	10 yr	Future	6.17	782	8.00	10 yr	10yr	Future	5.59	454	8.00	6.17	782	High
250 yr	10 yr	Future	6.42	974	8.00	10 yr	10yr	Future	5.59	454	8.00	6.42	974	High
500 yr	10 yr	Future	6.58	1113	8.00	10 yr	10yr	Future	5.59	454	8.00	6.58	1113	High

Canarsie - Minimum Facility, Present Tides													
Subbasin C1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.88	165	2.75							2.88	165	Low
5 yr	Normal	Present	3.10	227	2.75							3.10	227	Low
10 yr	Normal	Present	3.32	279	2.75							3.32	279	Low
25 yr	Normal	Present	3.62	348	2.75							3.62	348	Low
50 yr	Normal	Present	4.08	401	2.75							4.08	401	Low
100 yr	Normal	Present	4.49	455	2.75							4.49	455	Low
250 yr	Normal	Present	5.18	559	2.75							5.18	559	Low
500 yr	Normal	Present	5.63	634	2.75							5.63	634	Low
2 yr	2 yr	Present	4.77	165	4.64	2 yr	2 yr	Present	4.77	165	4.64	4.77	165	Likely
5 yr	2 yr	Present	4.95	227	4.64	2 yr	5 yr	Present	5.96	165	5.84	5.96	227	Likely
10 yr	2 yr	Present	5.12	279	4.64	2 yr	10 yr	Present	6.88	165	6.94	6.88	279	Likely
25 yr	2 yr	Present	5.39	348	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	348	Likely
50 yr	2 yr	Present	5.61	401	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	401	Likely
100 yr	2 yr	Present	5.84	455	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	455	Likely
250 yr	2 yr	Present	6.30	559	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	559	Likely
500 yr	2 yr	Present	6.59	634	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	634	Likely
2 yr	2 yr	Present	4.77	165	4.64	2 yr	2 yr	Present	4.77	165	4.64	4.77	165	High
5 yr	5 yr	Present	6.11	227	5.84	5 yr	5 yr	Present	6.11	227	5.84	6.11	227	High
10 yr	10 yr	Present	7.21	279	6.94	10 yr	10 yr	Present	7.21	279	6.94	7.21	279	High
25 yr	10 yr	Present	7.38	348	6.94	10 yr	10yr	Present	7.21	279	6.94	7.38	348	High
50 yr	10 yr	Present	7.50	401	6.94	10 yr	10yr	Present	7.21	279	6.94	7.50	401	High
100 yr	10 yr	Present	7.63	455	6.94	10 yr	10yr	Present	7.21	279	6.94	7.63	455	High
250 yr	10 yr	Present	7.85	559	6.94	10 yr	10yr	Present	7.21	279	6.94	7.85	559	High
500 yr	10 yr	Present	8.01	634	6.94	10 yr	10yr	Present	7.21	279	6.94	8.01	634	High

Canarsie - Pump Alternative 1, Present Tides													
Subbasin C1, 70 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.75	165	2.75							2.75	165	Low
5 yr	Normal	Present	2.88	227	2.75							2.88	227	Low
10 yr	Normal	Present	3.03	279	2.75							3.03	279	Low
25 yr	Normal	Present	3.31	348	2.75							3.31	348	Low
50 yr	Normal	Present	3.53	401	2.75							3.53	401	Low
100 yr	Normal	Present	3.93	455	2.75							3.93	455	Low
250 yr	Normal	Present	4.73	559	2.75							4.73	559	Low
500 yr	Normal	Present	5.20	634	2.75							5.20	634	Low
2 yr	2 yr	Present	4.63	165	4.64	2 yr	2 yr	Present	4.63	165	4.64	4.63	165	Likely
5 yr	2 yr	Present	4.75	227	4.64	2 yr	5 yr	Present	5.68	165	5.84	5.68	227	Likely
10 yr	2 yr	Present	4.89	279	4.64	2 yr	10 yr	Present	5.96	165	6.94	5.96	279	Likely
25 yr	2 yr	Present	5.11	348	4.64	2 yr	10yr	Present	5.96	165	6.94	5.96	348	Likely
50 yr	2 yr	Present	5.32	401	4.64	2 yr	10yr	Present	5.96	165	6.94	5.96	401	Likely
100 yr	2 yr	Present	5.53	455	4.64	2 yr	10yr	Present	5.96	165	6.94	5.96	455	Likely
250 yr	2 yr	Present	5.97	559	4.64	2 yr	10yr	Present	5.96	165	6.94	5.97	559	Likely
500 yr	2 yr	Present	6.30	634	4.64	2 yr	10yr	Present	5.96	165	6.94	6.30	634	Likely
2 yr	2 yr	Present	4.63	165	4.64	2 yr	2 yr	Present	4.63	165	4.64	4.63	165	High
5 yr	5 yr	Present	5.86	227	5.84	5 yr	5 yr	Present	5.86	227	5.84	5.86	227	High
10 yr	10 yr	Present	6.80	279	6.94	10 yr	10 yr	Present	6.80	279	6.94	6.80	279	High
25 yr	10 yr	Present	6.98	348	6.94	10 yr	10yr	Present	6.80	279	6.94	6.98	348	High
50 yr	10 yr	Present	7.11	401	6.94	10 yr	10yr	Present	6.80	279	6.94	7.11	401	High
100 yr	10 yr	Present	7.25	455	6.94	10 yr	10yr	Present	6.80	279	6.94	7.25	455	High
250 yr	10 yr	Present	7.51	559	6.94	10 yr	10yr	Present	6.80	279	6.94	7.51	559	High
500 yr	10 yr	Present	7.70	634	6.94	10 yr	10yr	Present	6.80	279	6.94	7.70	634	High

Canarsie - Pump Alternative 2, Present Tides													
Subbasin C1, 150 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.62	165	2.75							2.62	165	Low
5 yr	Normal	Present	2.72	227	2.75							2.72	227	Low
10 yr	Normal	Present	2.81	279	2.75							2.81	279	Low
25 yr	Normal	Present	3.00	348	2.75							3.00	348	Low
50 yr	Normal	Present	3.20	401	2.75							3.20	401	Low
100 yr	Normal	Present	3.39	455	2.75							3.39	455	Low
250 yr	Normal	Present	4.12	559	2.75							4.12	559	Low
500 yr	Normal	Present	4.68	634	2.75							4.68	634	Low
2 yr	2 yr	Present	2.92	165	4.64	2 yr	2 yr	Present	2.92	165	4.64	2.92	165	Likely
5 yr	2 yr	Present	4.59	227	4.64	2 yr	5 yr	Present	2.38	165	5.84	4.59	227	Likely
10 yr	2 yr	Present	4.69	279	4.64	2 yr	10 yr	Present	2.43	165	6.94	4.69	279	Likely
25 yr	2 yr	Present	4.86	348	4.64	2 yr	10yr	Present	2.43	165	6.94	4.86	348	Likely
50 yr	2 yr	Present	5.01	401	4.64	2 yr	10yr	Present	2.43	165	6.94	5.01	401	Likely
100 yr	2 yr	Present	5.20	455	4.64	2 yr	10yr	Present	2.43	165	6.94	5.20	455	Likely
250 yr	2 yr	Present	5.61	559	4.64	2 yr	10yr	Present	2.43	165	6.94	5.61	559	Likely
500 yr	2 yr	Present	5.92	634	4.64	2 yr	10yr	Present	2.43	165	6.94	5.92	634	Likely
2 yr	2 yr	Present	2.92	165	4.64	2 yr	2 yr	Present	2.92	165	4.64	2.92	165	High
5 yr	5 yr	Present	5.41	227	5.84	5 yr	5 yr	Present	5.41	227	5.84	5.41	227	High
10 yr	10 yr	Present	6.09	279	6.94	10 yr	10 yr	Present	6.09	279	6.94	6.09	279	High
25 yr	10 yr	Present	6.68	348	6.94	10 yr	10yr	Present	6.09	279	6.94	6.68	348	High
50 yr	10 yr	Present	6.84	401	6.94	10 yr	10yr	Present	6.09	279	6.94	6.84	401	High
100 yr	10 yr	Present	6.98	455	6.94	10 yr	10yr	Present	6.09	279	6.94	6.98	455	High
250 yr	10 yr	Present	7.23	559	6.94	10 yr	10yr	Present	6.09	279	6.94	7.23	559	High
500 yr	10 yr	Present	7.40	634	6.94	10 yr	10yr	Present	6.09	279	6.94	7.40	634	High

Canarsie - Minimum Facility, Future Tides													
Subbasin C1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.96	165	3.82							3.96	165	Low
5 yr	Normal	Future	4.16	227	3.82							4.16	227	Low
10 yr	Normal	Future	4.35	279	3.82							4.35	279	Low
25 yr	Normal	Future	4.66	348	3.82							4.66	348	Low
50 yr	Normal	Future	4.93	401	3.82							4.93	401	Low
100 yr	Normal	Future	5.20	455	3.82							5.20	455	Low
250 yr	Normal	Future	5.70	559	3.82							5.70	559	Low
500 yr	Normal	Future	6.07	634	3.82							6.07	634	Low
2 yr	2 yr	Future	5.83	165	5.71	2 yr	2 yr	Future	5.83	165	5.71	5.83	165	Likely
5 yr	2 yr	Future	5.98	227	5.71	2 yr	5 yr	Future	6.86	165	6.91	6.86	227	Likely
10 yr	2 yr	Future	6.13	279	5.71	2 yr	10 yr	Future	7.37	165	8.00	7.37	279	Likely
25 yr	2 yr	Future	6.35	348	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	348	Likely
50 yr	2 yr	Future	6.54	401	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	401	Likely
100 yr	2 yr	Future	6.71	455	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	455	Likely
250 yr	2 yr	Future	7.03	559	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	559	Likely
500 yr	2 yr	Future	7.24	634	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	634	Likely
2 yr	2 yr	Future	5.83	165	5.71	2 yr	2 yr	Future	5.83	165	5.71	5.83	165	High
5 yr	5 yr	Future	7.04	227	6.91	5 yr	5 yr	Future	7.04	227	6.91	7.04	227	High
10 yr	10 yr	Future	7.83	279	8.00	10 yr	10 yr	Future	7.83	279	8.00	7.83	279	High
25 yr	10 yr	Future	8.02	348	8.00	10 yr	10yr	Future	7.83	279	8.00	8.02	348	High
50 yr	10 yr	Future	8.14	401	8.00	10 yr	10yr	Future	7.83	279	8.00	8.14	401	High
100 yr	10 yr	Future	8.26	455	8.00	10 yr	10yr	Future	7.83	279	8.00	8.26	455	High
250 yr	10 yr	Future	8.48	559	8.00	10 yr	10yr	Future	7.83	279	8.00	8.48	559	High
500 yr	10 yr	Future	8.63	634	8.00	10 yr	10yr	Future	7.83	279	8.00	8.63	634	High

Canarsie - Pump Alternative 1, Future Tides													
Subbasin C1, 70 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.82	165	3.82							3.82	165	Low
5 yr	Normal	Future	3.94	227	3.82							3.94	227	Low
10 yr	Normal	Future	4.10	279	3.82							4.10	279	Low
25 yr	Normal	Future	4.35	348	3.82							4.35	348	Low
50 yr	Normal	Future	4.58	401	3.82							4.58	401	Low
100 yr	Normal	Future	4.83	455	3.82							4.83	455	Low
250 yr	Normal	Future	5.34	559	3.82							5.34	559	Low
500 yr	Normal	Future	5.70	634	3.82							5.70	634	Low
2 yr	2 yr	Future	5.59	165	5.71	2 yr	2 yr	Future	5.59	165	5.71	5.59	165	Likely
5 yr	2 yr	Future	5.76	227	5.71	2 yr	5 yr	Future	5.96	165	6.91	5.96	227	Likely
10 yr	2 yr	Future	5.89	279	5.71	2 yr	10 yr	Future	5.96	165	8.00	5.96	279	Likely
25 yr	2 yr	Future	6.09	348	5.71	2 yr	10yr	Future	5.96	165	8.00	6.09	348	Likely
50 yr	2 yr	Future	6.26	401	5.71	2 yr	10yr	Future	5.96	165	8.00	6.26	401	Likely
100 yr	2 yr	Future	6.44	455	5.71	2 yr	10yr	Future	5.96	165	8.00	6.44	455	Likely
250 yr	2 yr	Future	6.78	559	5.71	2 yr	10yr	Future	5.96	165	8.00	6.78	559	Likely
500 yr	2 yr	Future	7.01	634	5.71	2 yr	10yr	Future	5.96	165	8.00	7.01	634	Likely
2 yr	2 yr	Future	5.59	165	5.71	2 yr	2 yr	Future	5.59	165	5.71	5.59	165	High
5 yr	5 yr	Future	6.59	227	6.91	5 yr	5 yr	Future	6.59	227	6.91	6.59	227	High
10 yr	10 yr	Future	7.12	279	8.00	10 yr	10 yr	Future	7.12	279	8.00	7.12	279	High
25 yr	10 yr	Future	7.48	348	8.00	10 yr	10yr	Future	7.12	279	8.00	7.48	348	High
50 yr	10 yr	Future	7.66	401	8.00	10 yr	10yr	Future	7.12	279	8.00	7.66	401	High
100 yr	10 yr	Future	7.79	455	8.00	10 yr	10yr	Future	7.12	279	8.00	7.79	455	High
250 yr	10 yr	Future	8.03	559	8.00	10 yr	10yr	Future	7.12	279	8.00	8.03	559	High
500 yr	10 yr	Future	8.18	634	8.00	10 yr	10yr	Future	7.12	279	8.00	8.18	634	High

Canarsie - Pump Alternative 2, Future Tides													
Subbasin C1, 150 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	2.56	165	3.82							2.56	165	Low
5 yr	Normal	Future	3.79	227	3.82							3.79	227	Low
10 yr	Normal	Future	3.88	279	3.82							3.88	279	Low
25 yr	Normal	Future	4.06	348	3.82							4.06	348	Low
50 yr	Normal	Future	4.25	401	3.82							4.25	401	Low
100 yr	Normal	Future	4.46	455	3.82							4.46	455	Low
250 yr	Normal	Future	4.95	559	3.82							4.95	559	Low
500 yr	Normal	Future	5.31	634	3.82							5.31	634	Low
2 yr	2 yr	Future	2.26	165	5.71	2 yr	2 yr	Future	2.26	165	5.71	2.26	165	Likely
5 yr	2 yr	Future	5.41	227	5.71	2 yr	5 yr	Future	2.43	165	6.91	5.41	227	Likely
10 yr	2 yr	Future	5.64	279	5.71	2 yr	10 yr	Future	2.43	165	8.00	5.64	279	Likely
25 yr	2 yr	Future	5.83	348	5.71	2 yr	10yr	Future	2.43	165	8.00	5.83	348	Likely
50 yr	2 yr	Future	5.98	401	5.71	2 yr	10yr	Future	2.43	165	8.00	5.98	401	Likely
100 yr	2 yr	Future	6.14	455	5.71	2 yr	10yr	Future	2.43	165	8.00	6.14	455	Likely
250 yr	2 yr	Future	6.47	559	5.71	2 yr	10yr	Future	2.43	165	8.00	6.47	559	Likely
500 yr	2 yr	Future	6.70	634	5.71	2 yr	10yr	Future	2.43	165	8.00	6.70	634	Likely
2 yr	2 yr	Future	2.26	165	5.71	2 yr	2 yr	Future	2.26	165	5.71	2.26	165	High
5 yr	5 yr	Future	5.38	227	6.91	5 yr	5 yr	Future	5.38	227	6.91	5.38	227	High
10 yr	10 yr	Future	6.09	279	8.00	10 yr	10 yr	Future	6.09	279	8.00	6.09	279	High
25 yr	10 yr	Future	6.77	348	8.00	10 yr	10yr	Future	6.09	279	8.00	6.77	348	High
50 yr	10 yr	Future	7.13	401	8.00	10 yr	10yr	Future	6.09	279	8.00	7.13	401	High
100 yr	10 yr	Future	7.42	455	8.00	10 yr	10yr	Future	6.09	279	8.00	7.42	455	High
250 yr	10 yr	Future	7.75	559	8.00	10 yr	10yr	Future	6.09	279	8.00	7.75	559	High
500 yr	10 yr	Future	7.90	634	8.00	10 yr	10yr	Future	6.09	279	8.00	7.90	634	High

Canarsie - Minimum Facility, Present Tides													
Subbasin C2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.89	89	2.75							2.89	89	Low
5 yr	Normal	Present	3.11	122	2.75							3.11	122	Low
10 yr	Normal	Present	3.39	150	2.75							3.39	150	Low
25 yr	Normal	Present	3.87	187	2.75							3.87	187	Low
50 yr	Normal	Present	4.49	216	2.75							4.49	216	Low
100 yr	Normal	Present	4.99	245	2.75							4.99	245	Low
250 yr	Normal	Present	5.92	301	2.75							5.92	301	Low
500 yr	Normal	Present	6.38	341	2.75							6.38	341	Low
2 yr	2 yr	Present	4.78	89	4.64	2 yr	2 yr	Present	4.78	89	4.64	4.78	89	Likely
5 yr	2 yr	Present	4.99	122	4.64	2 yr	5 yr	Present	5.98	89	5.84	5.98	122	Likely
10 yr	2 yr	Present	5.26	150	4.64	2 yr	10 yr	Present	7.03	89	6.94	7.03	150	Likely
25 yr	2 yr	Present	5.62	187	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	187	Likely
50 yr	2 yr	Present	5.95	216	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	216	Likely
100 yr	2 yr	Present	6.23	245	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	245	Likely
250 yr	2 yr	Present	6.69	301	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	301	Likely
500 yr	2 yr	Present	6.95	341	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	341	Likely
2 yr	2 yr	Present	4.78	89	4.64	2 yr	2 yr	Present	4.78	89	4.64	4.78	89	High
5 yr	5 yr	Present	6.17	122	5.84	5 yr	5 yr	Present	6.17	122	5.84	6.17	122	High
10 yr	10 yr	Present	7.28	150	6.94	10 yr	10 yr	Present	7.28	150	6.94	7.28	150	High
25 yr	10 yr	Present	7.43	187	6.94	10 yr	10yr	Present	7.28	150	6.94	7.43	187	High
50 yr	10 yr	Present	7.55	216	6.94	10 yr	10yr	Present	7.28	150	6.94	7.55	216	High
100 yr	10 yr	Present	7.66	245	6.94	10 yr	10yr	Present	7.28	150	6.94	7.66	245	High
250 yr	10 yr	Present	7.88	301	6.94	10 yr	10yr	Present	7.28	150	6.94	7.88	301	High
500 yr	10 yr	Present	8.03	341	6.94	10 yr	10yr	Present	7.28	150	6.94	8.03	341	High

Canarsie - Pump Alternative 1, Present Tides													
Subbasin C2, 56 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.71	89	2.75							2.71	89	Low
5 yr	Normal	Present	2.79	122	2.75							2.79	122	Low
10 yr	Normal	Present	2.92	150	2.75							2.92	150	Low
25 yr	Normal	Present	3.19	187	2.75							3.19	187	Low
50 yr	Normal	Present	3.47	216	2.75							3.47	216	Low
100 yr	Normal	Present	3.87	245	2.75							3.87	245	Low
250 yr	Normal	Present	5.00	301	2.75							5.00	301	Low
500 yr	Normal	Present	5.69	341	2.75							5.69	341	Low
2 yr	2 yr	Present	4.58	89	4.64	2 yr	2 yr	Present	4.58	89	4.64	4.58	89	Likely
5 yr	2 yr	Present	4.67	122	4.64	2 yr	5 yr	Present	5.38	89	5.84	5.38	122	Likely
10 yr	2 yr	Present	4.80	150	4.64	2 yr	10 yr	Present	6.55	89	6.94	6.55	150	Likely
25 yr	2 yr	Present	5.10	187	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	187	Likely
50 yr	2 yr	Present	5.34	216	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	216	Likely
100 yr	2 yr	Present	5.68	245	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	245	Likely
250 yr	2 yr	Present	6.22	301	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	301	Likely
500 yr	2 yr	Present	6.54	341	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	341	Likely
2 yr	2 yr	Present	4.58	89	4.64	2 yr	2 yr	Present	4.58	89	4.64	4.58	89	High
5 yr	5 yr	Present	5.87	122	5.84	5 yr	5 yr	Present	5.87	122	5.84	5.87	122	High
10 yr	10 yr	Present	6.93	150	6.94	10 yr	10 yr	Present	6.93	150	6.94	6.93	150	High
25 yr	10 yr	Present	7.09	187	6.94	10 yr	10yr	Present	6.93	150	6.94	7.09	187	High
50 yr	10 yr	Present	7.21	216	6.94	10 yr	10yr	Present	6.93	150	6.94	7.21	216	High
100 yr	10 yr	Present	7.33	245	6.94	10 yr	10yr	Present	6.93	150	6.94	7.33	245	High
250 yr	10 yr	Present	7.56	301	6.94	10 yr	10yr	Present	6.93	150	6.94	7.56	301	High
500 yr	10 yr	Present	7.72	341	6.94	10 yr	10yr	Present	6.93	150	6.94	7.72	341	High

Canarsie - Minimum Facility, Future Tides													
Subbasin C2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.97	89	3.82							3.97	89	Low
5 yr	Normal	Future	4.18	122	3.82							4.18	122	Low
10 yr	Normal	Future	4.43	150	3.82							4.43	150	Low
25 yr	Normal	Future	4.87	187	3.82							4.87	187	Low
50 yr	Normal	Future	5.21	216	3.82							5.21	216	Low
100 yr	Normal	Future	5.59	245	3.82							5.59	245	Low
250 yr	Normal	Future	6.27	301	3.82							6.27	301	Low
500 yr	Normal	Future	6.61	341	3.82							6.61	341	Low
2 yr	2 yr	Future	5.85	89	5.71	2 yr	2 yr	Future	5.85	89	5.71	5.85	89	Likely
5 yr	2 yr	Future	6.05	122	5.71	2 yr	5 yr	Future	7.00	89	6.91	7.00	122	Likely
10 yr	2 yr	Future	6.24	150	5.71	2 yr	10 yr	Future	7.62	89	8.00	7.62	150	Likely
25 yr	2 yr	Future	6.51	187	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	187	Likely
50 yr	2 yr	Future	6.70	216	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	216	Likely
100 yr	2 yr	Future	6.89	245	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	245	Likely
250 yr	2 yr	Future	7.21	301	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	301	Likely
500 yr	2 yr	Future	7.41	341	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	341	Likely
2 yr	2 yr	Future	5.85	89	5.71	2 yr	2 yr	Future	5.85	89	5.71	5.85	89	High
5 yr	5 yr	Future	7.13	122	6.91	5 yr	5 yr	Future	7.13	122	6.91	7.13	122	High
10 yr	10 yr	Future	7.94	150	8.00	10 yr	10 yr	Future	7.94	150	8.00	7.94	150	High
25 yr	10 yr	Future	8.09	187	8.00	10 yr	10yr	Future	7.94	150	8.00	8.09	187	High
50 yr	10 yr	Future	8.20	216	8.00	10 yr	10yr	Future	7.94	150	8.00	8.20	216	High
100 yr	10 yr	Future	8.30	245	8.00	10 yr	10yr	Future	7.94	150	8.00	8.30	245	High
250 yr	10 yr	Future	8.50	301	8.00	10 yr	10yr	Future	7.94	150	8.00	8.50	301	High
500 yr	10 yr	Future	8.63	341	8.00	10 yr	10yr	Future	7.94	150	8.00	8.63	341	High

Canarsie - Pump Alternative 1, Future Tides													
Subbasin C2, 56 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.78	89	3.82							3.78	89	Low
5 yr	Normal	Future	3.85	122	3.82							3.85	122	Low
10 yr	Normal	Future	3.99	150	3.82							3.99	150	Low
25 yr	Normal	Future	4.29	187	3.82							4.29	187	Low
50 yr	Normal	Future	4.60	216	3.82							4.60	216	Low
100 yr	Normal	Future	4.93	245	3.82							4.93	245	Low
250 yr	Normal	Future	5.66	301	3.82							5.66	301	Low
500 yr	Normal	Future	6.09	341	3.82							6.09	341	Low
2 yr	2 yr	Future	5.65	89	5.71	2 yr	2 yr	Future	5.65	89	5.71	5.65	89	Likely
5 yr	2 yr	Future	5.74	122	5.71	2 yr	5 yr	Future	6.54	89	6.91	6.54	122	Likely
10 yr	2 yr	Future	5.87	150	5.71	2 yr	10 yr	Future	6.55	89	8.00	6.55	150	Likely
25 yr	2 yr	Future	6.11	187	5.71	2 yr	10yr	Future	6.55	89	8.00	6.55	187	Likely
50 yr	2 yr	Future	6.31	216	5.71	2 yr	10yr	Future	6.55	89	8.00	6.55	216	Likely
100 yr	2 yr	Future	6.50	245	5.71	2 yr	10yr	Future	6.55	89	8.00	6.55	245	Likely
250 yr	2 yr	Future	6.86	301	5.71	2 yr	10yr	Future	6.55	89	8.00	6.86	301	Likely
500 yr	2 yr	Future	7.08	341	5.71	2 yr	10yr	Future	6.55	89	8.00	7.08	341	Likely
2 yr	2 yr	Future	5.65	89	5.71	2 yr	2 yr	Future	5.65	89	5.71	5.65	89	High
5 yr	5 yr	Future	6.80	122	6.91	5 yr	5 yr	Future	6.80	122	6.91	6.80	122	High
10 yr	10 yr	Future	7.36	150	8.00	10 yr	10 yr	Future	7.36	150	8.00	7.36	150	High
25 yr	10 yr	Future	7.61	187	8.00	10 yr	10yr	Future	7.36	150	8.00	7.61	187	High
50 yr	10 yr	Future	7.74	216	8.00	10 yr	10yr	Future	7.36	150	8.00	7.74	216	High
100 yr	10 yr	Future	7.85	245	8.00	10 yr	10yr	Future	7.36	150	8.00	7.85	245	High
250 yr	10 yr	Future	8.04	301	8.00	10 yr	10yr	Future	7.36	150	8.00	8.04	301	High
500 yr	10 yr	Future	8.18	341	8.00	10 yr	10yr	Future	7.36	150	8.00	8.18	341	High

Canarsie - Minimum Facility, Present Tides													
Subbasin C3 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	117	2.75							2.76	117	Low
5 yr	Normal	Present	2.79	161	2.75							2.79	161	Low
10 yr	Normal	Present	2.85	198	2.75							2.85	198	Low
25 yr	Normal	Present	2.94	247	2.75							2.94	247	Low
50 yr	Normal	Present	3.03	285	2.75							3.03	285	Low
100 yr	Normal	Present	3.14	323	2.75							3.14	323	Low
250 yr	Normal	Present	3.40	396	2.75							3.40	396	Low
500 yr	Normal	Present	3.60	449	2.75							3.60	449	Low
2 yr	2 yr	Present	4.65	117	4.64	2 yr	2 yr	Present	4.65	117	4.64	4.65	117	Likely
5 yr	2 yr	Present	4.67	161	4.64	2 yr	5 yr	Present	5.85	117	5.84	5.85	161	Likely
10 yr	2 yr	Present	4.73	198	4.64	2 yr	10 yr	Present	6.86	117	6.94	6.86	198	Likely
25 yr	2 yr	Present	4.82	247	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	247	Likely
50 yr	2 yr	Present	4.90	285	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	285	Likely
100 yr	2 yr	Present	5.00	323	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	323	Likely
250 yr	2 yr	Present	5.22	396	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	396	Likely
500 yr	2 yr	Present	5.41	449	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	449	Likely
2 yr	2 yr	Present	4.65	117	4.64	2 yr	2 yr	Present	4.65	117	4.64	4.65	117	High
5 yr	5 yr	Present	5.88	161	5.84	5 yr	5 yr	Present	5.88	161	5.84	5.88	161	High
10 yr	10 yr	Present	7.01	198	6.94	10 yr	10 yr	Present	7.01	198	6.94	7.01	198	High
25 yr	10 yr	Present	7.08	247	6.94	10 yr	10yr	Present	7.01	198	6.94	7.08	247	High
50 yr	10 yr	Present	7.14	285	6.94	10 yr	10yr	Present	7.01	198	6.94	7.14	285	High
100 yr	10 yr	Present	7.20	323	6.94	10 yr	10yr	Present	7.01	198	6.94	7.20	323	High
250 yr	10 yr	Present	7.32	396	6.94	10 yr	10yr	Present	7.01	198	6.94	7.32	396	High
500 yr	10 yr	Present	7.41	449	6.94	10 yr	10yr	Present	7.01	198	6.94	7.41	449	High

Canarsie - Pump Alternative 1, Present Tides													
Subbasin C3, 84 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.71	117	2.75							2.71	117	Low
5 yr	Normal	Present	2.74	161	2.75							2.74	161	Low
10 yr	Normal	Present	2.74	198	2.75							2.74	198	Low
25 yr	Normal	Present	2.79	247	2.75							2.79	247	Low
50 yr	Normal	Present	2.85	285	2.75							2.85	285	Low
100 yr	Normal	Present	2.92	323	2.75							2.92	323	Low
250 yr	Normal	Present	3.12	396	2.75							3.12	396	Low
500 yr	Normal	Present	3.28	449	2.75							3.28	449	Low
2 yr	2 yr	Present	4.55	117	4.64	2 yr	2 yr	Present	4.55	117	4.64	4.55	117	Likely
5 yr	2 yr	Present	4.60	161	4.64	2 yr	5 yr	Present	5.26	117	5.84	5.26	161	Likely
10 yr	2 yr	Present	4.62	198	4.64	2 yr	10 yr	Present	5.42	117	6.94	5.42	198	Likely
25 yr	2 yr	Present	4.67	247	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	247	Likely
50 yr	2 yr	Present	4.73	285	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	285	Likely
100 yr	2 yr	Present	4.80	323	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	323	Likely
250 yr	2 yr	Present	4.98	396	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	396	Likely
500 yr	2 yr	Present	5.13	449	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	449	Likely
2 yr	2 yr	Present	4.55	117	4.64	2 yr	2 yr	Present	4.55	117	4.64	4.55	117	High
5 yr	5 yr	Present	5.76	161	5.84	5 yr	5 yr	Present	5.76	161	5.84	5.76	161	High
10 yr	10 yr	Present	6.66	198	6.94	10 yr	10 yr	Present	6.66	198	6.94	6.66	198	High
25 yr	10 yr	Present	6.82	247	6.94	10 yr	10yr	Present	6.66	198	6.94	6.82	247	High
50 yr	10 yr	Present	6.89	285	6.94	10 yr	10yr	Present	6.66	198	6.94	6.89	285	High
100 yr	10 yr	Present	6.96	323	6.94	10 yr	10yr	Present	6.66	198	6.94	6.96	323	High
250 yr	10 yr	Present	7.08	396	6.94	10 yr	10yr	Present	6.66	198	6.94	7.08	396	High
500 yr	10 yr	Present	7.18	449	6.94	10 yr	10yr	Present	6.66	198	6.94	7.18	449	High

Canarsie - Minimum Facility, Future Tides													
Subbasin C3 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.83	117	3.82							3.83	117	Low
5 yr	Normal	Future	3.86	161	3.82							3.86	161	Low
10 yr	Normal	Future	3.91	198	3.82							3.91	198	Low
25 yr	Normal	Future	4.01	247	3.82							4.01	247	Low
50 yr	Normal	Future	4.10	285	3.82							4.10	285	Low
100 yr	Normal	Future	4.20	323	3.82							4.20	323	Low
250 yr	Normal	Future	4.40	396	3.82							4.40	396	Low
500 yr	Normal	Future	4.60	449	3.82							4.60	449	Low
2 yr	2 yr	Future	5.72	117	5.71	2 yr	2 yr	Future	5.72	117	5.71	5.72	117	Likely
5 yr	2 yr	Future	5.75	161	5.71	2 yr	5 yr	Future	6.84	117	6.91	6.84	161	Likely
10 yr	2 yr	Future	5.80	198	5.71	2 yr	10 yr	Future	7.31	117	8.00	7.31	198	Likely
25 yr	2 yr	Future	5.88	247	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	247	Likely
50 yr	2 yr	Future	5.97	285	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	285	Likely
100 yr	2 yr	Future	6.05	323	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	323	Likely
250 yr	2 yr	Future	6.23	396	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	396	Likely
500 yr	2 yr	Future	6.38	449	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	449	Likely
2 yr	2 yr	Future	5.72	117	5.71	2 yr	2 yr	Future	5.72	117	5.71	5.72	117	High
5 yr	5 yr	Future	6.92	161	6.91	5 yr	5 yr	Future	6.92	161	6.91	6.92	161	High
10 yr	10 yr	Future	7.68	198	8.00	10 yr	10 yr	Future	7.68	198	8.00	7.68	198	High
25 yr	10 yr	Future	7.81	247	8.00	10 yr	10yr	Future	7.68	198	8.00	7.81	247	High
50 yr	10 yr	Future	7.90	285	8.00	10 yr	10yr	Future	7.68	198	8.00	7.90	285	High
100 yr	10 yr	Future	7.97	323	8.00	10 yr	10yr	Future	7.68	198	8.00	7.97	323	High
250 yr	10 yr	Future	8.10	396	8.00	10 yr	10yr	Future	7.68	198	8.00	8.10	396	High
500 yr	10 yr	Future	8.19	449	8.00	10 yr	10yr	Future	7.68	198	8.00	8.19	449	High

Canarsie - Pump Alternative 1, Future Tides													
Subbasin C3, 84 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.76	117	3.82							3.76	117	Low
5 yr	Normal	Future	3.80	161	3.82							3.80	161	Low
10 yr	Normal	Future	3.81	198	3.82							3.81	198	Low
25 yr	Normal	Future	3.86	247	3.82							3.86	247	Low
50 yr	Normal	Future	3.92	285	3.82							3.92	285	Low
100 yr	Normal	Future	4.00	323	3.82							4.00	323	Low
250 yr	Normal	Future	4.18	396	3.82							4.18	396	Low
500 yr	Normal	Future	4.34	449	3.82							4.34	449	Low
2 yr	2 yr	Future	5.46	117	5.71	2 yr	2 yr	Future	5.46	117	5.71	5.46	117	Likely
5 yr	2 yr	Future	5.64	161	5.71	2 yr	5 yr	Future	5.42	117	6.91	5.64	161	Likely
10 yr	2 yr	Future	5.69	198	5.71	2 yr	10 yr	Future	5.42	117	8.00	5.69	198	Likely
25 yr	2 yr	Future	5.75	247	5.71	2 yr	10yr	Future	5.42	117	8.00	5.75	247	Likely
50 yr	2 yr	Future	5.80	285	5.71	2 yr	10yr	Future	5.42	117	8.00	5.80	285	Likely
100 yr	2 yr	Future	5.87	323	5.71	2 yr	10yr	Future	5.42	117	8.00	5.87	323	Likely
250 yr	2 yr	Future	6.02	396	5.71	2 yr	10yr	Future	5.42	117	8.00	6.02	396	Likely
500 yr	2 yr	Future	6.15	449	5.71	2 yr	10yr	Future	5.42	117	8.00	6.15	449	Likely
2 yr	2 yr	Future	5.46	117	5.71	2 yr	2 yr	Future	5.46	117	5.71	5.46	117	High
5 yr	5 yr	Future	6.31	161	6.91	5 yr	5 yr	Future	6.31	161	6.91	6.31	161	High
10 yr	10 yr	Future	6.72	198	8.00	10 yr	10 yr	Future	6.72	198	8.00	6.72	198	High
25 yr	10 yr	Future	7.09	247	8.00	10 yr	10yr	Future	6.72	198	8.00	7.09	247	High
50 yr	10 yr	Future	7.32	285	8.00	10 yr	10yr	Future	6.72	198	8.00	7.32	285	High
100 yr	10 yr	Future	7.48	323	8.00	10 yr	10yr	Future	6.72	198	8.00	7.48	323	High
250 yr	10 yr	Future	7.70	396	8.00	10 yr	10yr	Future	6.72	198	8.00	7.70	396	High
500 yr	10 yr	Future	7.80	449	8.00	10 yr	10yr	Future	6.72	198	8.00	7.80	449	High

Cedarhurst-Lawrence - Minimum Facility, Present Tides													
Subbasin L1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	127	2.75							2.76	127	Low
5 yr	Normal	Present	2.79	173	2.75							2.79	173	Low
10 yr	Normal	Present	2.85	212	2.75							2.85	212	Low
25 yr	Normal	Present	2.94	264	2.75							2.94	264	Low
50 yr	Normal	Present	3.03	303	2.75							3.03	303	Low
100 yr	Normal	Present	3.14	343	2.75							3.14	343	Low
250 yr	Normal	Present	3.37	421	2.75							3.37	421	Low
500 yr	Normal	Present	3.58	477	2.75							3.58	477	Low
2 yr	2 yr	Present	4.65	127	4.64	2 yr	2 yr	Present	4.65	127	4.64	4.65	127	Likely
5 yr	2 yr	Present	4.68	173	4.64	2 yr	5 yr	Present	5.64	127	5.84	5.64	173	Likely
10 yr	2 yr	Present	4.73	212	4.64	2 yr	10 yr	Present	5.90	127	6.94	5.90	212	Likely
25 yr	2 yr	Present	4.82	264	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	264	Likely
50 yr	2 yr	Present	4.90	303	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	303	Likely
100 yr	2 yr	Present	4.98	343	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	343	Likely
250 yr	2 yr	Present	5.15	421	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	421	Likely
500 yr	2 yr	Present	5.27	477	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	477	Likely
2 yr	2 yr	Present	4.65	127	4.64	2 yr	2 yr	Present	4.65	127	4.64	4.65	127	High
5 yr	5 yr	Present	5.75	173	5.84	5 yr	5 yr	Present	5.75	173	5.84	5.75	173	High
10 yr	10 yr	Present	6.25	212	6.94	10 yr	10 yr	Present	6.25	212	6.94	6.25	212	High
25 yr	10 yr	Present	6.41	264	6.94	10 yr	10yr	Present	6.25	212	6.94	6.41	264	High
50 yr	10 yr	Present	6.50	303	6.94	10 yr	10yr	Present	6.25	212	6.94	6.50	303	High
100 yr	10 yr	Present	6.58	343	6.94	10 yr	10yr	Present	6.25	212	6.94	6.58	343	High
250 yr	10 yr	Present	6.73	421	6.94	10 yr	10yr	Present	6.25	212	6.94	6.73	421	High
500 yr	10 yr	Present	6.82	477	6.94	10 yr	10yr	Present	6.25	212	6.94	6.82	477	High

Cedarhurst-Lawrence - Pump Alternative 1, Present Tides													
Subbasin L1, 90 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.69	127	2.75							2.69	127	Low
5 yr	Normal	Present	2.73	173	2.75							2.73	173	Low
10 yr	Normal	Present	2.74	212	2.75							2.74	212	Low
25 yr	Normal	Present	2.79	264	2.75							2.79	264	Low
50 yr	Normal	Present	2.85	303	2.75							2.85	303	Low
100 yr	Normal	Present	2.92	343	2.75							2.92	343	Low
250 yr	Normal	Present	3.10	421	2.75							3.10	421	Low
500 yr	Normal	Present	3.26	477	2.75							3.26	477	Low
2 yr	2 yr	Present	4.48	127	4.64	2 yr	2 yr	Present	4.48	127	4.64	4.48	127	Likely
5 yr	2 yr	Present	4.57	173	4.64	2 yr	5 yr	Present	4.66	127	5.84	4.66	173	Likely
10 yr	2 yr	Present	4.62	212	4.64	2 yr	10 yr	Present	4.67	127	6.94	4.67	212	Likely
25 yr	2 yr	Present	4.67	264	4.64	2 yr	10yr	Present	4.67	127	6.94	4.67	264	Likely
50 yr	2 yr	Present	4.73	303	4.64	2 yr	10yr	Present	4.67	127	6.94	4.73	303	Likely
100 yr	2 yr	Present	4.79	343	4.64	2 yr	10yr	Present	4.67	127	6.94	4.79	343	Likely
250 yr	2 yr	Present	4.95	421	4.64	2 yr	10yr	Present	4.67	127	6.94	4.95	421	Likely
500 yr	2 yr	Present	5.06	477	4.64	2 yr	10yr	Present	4.67	127	6.94	5.06	477	Likely
2 yr	2 yr	Present	4.48	127	4.64	2 yr	2 yr	Present	4.48	127	4.64	4.48	127	High
5 yr	5 yr	Present	5.17	173	5.84	5 yr	5 yr	Present	5.17	173	5.84	5.17	173	High
10 yr	10 yr	Present	5.43	212	6.94	10 yr	10 yr	Present	5.43	212	6.94	5.43	212	High
25 yr	10 yr	Present	5.69	264	6.94	10 yr	10yr	Present	5.43	212	6.94	5.69	264	High
50 yr	10 yr	Present	5.86	303	6.94	10 yr	10yr	Present	5.43	212	6.94	5.86	303	High
100 yr	10 yr	Present	6.01	343	6.94	10 yr	10yr	Present	5.43	212	6.94	6.01	343	High
250 yr	10 yr	Present	6.25	421	6.94	10 yr	10yr	Present	5.43	212	6.94	6.25	421	High
500 yr	10 yr	Present	6.39	477	6.94	10 yr	10yr	Present	5.43	212	6.94	6.39	477	High

Cedarhurst-Lawrence - Minimum Facility, Future Tides													
Subbasin L1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.83	127	3.82							3.83	127	Low
5 yr	Normal	Future	3.86	173	3.82							3.86	173	Low
10 yr	Normal	Future	3.92	212	3.82							3.92	212	Low
25 yr	Normal	Future	4.01	264	3.82							4.01	264	Low
50 yr	Normal	Future	4.10	303	3.82							4.10	303	Low
100 yr	Normal	Future	4.21	343	3.82							4.21	343	Low
250 yr	Normal	Future	4.44	421	3.82							4.44	421	Low
500 yr	Normal	Future	4.62	477	3.82							4.62	477	Low
2 yr	2 yr	Future	5.58	127	5.71	2 yr	2 yr	Future	5.58	127	5.71	5.58	127	Likely
5 yr	2 yr	Future	5.67	173	5.71	2 yr	5 yr	Future	5.90	127	6.91	5.90	173	Likely
10 yr	2 yr	Future	5.73	212	5.71	2 yr	10 yr	Future	5.97	127	8.00	5.97	212	Likely
25 yr	2 yr	Future	5.80	264	5.71	2 yr	10yr	Future	5.97	127	8.00	5.97	264	Likely
50 yr	2 yr	Future	5.86	303	5.71	2 yr	10yr	Future	5.97	127	8.00	5.97	303	Likely
100 yr	2 yr	Future	5.92	343	5.71	2 yr	10yr	Future	5.97	127	8.00	5.97	343	Likely
250 yr	2 yr	Future	6.03	421	5.71	2 yr	10yr	Future	5.97	127	8.00	6.03	421	Likely
500 yr	2 yr	Future	6.11	477	5.71	2 yr	10yr	Future	5.97	127	8.00	6.11	477	Likely
2 yr	2 yr	Future	5.58	127	5.71	2 yr	2 yr	Future	5.58	127	5.71	5.58	127	High
5 yr	5 yr	Future	6.11	173	6.91	5 yr	5 yr	Future	6.11	173	6.91	6.11	173	High
10 yr	10 yr	Future	6.37	212	8.00	10 yr	10 yr	Future	6.37	212	8.00	6.37	212	High
25 yr	10 yr	Future	6.56	264	8.00	10 yr	10yr	Future	6.37	212	8.00	6.56	264	High
50 yr	10 yr	Future	6.69	303	8.00	10 yr	10yr	Future	6.37	212	8.00	6.69	303	High
100 yr	10 yr	Future	6.80	343	8.00	10 yr	10yr	Future	6.37	212	8.00	6.80	343	High
250 yr	10 yr	Future	7.01	421	8.00	10 yr	10yr	Future	6.37	212	8.00	7.01	421	High
500 yr	10 yr	Future	7.13	477	8.00	10 yr	10yr	Future	6.37	212	8.00	7.13	477	High

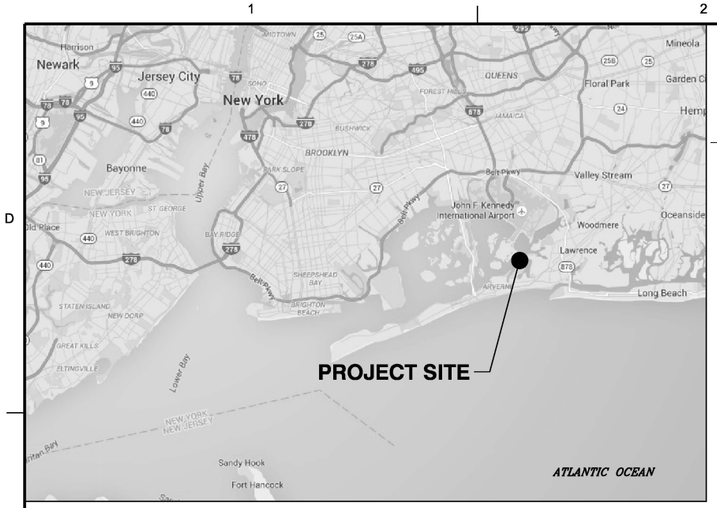
Cedarhurst-Lawrence - Pump Alternative 1, Future Tides													
Subbasin L1, 90 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.74	127	3.82							3.74	127	Low
5 yr	Normal	Future	3.79	173	3.82							3.79	173	Low
10 yr	Normal	Future	3.81	212	3.82							3.81	212	Low
25 yr	Normal	Future	3.86	264	3.82							3.86	264	Low
50 yr	Normal	Future	3.91	303	3.82							3.91	303	Low
100 yr	Normal	Future	3.99	343	3.82							3.99	343	Low
250 yr	Normal	Future	4.17	421	3.82							4.17	421	Low
500 yr	Normal	Future	4.33	477	3.82							4.33	477	Low
2 yr	2 yr	Future	4.65	127	5.71	2 yr	2 yr	Future	4.65	127	5.71	4.65	127	Likely
5 yr	2 yr	Future	5.17	173	5.71	2 yr	5 yr	Future	4.67	127	6.91	5.17	173	Likely
10 yr	2 yr	Future	5.39	212	5.71	2 yr	10 yr	Future	4.67	127	8.00	5.39	212	Likely
25 yr	2 yr	Future	5.52	264	5.71	2 yr	10yr	Future	4.67	127	8.00	5.52	264	Likely
50 yr	2 yr	Future	5.60	303	5.71	2 yr	10yr	Future	4.67	127	8.00	5.60	303	Likely
100 yr	2 yr	Future	5.66	343	5.71	2 yr	10yr	Future	4.67	127	8.00	5.66	343	Likely
250 yr	2 yr	Future	5.78	421	5.71	2 yr	10yr	Future	4.67	127	8.00	5.78	421	Likely
500 yr	2 yr	Future	5.85	477	5.71	2 yr	10yr	Future	4.67	127	8.00	5.85	477	Likely
2 yr	2 yr	Future	4.65	127	5.71	2 yr	2 yr	Future	4.65	127	5.71	4.65	127	High
5 yr	5 yr	Future	5.17	173	6.91	5 yr	5 yr	Future	5.17	173	6.91	5.17	173	High
10 yr	10 yr	Future	5.43	212	8.00	10 yr	10 yr	Future	5.43	212	8.00	5.43	212	High
25 yr	10 yr	Future	5.69	264	8.00	10 yr	10yr	Future	5.43	212	8.00	5.69	264	High
50 yr	10 yr	Future	5.86	303	8.00	10 yr	10yr	Future	5.43	212	8.00	5.86	303	High
100 yr	10 yr	Future	6.01	343	8.00	10 yr	10yr	Future	5.43	212	8.00	6.01	343	High
250 yr	10 yr	Future	6.27	421	8.00	10 yr	10yr	Future	5.43	212	8.00	6.27	421	High
500 yr	10 yr	Future	6.45	477	8.00	10 yr	10yr	Future	5.43	212	8.00	6.45	477	High

Motts Basin North - Minimum Facility, Present Tides													
Subbasin M1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.85	39	2.75							2.85	39	Low
5 yr	Normal	Present	3.04	57	2.75							3.04	57	Low
10 yr	Normal	Present	3.24	71	2.75							3.24	71	Low
25 yr	Normal	Present	3.58	91	2.75							3.58	91	Low
50 yr	Normal	Present	4.20	107	2.75							4.20	107	Low
100 yr	Normal	Present	4.53	122	2.75							4.53	122	Low
250 yr	Normal	Present	4.96	152	2.75							4.96	152	Low
500 yr	Normal	Present	5.19	173	2.75							5.19	173	Low
2 yr	2 yr	Present	4.73	39	4.64	2 yr	2 yr	Present	4.73	39	4.64	4.73	39	Likely
5 yr	2 yr	Present	4.86	57	4.64	2 yr	5 yr	Present	5.56	39	5.84	5.56	57	Likely
10 yr	2 yr	Present	4.99	71	4.64	2 yr	10 yr	Present	5.70	39	6.94	5.70	71	Likely
25 yr	2 yr	Present	5.15	91	4.64	2 yr	10yr	Present	5.70	39	6.94	5.70	91	Likely
50 yr	2 yr	Present	5.27	107	4.64	2 yr	10yr	Present	5.70	39	6.94	5.70	107	Likely
100 yr	2 yr	Present	5.38	122	4.64	2 yr	10yr	Present	5.70	39	6.94	5.70	122	Likely
250 yr	2 yr	Present	5.59	152	4.64	2 yr	10yr	Present	5.70	39	6.94	5.70	152	Likely
500 yr	2 yr	Present	5.74	173	4.64	2 yr	10yr	Present	5.70	39	6.94	5.74	173	Likely
2 yr	2 yr	Present	4.73	39	4.64	2 yr	2 yr	Present	4.73	39	4.64	4.73	39	High
5 yr	5 yr	Present	5.71	57	5.84	5 yr	5 yr	Present	5.71	57	5.84	5.71	57	High
10 yr	10 yr	Present	6.11	71	6.94	10 yr	10 yr	Present	6.11	71	6.94	6.11	71	High
25 yr	10 yr	Present	6.30	91	6.94	10 yr	10yr	Present	6.11	71	6.94	6.30	91	High
50 yr	10 yr	Present	6.43	107	6.94	10 yr	10yr	Present	6.11	71	6.94	6.43	107	High
100 yr	10 yr	Present	6.54	122	6.94	10 yr	10yr	Present	6.11	71	6.94	6.54	122	High
250 yr	10 yr	Present	6.72	152	6.94	10 yr	10yr	Present	6.11	71	6.94	6.72	152	High
500 yr	10 yr	Present	6.84	173	6.94	10 yr	10yr	Present	6.11	71	6.94	6.84	173	High

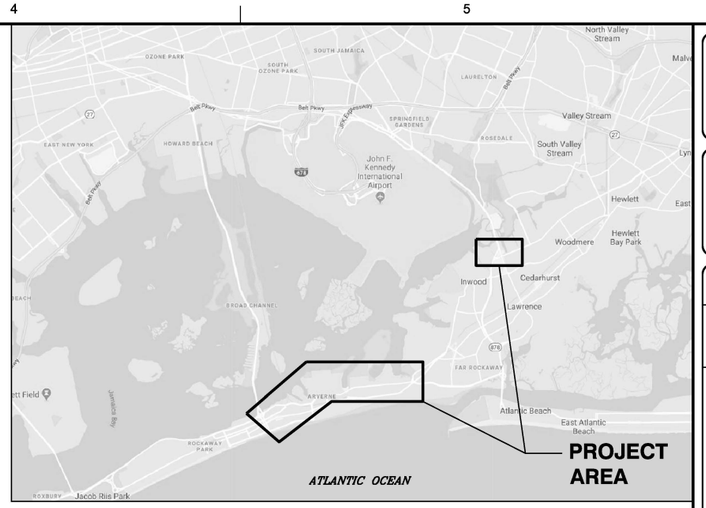
Motts Basin North - Pump Alternative 1, Present Tides													
Subbasin M1, 26 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.73	39	2.75							2.73	39	Low
5 yr	Normal	Present	2.79	57	2.75							2.79	57	Low
10 yr	Normal	Present	2.91	71	2.75							2.91	71	Low
25 yr	Normal	Present	3.11	91	2.75							3.11	91	Low
50 yr	Normal	Present	3.44	107	2.75							3.44	107	Low
100 yr	Normal	Present	3.67	122	2.75							3.67	122	Low
250 yr	Normal	Present	4.58	152	2.75							4.58	152	Low
500 yr	Normal	Present	4.88	173	2.75							4.88	173	Low
2 yr	2 yr	Present	4.56	39	4.64	2 yr	2 yr	Present	4.56	39	4.64	4.56	39	Likely
5 yr	2 yr	Present	4.66	57	4.64	2 yr	5 yr	Present	4.72	39	5.84	4.72	57	Likely
10 yr	2 yr	Present	4.76	71	4.64	2 yr	10 yr	Present	4.72	39	6.94	4.76	71	Likely
25 yr	2 yr	Present	4.92	91	4.64	2 yr	10yr	Present	4.72	39	6.94	4.92	91	Likely
50 yr	2 yr	Present	5.04	107	4.64	2 yr	10yr	Present	4.72	39	6.94	5.04	107	Likely
100 yr	2 yr	Present	5.16	122	4.64	2 yr	10yr	Present	4.72	39	6.94	5.16	122	Likely
250 yr	2 yr	Present	5.37	152	4.64	2 yr	10yr	Present	4.72	39	6.94	5.37	152	Likely
500 yr	2 yr	Present	5.53	173	4.64	2 yr	10yr	Present	4.72	39	6.94	5.53	173	Likely
2 yr	2 yr	Present	4.56	39	4.64	2 yr	2 yr	Present	4.56	39	4.64	4.56	39	High
5 yr	5 yr	Present	5.16	57	5.84	5 yr	5 yr	Present	5.16	57	5.84	5.16	57	High
10 yr	10 yr	Present	5.40	71	6.94	10 yr	10 yr	Present	5.40	71	6.94	5.40	71	High
25 yr	10 yr	Present	5.66	91	6.94	10 yr	10yr	Present	5.40	71	6.94	5.66	91	High
50 yr	10 yr	Present	5.83	107	6.94	10 yr	10yr	Present	5.40	71	6.94	5.83	107	High
100 yr	10 yr	Present	5.98	122	6.94	10 yr	10yr	Present	5.40	71	6.94	5.98	122	High
250 yr	10 yr	Present	6.23	152	6.94	10 yr	10yr	Present	5.40	71	6.94	6.23	152	High
500 yr	10 yr	Present	6.40	173	6.94	10 yr	10yr	Present	5.40	71	6.94	6.40	173	High

Motts Basin North - Minimum Facility, Future Tides													
Subbasin M1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.93	39	3.82							3.93	39	Low
5 yr	Normal	Future	4.10	57	3.82							4.10	57	Low
10 yr	Normal	Future	4.29	71	3.82							4.29	71	Low
25 yr	Normal	Future	4.56	91	3.82							4.56	91	Low
50 yr	Normal	Future	4.75	107	3.82							4.75	107	Low
100 yr	Normal	Future	4.92	122	3.82							4.92	122	Low
250 yr	Normal	Future	5.22	152	3.82							5.22	152	Low
500 yr	Normal	Future	5.39	173	3.82							5.39	173	Low
2 yr	2 yr	Future	5.51	39	5.71	2 yr	2 yr	Future	5.51	39	5.71	5.51	39	Likely
5 yr	2 yr	Future	5.65	57	5.71	2 yr	5 yr	Future	5.70	39	6.91	5.70	57	Likely
10 yr	2 yr	Future	5.76	71	5.71	2 yr	10 yr	Future	5.75	39	8.00	5.76	71	Likely
25 yr	2 yr	Future	5.88	91	5.71	2 yr	10yr	Future	5.75	39	8.00	5.88	91	Likely
50 yr	2 yr	Future	5.97	107	5.71	2 yr	10yr	Future	5.75	39	8.00	5.97	107	Likely
100 yr	2 yr	Future	6.06	122	5.71	2 yr	10yr	Future	5.75	39	8.00	6.06	122	Likely
250 yr	2 yr	Future	6.23	152	5.71	2 yr	10yr	Future	5.75	39	8.00	6.23	152	Likely
500 yr	2 yr	Future	6.35	173	5.71	2 yr	10yr	Future	5.75	39	8.00	6.35	173	Likely
2 yr	2 yr	Future	5.51	39	5.71	2 yr	2 yr	Future	5.51	39	5.71	5.51	39	High
5 yr	5 yr	Future	5.94	57	6.91	5 yr	5 yr	Future	5.94	57	6.91	5.94	57	High
10 yr	10 yr	Future	6.20	71	8.00	10 yr	10 yr	Future	6.20	71	8.00	6.20	71	High
25 yr	10 yr	Future	6.42	91	8.00	10 yr	10yr	Future	6.20	71	8.00	6.42	91	High
50 yr	10 yr	Future	6.57	107	8.00	10 yr	10yr	Future	6.20	71	8.00	6.57	107	High
100 yr	10 yr	Future	6.70	122	8.00	10 yr	10yr	Future	6.20	71	8.00	6.70	122	High
250 yr	10 yr	Future	6.94	152	8.00	10 yr	10yr	Future	6.20	71	8.00	6.94	152	High
500 yr	10 yr	Future	7.09	173	8.00	10 yr	10yr	Future	6.20	71	8.00	7.09	173	High

Motts Basin North - Pump Alternative 1, Future Tides													
Subbasin M1, 26 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.79	39	3.82							3.79	39	Low
5 yr	Normal	Future	3.86	57	3.82							3.86	57	Low
10 yr	Normal	Future	3.98	71	3.82							3.98	71	Low
25 yr	Normal	Future	4.25	91	3.82							4.25	91	Low
50 yr	Normal	Future	4.42	107	3.82							4.42	107	Low
100 yr	Normal	Future	4.61	122	3.82							4.61	122	Low
250 yr	Normal	Future	4.94	152	3.82							4.94	152	Low
500 yr	Normal	Future	5.15	173	3.82							5.15	173	Low
2 yr	2 yr	Future	4.72	39	5.71	2 yr	2 yr	Future	4.72	39	5.71	4.72	39	Likely
5 yr	2 yr	Future	5.16	57	5.71	2 yr	5 yr	Future	4.72	39	6.91	5.16	57	Likely
10 yr	2 yr	Future	5.40	71	5.71	2 yr	10 yr	Future	4.72	39	8.00	5.40	71	Likely
25 yr	2 yr	Future	5.56	91	5.71	2 yr	10yr	Future	4.72	39	8.00	5.56	91	Likely
50 yr	2 yr	Future	5.66	107	5.71	2 yr	10yr	Future	4.72	39	8.00	5.66	107	Likely
100 yr	2 yr	Future	5.75	122	5.71	2 yr	10yr	Future	4.72	39	8.00	5.75	122	Likely
250 yr	2 yr	Future	5.90	152	5.71	2 yr	10yr	Future	4.72	39	8.00	5.90	152	Likely
500 yr	2 yr	Future	6.02	173	5.71	2 yr	10yr	Future	4.72	39	8.00	6.02	173	Likely
2 yr	2 yr	Future	4.72	39	5.71	2 yr	2 yr	Future	4.72	39	5.71	4.72	39	High
5 yr	5 yr	Future	5.16	57	6.91	5 yr	5 yr	Future	5.16	57	6.91	5.16	57	High
10 yr	10 yr	Future	5.40	71	8.00	10 yr	10 yr	Future	5.40	71	8.00	5.40	71	High
25 yr	10 yr	Future	5.66	91	8.00	10 yr	10yr	Future	5.40	71	8.00	5.66	91	High
50 yr	10 yr	Future	5.82	107	8.00	10 yr	10yr	Future	5.40	71	8.00	5.82	107	High
100 yr	10 yr	Future	5.98	122	8.00	10 yr	10yr	Future	5.40	71	8.00	5.98	122	High
250 yr	10 yr	Future	6.24	152	8.00	10 yr	10yr	Future	5.40	71	8.00	6.24	152	High
500 yr	10 yr	Future	6.42	173	8.00	10 yr	10yr	Future	5.40	71	8.00	6.42	173	High



VICINITY MAP
NTS



LOCATION PLAN
NTS

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

ATLANTIC COAST OF NEW YORK

JAMAICA BAY

INDEX TO DRAWINGS

INDEX NO.	SHEET NO.	SHEET TITLE
1	G-001	COVER SHEET
2	G-101	SHEET KEY PLAN
3	CS-101	SITE PLAN (1 OF 8)
4	CS-102	SITE PLAN (2 OF 8)
5	CS-103	SITE PLAN (3 OF 8)
6	CS-104	SITE PLAN (4 OF 8)
7	CS-105	SITE PLAN (5 OF 8)
8	CS-106	SITE PLAN (6 OF 8)
9	CS-107	SITE PLAN (7 OF 8)
10	CS-108	SITE PLAN (8 OF 8)
11	CS-501	FLOODWALL AND BULKHEAD TYPICAL SECTIONS
12	CS-502	BERM AND REVETMENT WITH FLOODWALL TYPICAL SECTIONS
13	CS-503	NATURAL AND NATURE BASED FEATURES (NNBF) SECTION
14	CS-504	ROAD RAMP SECTIONS
15	CS-505	SWING GATE PLAN AND ELEVATION
16	CU-101	INTERIOR DRAINAGE PLAN (1 OF 8)
17	CU-102	INTERIOR DRAINAGE PLAN (2 OF 8)
18	CU-103	INTERIOR DRAINAGE PLAN (3 OF 8)
19	CU-104	INTERIOR DRAINAGE PLAN (4 OF 8)
20	CU-105	INTERIOR DRAINAGE PLAN (5 OF 8)
21	CU-106	INTERIOR DRAINAGE PLAN (6 OF 8)
22	CU-107	INTERIOR DRAINAGE PLAN (7 OF 8)
23	CU-108	INTERIOR DRAINAGE PLAN (8 OF 8)
24	CU-501	TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 1
25	CU-502	TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 2
26	CU-503	TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 3

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:33:11 AM 12/3/2018 FILE: W912DS_A1_G-001.dgn

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

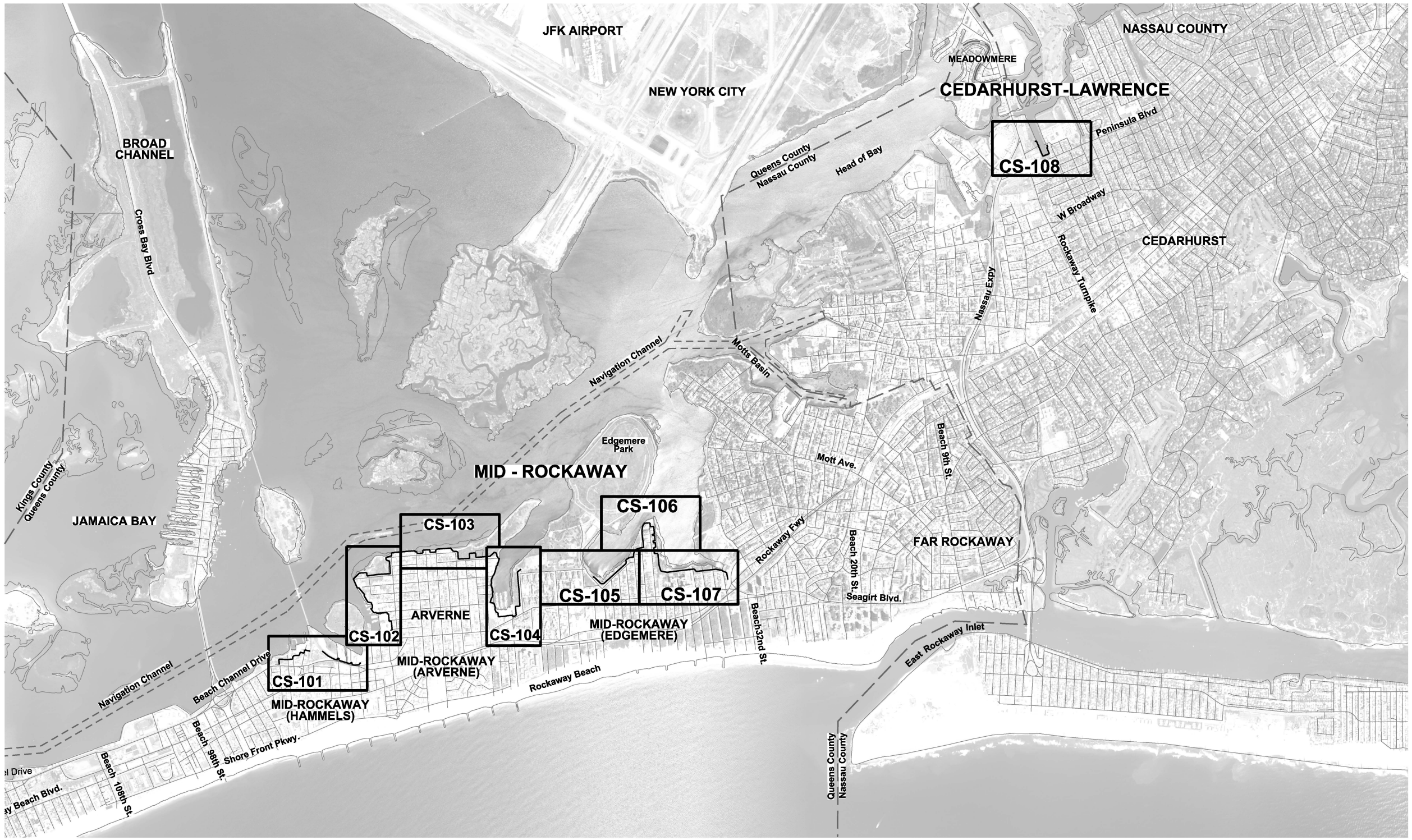
DESIGNED BY: IK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:1.50000
SIZE: ANSI D
DATE: 12.05.18
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_G-001.dgn
SOLICITATION NO.:
CONTRACT NO.: 9781-02
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

COVER SHEET

SHEET ID
G-001
SHEET 1 OF 26



HIGH FREQUENCY FLOOD RISK REDUCTION FEATURES (HFFRRF) FOR JAMAICA BAY

PROJECT SITES: 1. MID - ROCKAWAY
2. CEDARHURST-LAWRENCE

PRELIMINARY
NOT FOR CONSTRUCTION

0 1500' 3000'
SCALE:1"=1500'

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

US Army Corps of Engineers®

DESIGNED BY: MK
DRWN BY: ME
CHKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1.000000
PLOT DATE: 12/3/2018
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:
FILE NAME: W912DS_A2_G-101.dgn

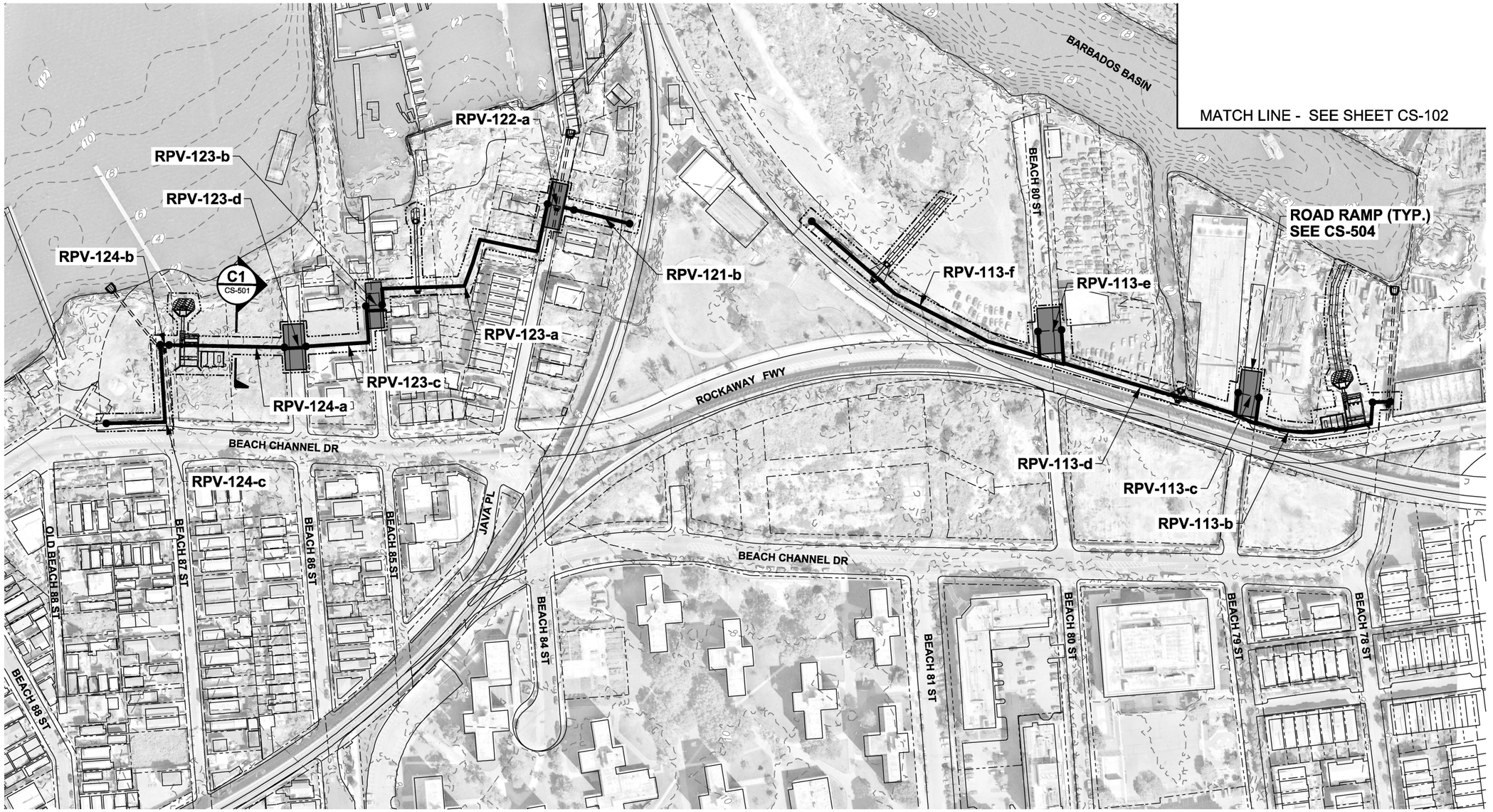
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SHEETS KEY PLAN

SHEET ID
G-101
SHEET 2 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:38:54 AM 12/3/2018 FILE: W912DS_A2_G-101.dgn



MID-ROCKAWAY - HAMMELS

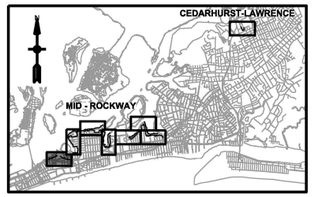
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

US Army Corps of Engineers®

DESIGNED BY: IK
DRAWN BY: ME
SUBMITTED BY: SA
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MK
PLOT SCALE: 1:2
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CS-101.dgn
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

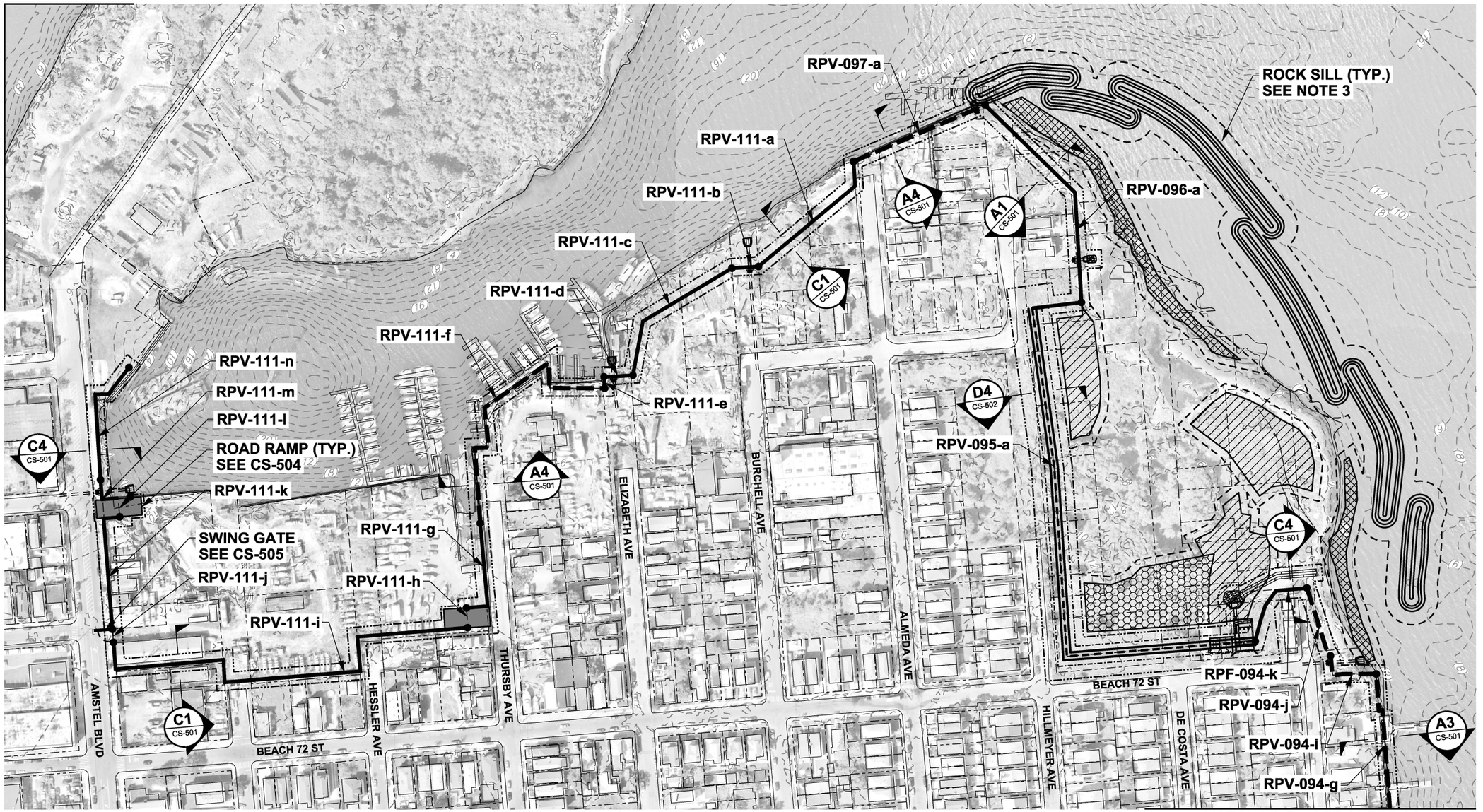
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (1 OF 8)

SHEET ID
CS-101
SHEET 3 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
FILE: W912DS_A2_CS-101.dgn
12/3/2018
11:33:36 AM
LAST PLOTTED BY: mestimable

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:33:53 AM 12/3/2018 FILE: W912DS_A2_CS-102.dgn



MID-ROCKAWAY - ARVERNE (SHEET 1)
SCALE: 1" = 100'

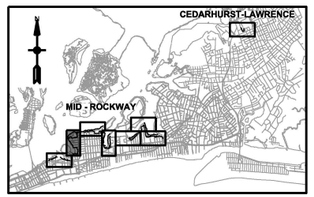
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

0 100' 200'
SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

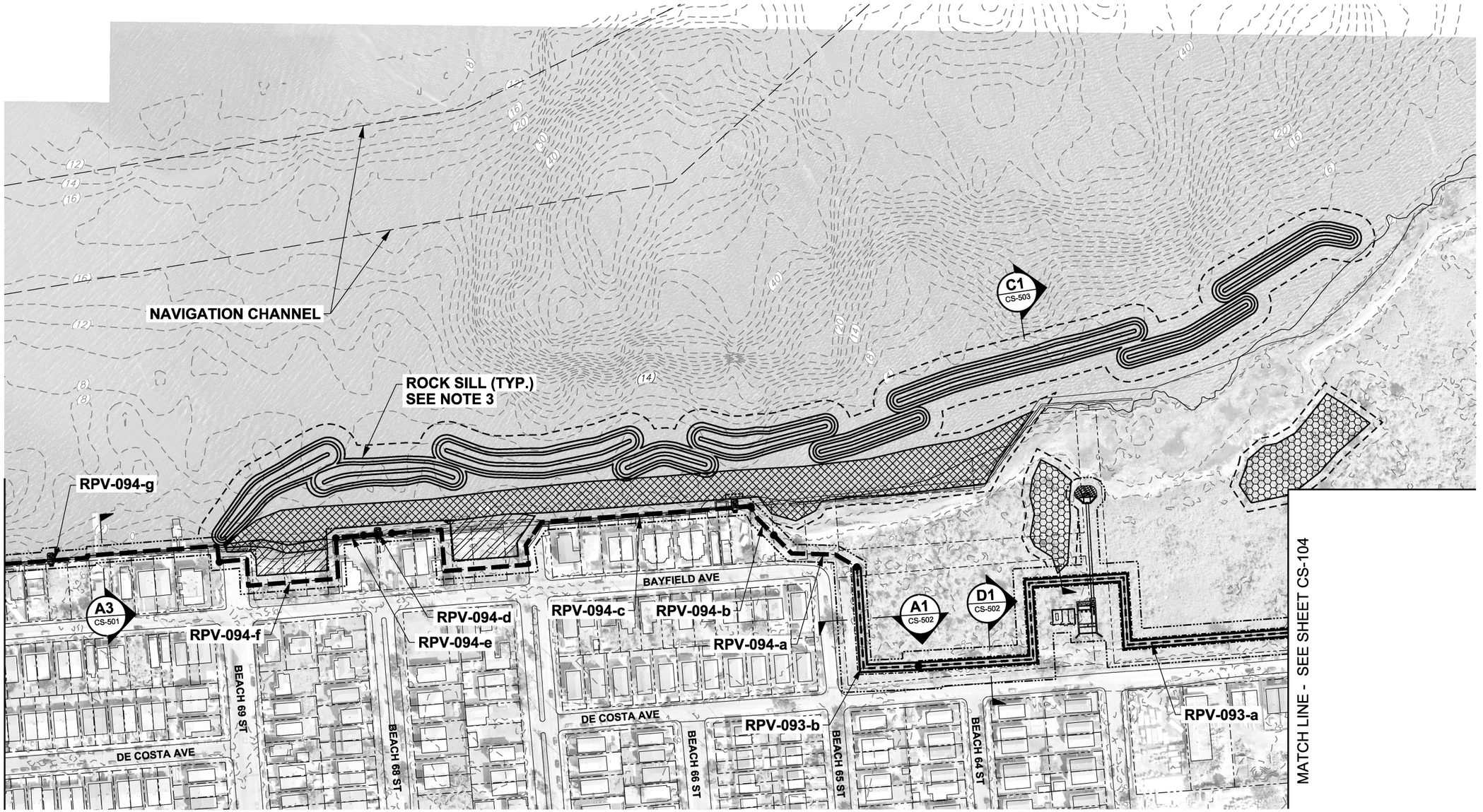
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

DESIGNED BY: IK
DRWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1.000000
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W91-02
FILE NUMBER:
PLOT DATE: 12/7/2018
FILE NAME: W912DS_A2_CS-102.dgn

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (2 OF 8)

SHEET ID
CS-102
SHEET 4 OF 26



MID-ROCKAWAY - ARVERNE (SHEET 2)

SCALE: 1" = 100'

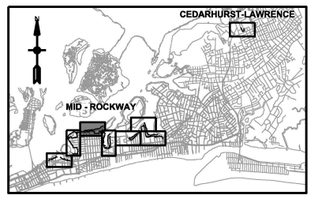
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2-F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2-E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2-E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2-E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2-E	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

DESIGNED BY:	IK
DWN BY:	ME
SUBMITTED BY:	SA
PLOT SCALE:	1.00000000
PLOT DATE:	12/3/2018
FILE NAME:	W912DS_A2_CS-103.dgn
DATE:	12.05.18
SOLICITATION NO.:	
CONTRACT NO.:	W912-02
FILE NUMBER:	

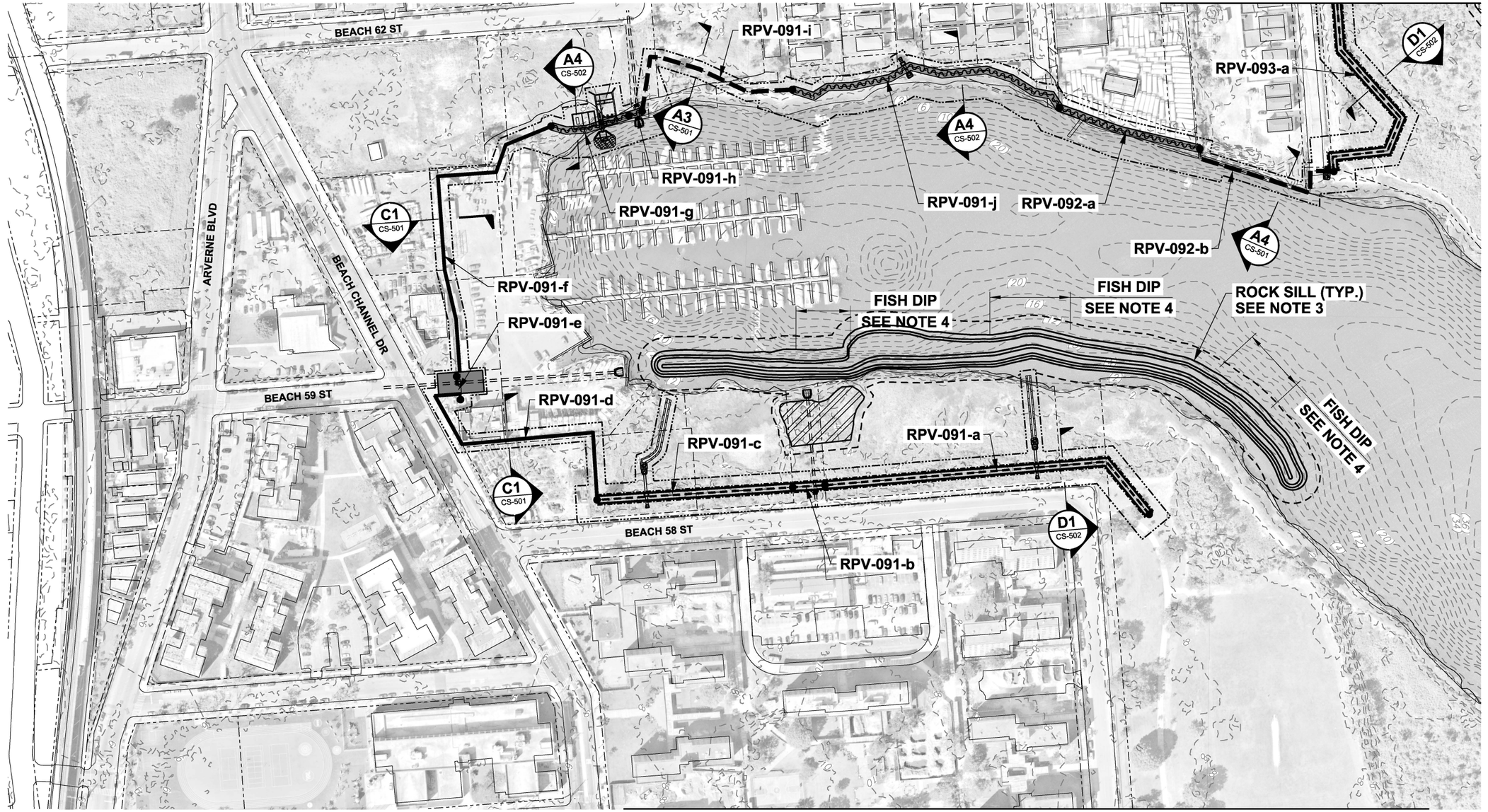
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (3 OF 8)

SHEET ID
CS-103
SHEET 5 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:34:11 AM 12/3/2018 FILE: W912DS_A2_CS-103.dgn

MATCH LINE - SEE SHEET CS-103



MATCH LINE - SEE SHEET CS-105

MID-ROCKAWAY - ARVERNE (SHEET 3)
SCALE: 1" = 100'

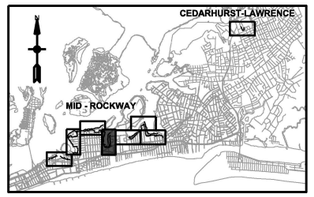
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.
4. IN LOCATIONS WHERE THE BATHYMETRY PROFILE DOES NOT ALLOW FOR OVERLAP, TO PROVIDE FOR SUFFICIENT HYDRAULIC COMMUNICATION AND ORGANISM EXCHANGE BEHIND THE ROCK SILLS, THE PLACEMENT OF PERIODIC LOWERED ROCK SILL ELEVATIONS (FISH DIPS) OF 0.0 FEET MSL OF 100 FEET ARE PROVIDED.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

0 100' 200'
SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

DESIGNED BY: IK | DRWN BY: ME | SUBMITTED BY: SA | PLOT SCALE: 1:1.0000 | SIZE: ANSI D
DATE: 12.05.18 | CKD BY: MK | SOLICITATION NO.: | CONTRACT NO.: W912-02 | PLOT DATE: 12/3/2018 | FILE NUMBER: | FILE NAME: W912DS_A2_CS-104.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

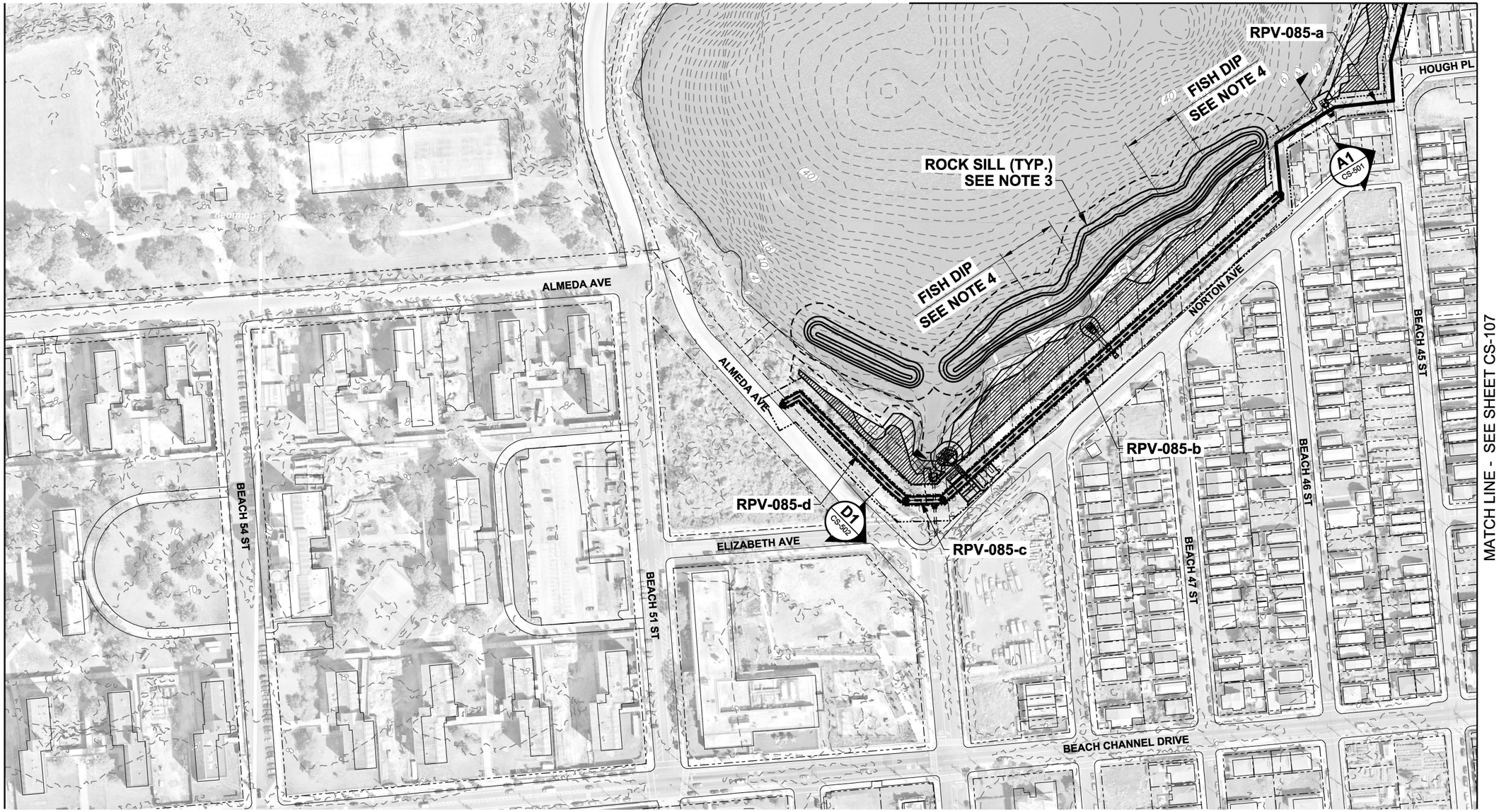
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (4 OF 8)

SHEET ID
CS-104
SHEET 6 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:34:28 AM 12/3/2018 FILE: W912DS_A2_CS-104.dgn

MATCH LINE - SEE SHEET CS-106



MATCH LINE - SEE SHEET CS-104

MATCH LINE - SEE SHEET CS-107

MID-ROCKAWAY - EDGEMERE (SHEET 1)

SCALE: 1" = 100'

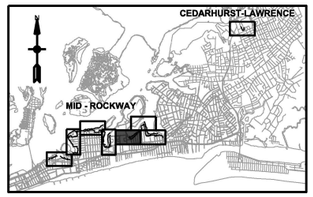
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.
4. IN LOCATIONS WHERE THE BATHYMETRY PROFILE DOES NOT ALLOW FOR OVERLAP, TO PROVIDE FOR SUFFICIENT HYDRAULIC COMMUNICATION AND ORGANISM EXCHANGE BEHIND THE ROCK SILLS, THE PLACEMENT OF PERIODIC LOWERED ROCK SILL ELEVATIONS (FISH DIPS) OF 0.0 FEET MSL OF 100 FEET ARE PROVIDED.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

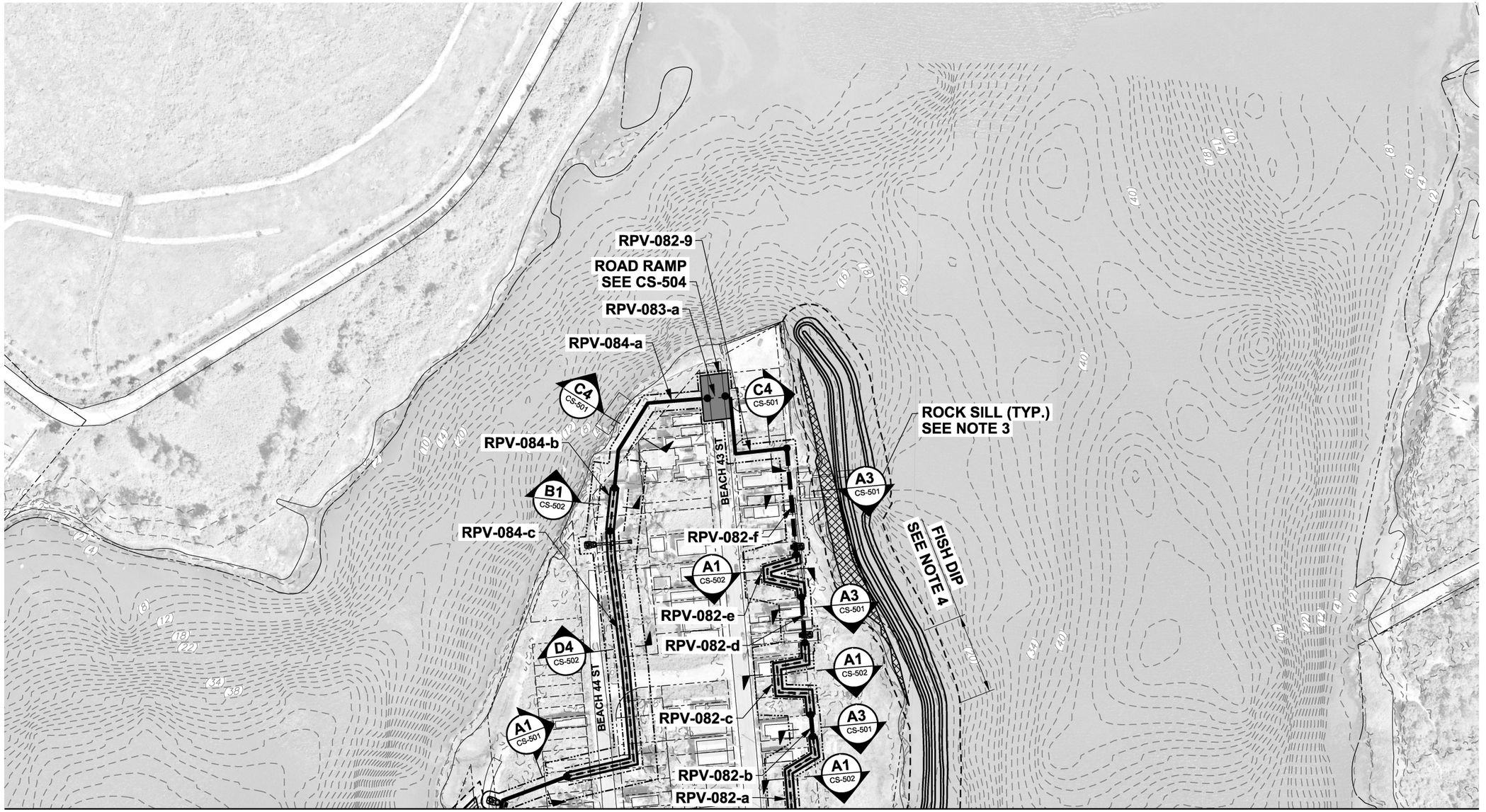
DESIGNED BY: IK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1.00000
PLOT DATE: 12/3/2018
SIZE: ANSI D
FILE NAME: W912DS_A2_CS-105.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (5 OF 8)

SHEET ID
CS-105
SHEET 7 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:34:47 AM 12/3/2018 FILE: W912DS_A2_CS-105.dgn



MATCH LINE - SEE SHEET CS-105

MATCH LINE - SEE SHEET CS-107

MID-ROCKAWAY - EDGEMERE (SHEET 2)

SCALE: 1" = 100'

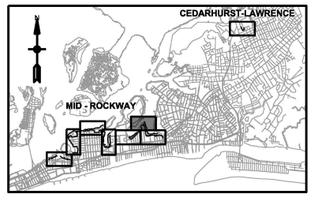
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.
4. IN LOCATIONS WHERE THE BATHYMETRY PROFILE DOES NOT ALLOW FOR OVERLAP, TO PROVIDE FOR SUFFICIENT HYDRAULIC COMMUNICATION AND ORGANISM EXCHANGE BEHIND THE ROCK SILLS, THE PLACEMENT OF PERIODIC LOWERED ROCK SILL ELEVATIONS (FISH DIPS) OF 0.0 FEET MSL OF 100 FEET ARE PROVIDED.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
FILE: W912DS_A2_CS-106.dgn
12/3/2018
11:35:08 AM
LAST PLOTTED BY: mestimable

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

DESIGNED BY: IK
DRN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 1.000000
PLOT STYLE: ANSI D
DATE: 12.05.18
CKD BY: MK
CONTRACT NO.: W91-02
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CS-106.dgn
SOLICITATION NO.:
FILE NUMBER:

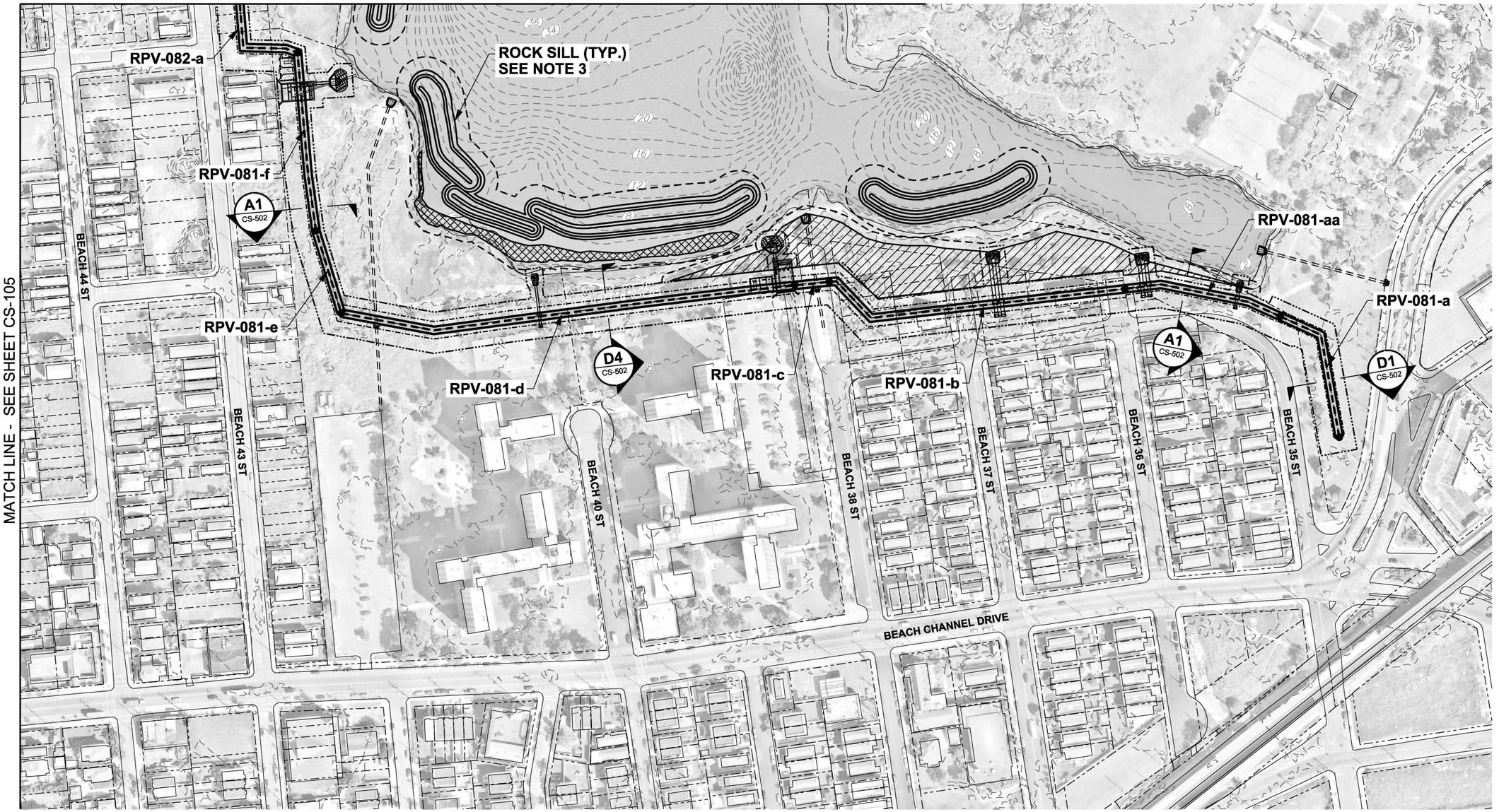
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-788-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (6 OF 8)

SHEET ID
CS-106
SHEET 8 OF 26

MATCH LINE - SEE SHEET CS-106



MATCH LINE - SEE SHEET CS-105

MID-ROCKAWAY - EDGEMERE (SHEET 3)

SCALE: 1" = 100'

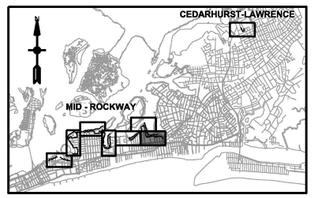
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.
4. IN LOCATIONS WHERE THE BATHYMETRY PROFILE DOES NOT ALLOW FOR OVERLAP, TO PROVIDE FOR SUFFICIENT HYDRAULIC COMMUNICATION AND ORGANISM EXCHANGE BEHIND THE ROCK SILLS, THE PLACEMENT OF PERIODIC LOWERED ROCK SILL ELEVATIONS (FISH DIPS) OF 0.0 FEET MSL OF 100 FEET ARE PROVIDED.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

DESIGNED BY: IK
DRWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 1:1
PLOT SIZE: ANSI D
DATE: 12.05.18
CKD BY: MK
CONTRACT NO.: W912-02
PLOT DATE: 12/5/2018
FILE NAME: W912DS_A2_CS-107.dgn
SOLICITATION NO.:
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

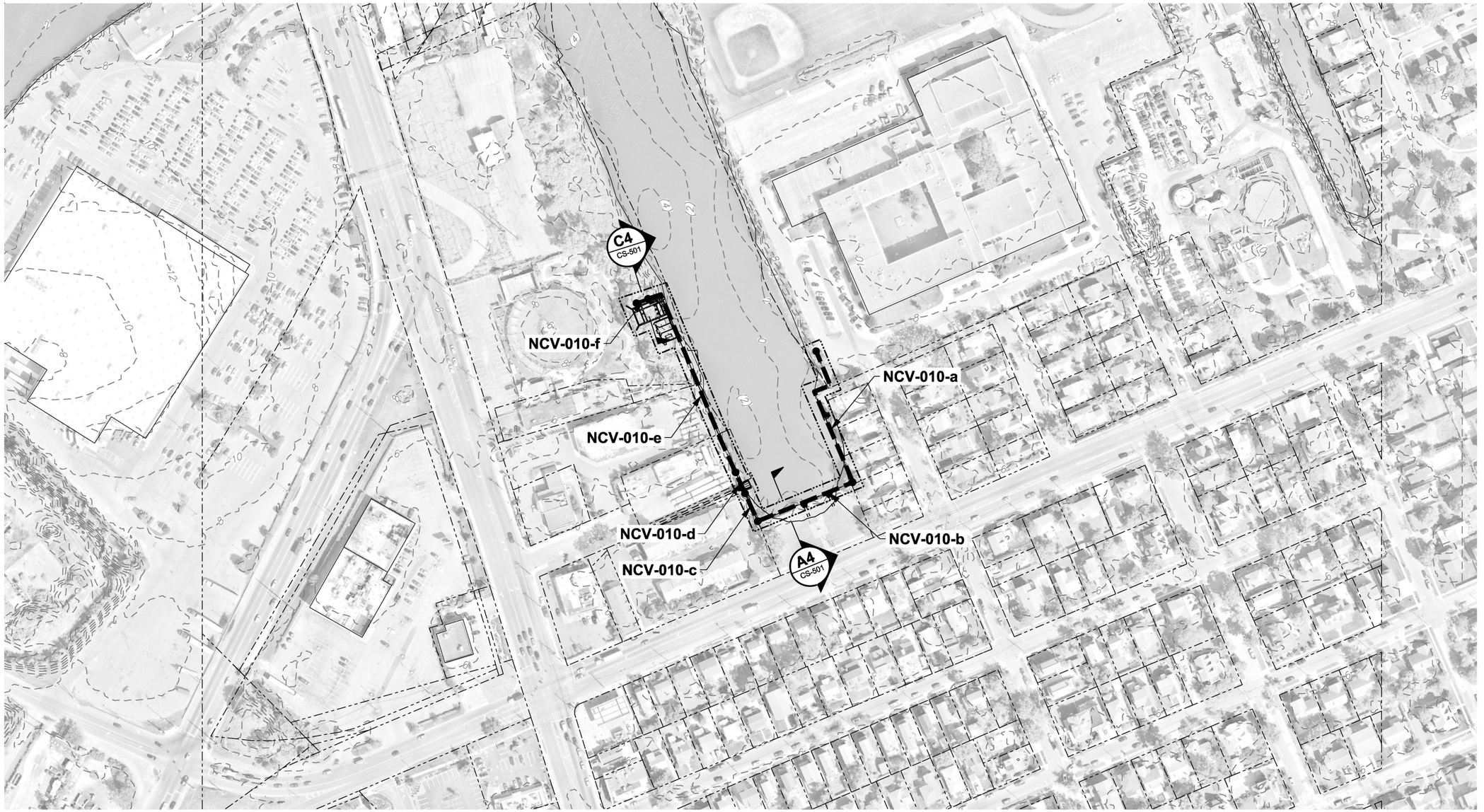
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (7 OF 8)

SHEET ID
CS-107
SHEET 9 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:37:28 AM 12/3/2018 FILE: W912DS_A2_CS-107.dgn



CEDARHURST-LAWRENCE

SCALE: 1" = 100'

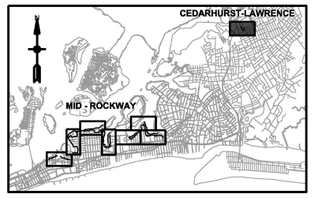
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.

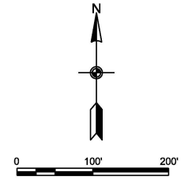
PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- 4 EXISTING CONTOURS (LANDSIDE)
- (4) EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN



SCALE:1"=100'

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
FILE: W912DS_A2_CS-108.dgn
12/3/2018
11:37:58 AM
mestimable
LAST PLOTTED BY:

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

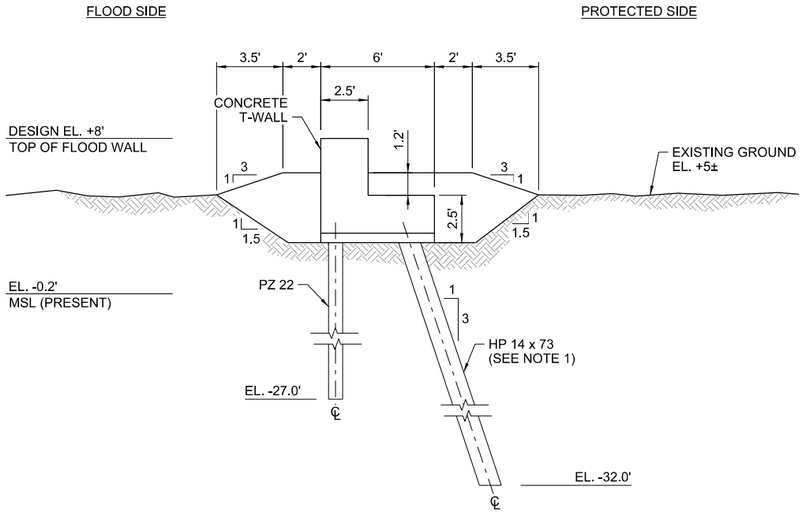
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

DESIGNED BY: MK	DATE: 12.05.18
DWN BY: ME	CKD BY: MK
SUBMITTED BY: SA	SOLICITATION NO.:
PLOT SCALE: 1.00000	CONTRACT NO.: W912-02
SIZE: ANSI D	PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CS-108.dgn	FILE NUMBER:

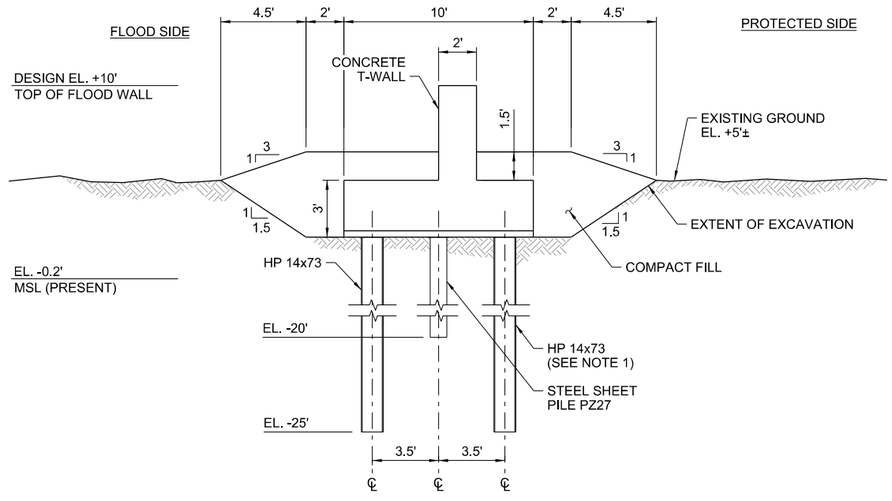
INTEGRATED HURRICANE SANDY GENERAL
RE-EVALUATION REPORT AND ENVIRONMENTAL
IMPACT STATEMENT

SITE PLAN (8 OF 8)

SHEET ID
CS-108
SHEET 10 OF 26



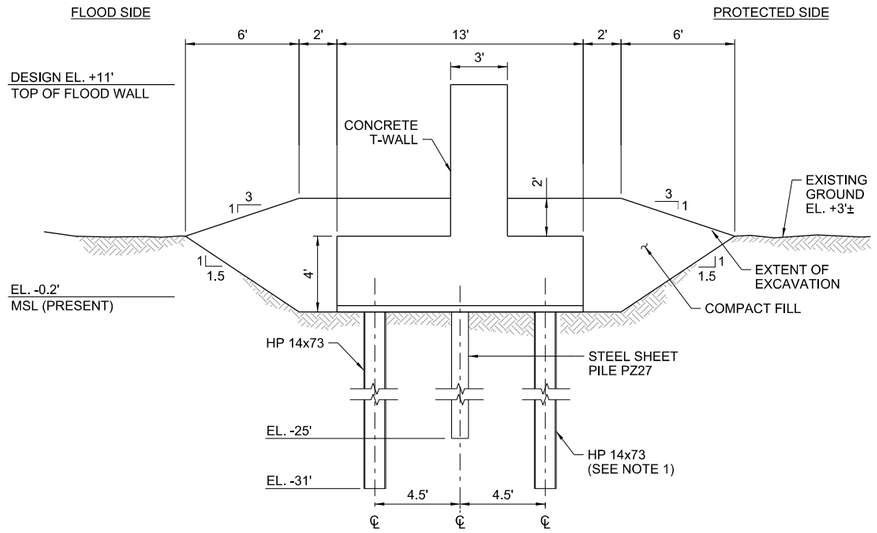
C1 LOW FLOODWALL
SCALE: 1/4" = 1'-0"
CS-101, CS-102, CS-104



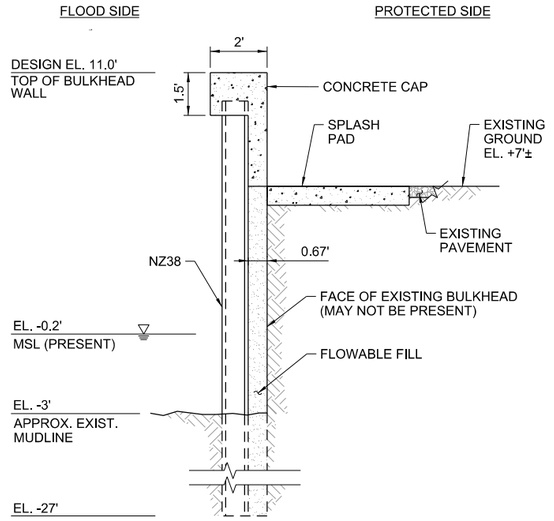
C4 MEDIUM FLOODWALL
SCALE: 1/4" = 1'-0"
CS-102, CS-106, CS-108

NOTE

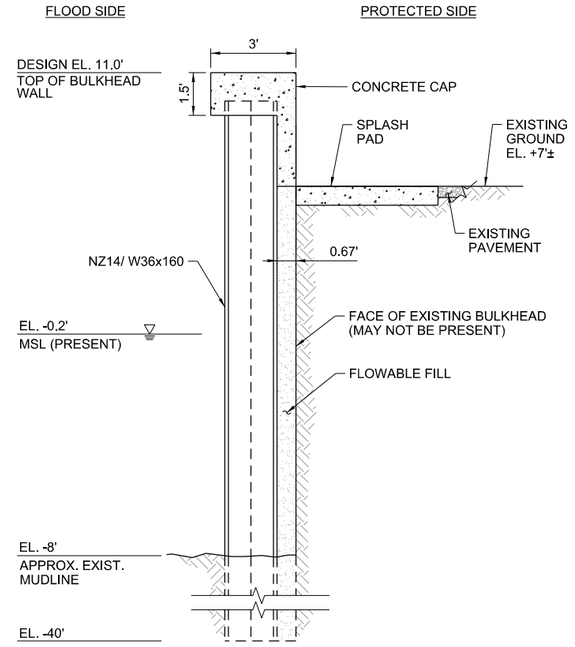
1. PILE SPACINGS FOR LOW, MEDIUM, AND HIGH FLOODWALLS ARE 10', 8.5' AND 6.5', RESPECTIVELY.



A1 HIGH FLOODWALL
SCALE: 1/4" = 1'-0"
CS-102, CS-105, CS-106



A3 SHALLOW BULKHEAD
SCALE: 3/8" = 1'-0"
CS-102, CS-103, CS-104, CS-106



A4 DEEP BULKHEAD
SCALE: 3/8" = 1'-0"
CS-102, CS-104, CS-108

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

DESIGNED BY: MK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:1.000000
PLOT DATE: 12/5/2018
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:
FILE NAME: W912DS_A2_CS-501.dgn

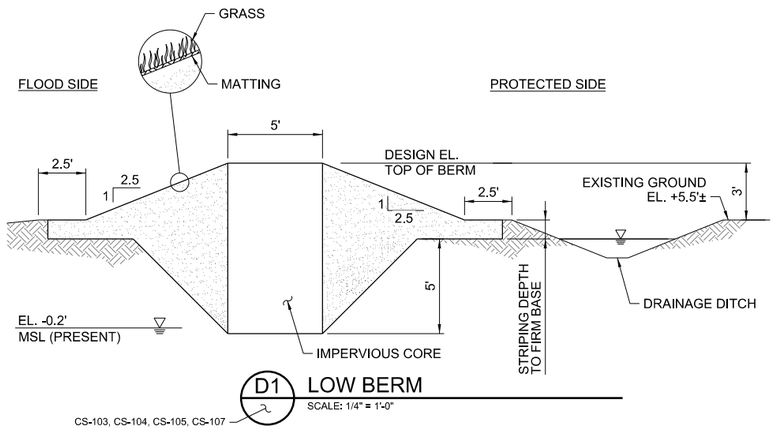
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

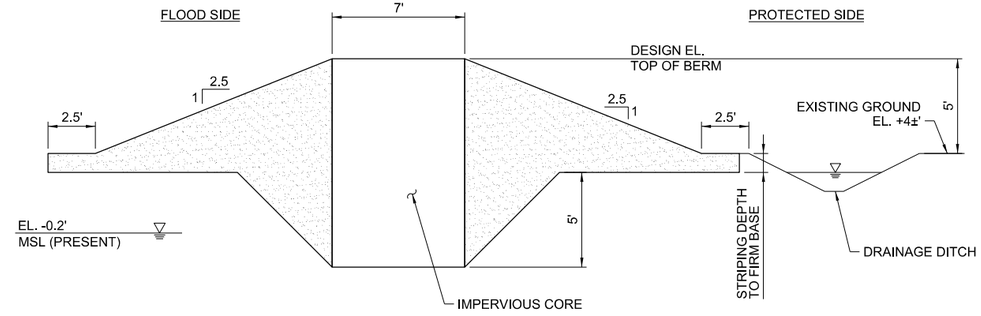
FLOODWALL AND BULKHEAD TYPICAL SECTIONS

SHEET ID
CS-501
SHEET 11 OF 26

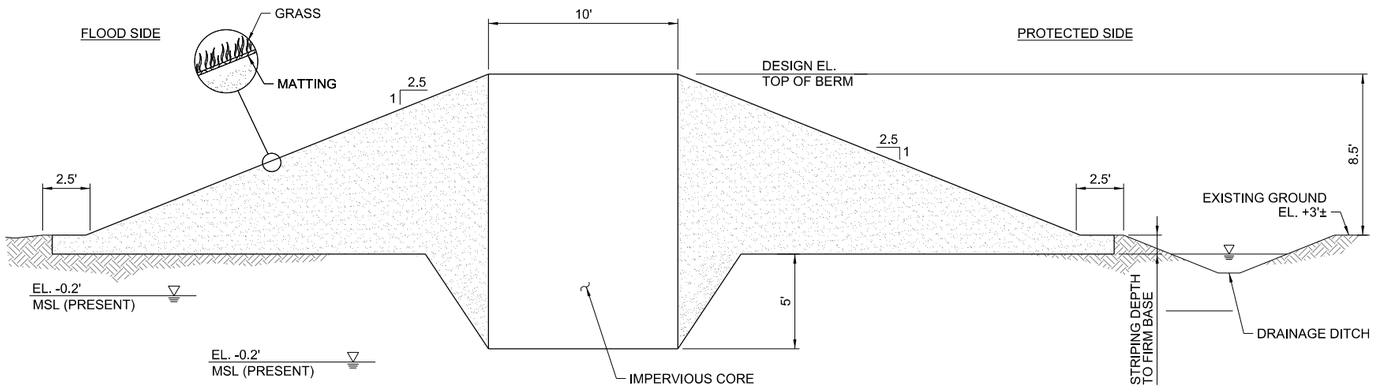
PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
FILE: W912DS_A2_CS-501.dgn
12/3/2018
11:39:50 AM
LAST PLOTTED BY: mestimable



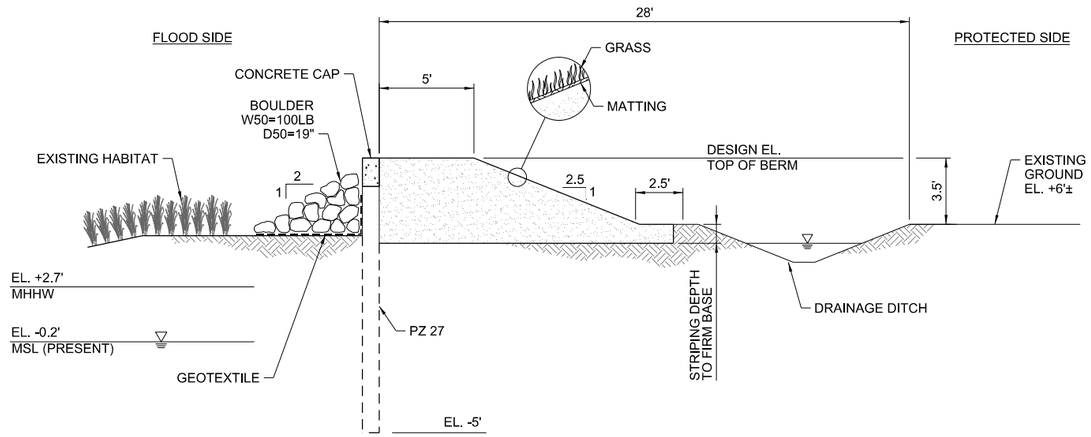
D1 LOW BERM
SCALE: 1/4" = 1'-0"
CS-103, CS-104, CS-105, CS-107



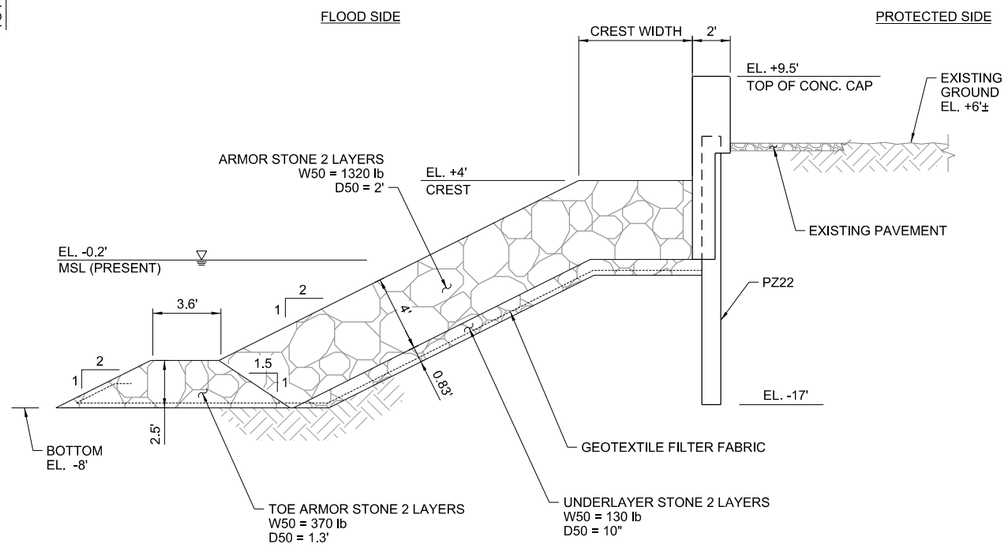
D4 MEDIUM BERM
SCALE: 1/4" = 1'-0"
CS-102, CS-106



B1 HIGH BERM
CS-106
SCALE: 1/4" = 1'-0"



A1 HYBRID BERM
SCALE: 1/4" = 1'-0"
CS-103, CS-106, CS-107



A4 REVETMENT WITH FLOODWALL
CS-104
SCALE: 1/4" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:40:01 AM 12/3/2018 FILE: W912DS_A2_CS-502.dgn

US Army Corps of Engineers®

E	FINAL GRR - APPENDIX A2,F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2,E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2,E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2,E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2,E	07.19.18	MK
MARK	DESCRIPTION	DATE	APPR.

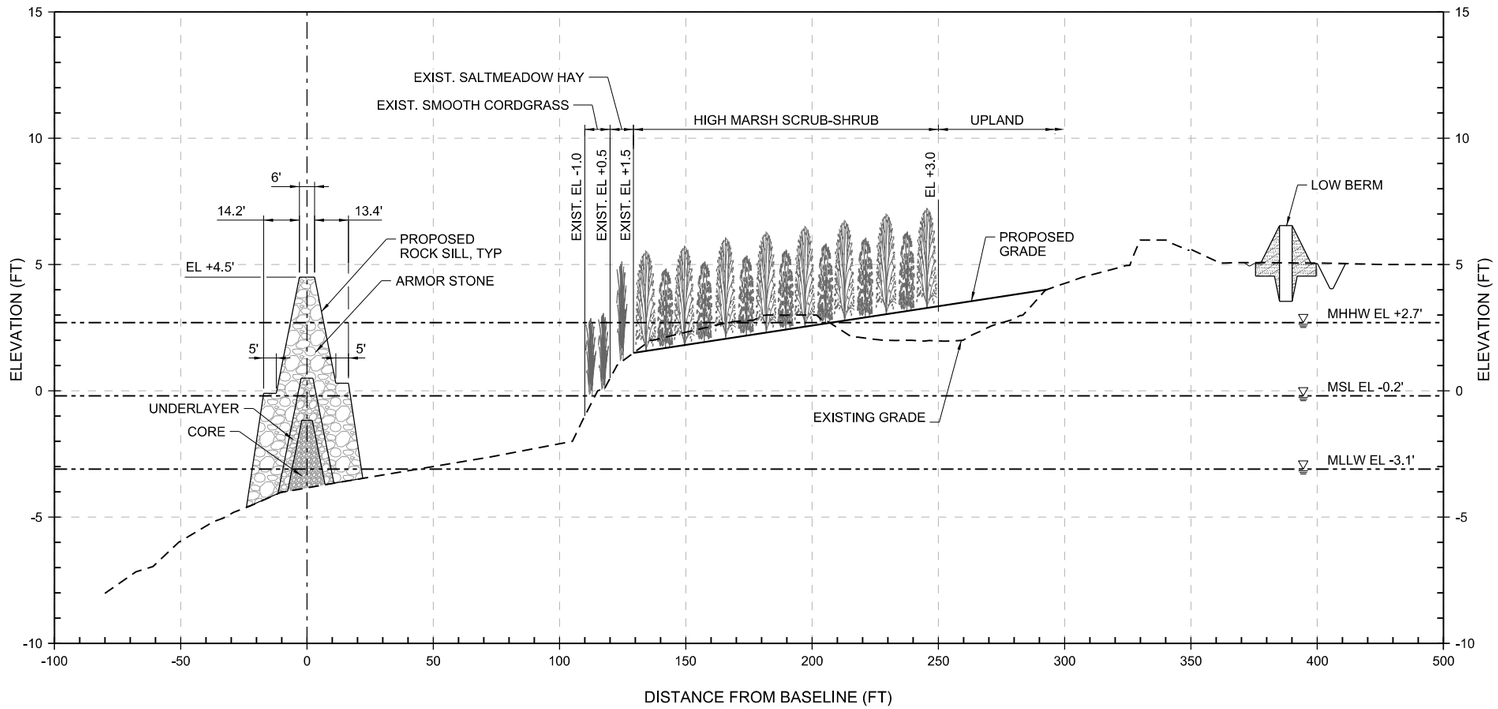
DESIGNED BY: MK
DRN BY: ME
CKD BY: MK
SUBMITTED BY: SA
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
PLOT SCALE: 1:2
PLOT DATE: 12/5/2018
FILE NUMBER:
SIZE: ANSI D
FILE NAME: W912DS_A2_CS-502.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL
RE-EVALUATION REPORT AND ENVIRONMENTAL
IMPACT STATEMENT

BERM AND REVETMENT WITH FLOODWALL TYPICAL SECTIONS

SHEET ID
CS-502
SHEET 12 OF 26



C1 / CS-103 NATURAL AND NATURE BASED FEATURES (NNBF) TYPICAL SECTION

SCALE: 1/4" = 1'-0"

NOTE

1. ALL ELEVATIONS REFERENCED TO NAVD88.

PLANTING PLAN

1. REMOVE ALL STRUCTURES AND DEBRIS.
2. REGRADE SHORELINE SLOPES TO MINIMIZE EXCAVATION AND/OR FILL ACTIVITIES AND TO PROVIDE OPTIMAL HABITAT SPECIFIC ELEVATIONS:
   A. LOW MARSH (COMMON CORDGRASS) -1.0 TO +0.5
   B. INTERMEDIATE MARSH (SALTMEADOW HAY/BLACKGRASS) +0.5 TO + 1.5
   C. HIGH MARSH – SCRUB SHRUB (MARSH ELDER/GROUNDSEL BUSH) + 1.5 TO +3.0
   D. UPLANDS HABITAT + 3.0 AND GREATER
3. SEED OR PLANT (PLUG/POT) WITH APPROPRIATE SPECIES. PLANTING OF PLUGS FOR COMMON CORDGRASS AND SALTMEADOW HAY SHOULD BE PLANTED ON 3 FT. CENTERS. MARSH ELDER/GROUNDSEL POTS SHOULD BE PLANTED ON 5 FT. CENTERS.

PRELIMINARY
NOT FOR CONSTRUCTION

0 3' 6'
HOR. SCALE: 1"=3'

0 30' 60'
HOR. SCALE: 1"=30'

MARK	DESCRIPTION	DATE	APPR.
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK

US Army Corps of Engineers®

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

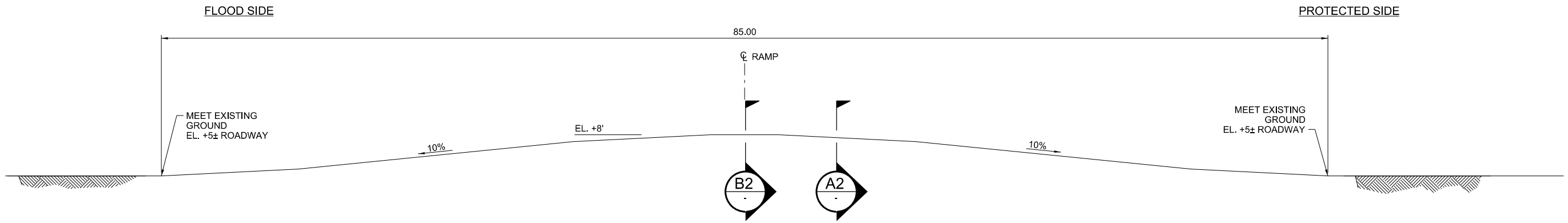
DESIGNED BY: MK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 12
PLOT STYLE TABLE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
PLOT DATE:
FILE NUMBER:
FILE NAME: W912DS_A2_CS-503.dgn

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

NATURAL AND NATURE BASED FEATURES (NNBF) SECTION

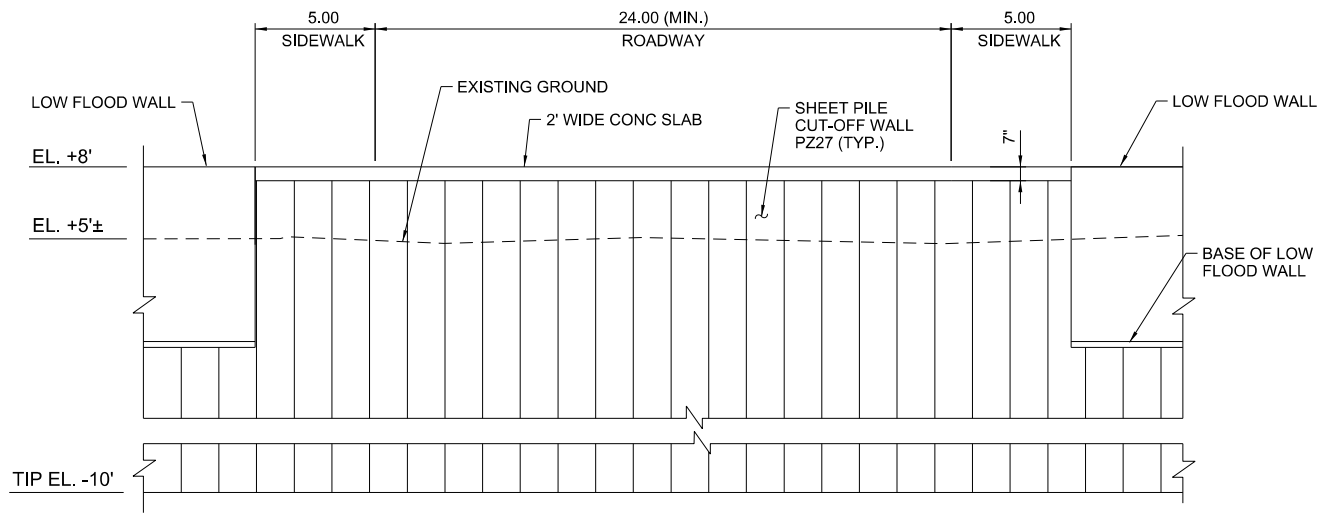
SHEET ID
CS-503
SHEET 13 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:40:10 AM 12/3/2018 FILE: W912DS_A2_CS-503.dgn



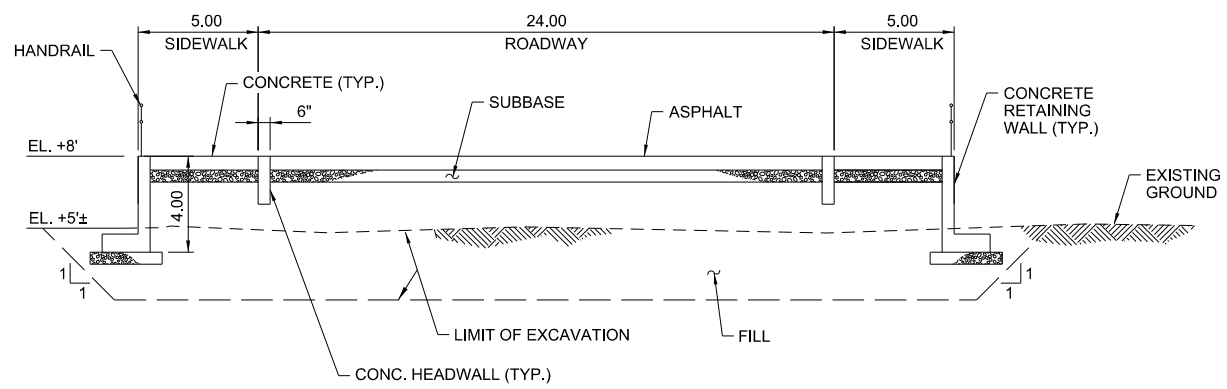
D1 - SECTION - CENTER OF ROAD RAMP

SCALE: 1/4" = 1'-0"



B2 - SECTION - CENTER OF ROAD RAMP

SCALE: 1/4" = 1'-0"



A2 - SECTION - PROTECTED SIDE

SCALE: 1/4" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

0 2' 4' 8'

SCALE: 1/4" = 1'-0"

LAST PLOTTED BY: mestimable 11:40:20 AM 12/3/2018 FILE: W912DS_A2_CS-504.dgn PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2,F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2,E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2,E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2,E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2,E	07.19.18	MK

DESIGNED BY: IK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1/2" = 1'-0"
STEEL: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912DS-18-C-0002
PLOT DATE: 12/5/2018
FILE NAME: W912DS_A2_CS-504.dgn
FILE NUMBER:

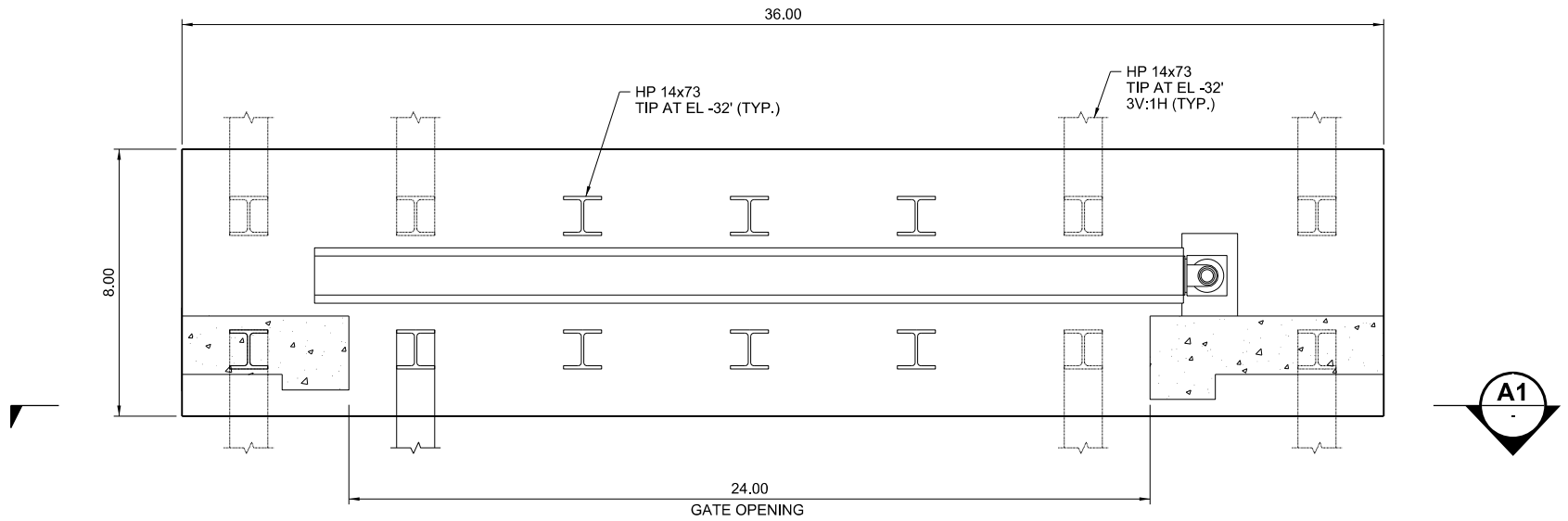
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

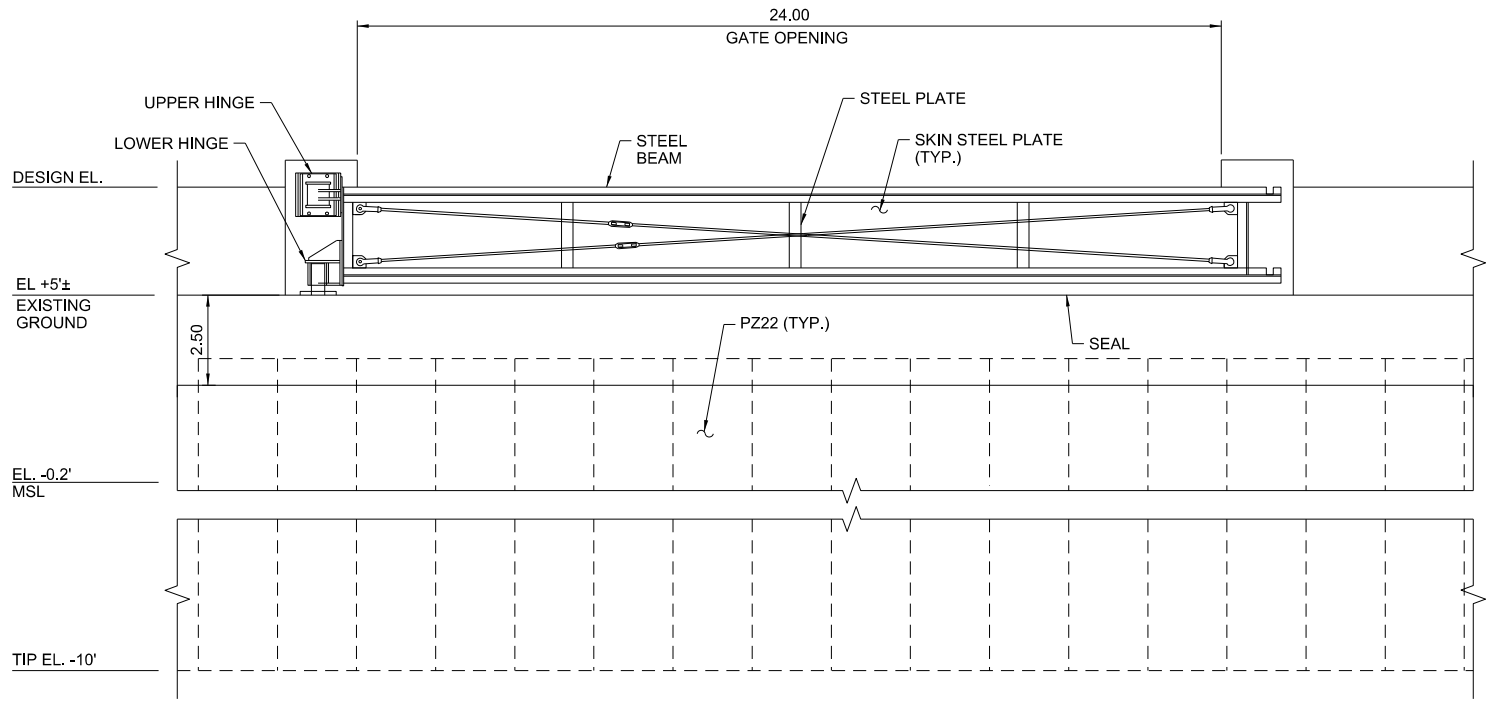
ROAD RAMP SECTIONS

SHEET ID
CS-504
SHEET 14 OF 26



PROTECTED SIDE

C1 / - PLAN - SWING GATE
SCALE: 3/8" = 1'-0"



A1 / - ELEVATION - SWING GATE
SCALE: 3/8" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

0 2' 4' 8'
SCALE: 3/8" = 1'-0"

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:41:54 AM 12/3/2018 FILE: W912DS_A2_CS-505.dgn

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2JF	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2JE	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2JE	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2JE	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2JE	07.19.18	MK

US Army Corps of Engineers®

DESIGNED BY: MK | DRWN BY: ME | SUBMITTED BY: SA | DRAWING NO: 505 | DATE: 12.05.18 | CKD BY: MK | PLOT SCALE: 1=1 | PLOT DATE: 12/3/2018 | SIZE: ANSI D | SOLICITATION NO.: | CONTRACT NO.: W912-02 | FILE NUMBER: | FILE NAME: W912DS_A2_CS-505.dgn

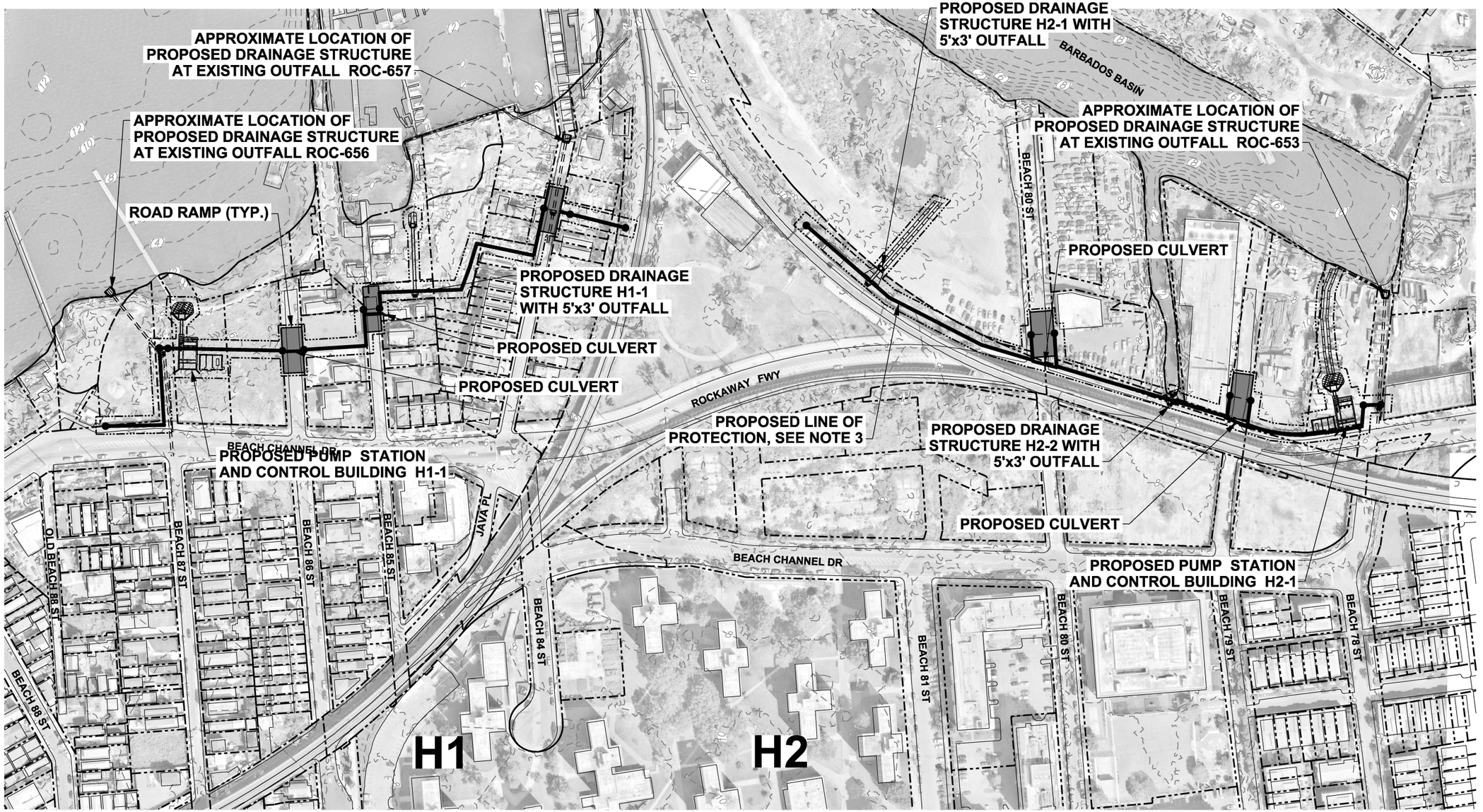
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SWING GATE PLAN AND ELEVATION

SHEET ID
CS-505
SHEET 15 OF 26



MID-ROCKAWAY - HAMMELS
SCALE: 1" = 100'

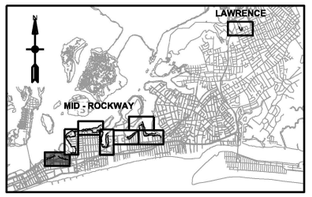
NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA

PRELIMINARY
NOT FOR CONSTRUCTION



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

US Army Corps of Engineers®

DESIGNED BY: BU | DRN BY: CM | SUBMITTED BY: MC | PLOT SCALE: 1.000000 | SIZE: ANSI D
DATE: 12.05.18 | SOLICITATION NO.: | CONTRACT NO.: W912DS-18-C-0002 | PLOT DATE: 12/3/2018 | FILE NUMBER: | FILE NAME: W912DS_A2_CU-101.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

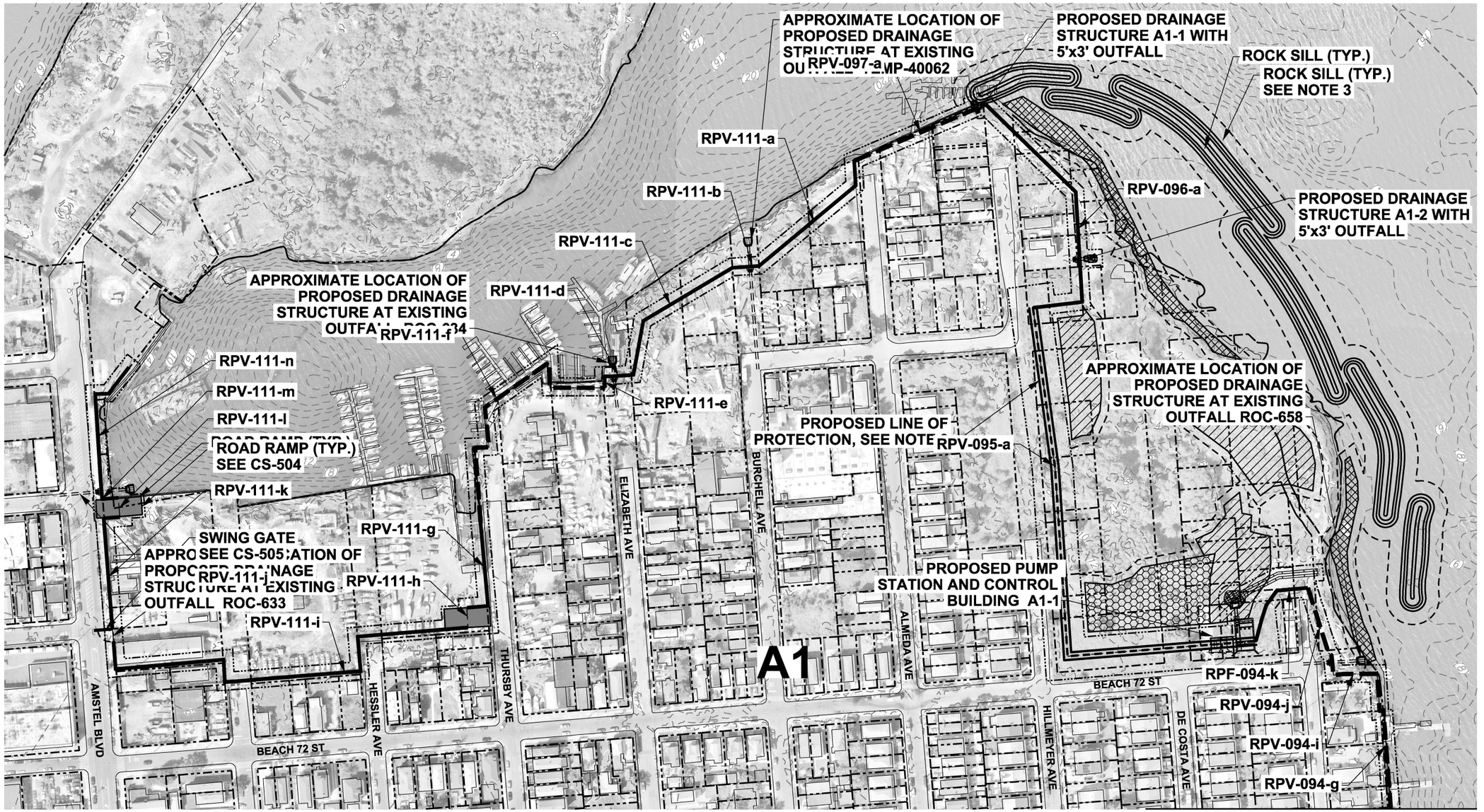
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (1 OF 8)

SHEET ID
CU-101
SHEET 16 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
LAST PLOTTED BY: mestimable 11:23:59 AM 12/3/2018 FILE: W912DS_A2_CU-101.dgn



MATCH LINE - SEE SHEET CU-103

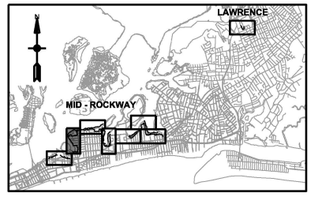
MID-ROCKAWAY - ARVERNE (SHEET 1)
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

0 100' 200'
SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

DESIGNED BY: BU
DRWN BY: CM
SUBMITTED BY: AC
PLOT SCALE: 1.000000'
ANSI D
DATE: 12.05.18
CKD BY: MJ
PLOT DATE: 12/5/2018
FILE NAME: W912DS_A2_CU-102.dgn
SOLICITATION NO.:
CONTRACT NO.: W91-02
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

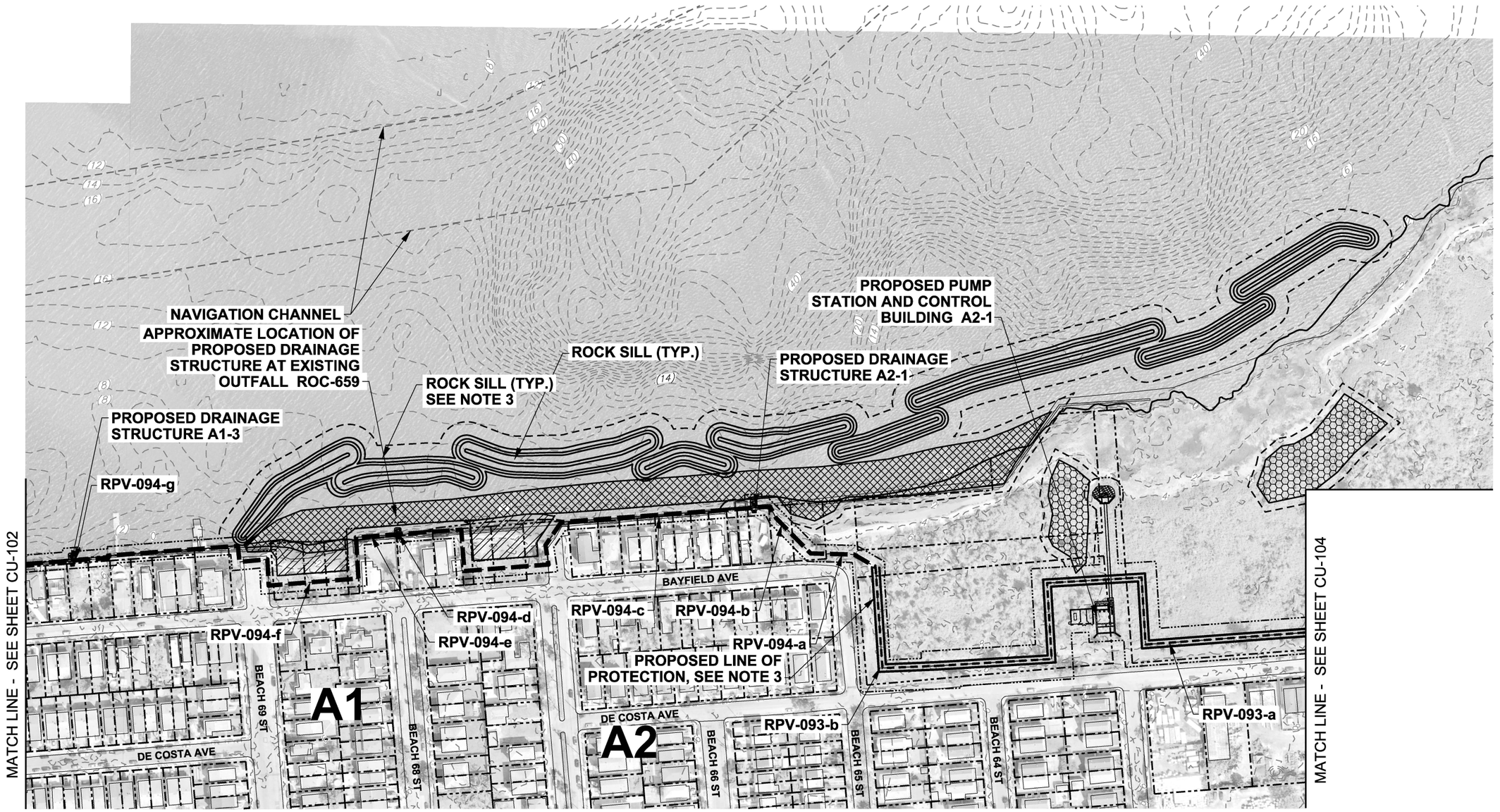
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (2 OF 8)

SHEET ID
CU-102
SHEET 17 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-102.dgn
12/3/2018
11:25:32 AM
LAST PLOTTED BY: mestimable

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
LAST PLOTTED BY: mestimable 11:25:54 AM 12/3/2018 FILE: W912DS_A2_CU-103.dgn



MID-ROCKAWAY - ARVERNE (SHEET 2)
SCALE: 1" = 100'

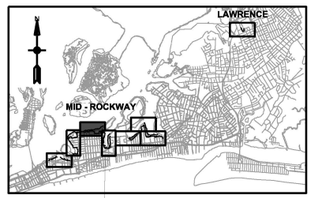
NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA

PRELIMINARY
NOT FOR CONSTRUCTION



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2-F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2-E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2-E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1-E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2-E	07.19.18	BU

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

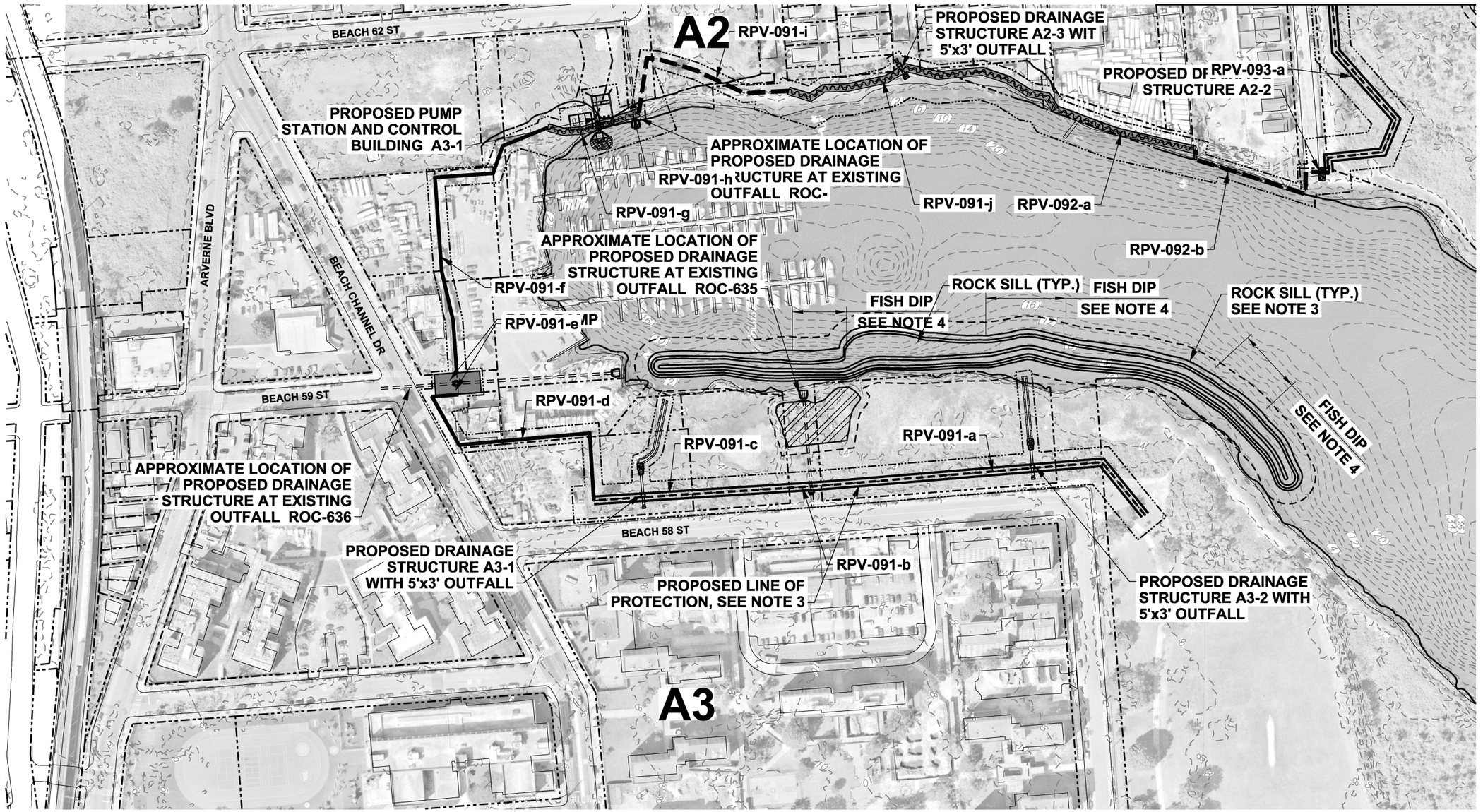
DESIGNED BY: BU
DRWN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 1.000000'
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MJ
PLOT DATE:
FILE NAME: W912DS_A2_CU-103.dgn
SOLICITATION NO.:
CONTRACT NO.: 97-81-02
FILE NUMBER:

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (3 OF 8)

SHEET ID
CU-103
SHEET 18 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
LAST PLOTTED BY: mestimable 11:26:16 AM 12/3/2018 FILE: W912DS_A2_CU-104.dgn



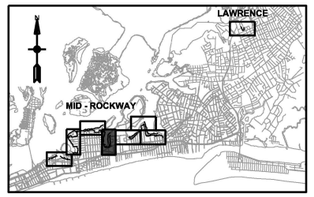
MID-ROCKAWAY - ARVERNE (SHEET 3)
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

0 100' 200'
SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2:F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2:E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2:E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1:E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2:E	07.19.18	BU

DESIGNED BY: BU
DRWN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 1:1.5000
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MJ
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CU-104.dgn
SOLICITATION NO.:
CONTRACT NO.: W91-02
FILE NUMBER:

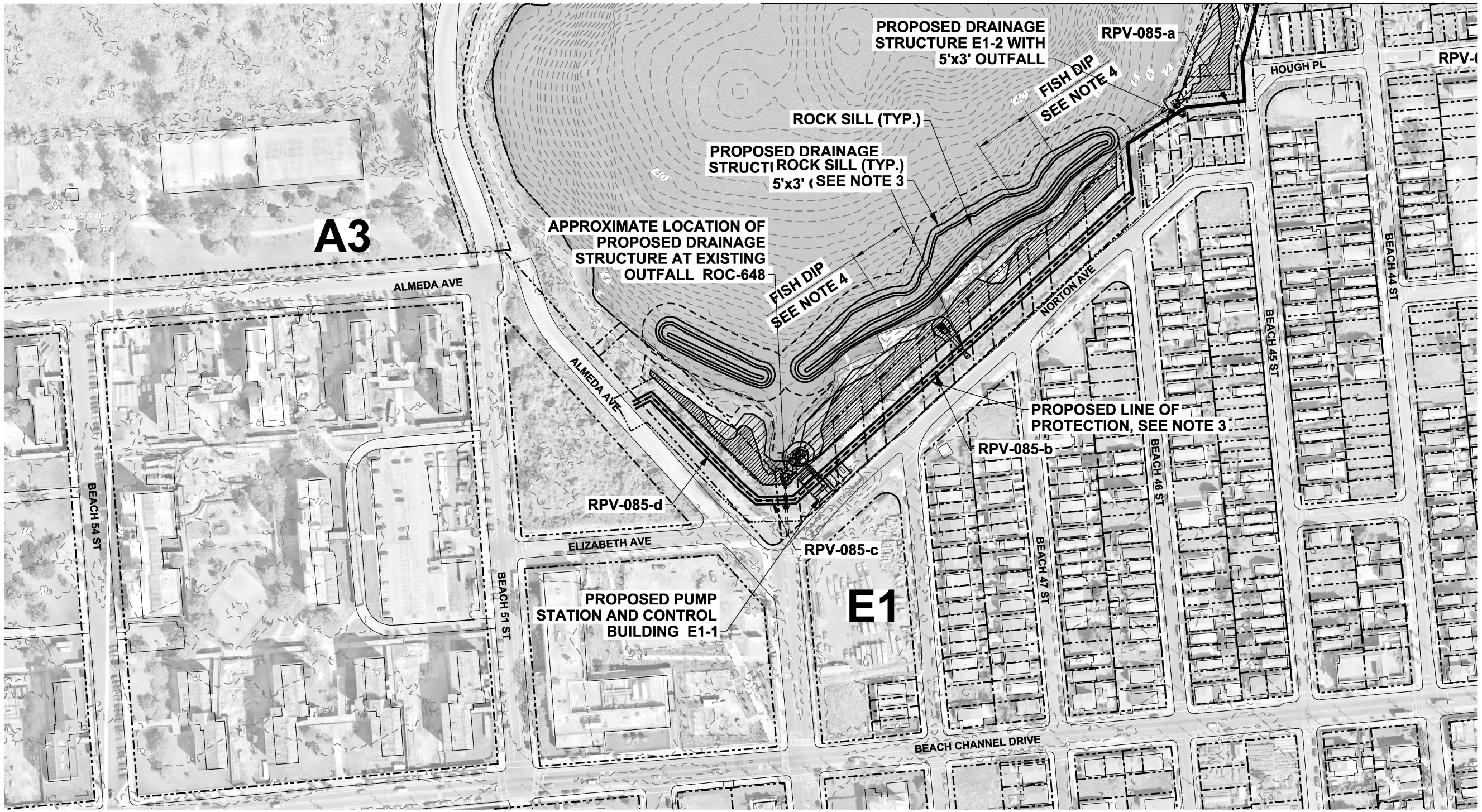
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (4 OF 8)

SHEET ID
CU-104
SHEET 19 OF 26

MATCH LINE - SEE SHEET CU-106



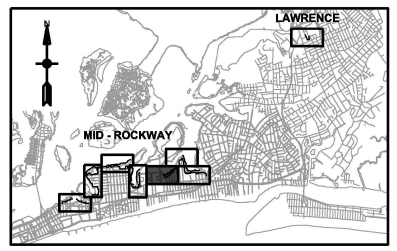
MID-ROCKAWAY - EDGEMERE (SHEET 1)
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2-F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2-E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2-E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1-E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2-E	07.19.18	BU

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

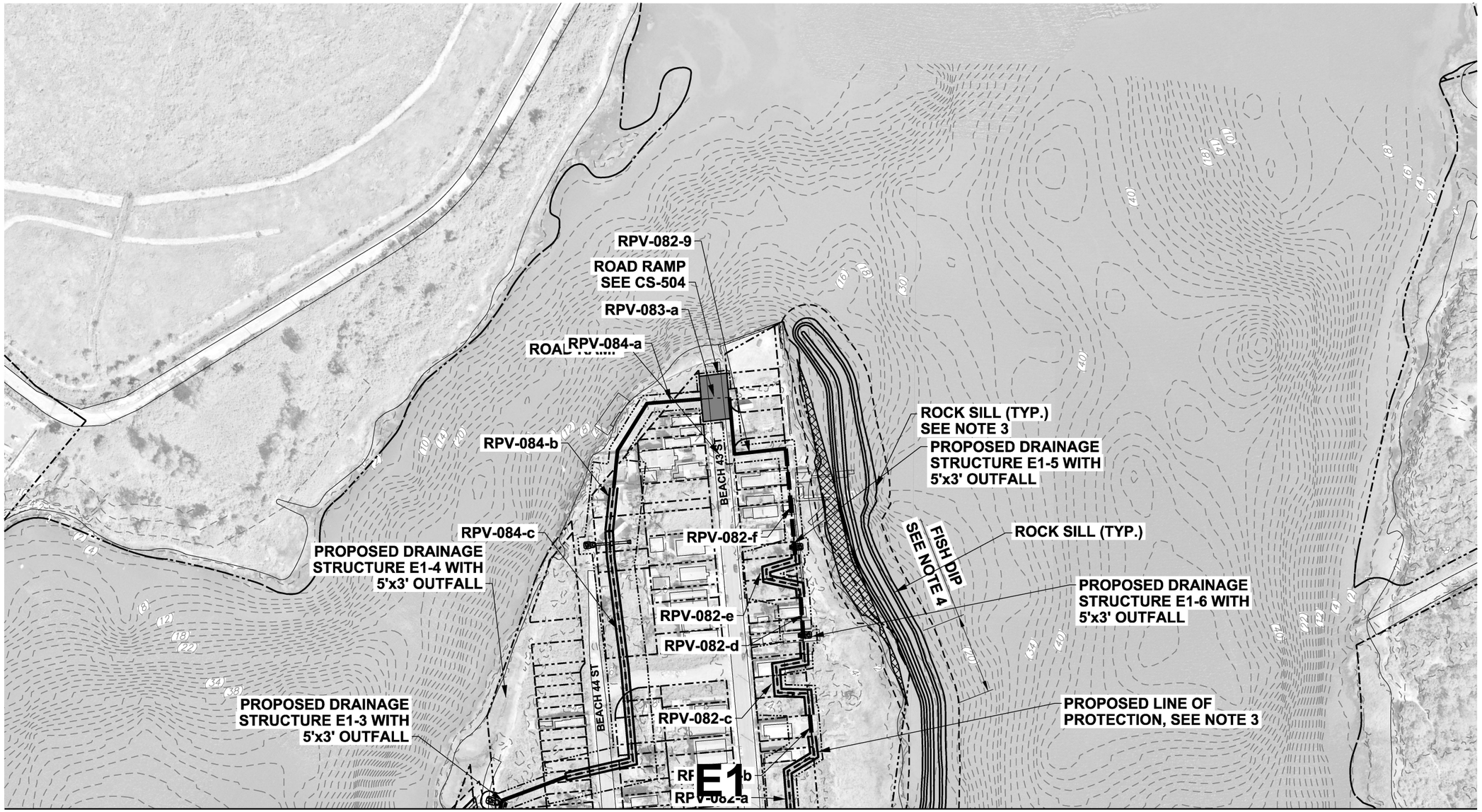
DESIGNED BY: BU | DATE: 12.05.18
DWN BY: CM | CKD BY: MJ | SOLICITATION NO.:
SUBMITTED BY: MC | CONTRACT NO.: W912DS-16-D-0002 | 9781-02
PLOT SCALE: 1.00000 | PLOT DATE: 12/3/2018 | FILE NUMBER:
SIZE: ANSI D | FILE NAME: W912DS_A2_CU-105.dgn

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (5 OF 8)

SHEET ID
CU-105
SHEET 20 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
LAST PLOTTED BY: mestimable 12/3/2018 11:26:38 AM FILE: W912DS_A2_CU-105.dgn



MATCH LINE - SEE SHEET CU-105

MATCH LINE - SEE SHEET CU-107

MID-ROCKAWAY - EDGEMERE (SHEET 2)

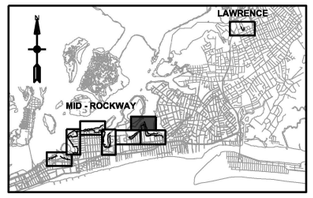
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2:F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2:E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2:E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1:E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2:E	07.19.18	BU

DESIGNED BY: BU
DRWN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 1:20.0667
PLOT STYLE TABLE: ANSI D
DATE: 12.05.18
CKD BY: MJ
PLOT DATE:
FILE NAME: W912DS_A2_CU-106.dgn
SOLICITATION NO.:
CONTRACT NO.: 97-81-02
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

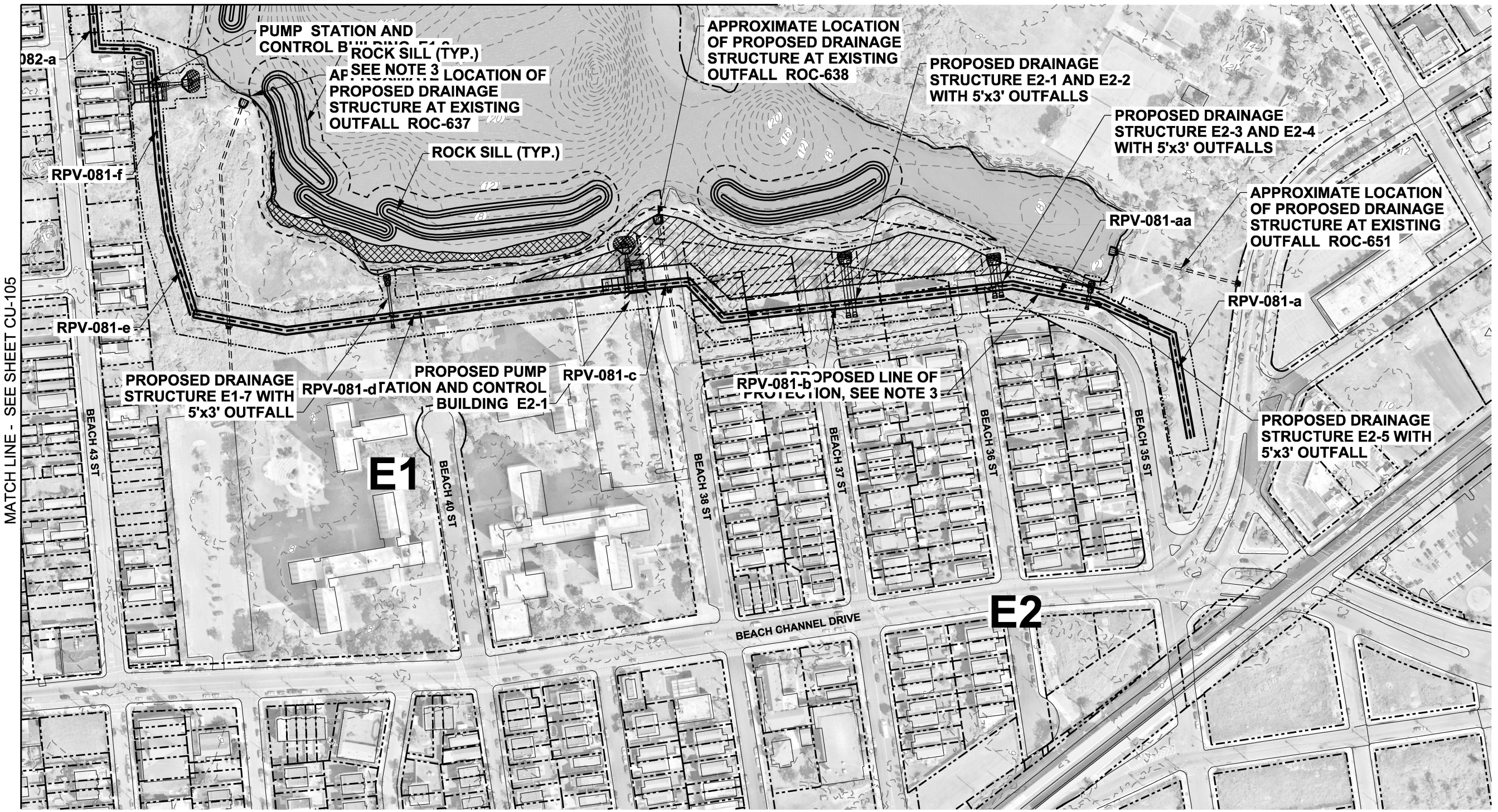
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (6 OF 8)

SHEET ID
CU-106
SHEET 21 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-106.dgn
12/3/2018 11:26:58 AM
LAST PLOTTED BY: mestimable

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-107.dgn
12/3/2018
11:27:20 AM
LAST PLOTTED BY: mestimable



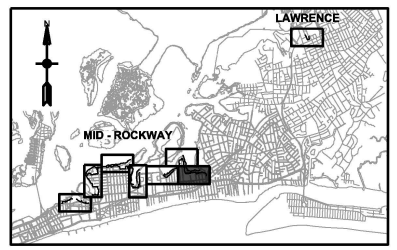
MID-ROCKAWAY - EDGEMERE (SHEET 3)
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

DESIGNED BY: BU
DRWN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 1:1
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MJ
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CU-107.dgn
SOLICITATION NO.:
CONTRACT NO.: W781-02
FILE NUMBER:

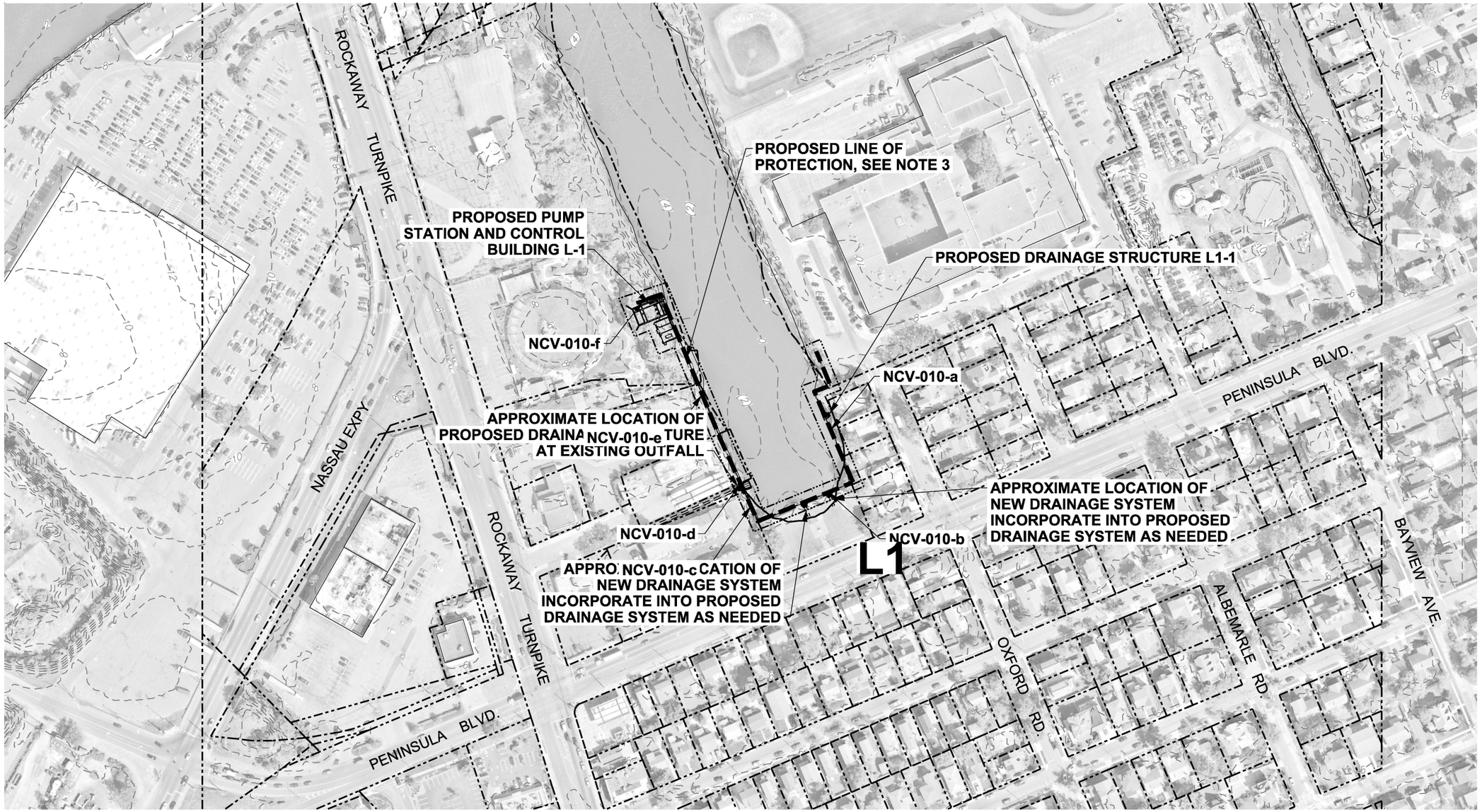
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (7 OF 8)

SHEET ID
CU-107
SHEET 22 OF 26



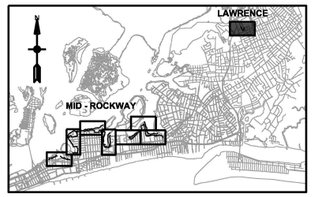
LAWRENCE
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2:F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2:E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2:E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1:E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2:E	07.19.18	BU

US Army Corps of Engineers®

DESIGNED BY: BU | DRN BY: CM | CHKD BY: MJ | SUBMITTED BY: MC | PLOT SCALE: 1:1.666667 | SIZE: ANSI D | DATE: 12.05.18 | SOLICITATION NO.: | CONTRACT NO.: W912DS-16-D-0002 | PLOT DATE: 12/3/2018 | FILE NUMBER: | FILE NAME: W912DS_A2_CU-108.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

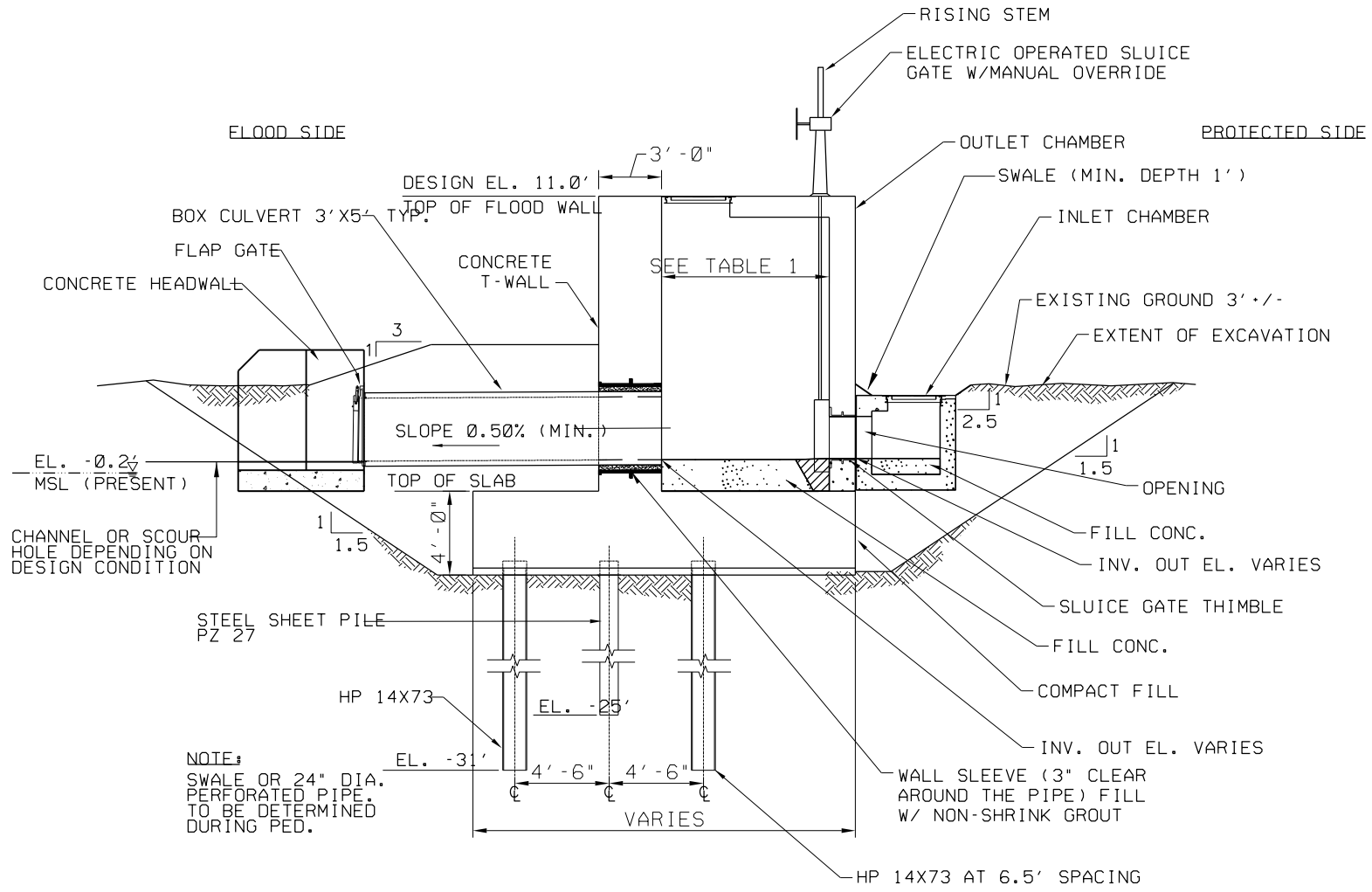
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

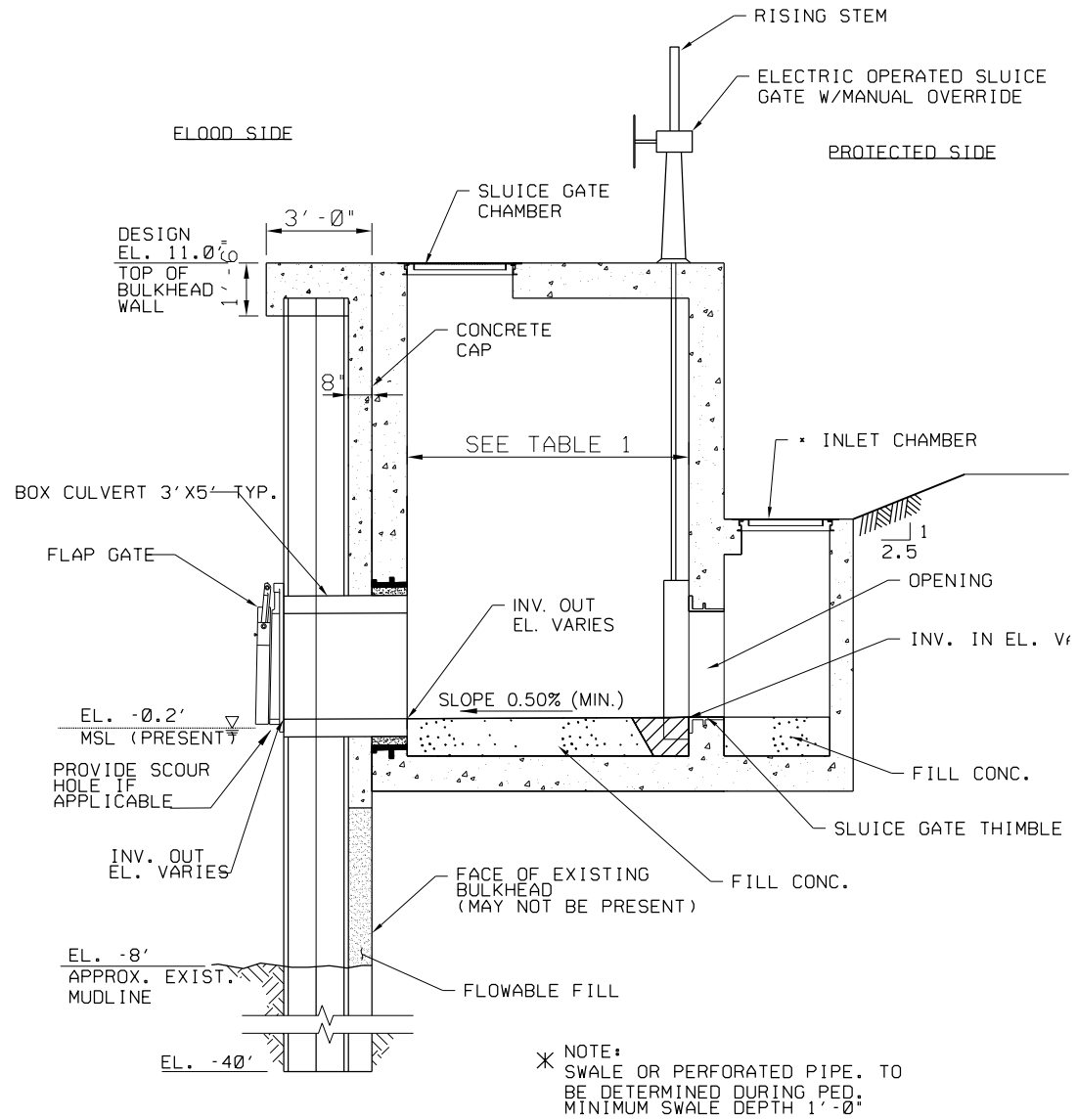
INTERIOR DRAINAGE PLAN (8 OF 8)

SHEET ID
CU-108
SHEET 23 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-108.dgn
12/3/2018
11:27:44 AM
LAST PLOTTED BY: mestimable



1 - TYPICAL OUTFALL DETAIL THROUGH FLOODWALL
SCALE: 1/4" = 1'-0"



2 - TYPICAL OUTFALL DETAIL THROUGH BULKHEAD
SCALE: 3/8" = 1'-0"

DRAINAGE STRUCTURE DIMENSION					
CULVERT SIZE	WALL THICKNESS (FT)	ROOF THICKNESS (FT)	FLOOR SLAB THICKNESS (FT)	CHAMBER WIDTH	CHAMBER LENGTH
5'X3'	1.5	1.0	1.5	8'-Ø"	8'-Ø"

0 2' 4' 8'
SCALE: 1/4" = 1'-0"

0 2' 4' 8'
SCALE: 3/8" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

LAST PLOTTED BY: mestimable 11:31:47 AM 12/3/2018 FILE: W912DS_A2_CU-501.dgn
PATH: Q:\NY\9781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

US Army Corps of Engineers®

DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W91-02
FILE NUMBER:
DESIGNED BY: BU
DRWN BY: CM
CKD BY: MJ
SUBMITTED BY: MC
PLOT DATE: 12/3/2018
PLOT SCALE: 1:1
SIZE: ANSI D
FILE NAME: W912DS_A2_CU-501.dgn

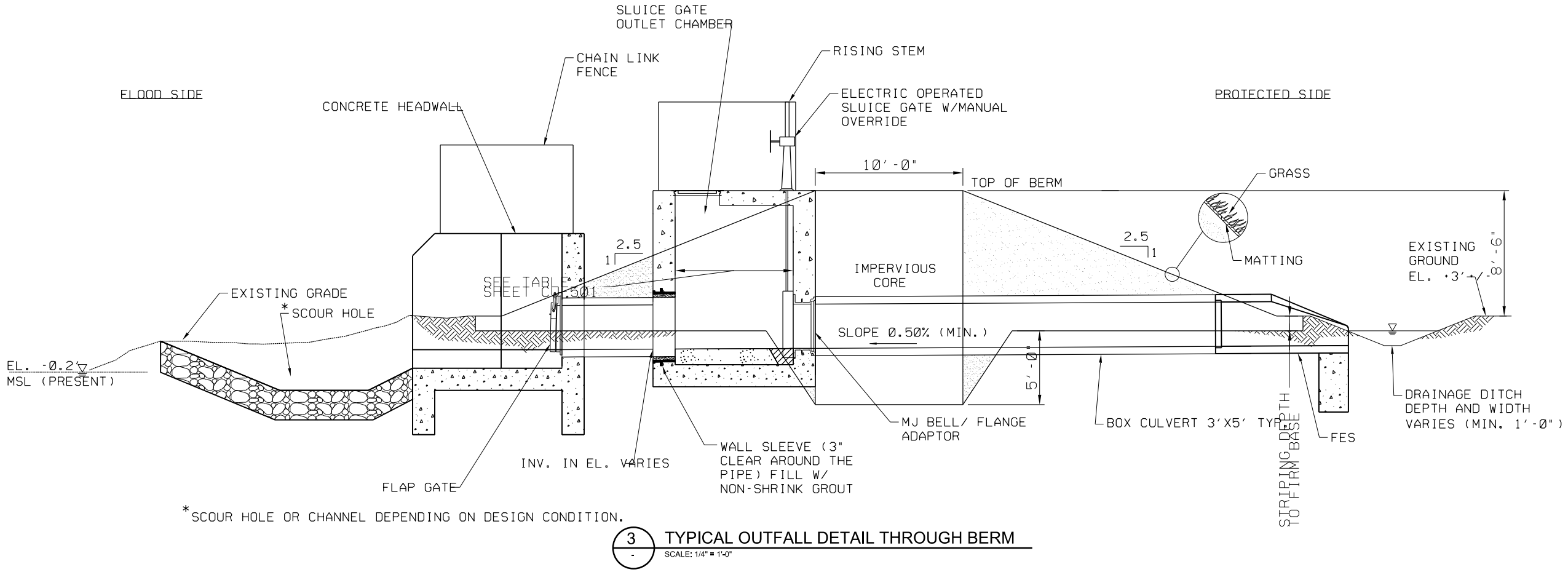
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 1

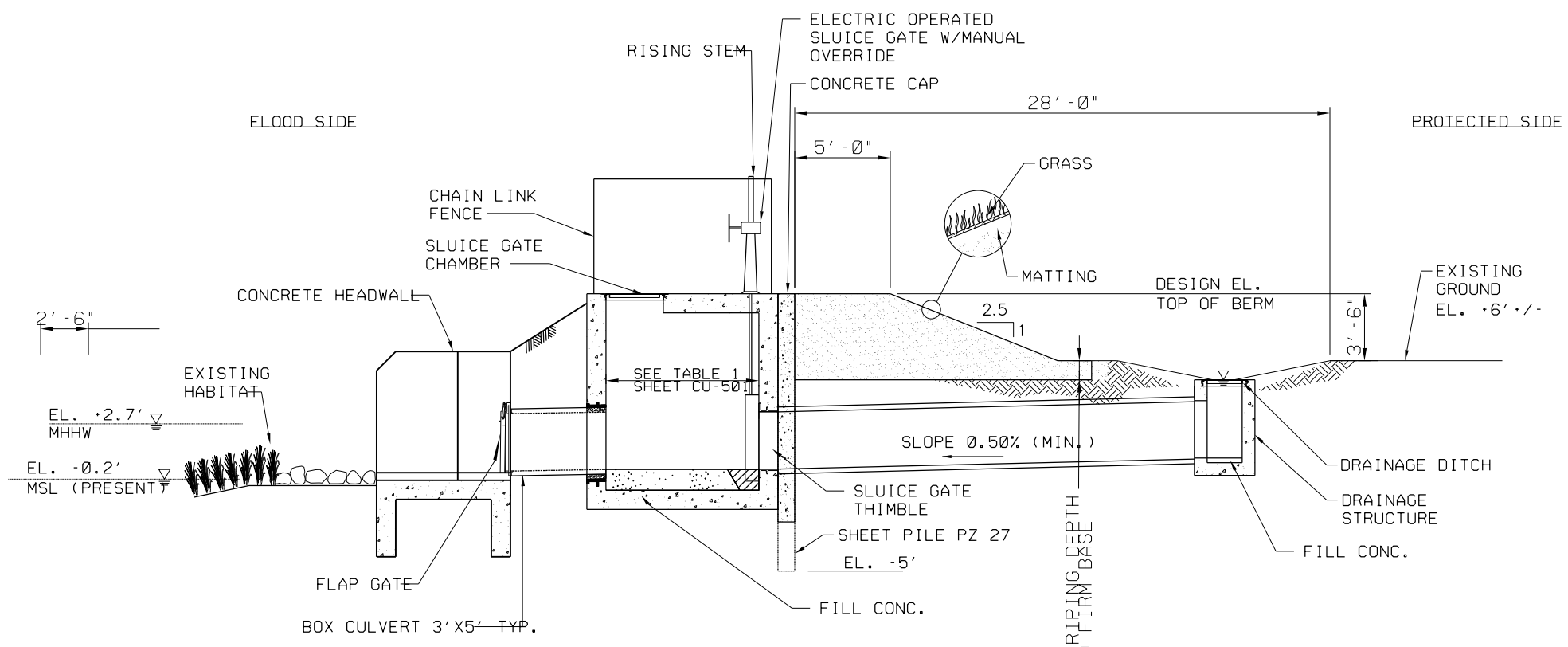
SHEET ID
CU-501
SHEET 24 OF 26



*SCOUR HOLE OR CHANNEL DEPENDING ON DESIGN CONDITION.

3 - TYPICAL OUTFALL DETAIL THROUGH BERM

SCALE: 1/4" = 1'-0"



4 - TYPICAL OUTFALL DETAIL THROUGH HYBRID BERM

SCALE: 1/4" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

0 2' 4' 8'
SCALE: 1/4" = 1'-0"

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

US Army Corps of Engineers®

DESIGNED BY: BU
DRN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 12
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W91-02
PLOT DATE: 5/3/2019
FILE NUMBER:
FILE NAME: W912DS_A2_CU-502.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

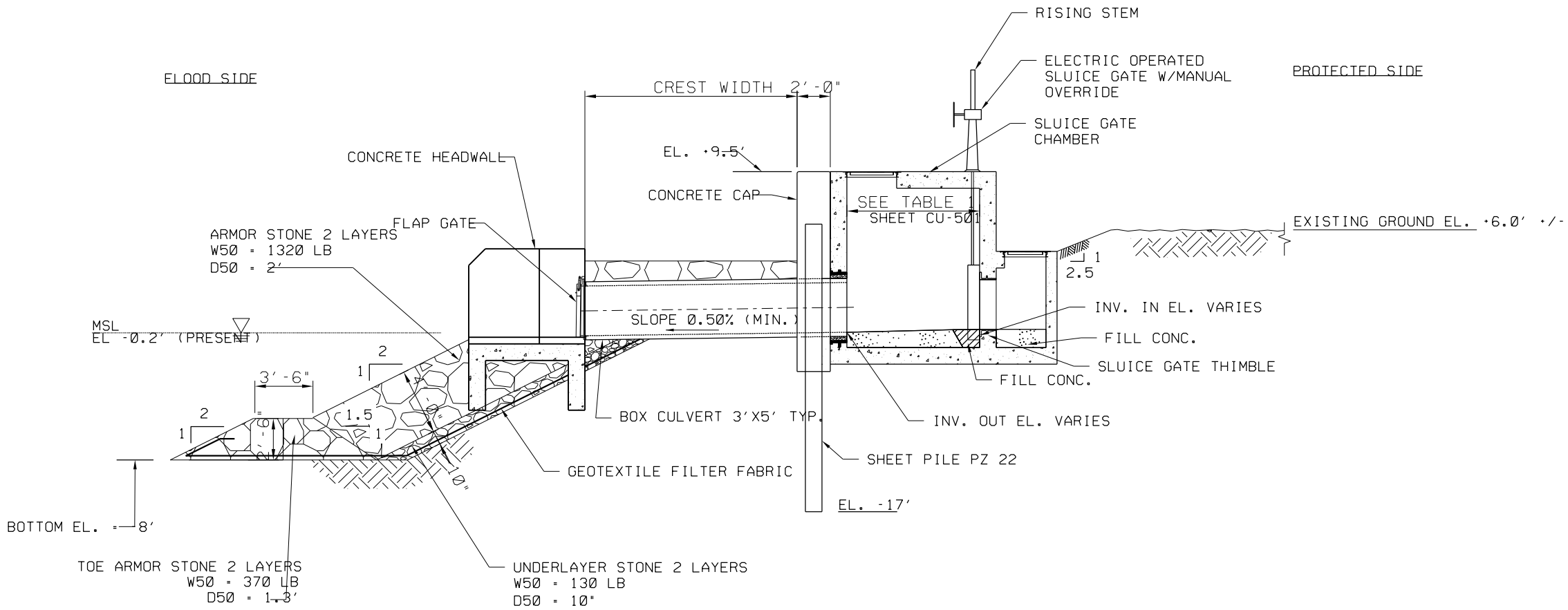
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 2

SHEET ID
CU-502
SHEET 25 OF 26

PATH: Q:\NY19781-021500_CADD_Active_HFERRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-502.dgn
12/3/2018
11:31:24 AM
LAST PLOTTED BY: mestimable



5 - TYPICAL OUTFALL DETAIL THROUGH REVETMENT WITH FOOLDWALL

SCALE: 1/4" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

0 2" 4" 8'

SCALE: 1/4" = 1'-0"

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\

LAST PLOTTED BY: mestimable 11:30:59 AM 12/3/2018 FILE: W912DS_A2_CU-503.dgn

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

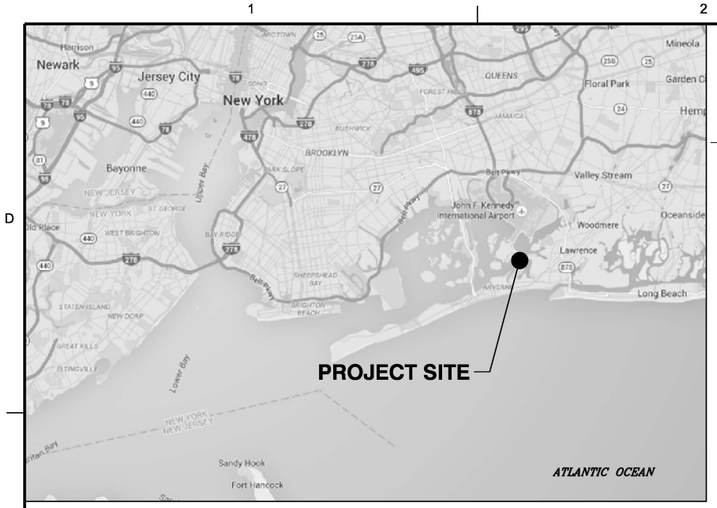
DESIGNED BY: BU
DWN BY: CM
CKD BY: MJ
SUBMITTED BY: MC
PLOT SCALE: 1:2
PLOT DATE: 12/05/18
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912DS-18-C-0002
FILE NUMBER:
FILE NAME: W912DS_A2_CU-503.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 3

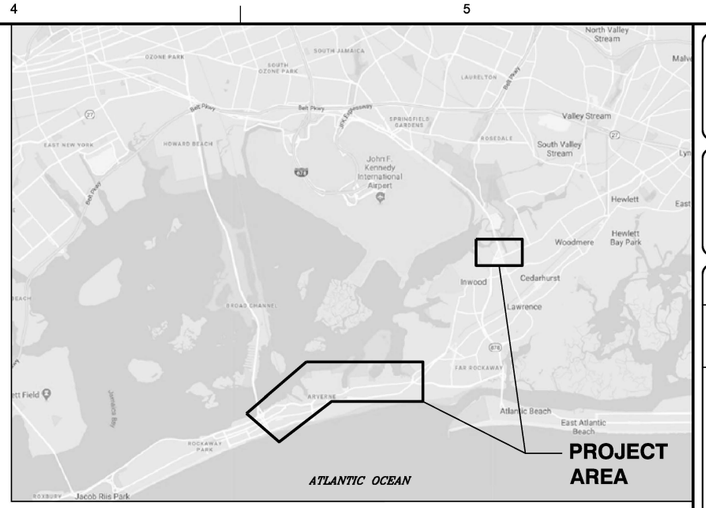
SHEET ID
CU-503
SHEET 26 OF 26



VICINITY MAP
NTS

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

ATLANTIC COAST OF NEW YORK



LOCATION PLAN
NTS

JAMAICA BAY

INDEX TO DRAWINGS

INDEX NO.	SHEET NO.	SHEET TITLE
1	G-001	COVER SHEET
2	G-101	SHEET KEY PLAN
3	CS-101	SITE PLAN (1 OF 8)
4	CS-102	SITE PLAN (2 OF 8)
5	CS-103	SITE PLAN (3 OF 8)
6	CS-104	SITE PLAN (4 OF 8)
7	CS-105	SITE PLAN (5 OF 8)
8	CS-106	SITE PLAN (6 OF 8)
9	CS-107	SITE PLAN (7 OF 8)
10	CS-108	SITE PLAN (8 OF 8)
11	CS-501	FLOODWALL AND BULKHEAD TYPICAL SECTIONS
12	CS-502	BERM AND REVETMENT WITH FLOODWALL TYPICAL SECTIONS
13	CS-503	NATURAL AND NATURE BASED FEATURES (NNBF) SECTION
14	CS-504	ROAD RAMP SECTIONS
15	CS-505	SWING GATE PLAN AND ELEVATION
16	CU-101	INTERIOR DRAINAGE PLAN (1 OF 8)
17	CU-102	INTERIOR DRAINAGE PLAN (2 OF 8)
18	CU-103	INTERIOR DRAINAGE PLAN (3 OF 8)
19	CU-104	INTERIOR DRAINAGE PLAN (4 OF 8)
20	CU-105	INTERIOR DRAINAGE PLAN (5 OF 8)
21	CU-106	INTERIOR DRAINAGE PLAN (6 OF 8)
22	CU-107	INTERIOR DRAINAGE PLAN (7 OF 8)
23	CU-108	INTERIOR DRAINAGE PLAN (8 OF 8)
24	CU-501	TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 1
25	CU-502	TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 2
26	CU-503	TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 3

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:33:11 AM 12/3/2018 FILE: W912DS_A1_G-001.dgn

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

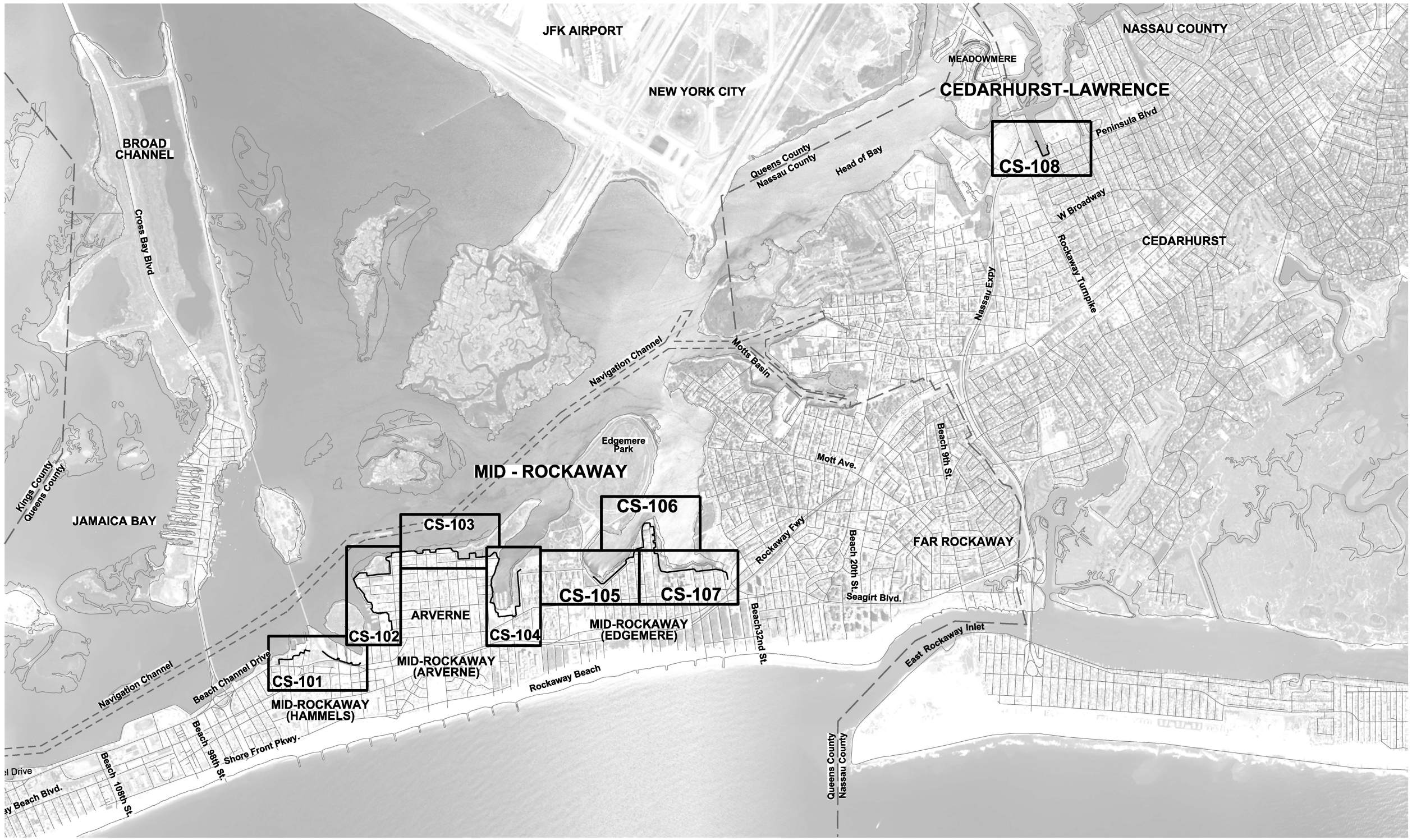
DESIGNED BY: IK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:1.50000
SIZE: ANSI D
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A1_G-001.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: 9781-02
FILE NUMBER:

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

COVER SHEET

SHEET ID
G-001
SHEET 1 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:38:54 AM 12/3/2018 FILE: W912DS_A2_G-101.dgn



HIGH FREQUENCY FLOOD RISK REDUCTION FEATURES (HFFRRF) FOR JAMAICA BAY

PROJECT SITES: 1. MID - ROCKAWAY
2. CEDARHURST-LAWRENCE

PRELIMINARY
NOT FOR CONSTRUCTION

N

0 1500' 3000'

SCALE:1"=1500'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

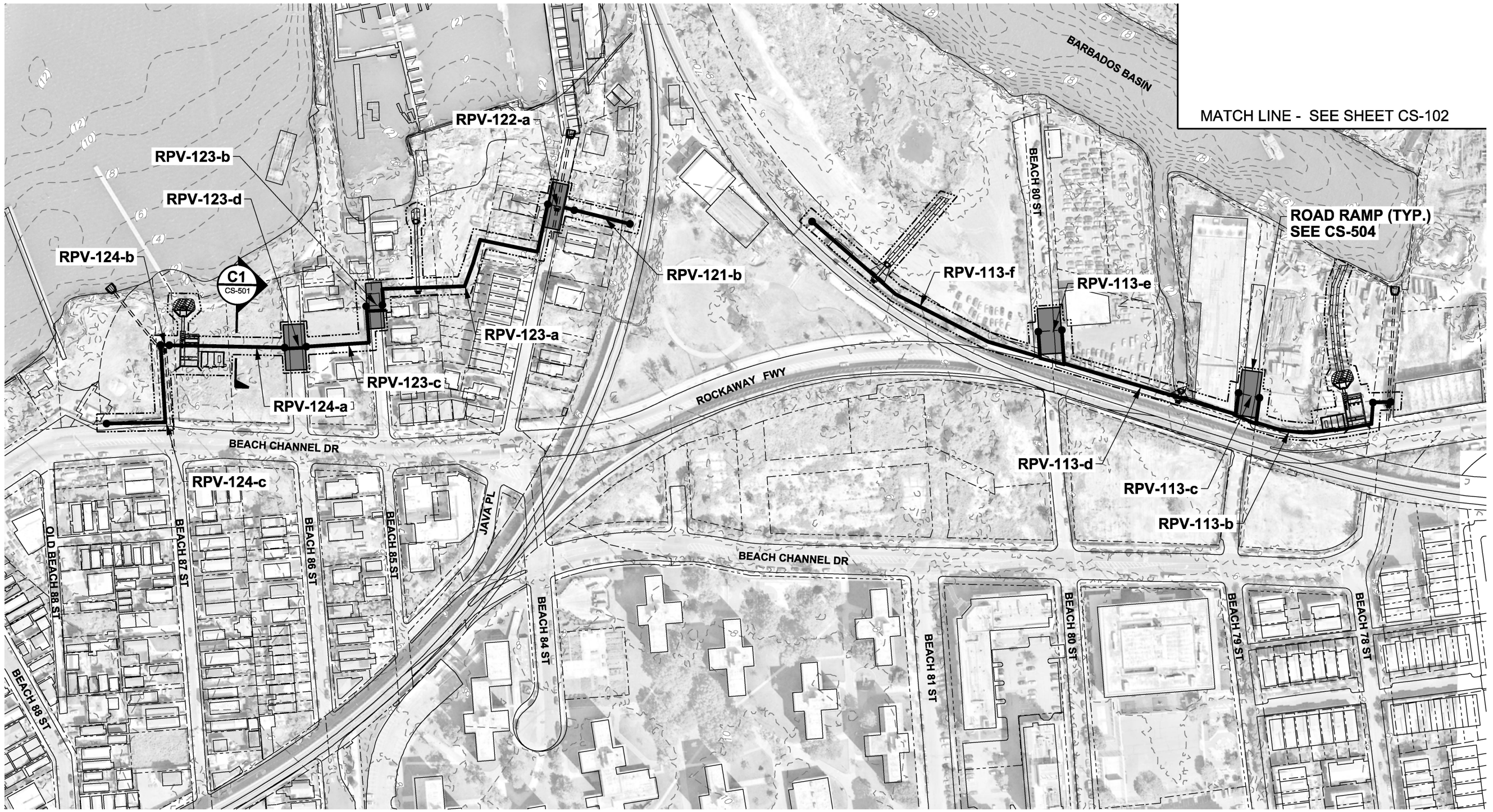
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

DESIGNED BY: MK | DRWN BY: ME | SUBMITTED BY: SA | PLOT SCALE: 1.00000' | SIZE: ANSI D
DATE: 12.05.18 | SOLICITATION NO.: | CONTRACT NO.: W912-02 | FILE NUMBER: | PLOT DATE: 12/3/2018 | FILE NAME: W912DS_A2_G-101.dgn

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SHEETS KEY PLAN

SHEET ID
G-101
SHEET 2 OF 26



MID-ROCKAWAY - HAMMELS

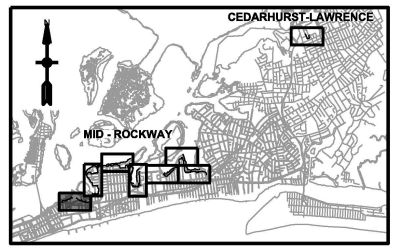
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

US Army Corps of Engineers®

DESIGNED BY: IK
DRN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:2
PLOT DATE: 12/3/2018
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:
FILE NAME: W912DS_A2_CS-101.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

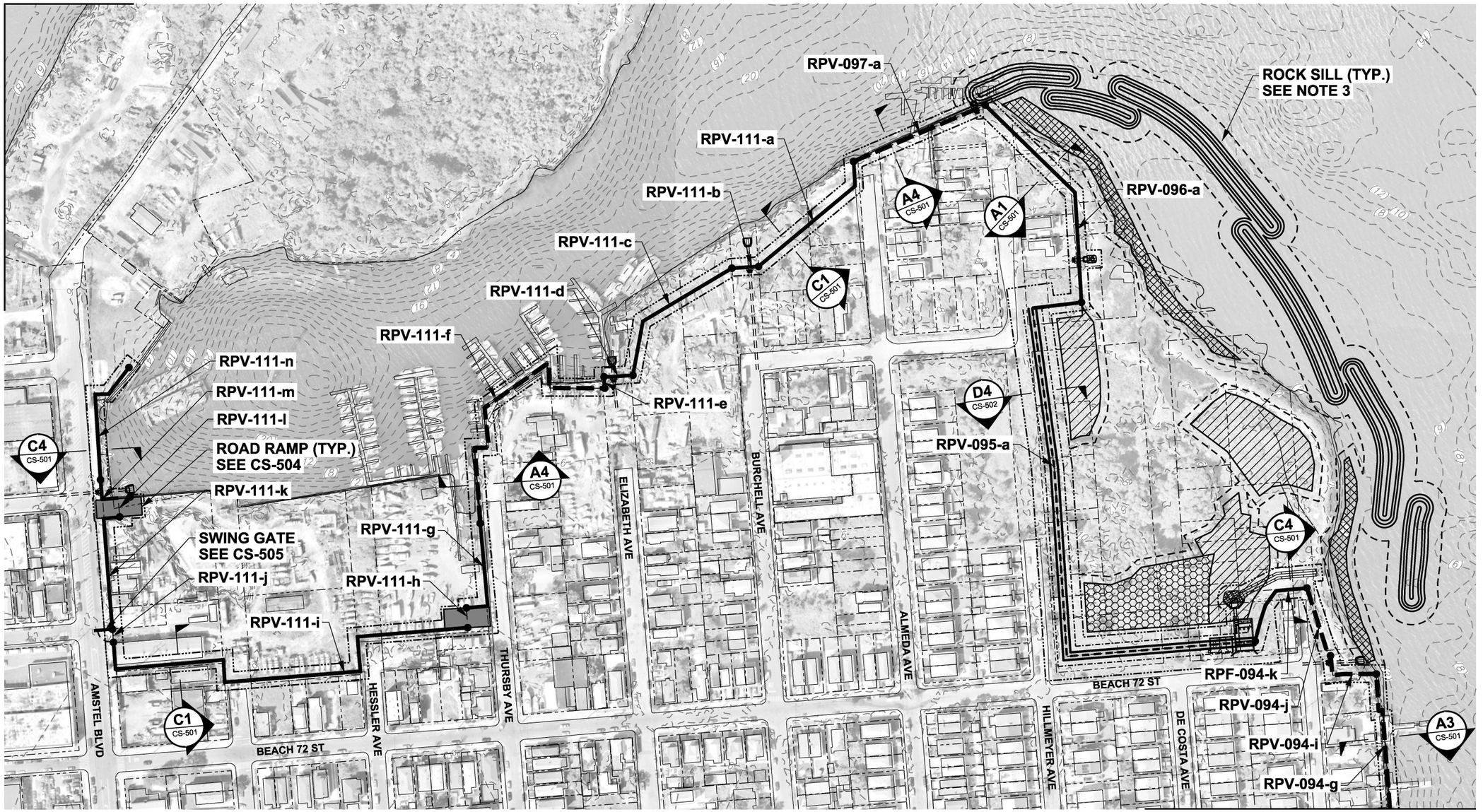
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (1 OF 8)

SHEET ID
CS-101
SHEET 3 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
FILE: W912DS_A2_CS-101.dgn
12/3/2018
11:33:36 AM
LAST PLOTTED BY: mestimable



MID-ROCKAWAY - ARVERNE (SHEET 1)

SCALE: 1" = 100'

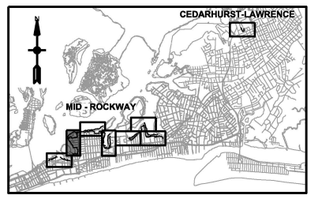
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

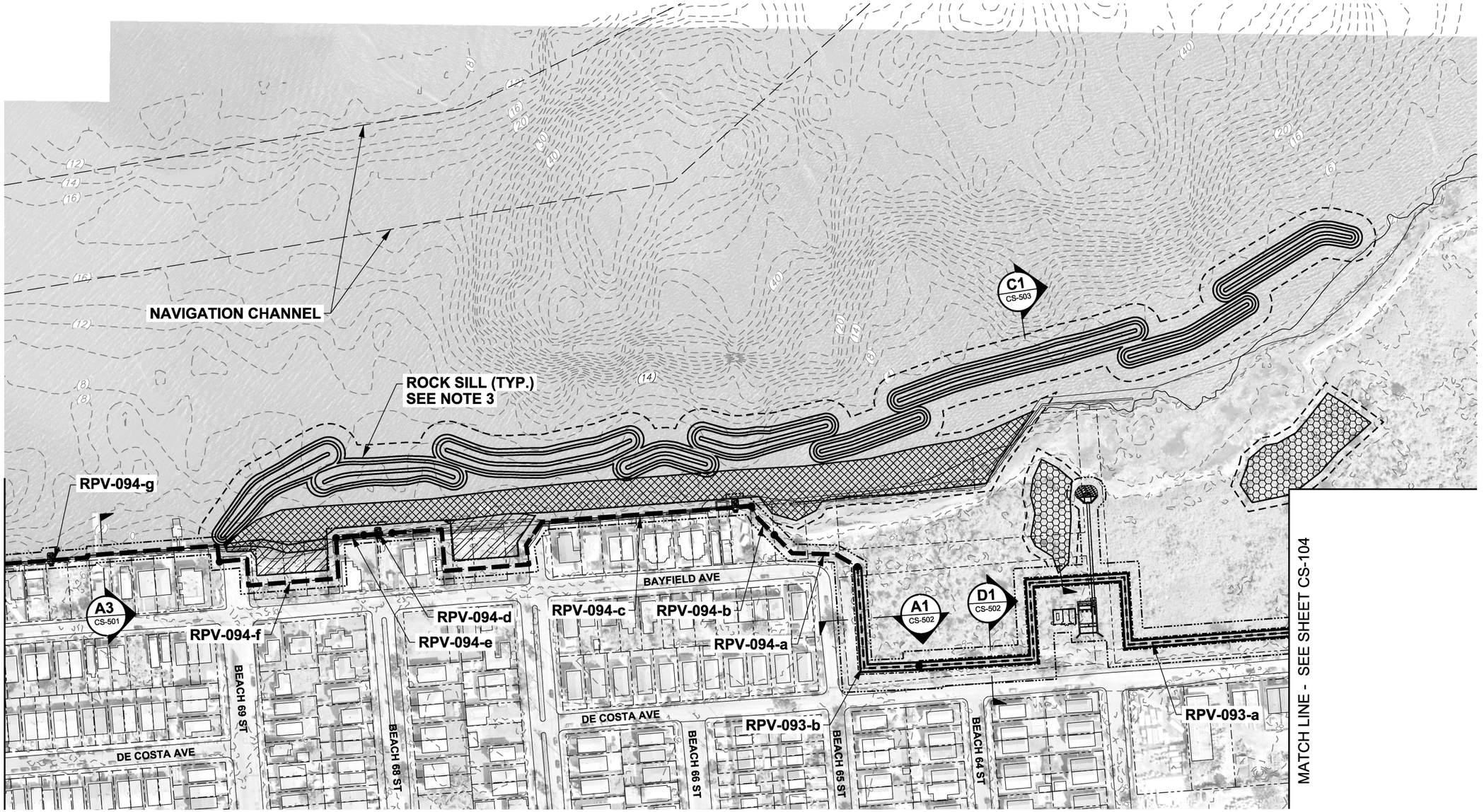
DESIGNED BY: IK
DRWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 1.00000000
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MK
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CS-102.dgn
SOLICITATION NO.:
CONTRACT NO.: W91-02
FILE NUMBER:

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (2 OF 8)

SHEET ID
CS-102
SHEET 4 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
FILE: W912DS_A2_CS-102.dgn
12/3/2018
11:33:53 AM
LAST PLOTTED BY: mestimable



MID-ROCKAWAY - ARVERNE (SHEET 2)

SCALE: 1" = 100'

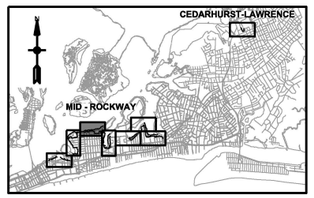
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

DESIGNED BY: MK | DRWN BY: ME | SUBMITTED BY: SA | PLOT SCALE: 1:1 | PLOT DATE: 12/3/2018 | SIZE: ANSI D

DATE: 12.05.18 | SOLICITATION NO.: | CONTRACT NO.: W912-02 | FILE NUMBER: | FILE NAME: W912DS_A2_CS-103.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

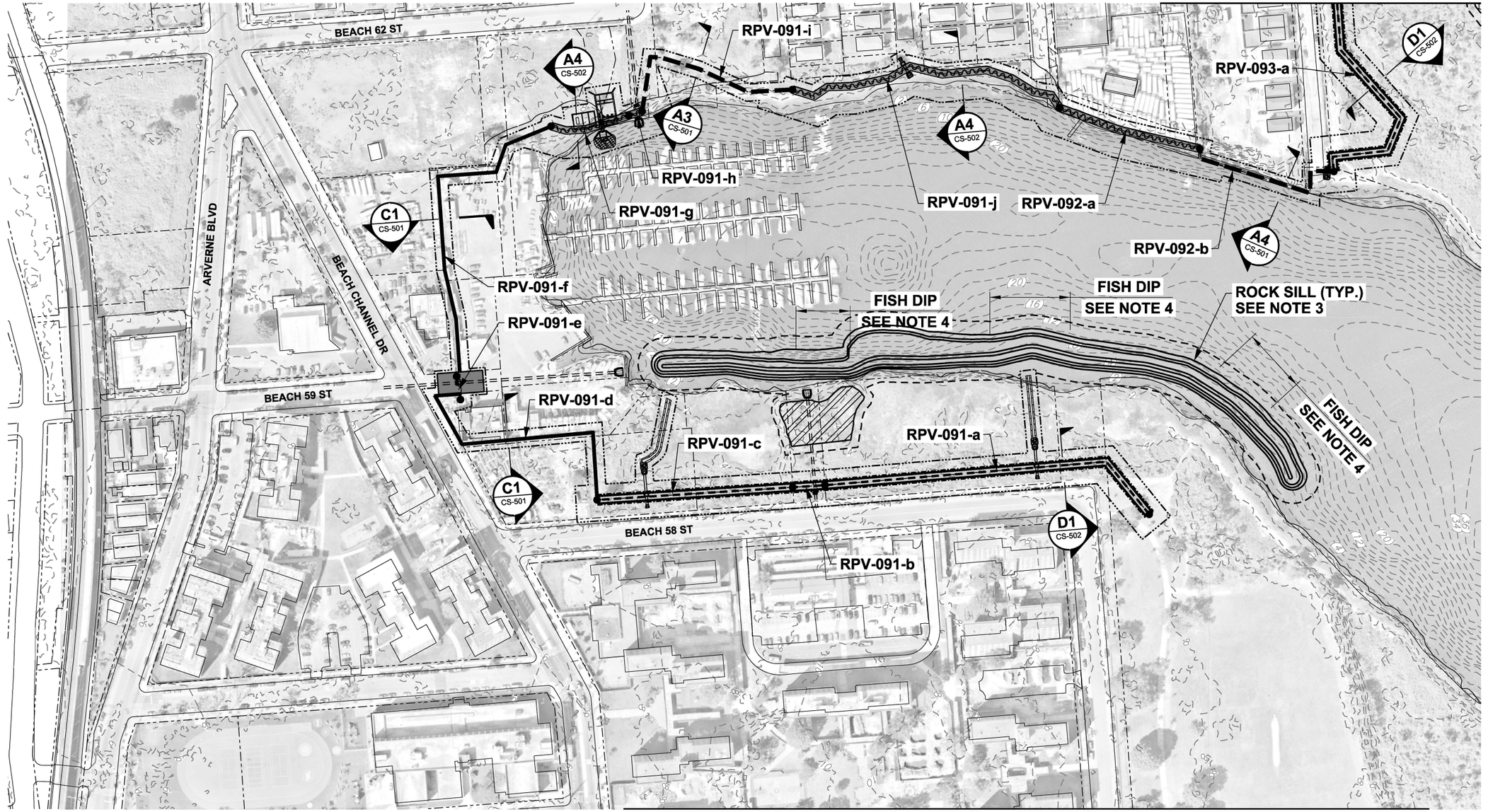
SITE PLAN (3 OF 8)

SHEET ID
CS-103
SHEET 5 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:34:11 AM 12/3/2018 FILE: W912DS_A2_CS-103.dgn

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:34:28 AM 12/3/2018 FILE: W912DS_A2_CS-104.dgn

MATCH LINE - SEE SHEET CS-103



MATCH LINE - SEE SHEET CS-105

MID-ROCKAWAY - ARVERNE (SHEET 3)

SCALE: 1" = 100'

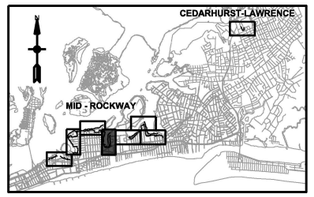
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.
4. IN LOCATIONS WHERE THE BATHYMETRY PROFILE DOES NOT ALLOW FOR OVERLAP, TO PROVIDE FOR SUFFICIENT HYDRAULIC COMMUNICATION AND ORGANISM EXCHANGE BEHIND THE ROCK SILLS, THE PLACEMENT OF PERIODIC LOWERED ROCK SILL ELEVATIONS (FISH DIPS) OF 0.0 FEET MSL OF 100 FEET ARE PROVIDED.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

DESIGNED BY: IK | DRAWN BY: ME | SUBMITTED BY: SA | SIZE: ANSI D
DATE: 12.05.18 | CKD BY: MK | PLOT SCALE: 1:1.0000 | PLOT DATE: 12/3/2018
SOLICITATION NO.: | CONTRACT NO.: W912-02 | FILE NUMBER: | FILE NAME: W912DS_A2_CS-104.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

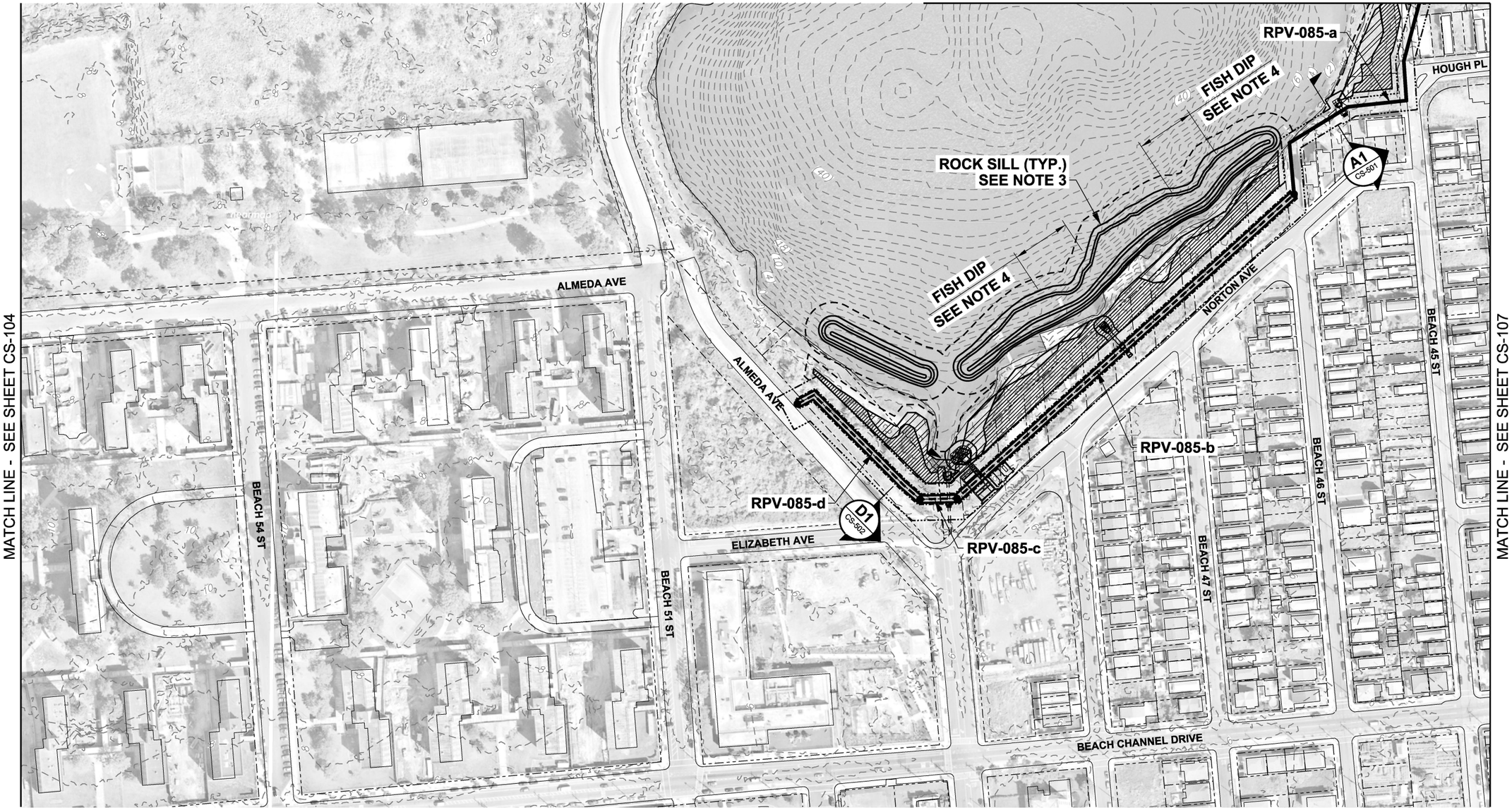
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (4 OF 8)

SHEET ID
CS-104
SHEET 6 OF 26

MATCH LINE - SEE SHEET CS-106



MATCH LINE - SEE SHEET CS-104

MATCH LINE - SEE SHEET CS-107

MID-ROCKAWAY - EDGEMERE (SHEET 1)

SCALE: 1" = 100'

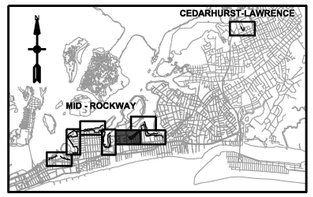
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.
4. IN LOCATIONS WHERE THE BATHYMETRY PROFILE DOES NOT ALLOW FOR OVERLAP, TO PROVIDE FOR SUFFICIENT HYDRAULIC COMMUNICATION AND ORGANISM EXCHANGE BEHIND THE ROCK SILLS, THE PLACEMENT OF PERIODIC LOWERED ROCK SILL ELEVATIONS (FISH DIPS) OF 0.0 FEET MSL OF 100 FEET ARE PROVIDED.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

DESIGNED BY: IK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1.00000
PLOT DATE: 12/3/2018
SIZE: ANSI D
FILE NAME: W912DS_A2_CS-105.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:

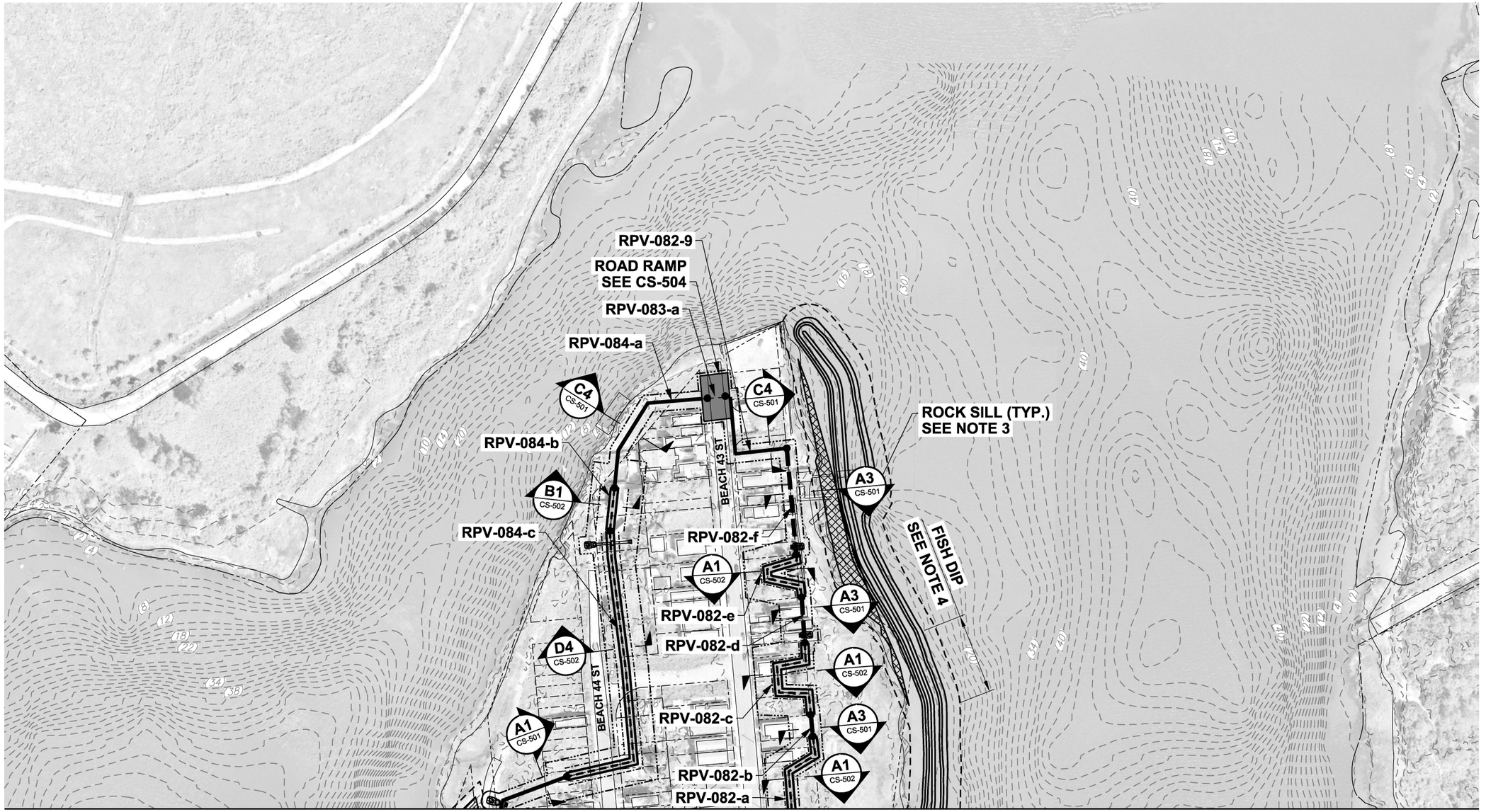
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (5 OF 8)

SHEET ID
CS-105
SHEET 7 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:34:47 AM 12/3/2018 FILE: W912DS_A2_CS-105.dgn

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
FILE: W912DS_A2_CS-106.dgn
12/3/2018
11:35:08 AM
LAST PLOTTED BY: mestimable



MATCH LINE - SEE SHEET CS-105

MATCH LINE - SEE SHEET CS-107

MID-ROCKAWAY - EDGEMERE (SHEET 2)
SCALE: 1" = 100'

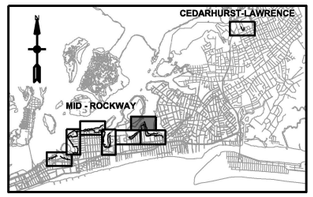
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.
4. IN LOCATIONS WHERE THE BATHYMETRY PROFILE DOES NOT ALLOW FOR OVERLAP, TO PROVIDE FOR SUFFICIENT HYDRAULIC COMMUNICATION AND ORGANISM EXCHANGE BEHIND THE ROCK SILLS, THE PLACEMENT OF PERIODIC LOWERED ROCK SILL ELEVATIONS (FISH DIPS) OF 0.0 FEET MSL OF 100 FEET ARE PROVIDED.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-788-7454

DESIGNED BY: IK
DRN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1.000000
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W91-02
PLOT DATE: 12/3/2018
FILE NUMBER:
FILE NAME: W912DS_A2_CS-106.dgn

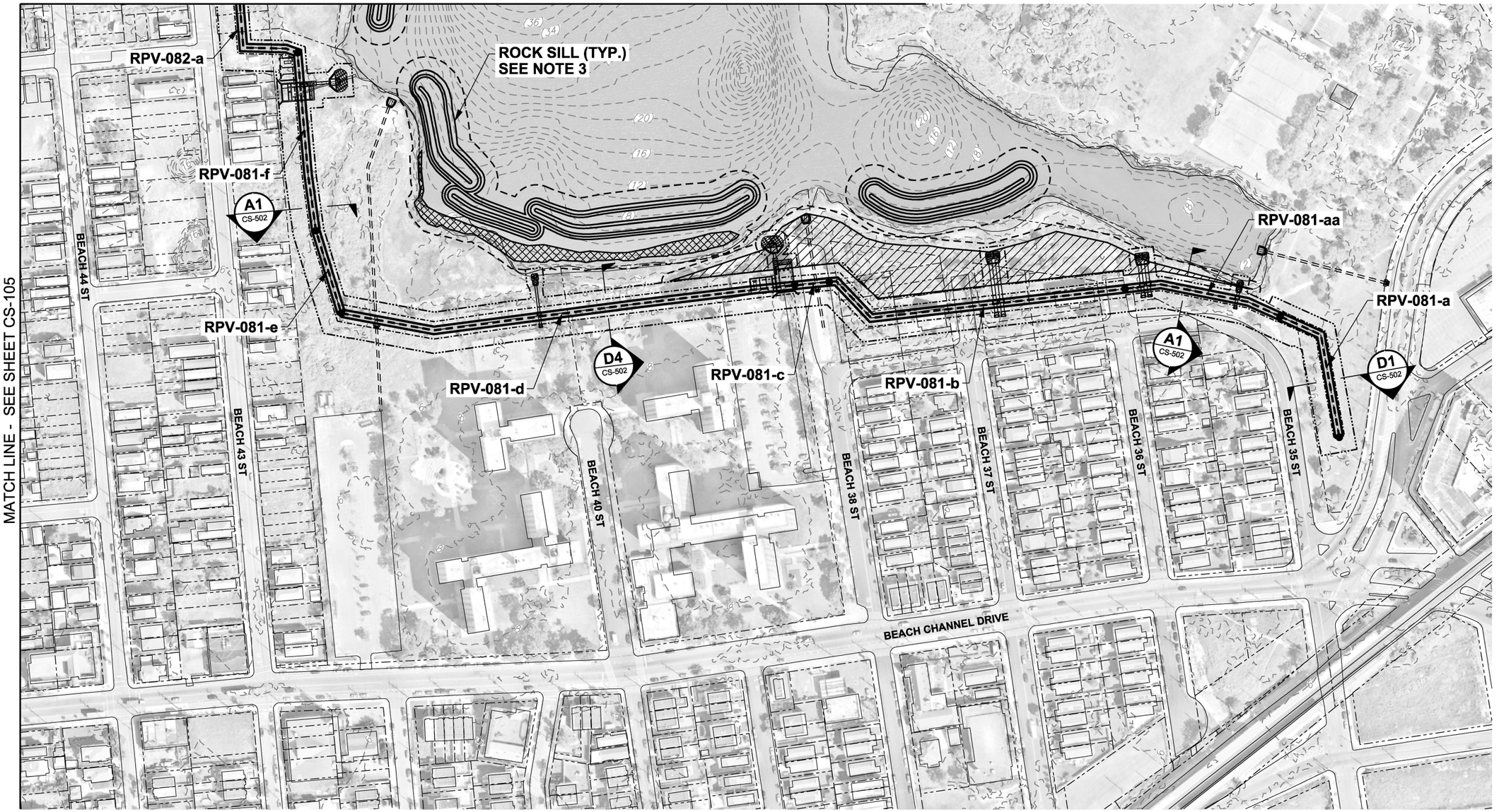
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (6 OF 8)

SHEET ID
CS-106
SHEET 8 OF 26

MATCH LINE - SEE SHEET CS-106

MATCH LINE - SEE SHEET CS-105



MID-ROCKAWAY - EDGEMERE (SHEET 3)

SCALE: 1" = 100'

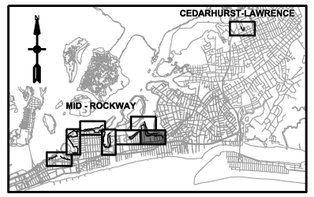
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.
3. THE OVERLAP IN ROCK SILL DESIGN IS TO ALLOW FOR EXCHANGE OF WATER AND AQUATIC ORGANISMS DURING TIDAL CYCLES. THE OVERLAP DESIGN ALLOWS FOR THE TRANSFER BUT ALSO PROVIDES CONTINUOUS SHORELINE PROTECTION.
4. IN LOCATIONS WHERE THE BATHYMETRY PROFILE DOES NOT ALLOW FOR OVERLAP, TO PROVIDE FOR SUFFICIENT HYDRAULIC COMMUNICATION AND ORGANISM EXCHANGE BEHIND THE ROCK SILLS, THE PLACEMENT OF PERIODIC LOWERED ROCK SILL ELEVATIONS (FISH DIPS) OF 0.0 FEET MSL OF 100 FEET ARE PROVIDED.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 12/3/2018 11:37:28 AM FILE: W912DS_A2_CS-107.dgn

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

DESIGNED BY: IK
DRWN BY: ME
SUBMITTED BY: SA
PLOT SCALE: 1:50.0000 '/ 1"
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MK
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CS-107.dgn
SOLICITATION NO.:
CONTRACT NO.: W81-02
FILE NUMBER:

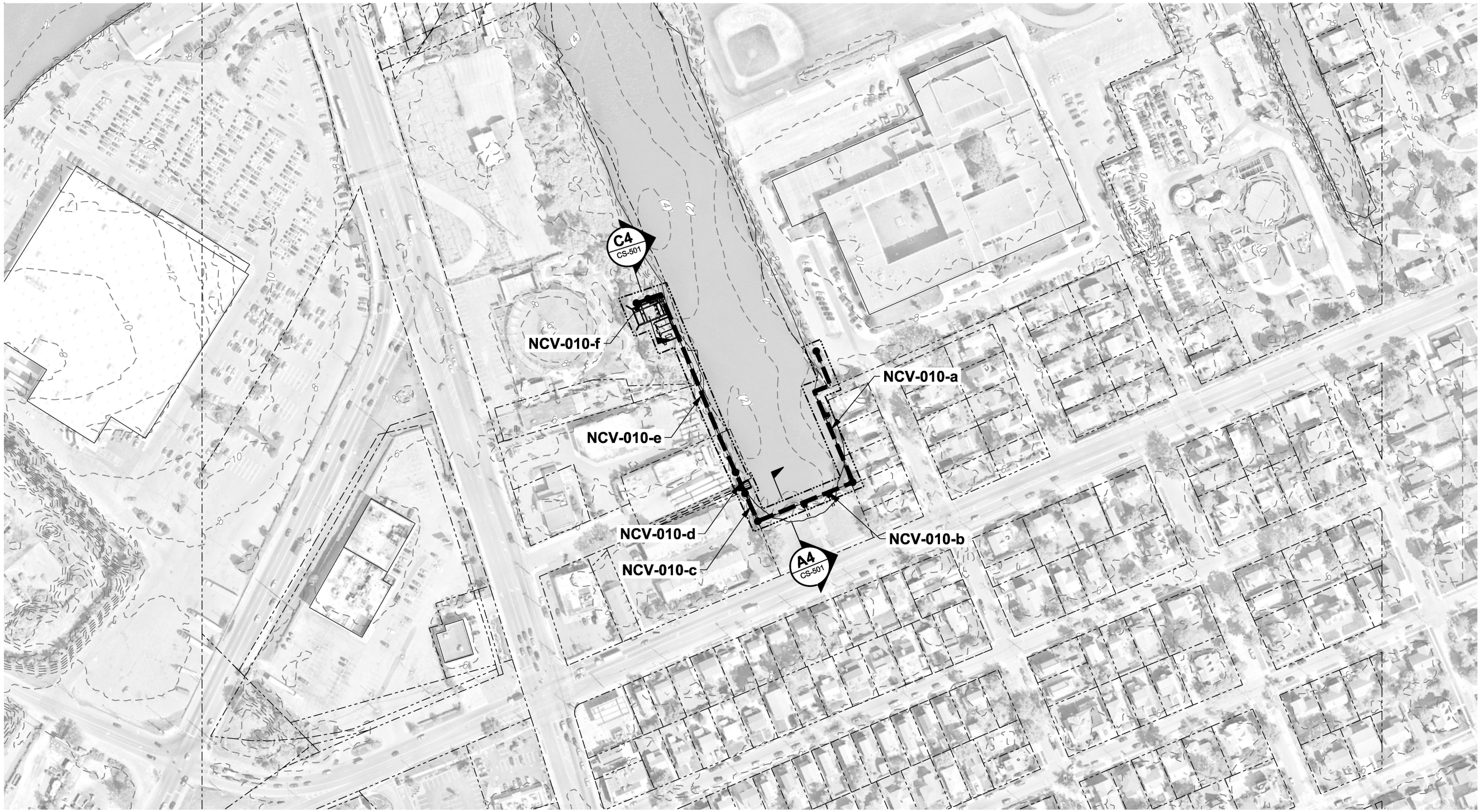
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SITE PLAN (7 OF 8)

SHEET ID
CS-107
SHEET 9 OF 26



CEDARHURST-LAWRENCE

SCALE: 1" = 100'

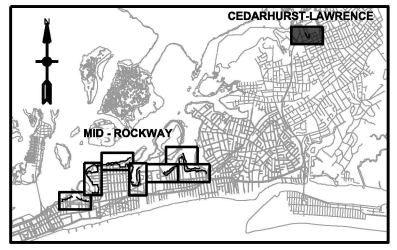
NOTES

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. ELEVATION CONTOURS BASED ON THE FOLLOWING SOURCES:
   - NATIONAL GEOPHYSICAL DATA CENTER (NGDC) HURRICANE SANDY DIGITAL ELEVATION MODELS, 2014.
   - NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DIGITAL COAST, 2014.
   - 2013-2014 U.S. GEOLOGICAL SURVEY CMGP LIDAR: POST SANDY (NEW YORK CITY), 2018.

PRELIMINARY
NOT FOR CONSTRUCTION

LEGEND

- FLOODWALL
- BULKHEAD
- REVETMENT
- BERM
- TOE OF BERM
- FLOOD PROTECTION LEVEE EASEMENT
- BANK PROTECTION EASEMENT
- TAX LOT PROPERTY LINE
- RPV-### REACH ID
- EXISTING CONTOURS (LANDSIDE)
- EXISTING CONTOURS (BATHYMETRY)
- INTERTIDAL MARSH SALTMEADOW HAY
- INTERTIDAL MARSH SMOOTH CORDGRASS
- HIGH MARSH SCRUB-SHRUB
- MARITIME FOREST



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

US Army Corps of Engineers®

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

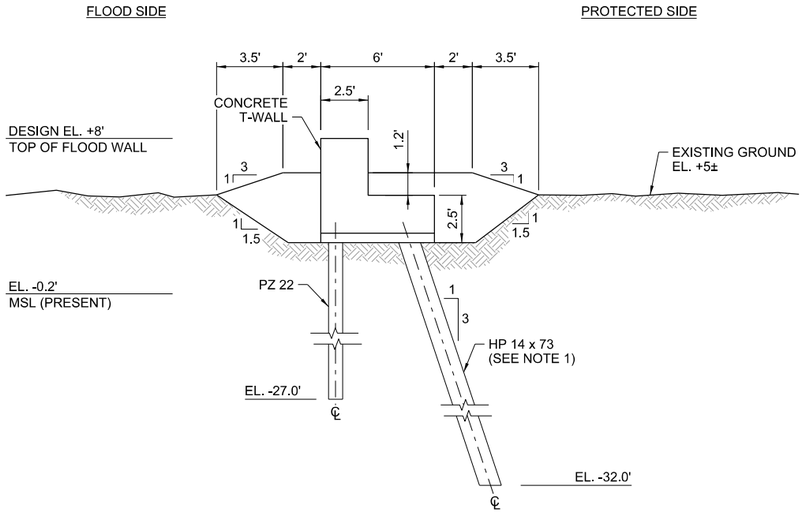
DESIGNED BY: MK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1.00000'
SIZE: ANSI D
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CS-108.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

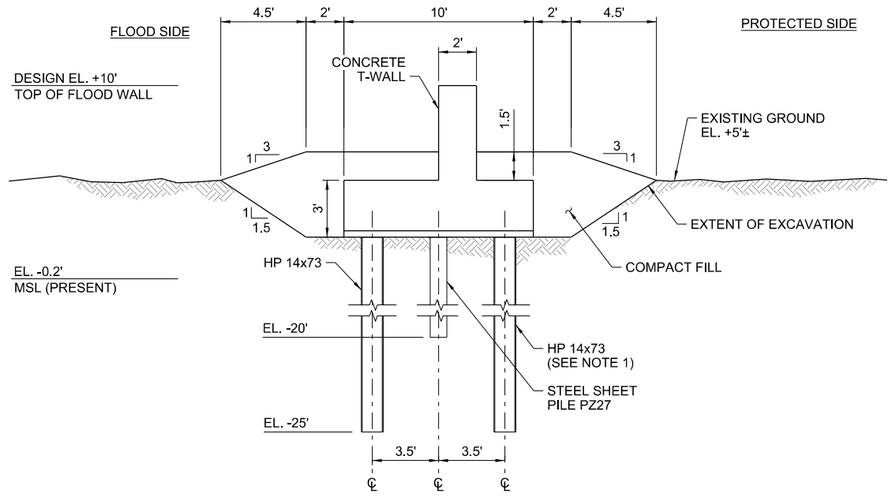
SITE PLAN (8 OF 8)

SHEET ID
CS-108
SHEET 10 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:37:58 AM 12/3/2018 FILE: W912DS_A2_CS-108.dgn



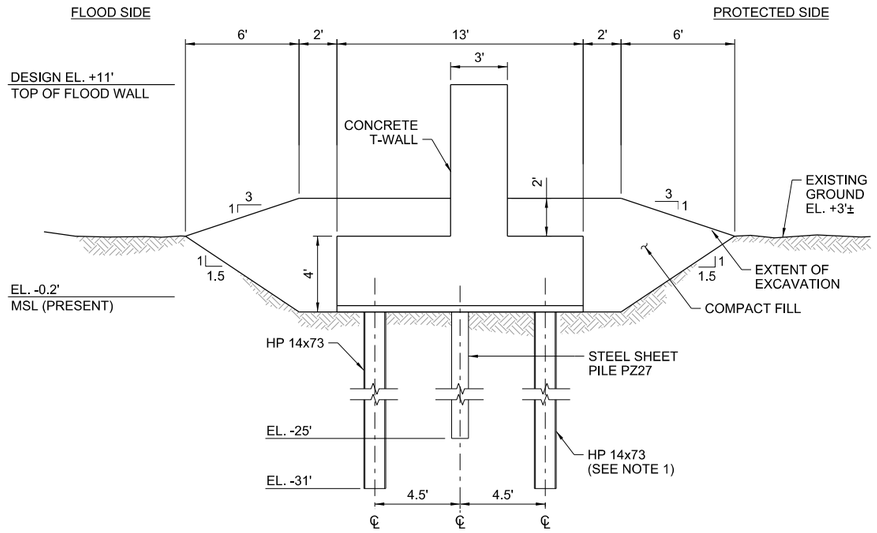
C1 LOW FLOODWALL
SCALE: 1/4" = 1'-0"
CS-101, CS-102, CS-104



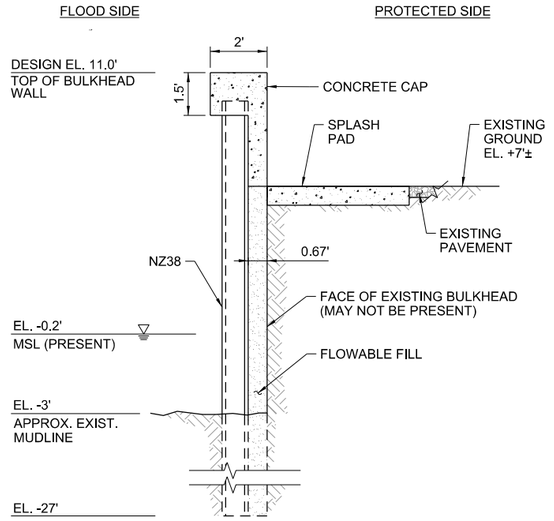
C4 MEDIUM FLOODWALL
SCALE: 1/4" = 1'-0"
CS-102, CS-106, CS-108

NOTE

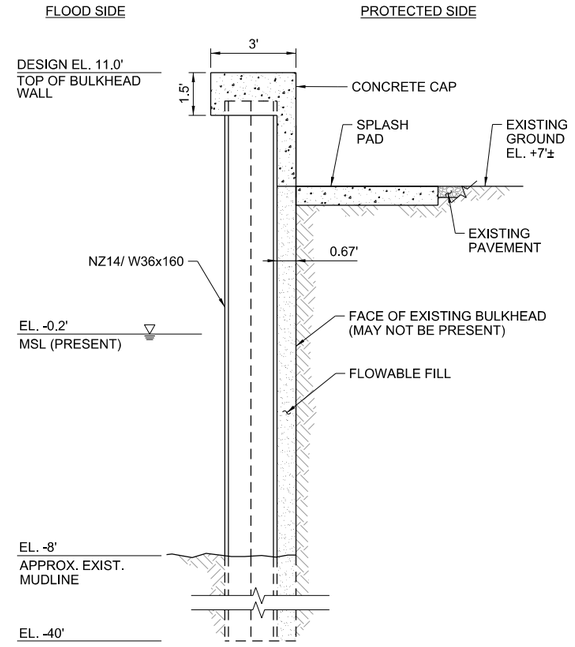
1. PILE SPACINGS FOR LOW, MEDIUM, AND HIGH FLOODWALLS ARE 10', 8.5' AND 6.5', RESPECTIVELY.



A1 HIGH FLOODWALL
SCALE: 1/4" = 1'-0"
CS-102, CS-105, CS-106



A3 SHALLOW BULKHEAD
SCALE: 3/8" = 1'-0"
CS-102, CS-103, CS-104, CS-106



A4 DEEP BULKHEAD
SCALE: 3/8" = 1'-0"
CS-102, CS-104, CS-108

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK

DESIGNED BY: MK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1:1.000000
PLOT DATE: 12/5/2018
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:
FILE NAME: W912DS_A2_CS-501.dgn

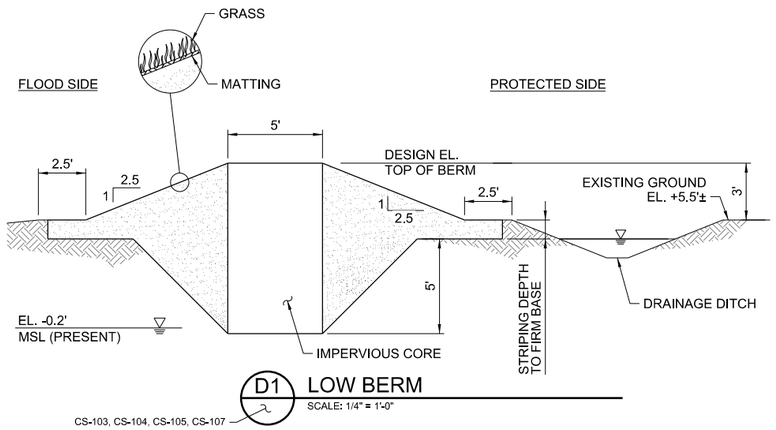
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

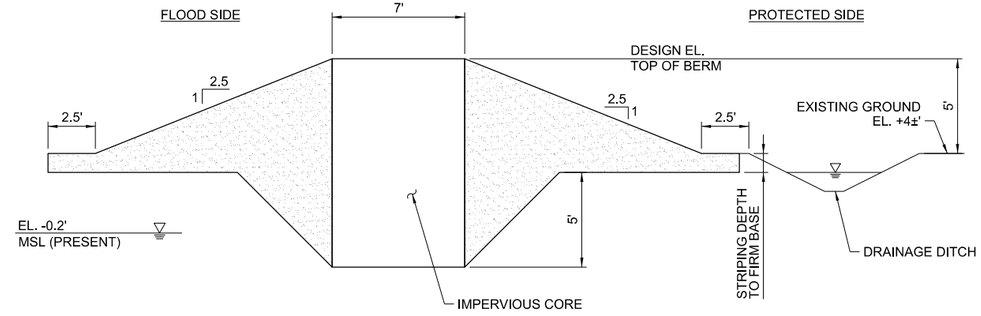
FLOODWALL AND BULKHEAD TYPICAL SECTIONS

SHEET ID
CS-501
SHEET 11 OF 26

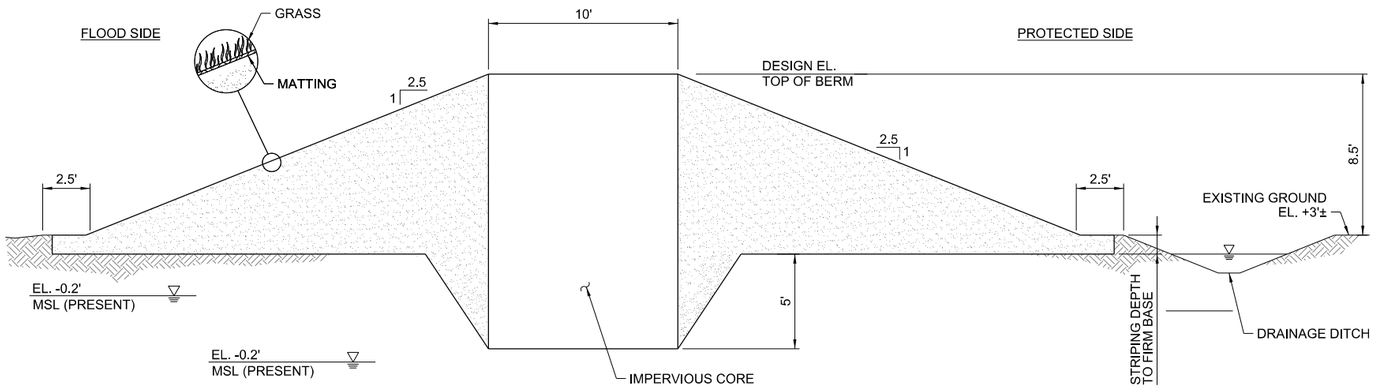
PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
FILE: W912DS_A2_CS-501.dgn
12/3/2018
11:39:50 AM
LAST PLOTTED BY: mestimable



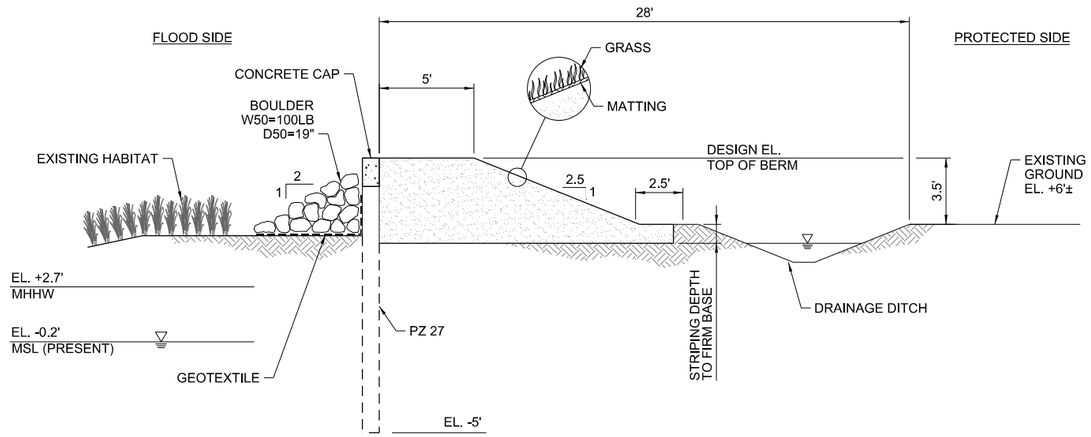
D1 LOW BERM
SCALE: 1/4" = 1'-0"
CS-103, CS-104, CS-105, CS-107



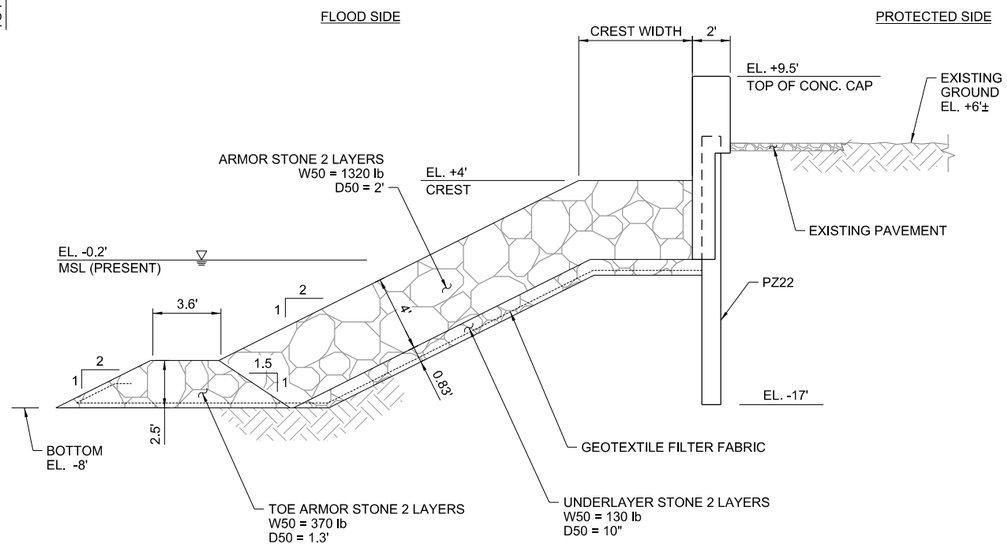
D4 MEDIUM BERM
SCALE: 1/4" = 1'-0"
CS-102, CS-106



B1 HIGH BERM
CS-106
SCALE: 1/4" = 1'-0"



A1 HYBRID BERM
SCALE: 1/4" = 1'-0"
CS-103, CS-106, CS-107



A4 REVETMENT WITH FLOODWALL
CS-104
SCALE: 1/4" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:40:01 AM 12/3/2018 FILE: W912DS_A2_CS-502.dgn

US Army Corps of Engineers®

E	FINAL GRR - APPENDIX A2,F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2,E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2,E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2,E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2,E	07.19.18	MK
MARK	DESCRIPTION	DATE	APPR.

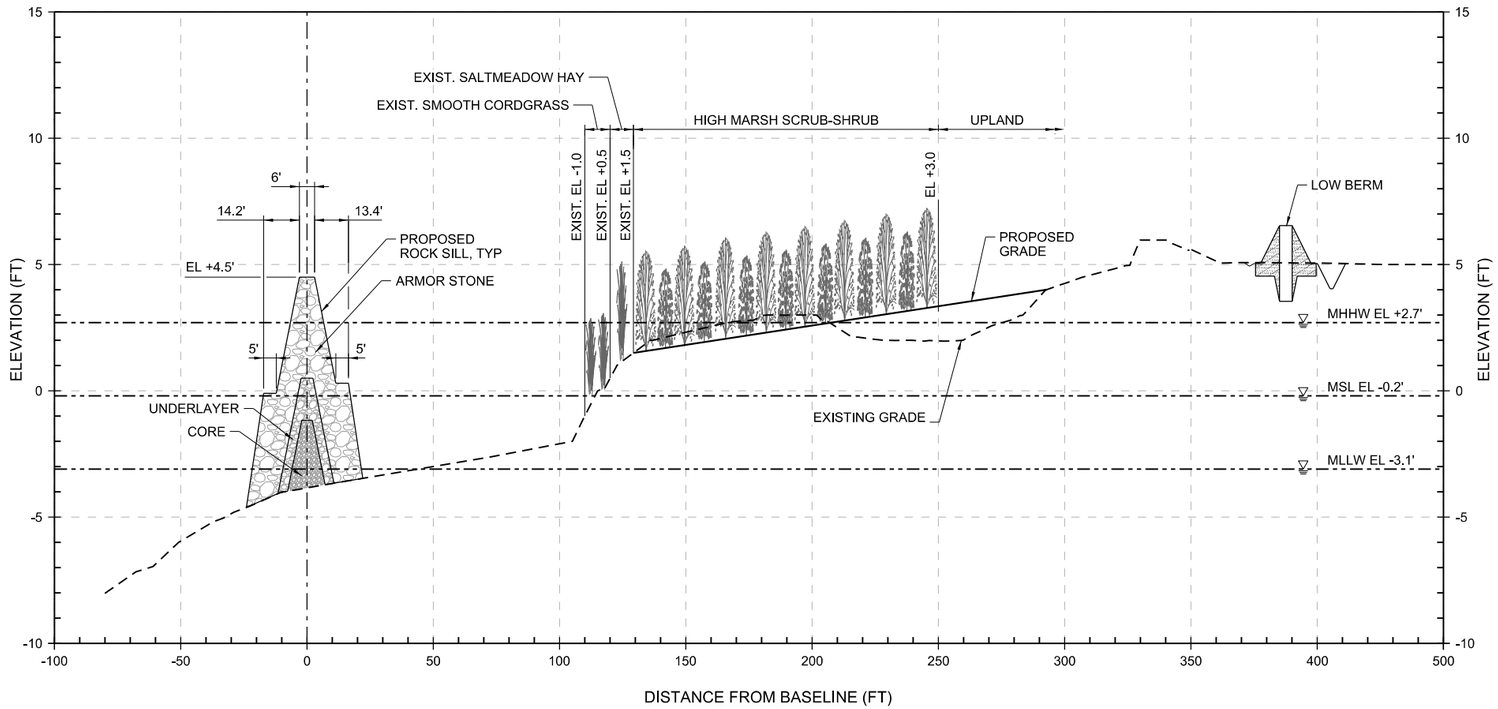
DESIGNED BY: MK
DRN BY: ME
CKD BY: MK
SUBMITTED BY: SA
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
PLOT SCALE: 1:2
PLOT DATE: 12/5/2018
FILE NUMBER:
SIZE: ANSI D
FILE NAME: W912DS_A2_CS-502.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL
RE-EVALUATION REPORT AND ENVIRONMENTAL
IMPACT STATEMENT

BERM AND REVETMENT WITH FLOODWALL TYPICAL SECTIONS

SHEET ID
CS-502
SHEET 12 OF 26



C1 / CS-103 NATURAL AND NATURE BASED FEATURES (NNBF) TYPICAL SECTION

SCALE: 1/4" = 1'-0"

NOTE

1. ALL ELEVATIONS REFERENCED TO NAVD88.

PLANTING PLAN

1. REMOVE ALL STRUCTURES AND DEBRIS.
2. REGRADE SHORELINE SLOPES TO MINIMIZE EXCAVATION AND/OR FILL ACTIVITIES AND TO PROVIDE OPTIMAL HABITAT SPECIFIC ELEVATIONS:
   A. LOW MARSH (COMMON CORDGRASS) -1.0 TO +0.5
   B. INTERMEDIATE MARSH (SALTMEADOW HAY/BLACKGRASS) +0.5 TO + 1.5
   C. HIGH MARSH – SCRUB SHRUB (MARSH ELDER/GROUNDSEL BUSH) + 1.5 TO +3.0
   D. UPLANDS HABITAT + 3.0 AND GREATER
3. SEED OR PLANT (PLUG/POT) WITH APPROPRIATE SPECIES. PLANTING OF PLUGS FOR COMMON CORDGRASS AND SALTMEADOW HAY SHOULD BE PLANTED ON 3 FT. CENTERS. MARSH ELDER/GROUNDSEL POTS SHOULD BE PLANTED ON 5 FT. CENTERS.

PRELIMINARY
NOT FOR CONSTRUCTION

0 3' 6'
HOR. SCALE: 1"=3'

0 30' 60'
HOR. SCALE: 1"=30'

MARK	DESCRIPTION	DATE	APPR.
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	MK
B	DRAFT FINAL GRR - APPENDIX A2.E	08.20.18	MK
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	MK
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	MK
E	FINAL GRR - APPENDIX A2.F	12.05.18	MK

US Army Corps of Engineers®

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

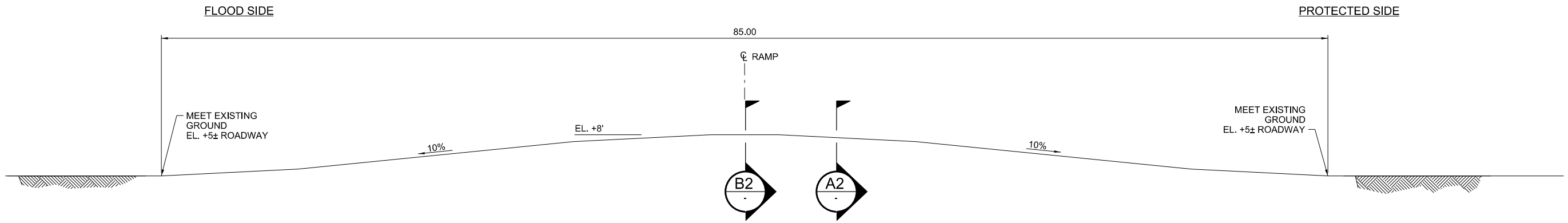
DESIGNED BY: MK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 12
PLOT STYLE TABLE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
PLOT DATE:
FILE NUMBER:
FILE NAME: W912DS_A2_CS-503.dgn

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

NATURAL AND NATURE BASED FEATURES (NNBF) SECTION

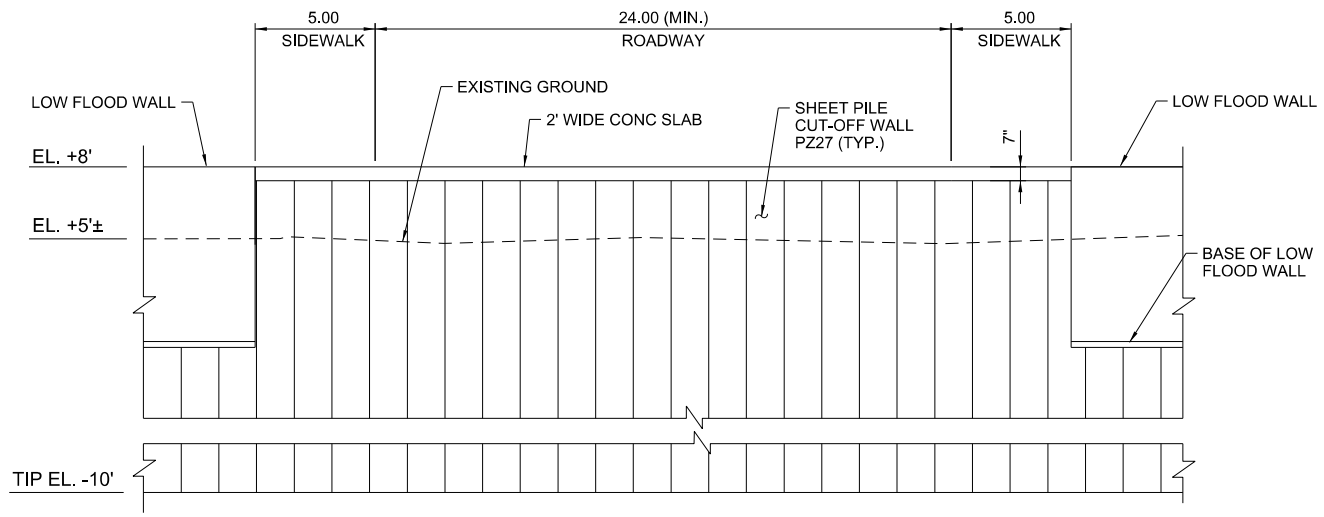
SHEET ID
CS-503
SHEET 13 OF 26

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:40:10 AM 12/3/2018 FILE: W912DS_A2_CS-503.dgn



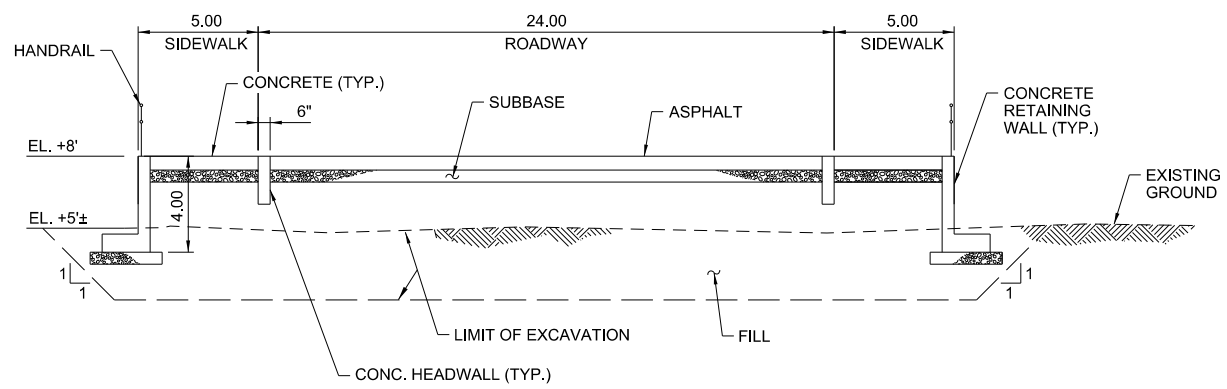
D1 - SECTION - CENTER OF ROAD RAMP

SCALE: 1/4" = 1'-0"



B2 - SECTION - CENTER OF ROAD RAMP

SCALE: 1/4" = 1'-0"



A2 - SECTION - PROTECTED SIDE

SCALE: 1/4" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

0 2' 4' 8'

SCALE: 1/4" = 1'-0"

LAST PLOTTED BY: mestimable 11:40:20 AM 12/3/2018 FILE: W912DS_A2_CS-504.dgn PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2,F	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2,E	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2,E	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2,E	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2,E	07.19.18	MK

DESIGNED BY: IK
DWN BY: ME
CKD BY: MK
SUBMITTED BY: SA
PLOT SCALE: 1/2" = 1'-0"
STEEL: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912DS-18-C-0002
PLOT DATE: 12/5/2018
FILE NAME: W912DS_A2_CS-504.dgn
FILE NUMBER:

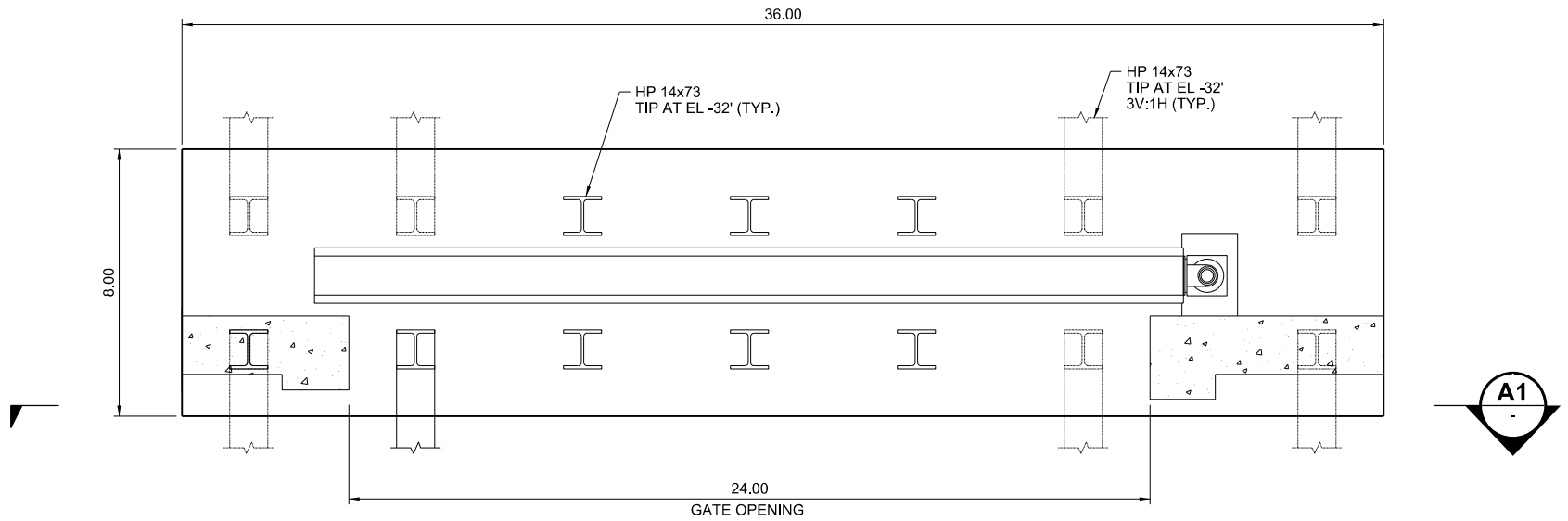
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

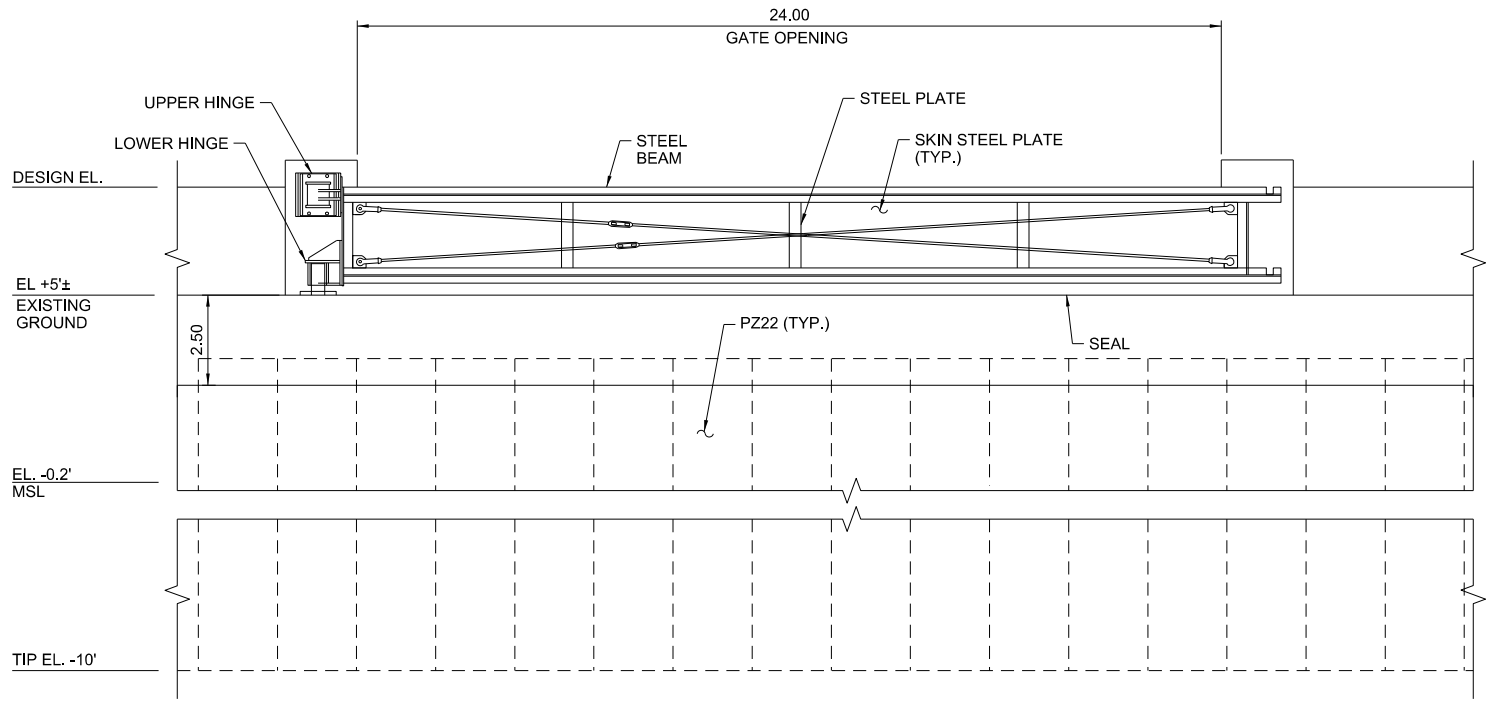
ROAD RAMP SECTIONS

SHEET ID
CS-504
SHEET 14 OF 26



PROTECTED SIDE

C1 / - PLAN - SWING GATE
SCALE: 3/8" = 1'-0"



A1 / - ELEVATION - SWING GATE
SCALE: 3/8" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

0 2' 4' 8'
SCALE: 3/8" = 1'-0"

PATH: Q:\NY\9781-02\500_CADD_Active_HFFRRF Report-App A2\
LAST PLOTTED BY: mestimable 11:41:54 AM 12/3/2018 FILE: W912DS_A2_CS-505.dgn

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2JF	12.05.18	MK
D	DRAFT FINAL GRR - APPENDIX A2JE	11.19.18	MK
C	DRAFT FINAL GRR - APPENDIX A2JE	08.30.18	MK
B	DRAFT FINAL GRR - APPENDIX A2JE	08.20.18	MK
A	DRAFT FINAL GRR - APPENDIX A2JE	07.19.18	MK

US Army Corps of Engineers®

DESIGNED BY: MK | DRWN BY: ME | SUBMITTED BY: SA | DRAWING NO: 505 | DATE: 12.05.18 | CKD BY: MK | PLOT SCALE: 1=1 | PLOT DATE: 12/3/2018 | SIZE: ANSI D | SOLICITATION NO.: | CONTRACT NO.: W912-02 | FILE NUMBER: | FILE NAME: W912DS_A2_CS-505.dgn

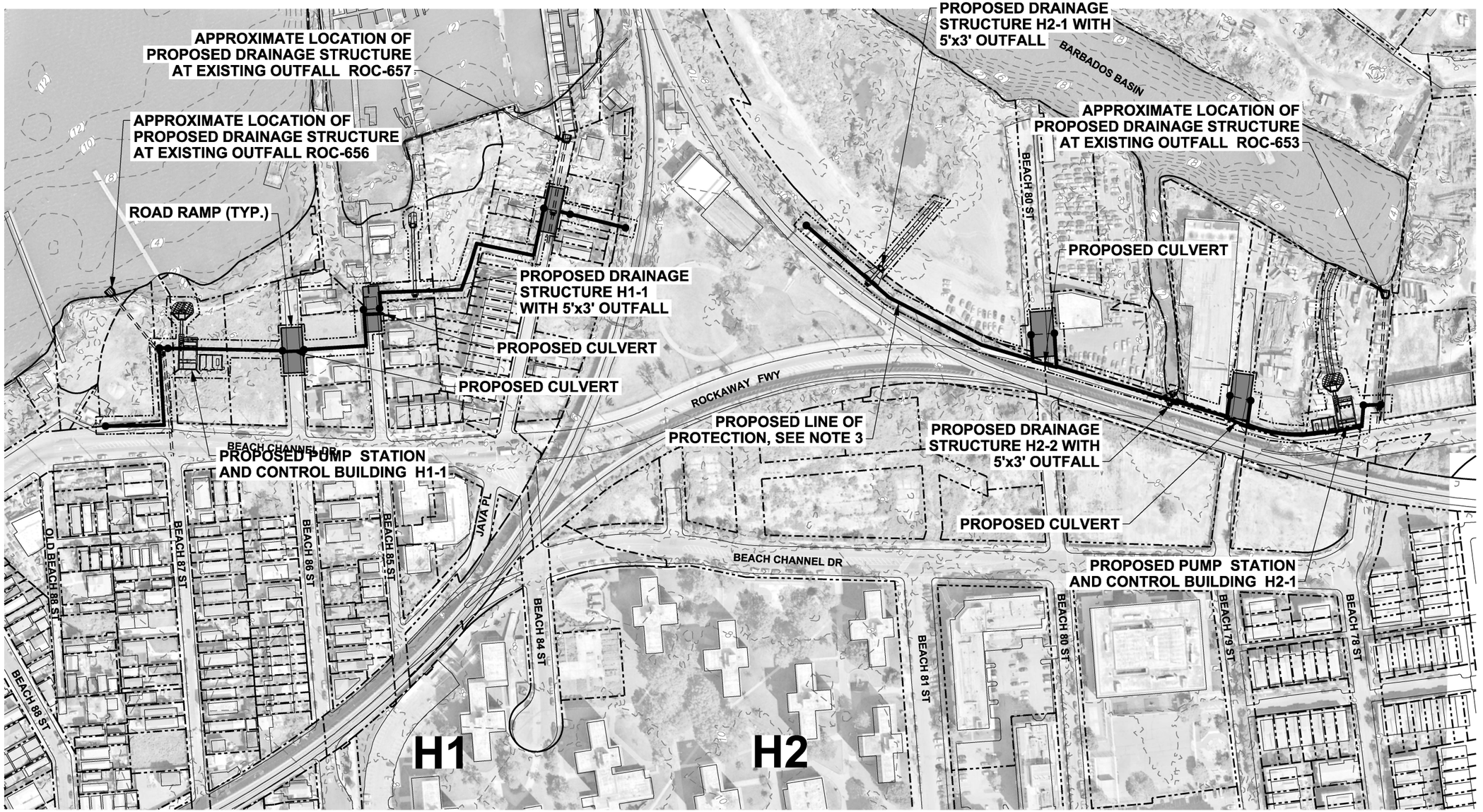
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SWING GATE PLAN AND ELEVATION

SHEET ID
CS-505
SHEET 15 OF 26



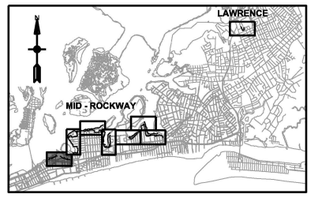
MID-ROCKAWAY - HAMMELS
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-101.dgn
12/3/2018
11:23:59 AM
LAST PLOTTED BY: mestimable

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

DESIGNED BY: BU
DRAWN BY: OM
SUBMITTED BY: MC
PLOT SCALE: 1.00000000
PLOT STYLE: ANSI D
DATE: 12.05.18
CKD BY: MJ
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CU-101.dgn
SOLICITATION NO.:
CONTRACT NO.: 97-81-02
FILE NUMBER:

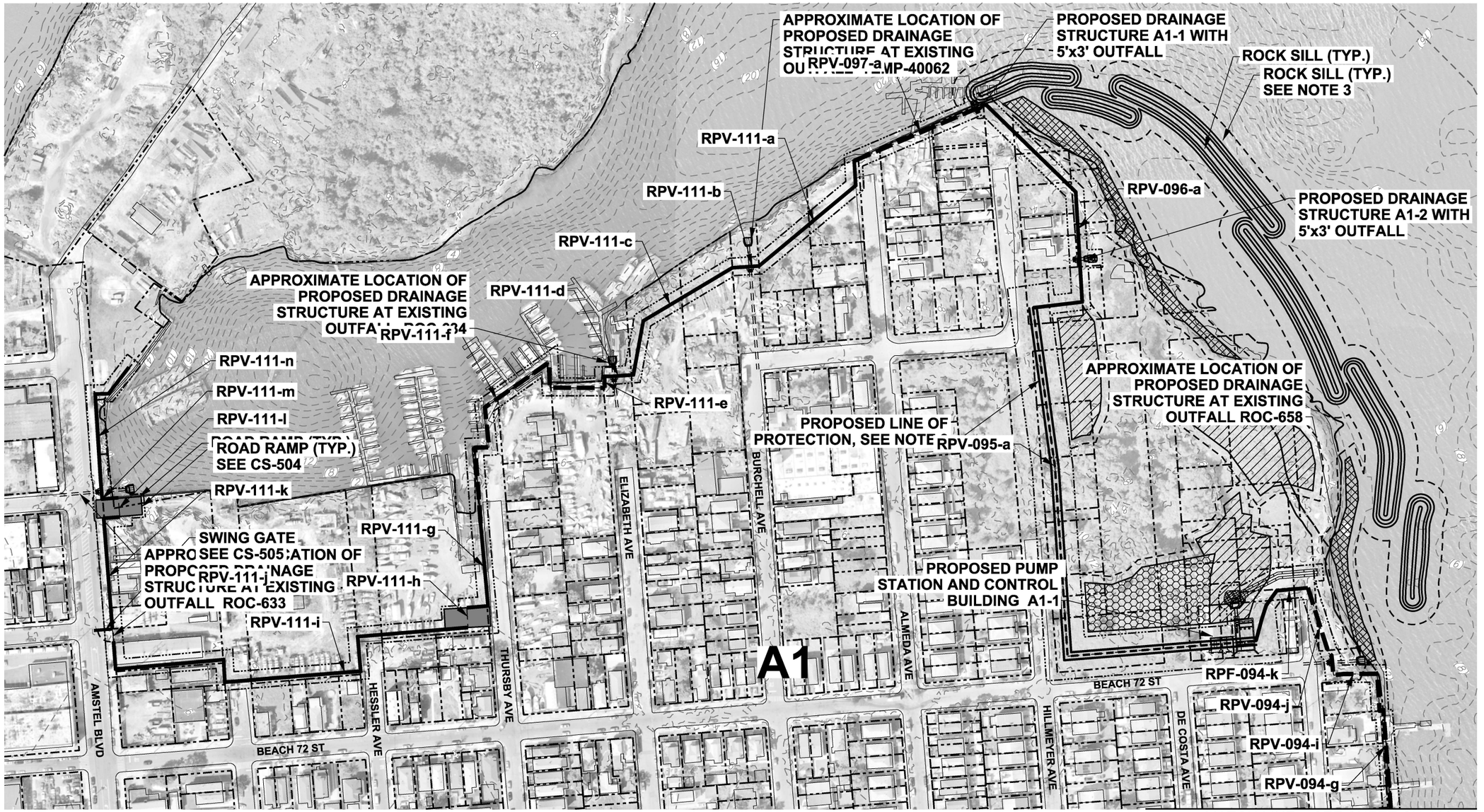
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (1 OF 8)

SHEET ID
CU-101
SHEET 16 OF 26



MATCH LINE - SEE SHEET CU-103

MID-ROCKAWAY - ARVERNE (SHEET 1)

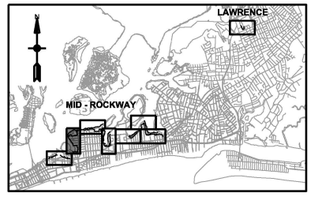
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\

LAST PLOTTED BY: mestimable 11:25:32 AM 12/3/2018 FILE: W912DS_A2_CU-102.dgn

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

DESIGNED BY: BU
DRWN BY: CM
SUBMITTED BY: AC
PLOT SCALE: 1.000000
PLOT STYLE TABLE: ANSI D
DATE: 12.05.18
CKD BY: MJ
SOLICITATION NO.:
CONTRACT NO.: W91-02
FILE NUMBER:
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CU-102.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

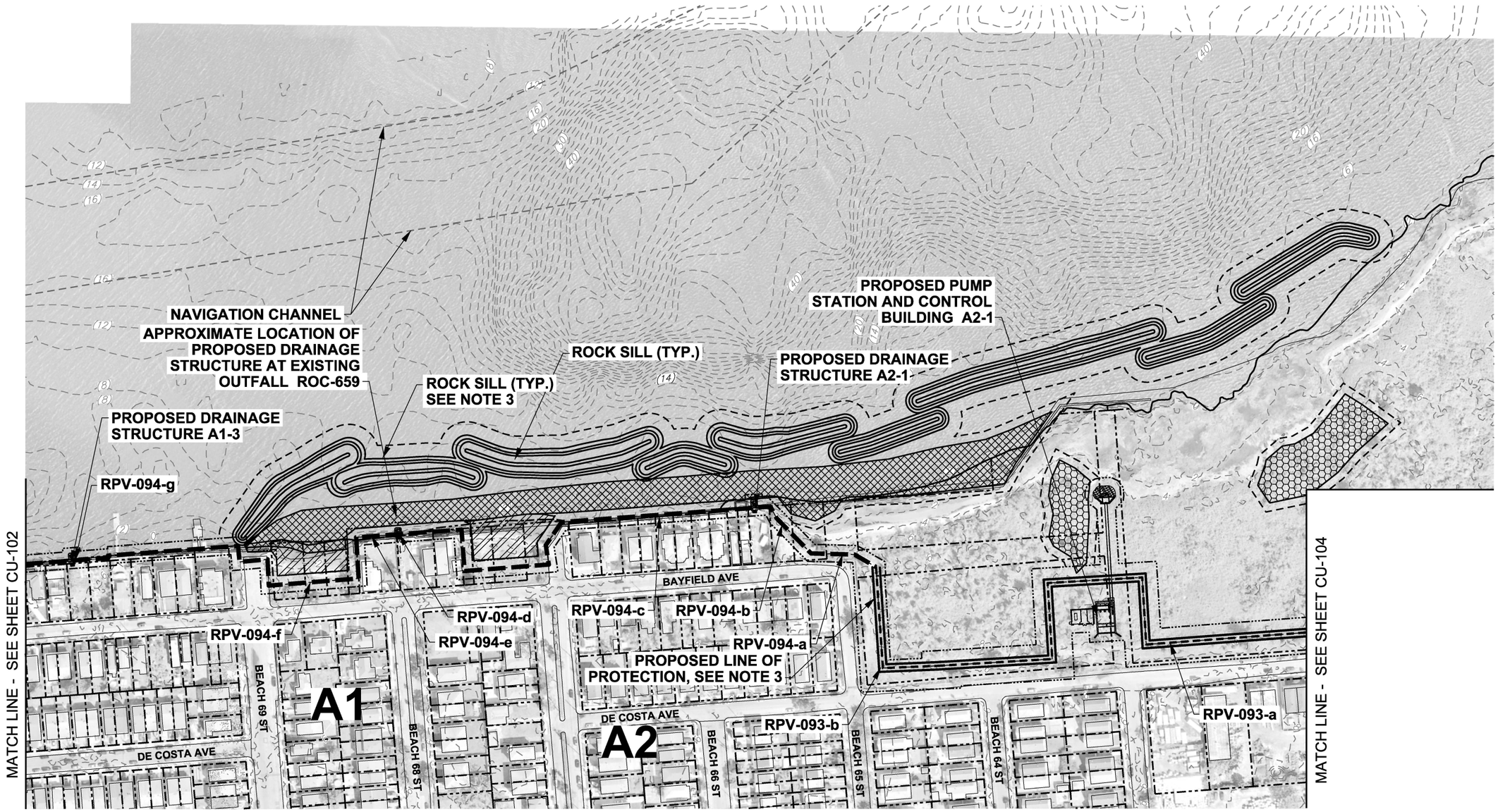
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (2 OF 8)

SHEET ID
CU-102
SHEET 17 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
LAST PLOTTED BY: mestimable 11:25:54 AM 12/3/2018 FILE: W912DS_A2_CU-103.dgn



MID-ROCKAWAY - ARVERNE (SHEET 2)
SCALE: 1" = 100'

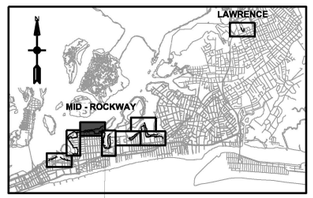
NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA

PRELIMINARY
NOT FOR CONSTRUCTION



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2-F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2-E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2-E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1-E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2-E	07.19.18	BU

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

DESIGNED BY: BU	DATE: 12.05.18
DWN BY: CM	CKD BY: MJ
SUBMITTED BY: MC	CONTRACT NO.: W912DS-18-D-0007
PLOT SCALE: 1:1	PLOT DATE: 12/3/2018
SIZE: ANSI D	FILE NAME: W912DS_A2_CU-103.dgn

SOLICITATION NO.:	
CONTRACT NO.:	97781-02
FILE NUMBER:	

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (3 OF 8)

SHEET ID
CU-103
SHEET 18 OF 26

MATCH LINE - SEE SHEET CU-103

BEACH 62 ST

A2

RPV-091-i

PROPOSED DRAINAGE STRUCTURE A2-3 WIT 5'x3' OUTFALL

PROPOSED DR STRUCTURE A2-2

RPV-093-a

PROPOSED PUMP STATION AND CONTROL BUILDING A3-1

APPROXIMATE LOCATION OF PROPOSED DRAINAGE

RPV-091-h RUCTURE AT EXISTING OUTFALL ROC-

RPV-091-j

RPV-092-a

RPV-091-g

RPV-092-b

APPROXIMATE LOCATION OF PROPOSED DRAINAGE STRUCTURE AT EXISTING OUTFALL ROC-635

RPV-091-f

ROCK SILL (TYP.)

FISH DIP

SEE NOTE 4

FISH DIP

SEE NOTE 4

ROCK SILL (TYP.) SEE NOTE 3

RPV-091-e MP

ARVERNE BLVD

BEACH CHANNEL DR

BEACH 59 ST

RPV-091-d

RPV-091-c

RPV-091-a

FISH DIP SEE NOTE 4

APPROXIMATE LOCATION OF PROPOSED DRAINAGE STRUCTURE AT EXISTING OUTFALL ROC-636

BEACH 58 ST

PROPOSED DRAINAGE STRUCTURE A3-1 WITH 5'x3' OUTFALL

RPV-091-b

PROPOSED LINE OF PROTECTION, SEE NOTE 3

PROPOSED DRAINAGE STRUCTURE A3-2 WITH 5'x3' OUTFALL

A3

MID-ROCKAWAY - ARVERNE (SHEET 3)

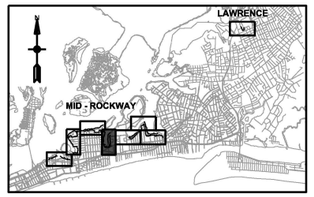
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2-F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2-E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2-E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1-E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2-E	07.19.18	BU

DESIGNED BY: BU
DRWN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 1:1.0000
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MJ
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CU-104.dgn
SOLICITATION NO.:
CONTRACT NO.: W91-02
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

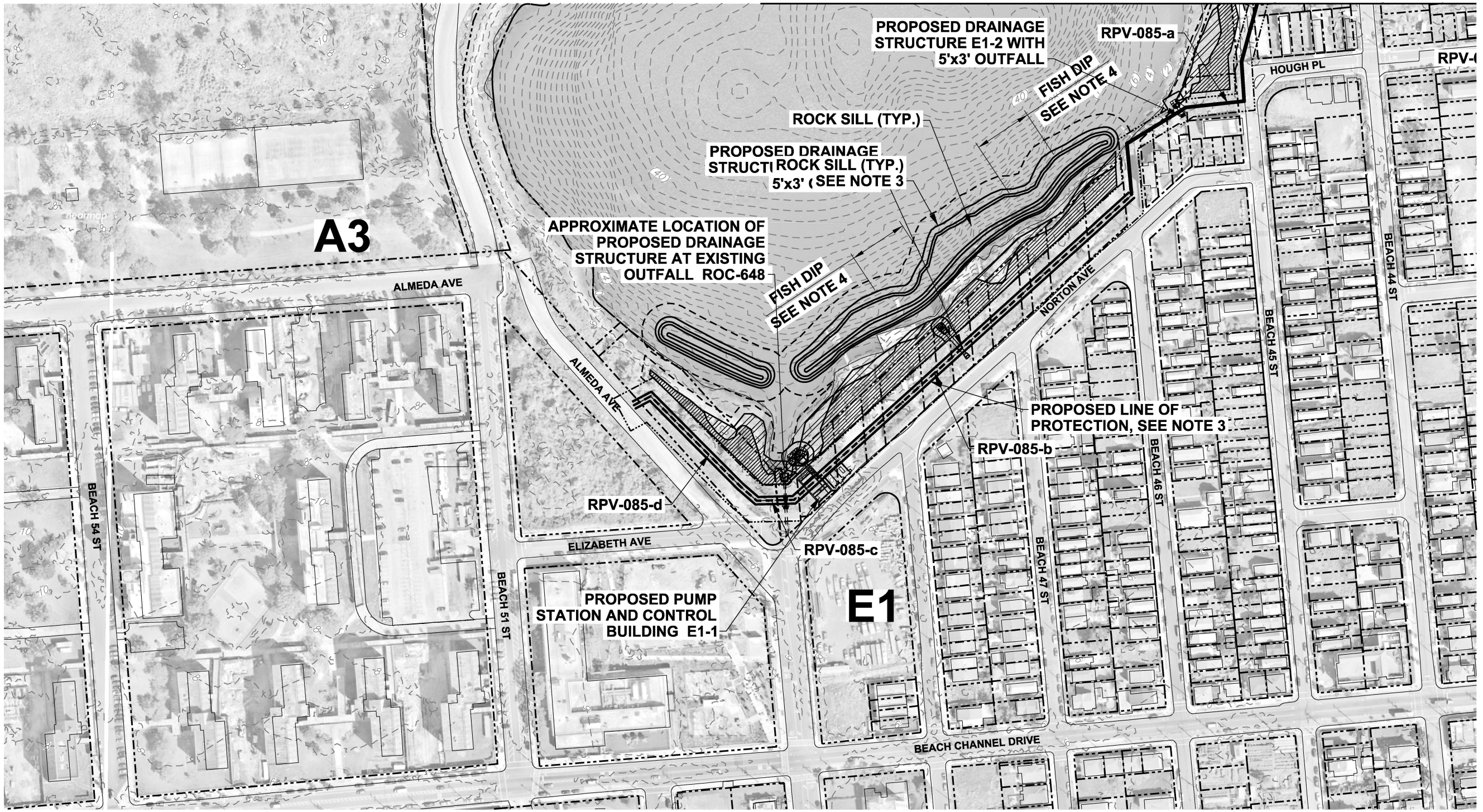
INTERIOR DRAINAGE PLAN (4 OF 8)

SHEET ID
CU-104
SHEET 19 OF 26

PATH: Q:\NY\9781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
LAST PLOTTED BY: mestimable 11:26:16 AM 12/3/2018 FILE: W912DS_A2_CU-104.dgn

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-105.dgn
12/3/2018
11:26:38 AM
LAST PLOTTED BY: mestimable

MATCH LINE - SEE SHEET CU-106



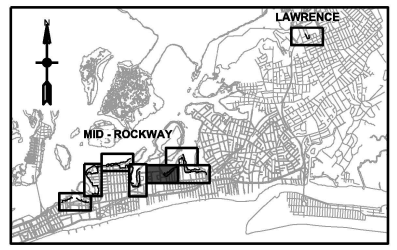
MID-ROCKAWAY - EDGEMERE (SHEET 1)
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 — DRAINAGE AREA



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2-F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2-E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2-E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1-E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2-E	07.19.18	BU

DESIGNED BY: BU
DRWN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 1.000000
SIZE: ANSI D
DATE: 12.05.18
CHKD BY: MJ
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CU-105.dgn
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

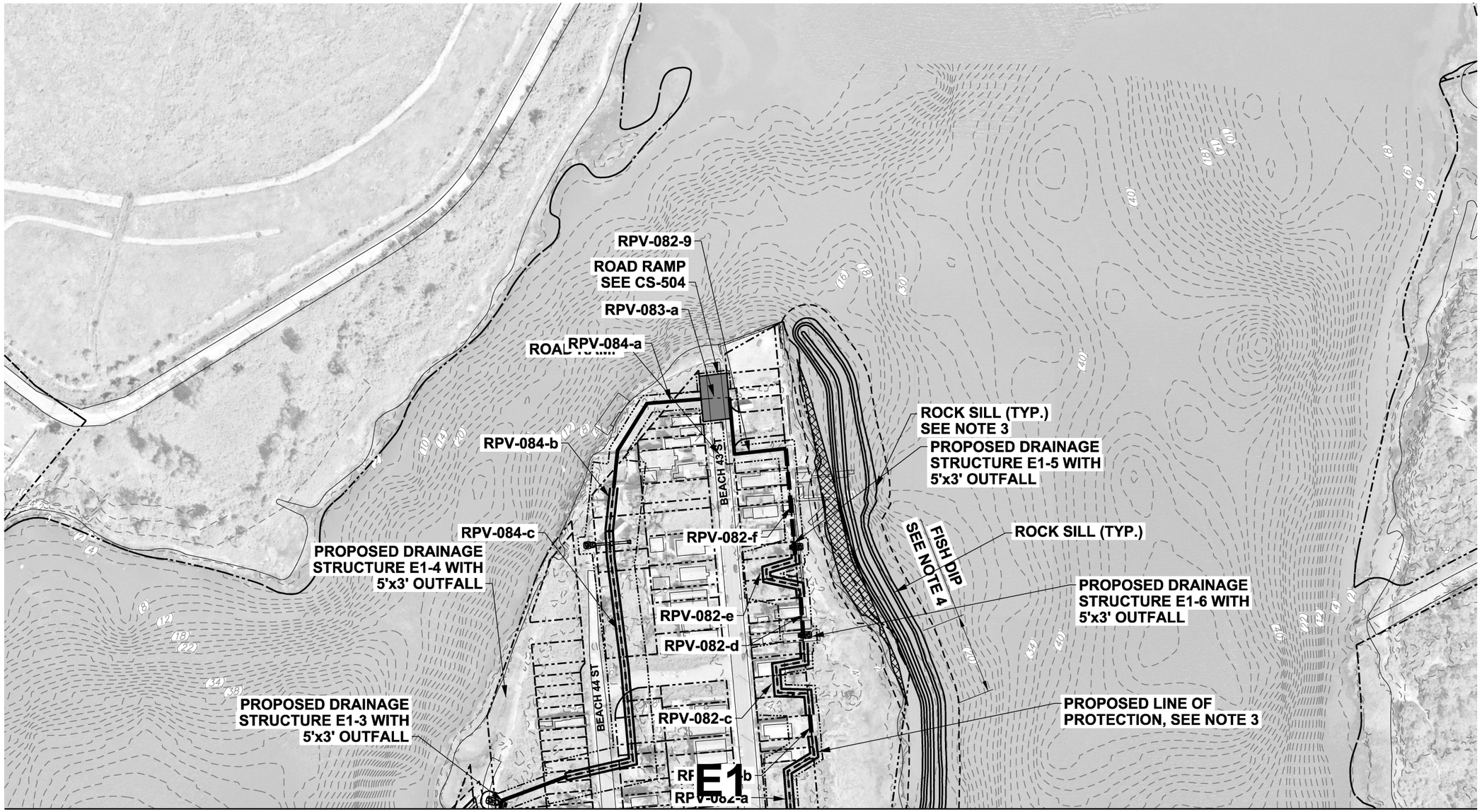
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (5 OF 8)

SHEET ID
CU-105
SHEET 20 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-106.dgn
12/3/2018
11:26:58 AM
LAST PLOTTED BY: mestimable



MATCH LINE - SEE SHEET CU-105

MATCH LINE - SEE SHEET CU-107

MID-ROCKAWAY - EDGEMERE (SHEET 2)

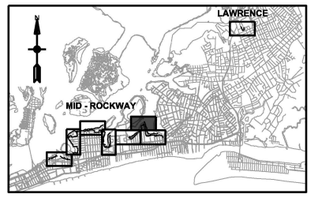
SCALE: 1" = 100'

NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

DESIGNED BY: BU
DRN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 1:1.000000
ANSI D
DATE: 12.05.18
CKD BY: MJ
SOLICITATION NO.:
CONTRACT NO.: W91-02
PLOT DATE:
FILE NUMBER:
FILE NAME: W912DS_A2_CU-106.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

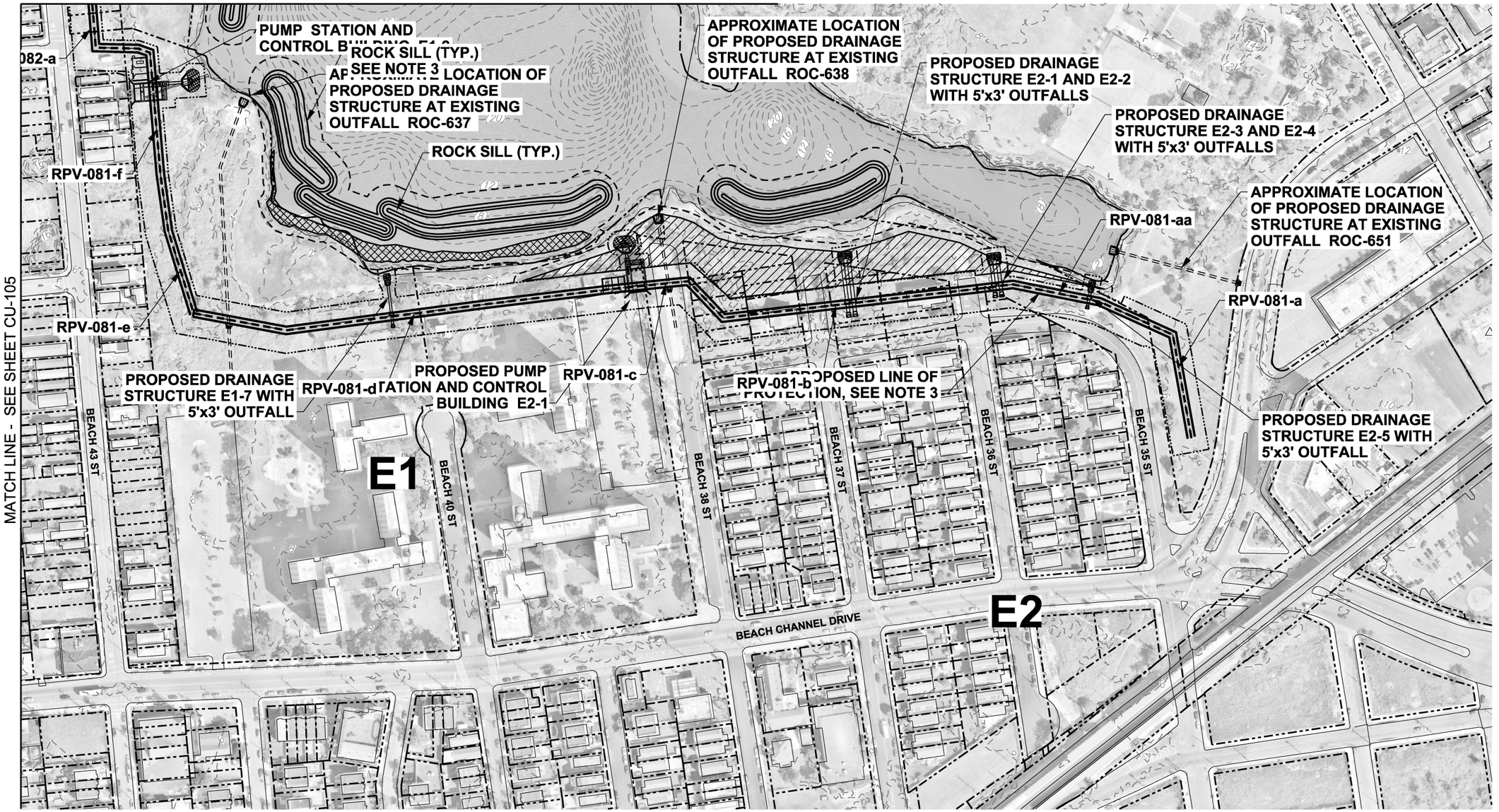
INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (6 OF 8)

SHEET ID
CU-106
SHEET 21 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-107.dgn
12/3/2018
11:27:20 AM
LAST PLOTTED BY: mestimable

MATCH LINE - SEE SHEET CU-106



MID-ROCKAWAY - EDGEMERE (SHEET 3)
SCALE: 1" = 100'

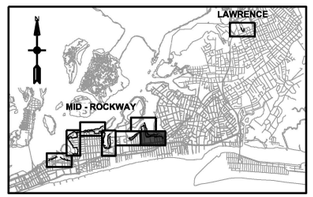
NOTES:

1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA

PRELIMINARY
NOT FOR CONSTRUCTION



KEY PLAN

N

0 100' 200'

SCALE:1"=100'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

DESIGNED BY: BU
DRWN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 1:1000
SIZE: ANSI D
DATE: 12.05.18
CKD BY: MJ
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CU-107.dgn
SOLICITATION NO.:
CONTRACT NO.: W781-02
FILE NUMBER:

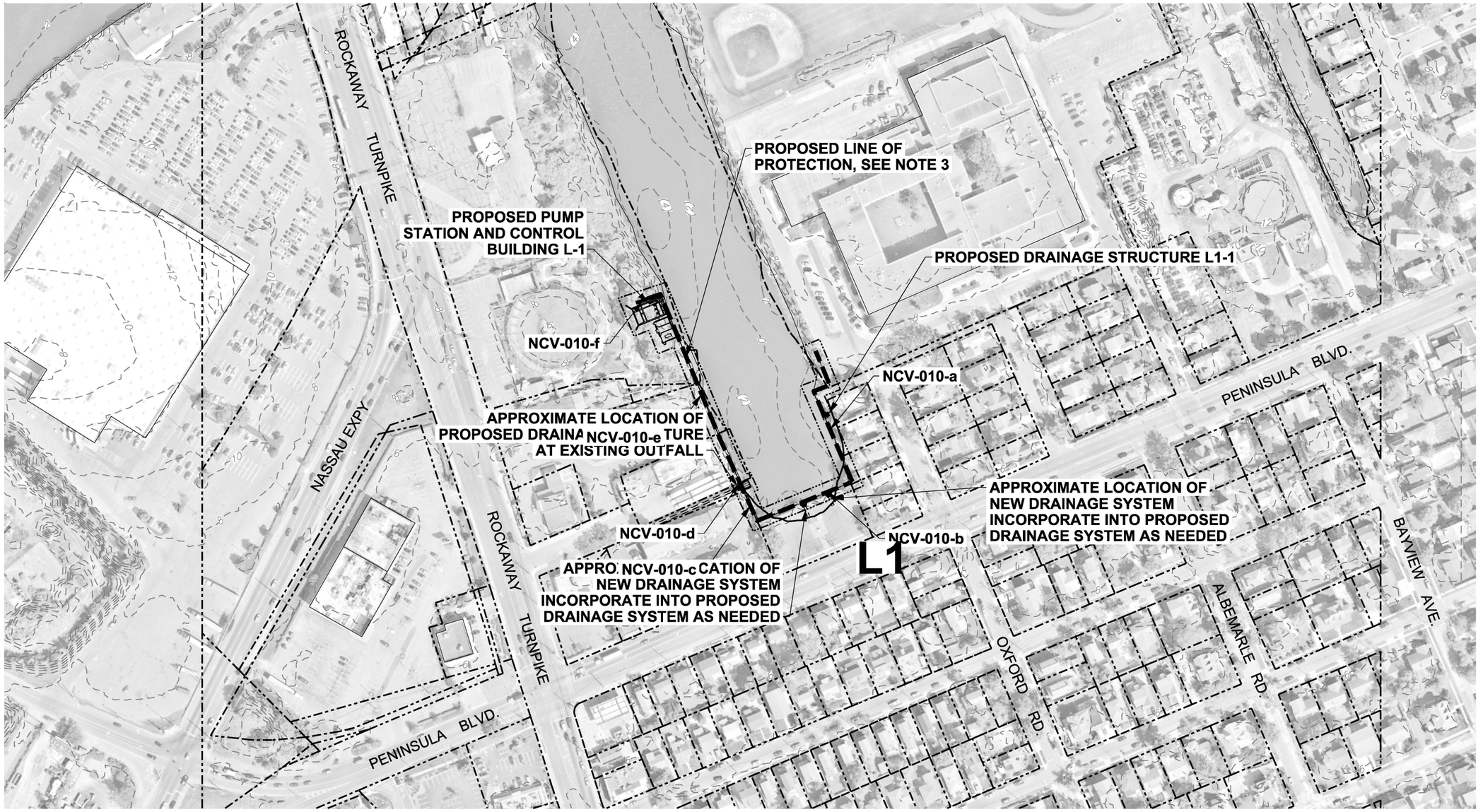
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

INTERIOR DRAINAGE PLAN (7 OF 8)

SHEET ID
CU-107
SHEET 22 OF 26



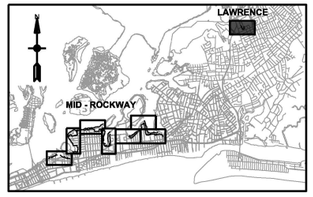
LAWRENCE
SCALE: 1" = 100'

NOTES:

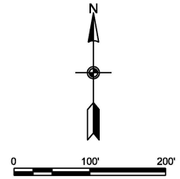
1. ALL ELEVATIONS REFERENCED TO NAVD88.
2. TYPICAL SECTIONS SHOWN ON SHEETS CU-501 TO CU-503.
3. LINE OF PROTECTION SHOWN ON SHEETS CS-101 TO CS-108.

LEGEND

- PROPOSED DRAINAGE AT EXISTING OUTFALL
- PROPOSED DRAINAGE AT BERM
- PROPOSED DRAINAGE AT FLOODWALL
- PROPOSED DRAINAGE AT BULKHEAD
- LIMIT OF DRAINAGE AREA
- A1 DRAINAGE AREA



KEY PLAN



SCALE:1"=100'

PRELIMINARY
NOT FOR CONSTRUCTION

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

US Army Corps of Engineers®

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

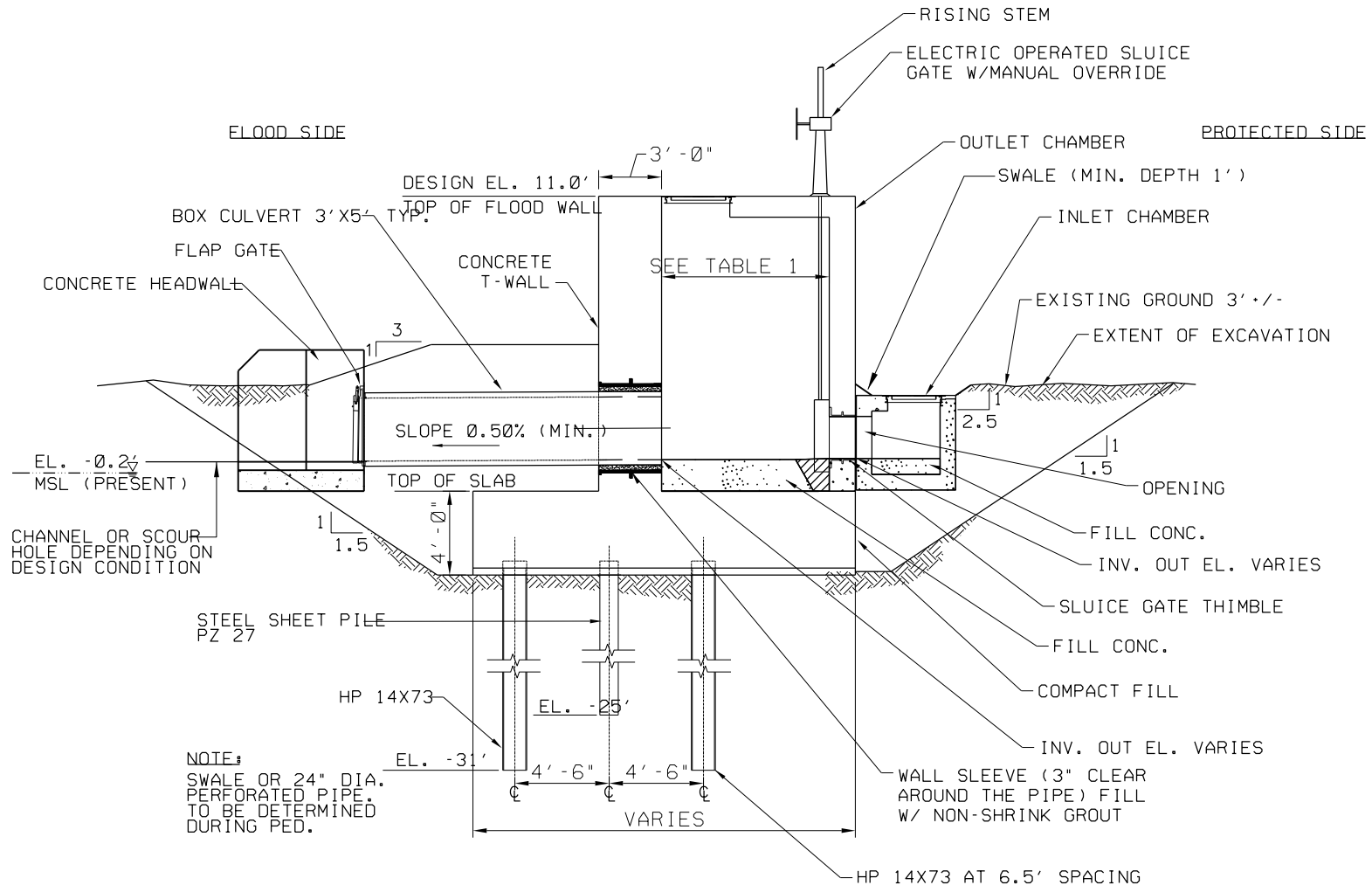
DESIGNED BY: BU
DRWN BY: CM
CKD BY: MJ
SUBMITTED BY: MC
PLOT SCALE: 1.00000'
SIZE: ANSI D
PLOT DATE: 12/3/2018
FILE NAME: W912DS_A2_CU-108.dgn
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W912-02
FILE NUMBER:

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

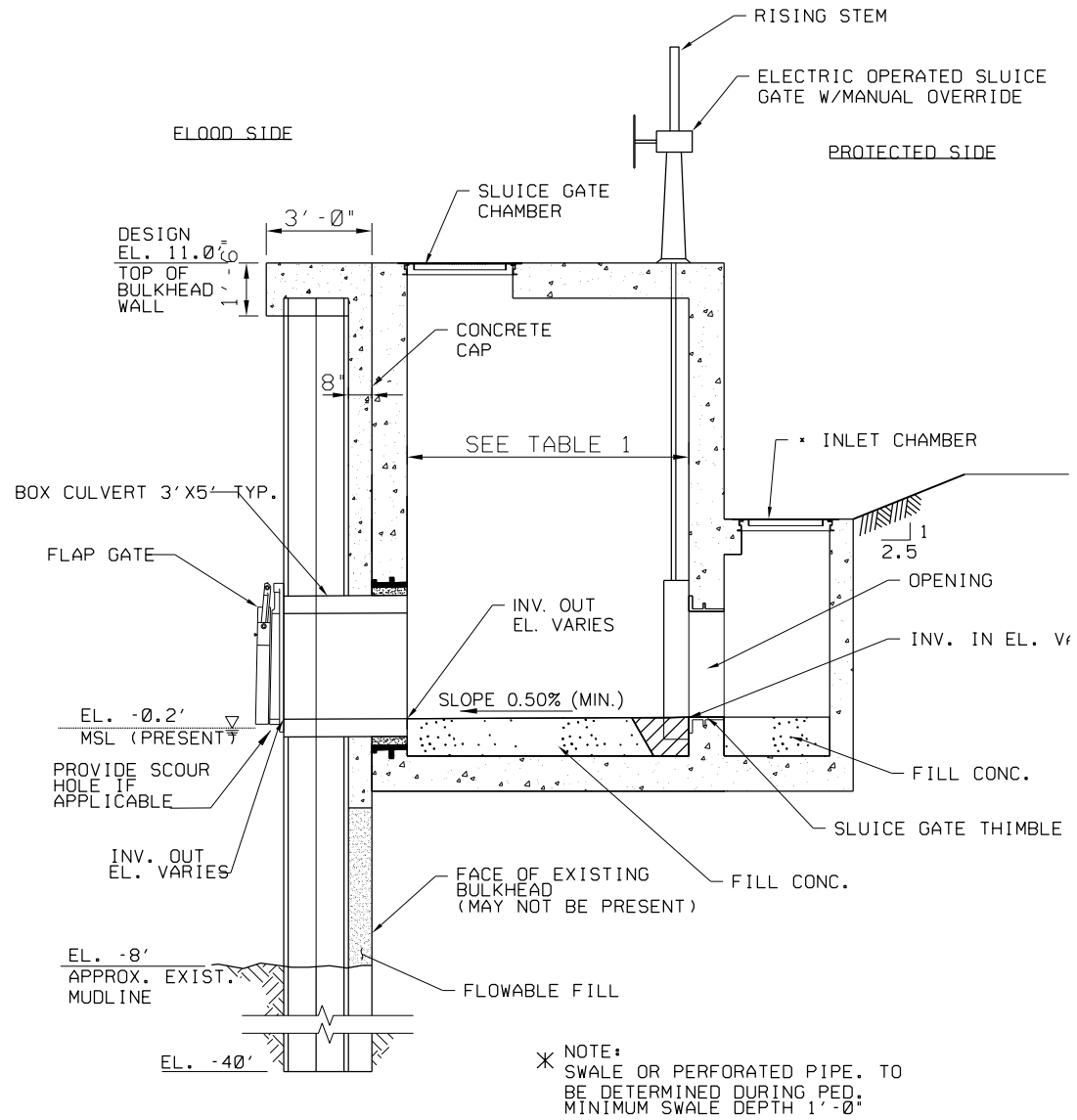
INTERIOR DRAINAGE PLAN (8 OF 8)

SHEET ID
CU-108
SHEET 23 OF 26

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-108.dgn
12/3/2018 11:27:44 AM
LAST PLOTTED BY: mestimable



1 - TYPICAL OUTFALL DETAIL THROUGH FLOODWALL
SCALE: 1/4" = 1'-0"



2 - TYPICAL OUTFALL DETAIL THROUGH BULKHEAD
SCALE: 3/8" = 1'-0"

DRAINAGE STRUCTURE DIMENSION					
CULVERT SIZE	WALL THICKNESS (FT)	ROOF THICKNESS (FT)	FLOOR SLAB THICKNESS (FT)	CHAMBER WIDTH	CHAMBER LENGTH
5'X3'	1.5	1.0	1.5	8'-Ø"	8'-Ø"

0 2' 4' 8'
SCALE: 1/4" = 1'-0"

0 2' 4' 8'
SCALE: 3/8" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

LAST PLOTTED BY: mestimable 11:31:47 AM 12/3/2018 FILE: W912DS_A2_CU-501.dgn
PATH: Q:\NY\9781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

US Army Corps of Engineers®

DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W91-02
FILE NUMBER:
DESIGNED BY: BU
DRWN BY: CM
CKD BY: MJ
SUBMITTED BY: MC
PLOT DATE: 12/3/2018
PLOT SCALE: 1:1
SIZE: ANSI D
FILE NAME: W912DS_A2_CU-501.dgn

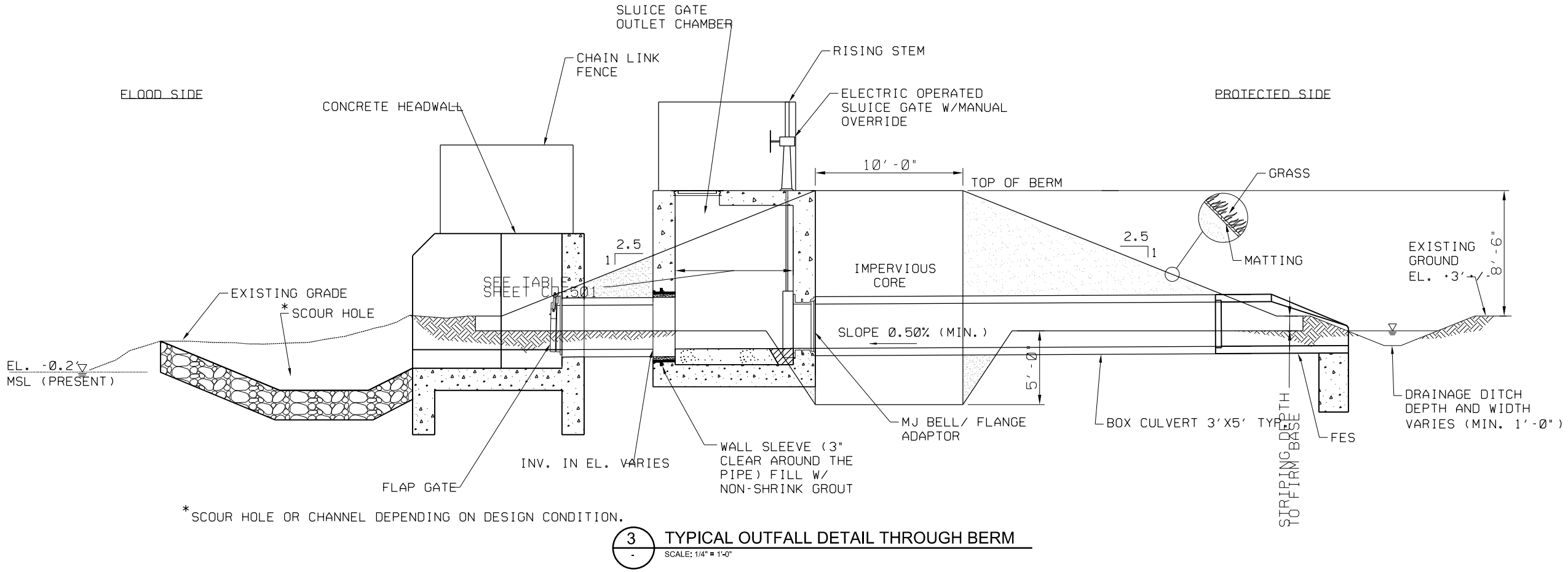
U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 1

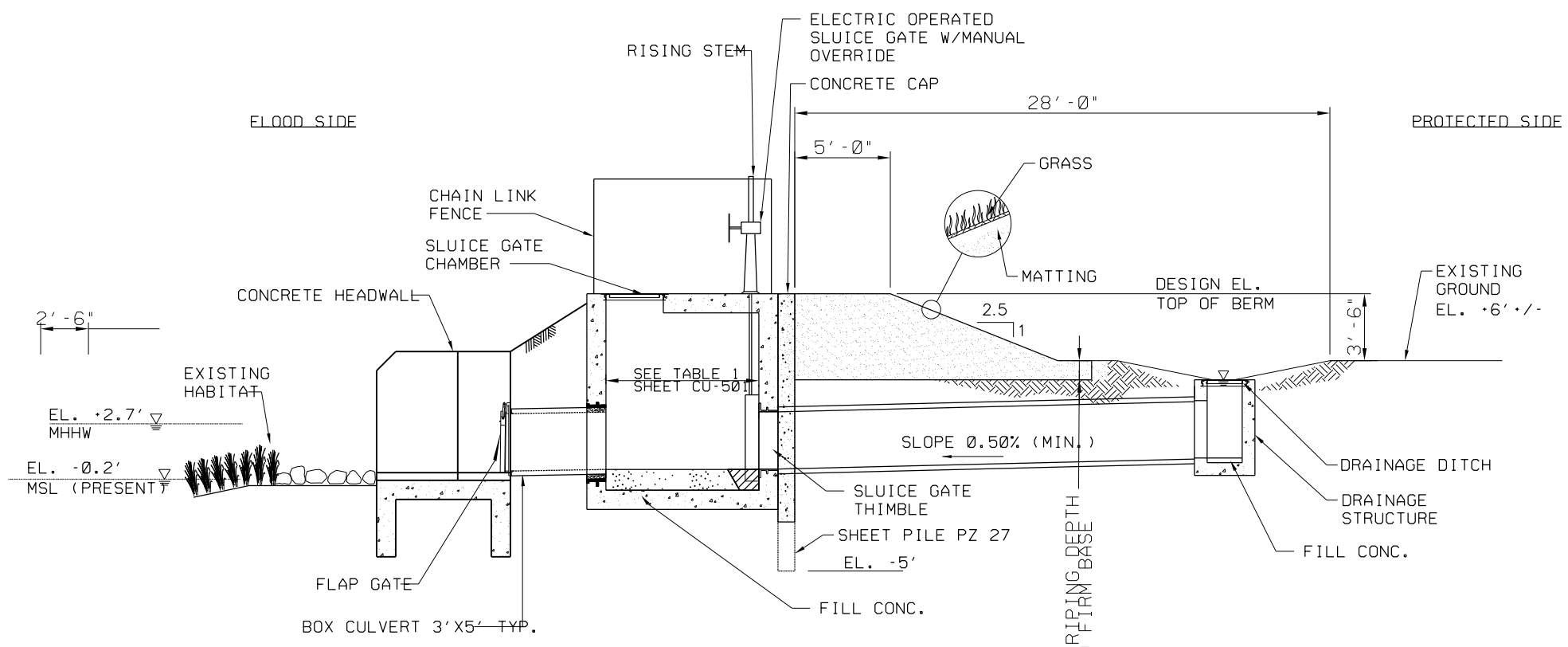
SHEET ID
CU-501
SHEET 24 OF 26



*SCOUR HOLE OR CHANNEL DEPENDING ON DESIGN CONDITION.

3 - TYPICAL OUTFALL DETAIL THROUGH BERM

SCALE: 1/4" = 1'-0"



4 - TYPICAL OUTFALL DETAIL THROUGH HYBRID BERM

SCALE: 1/4" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

0 2' 4' 8'
SCALE: 1/4" = 1'-0"

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

US Army Corps of Engineers®

DESIGNED BY: BU
DRN BY: CM
SUBMITTED BY: MC
PLOT SCALE: 12
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W91-02
PLOT DATE: 5/3/2019
FILE NUMBER:
FILE NAME: W912DS_A2_CU-502.dgn

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

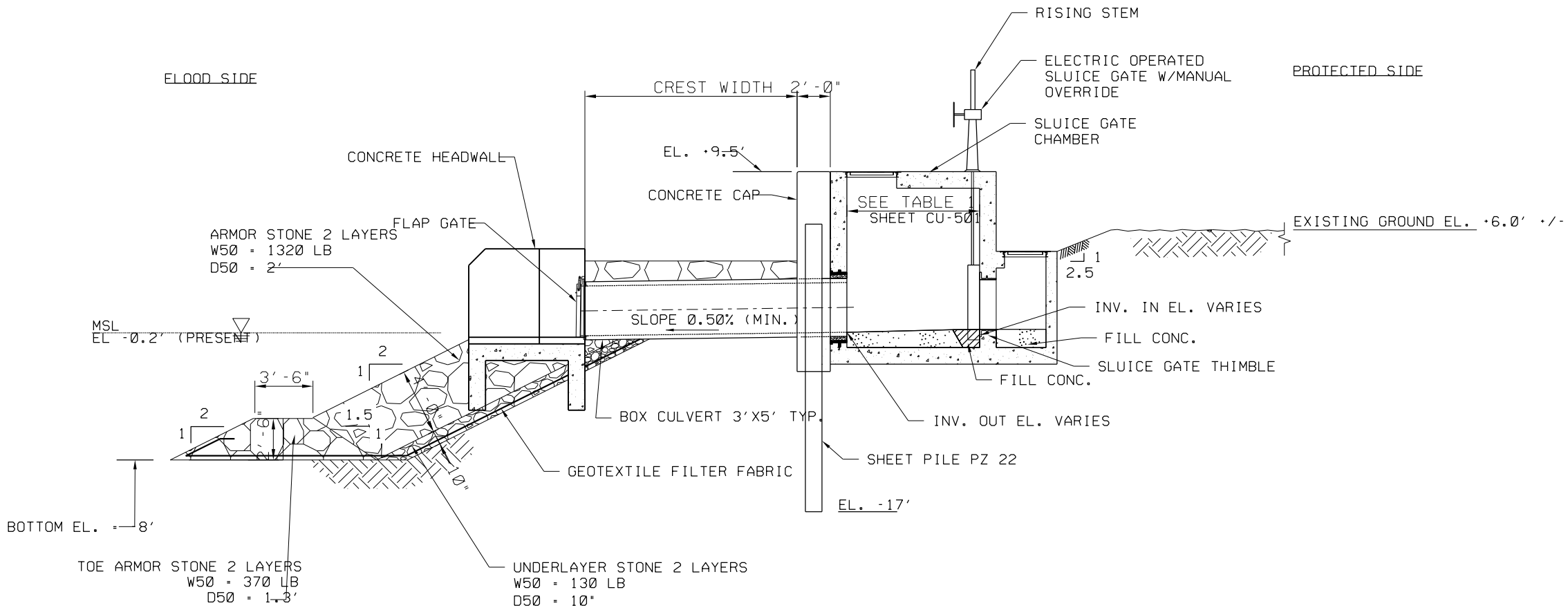
MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 2

SHEET ID
CU-502
SHEET 25 OF 26

PATH: Q:\NY19781-021500_CADD_Active_HFERRF Report-App A2\Aecom dwgs\
FILE: W912DS_A2_CU-502.dgn
12/3/2018
11:31:24 AM
LAST PLOTTED BY: mestimable



5 - TYPICAL OUTFALL DETAIL THROUGH REVETMENT WITH FOOLDWALL

SCALE: 1/4" = 1'-0"

PRELIMINARY
NOT FOR CONSTRUCTION

0 2" 4" 8'

SCALE: 1/4" = 1'-0"

PATH: Q:\NY\97781-021500_CADD_Active_HFFRRF Report-App A2\Aecom dwgs\

LAST PLOTTED BY: mestimable 11:30:59 AM 12/3/2018 FILE: W912DS_A2_CU-503.dgn

MARK	DESCRIPTION	DATE	APPR.
E	FINAL GRR - APPENDIX A2.F	12.05.18	BU
D	DRAFT FINAL GRR - APPENDIX A2.E	11.19.18	BU
C	DRAFT FINAL GRR - APPENDIX A2.E	08.30.18	BU
B	DRAFT FINAL GRR - APPENDIX A1.E	08.20.18	BU
A	DRAFT FINAL GRR - APPENDIX A2.E	07.19.18	BU

US Army Corps of Engineers®

U.S. ARMY CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT
NEW YORK
http://www.nan.usace.army.mil

MOFFATT & NICHOL
529 FIFTH AVE., 14TH FLOOR
NEW YORK, NY 10017
212-768-7454

DESIGNED BY: BU
DWN BY: OM
CKD BY: MJ
SUBMITTED BY: MC
PLOT SCALE: 1:2
PLOT DATE: 12/3/2018
SIZE: ANSI D
DATE: 12.05.18
SOLICITATION NO.:
CONTRACT NO.: W91-02
FILE NUMBER:
FILE NAME: W912DS_A2_CU-503.dgn

INTEGRATED HURRICANE SANDY GENERAL RE-EVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

TYPICAL DRAINAGE OUTFALL DETAILS - SHEET 3

SHEET ID
CU-503

SHEET 26 OF 26

US Army Corps of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix B – Economic Benefits

December 2018

DISCLAIMER

This is a draft interim document and
is not to be used as the basis for final design, construction,
or remedial action, or as a basis for major capital
decisions. Please be advised that this document
is subject to revision as the analysis continues.
Your comments will be incorporated
into future submissions.

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Purpose and Scope 1
1.2 Prior Studies 2
1.3 Prior Projects 2
1.4 Description of the Study Area 4
1.4.1 Location 4
1.4.2 Physical Setting 6
1.4.3 Accessibility 6
1.4.4 Socioeconomic Considerations 7
1.4.5 Economy 8
1.4.6 Land Use 9
1.4.7 Parks and Recreation 10
2 DESCRIPTION OF THE PROBLEM 12
3 WITHOUT-PROJECT FUTURE CONDITIONS 16
4 ANALYSIS OF STORM DAMAGE 18
4.1 General 18
4.2 Economic Reaches 18
4.3 Economic Parameters 21
4.4 Inventory Development 21
4.5 Structure Values 23
4.5.1 Approach 23
4.5.2 Shorefront and Peninsula Backbay Structures 24
4.5.3 Backbay Structures 31
4.6 Coastal Storm Data 45
4.6.1 Shorefront Reaches 45
4.6.2 Backbay Reaches 46
4.7 Damage Functions 49
5 AVERAGE ANNUAL DAMAGES 52
5.1 General 52
5.1.1 Damage to Shorefront Structures 52
5.1.2 Damage to Backbay Structures 53
5.2 Uncertainty 54
5.3 Estimated Without-Project Damages 55
5.4 Sea Level Change 60
5.5 Shoreline Change Calibration 63

6 COASTAL RISK MANAGEMENT BENEFITS 67
6.1 Introduction 67
6.2 Approach and Assumptions 67
6.3 Storm Damage Without Project 68
6.4 Storm Damage with Shorefront Risk Management Plans 68
6.5 Reduced FIA Administrative Costs 69
6.6 Emergency Nourishment Costs Avoided 69
6.7 High Frequency Risk Reduction Feature Benefits 69
7 RECREATION BENEFITS 73
8 SUMMARY OF COASTAL RISK MANAGEMENT BENEFITS AND COSTS 77
8.1 Summary of Formulation Results 77
8.2 Final Cost and Interest Rate Updates 83
8.3 Benefit Uncertainty 84

LIST OF TABLES

Table 1-1: Income Levels in the Study Area 9
Table 1-2: Percent of Civilian Employment by Industry for Study Area and Counties 9
Table 1-3: Study Area Land Use 10
Table 4-1: Number of Structures, Shorefront Reaches 20
Table 4-2: Number of Structures, Backbay Reaches 20
Table 4-3: Number of Structures, HFFRRF Areas 21
Table 4-4: Information Recorded for Structures 22
Table 4-5: Estimated Depreciated Structure Replacement Value in Shorefront Reaches 25
Table 4-6: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-2, by Stage 26
Table 4-7: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-3, by Stage 27
Table 4-8: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-4, by Stage 28
Table 4-9: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-5, by Stage 29
Table 4-10: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-6, by Stage 30
Table 4-11: Estimated Depreciated Structure Replacement Value in Non-Shorefront (Backbay/Cross-Shore) Reaches 31

Table 4-12: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-1, by Stage....32
Table 4-13: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-2, by Stage....33
Table 4-14: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-3, by Stage....34
Table 4-15: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-4, by Stage....35
Table 4-16: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-5, by Stage....36
Table 4-17: Value of Development in Backbay/Cross-Shore Reach BB-6, by Stage....37
Table 4-18: Estimated Depreciated Structure Replacement Value in Project Area 1 Hammels.38
Table 4-19: Estimated Depreciated Structure Replacement Value in Project Area 2 Arverne...38
Table 4-20: Estimated Depreciated Structure Replacement Value in Project Area 3 Edgemere39
Table 4-21: Estimated Depreciated Structure Replacement Value in Project Area 4 Norton Basin 39
Table 4-22: Estimated Depreciated Structure Replacement Value in Project Area 5 Bayswater....40
Table 4-23: Estimated Depreciated Structure Replacement Value in Project Area 6 Motts Basin South 40
Table 4-24: Estimated Depreciated Structure Replacement Value in Project Area 7 Motts Basin North 41
Table 4-25: Estimated Depreciated Structure Replacement Value in Project Area 8 Inwood Marina 41
Table 4-26: Estimated Depreciated Structure Replacement Value in Project Area 9.1 Cedarhurst -Lawrence....42
Table 4-27: Estimated Depreciated Structure Replacement Value in Project Area 9.2 Rosedale....43
Table 4-28: Estimated Depreciated Structure Replacement Value in Project Area 9.31 Meadowmere North....43
Table 4-29: Estimated Depreciated Structure Replacement Value in Project Area 9.32 Meadowmere....44
Table 4-30: Estimated Depreciated Structure Replacement Value in Project Area 9.33 Meadowmere East....44
Table 4-31: Estimated Depreciated Structure Replacement Value in Project Area 10 Old Howard Beach 44
Table 4-32: Estimated Depreciated Structure Replacement Value in Project Area 11 Canarsie 45

Table 4-33: Estimated Depreciated Structure Replacement Value in Project Area Broad Channel 45
Table 4-34: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-1 47
Table 4-35: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-2 47
Table 4-36: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-3 47
Table 4-37: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-4 48
Table 4-38: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-5 48
Table 4-39: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-6 48
Table 4-40: Sources and Assignment of Damage Functions in Beach-*fx* 50
Table 5-1: Equivalent Annual Without-Project Damage, Intermediate Sea Level Rise Scenario 53
Table 5-2: Summary of Without-Project Condition/ Base Year Average Annual Damage - Shorefront Reaches.....57
Table 5-3: Summary of Without-Project Condition/ Base Year Average Annual Damage – Damage Categories.....57
Table 5-4: Summary of Without-Project Condition/ Base Year Average Annual Damage – Backbay/Cross-Shore Reaches.....58
Table 5-5: Summary of Without-Project Condition/ Future Year Average Annual Damage – Backbay/Cross-Shore Reaches.....58
Table 5-6: Summary of Without-Project Equivalent Annual Damage – Backbay/Cross-Shore Reaches 60
Table 5-7: Summary of HFFRRF Without-Project Damages 60
Table 5-8: Sea Level Rise - Low Historic Sea Level Changes 61
Table 5-9: Accelerated Sea Level Rise - Intermediate (Curve1) Sea Level Changes.....62
Table 5-10: Accelerated Sea Level Rise - High (Curve3) Sea Level Changes.....62
Table 5-3: Without-Project and Beach Fill Calibration (feet/year).....64
Table 5-12: Comparison of Erosion Rates in Seawall Models (feet/year).....65
Table 5-13: Beach Fill Planform Rates (feet/year).....66
Table 6-1: HFFRRF Phase 1 Screening Results. Benefits and Costs in 1,000 of Dollars 71
Table 7-1: Present Value of Lost Visits by Year, Rockaway Beach, Without-Project.....74
Table 7-2: Present Value of Reduced Value Visits by Year, Rockaway Beach, Without-Project 75
Table 7-3: NED Recreation Benefits, Rockaway Beach, Without-Project.....76
Table 8-1: Cost, Damages and Benefits Summary for Low Sea Level Rise Scenario.....79
Table 8-2: Cost, Damages and Benefits Summary for Intermediate Sea Level Rise Scenario...80
Table 8-3: Cost, Damages and Benefits Summary for High Sea Level Rise Scenario 81

Table 8-4: Jamaica Bay HFFRRF Project Annual Damages and Benefits, Intermediate Sea Level Rise Scenario 82
Table 8-5: Jamaica Bay HFFRRF Project Annual Damages and Benefits, High SLR Scenario 82
Table 8-6: Rockaway Beach Combined Formulation Summary 83
Table 8-7: Rockaway Beach Selected Plan Summary 84
Table 8-8: Uncertainty in Economic Performance 86

LIST OF FIGURES

Figure 1-1: Study Area Map – Rockaway Peninsula and Jamaica Bay 5
Figure 1-2: Persons below Poverty Level 8
Figure 1-3: Land Use within Study Area 10
Figure 2-1: Hurricane Sandy Flood Inundation 13
Figure 2-2: Pre- and Post-Sandy Comparison at Rockaway Beach 14
Figure 2-3: Rockaway Beach Structure Damaged by Hurricane Sandy 15
Figure 2-4: Before and After Photos of Rockaway Beach Structures Damaged by Hurricane Sandy 15
Figure 4-1: Study Area Primary Economic Reaches 19
Figure 5-1: Sea Level Rise Relationships at Rockaway Beach NY 63

SUB-APPENDICES

Sub-Appendix A: Value of Development by Subreaches

Sub-Appendix B: Shorefront Damage Functions

Sub-Appendix C: NED Recreation Benefits Report

1 INTRODUCTION

1.1 Purpose and Scope

This interim report documents the procedures and results of the economic storm damage analysis for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Hurricane Sandy General Reevaluation Study. This document presents the findings of the different benefit and cost assessments in a format that will facilitate plan selection decisions. The alternatives discussed in the document are limited to plans constructed along the Atlantic Shoreline planning reach and alternatives to manage risk associated with high frequency flooding from Jamaica Bay.

As a result of the Agency Decision Milestone, the storm surge barrier for the Jamaica Bay component of the previous Tentatively Selected Plan (see the Draft General Reevaluation Report/Environmental Impact Statement (GRR/EIS) for more details) was moved into the New York and New Jersey Harbor and Tributaries Study for further study and possible recommendation. Without the barrier, the communities surrounding Jamaica Bay still experience substantial risk for coastal flooding. Therefore, the study team sought to identify stand-alone features that could complement a potential future storm surge barrier, but also be economically justified on their own. Residents in many parts of the Jamaica Bay vicinity experience frequent flooding due to storm tides. Since the proposed storm surge barrier would not be closed at every storm tide, there is an opportunity to recommend features to mitigate flood risk for high frequency flooding events where the proposed storm surge barrier would remain open. The project now includes an assessment of risk management measures to address high frequency flooding along Jamaica Bay.

Economic analyses include the development of stage versus damage relationships and annual damages over a 50-year analysis period. Damage assessments include damages due to tidal flood inundation along the shoreline and damages caused by cross-shore/backbay flooding.

Benefits that were evaluated for the alternatives are:

- Reduced inundation damage to structures
- Costs avoided (Emergency Nourishment)
- Cross-shore (ocean to bay flow) flood damages reduced
- Recreation

Estimates of damages are based on April 2018 price levels and a 50-year period of analysis. Damages were annualized over the 50-year analysis period using the fiscal year 2018 discount rate of 2.75 percent during the plan formulation process. However, since the FY 2019 discount rate was approved subsequent to the completion of the draft, these analyses were revised for the Selected Plan using the FY 2019 interest rate of 2.875 as per Economic Guidance Memorandum, 19-01 of 17 October2018.

This Benefits Appendix:

- provides an overview of the problems and opportunities,
- describes the without-project future conditions,
- summarizes the analysis methodologies,
- evaluates storm damage reduction benefits,
- summarizes total project benefits, including increased recreation use values.

1.2 Prior Studies

In an application dated January 6, 1959, a cooperative beach erosion control study was initiated by the State of New York acting through the Long Island State Park Commission. The application requested a study of the Atlantic Coast of Nassau County, New York, between Jones Inlet and East Rockaway Inlet; Atlantic Coast of New York City, between East Rockaway Inlet and Norton Point; and Staten Island, New York, between Fort Wadsworth and Arthur Kill. The Chief of Engineers approved the application on March 23, 1959, in accordance with Section 2 of Public Law 520 (River and Harbor Act of 1930).

In response to severe damage to coastal and tidal areas of the eastern and southeastern United States from the hurricanes of August 31, 1954 and September 11, 1954 in New England, New York and New Jersey, and the damages caused by other hurricanes in the past, a hurricane study was authorized by Public Law 71, 84th Congress, 1st Session on June 15, 1955. A combined report covering the cooperative beach erosion control study and the hurricane survey was approved by the Chief of Engineers on December 7, 1960.

1.3 Prior Projects

The shorefront of the Rockaway Peninsula has had a long history of beach nourishment and construction of erosion control structures. The shoreline has been stabilized since the 1880s with beach fill, groins, bulkheads, and a stone jetty at Rockaway Inlet. An overview of key activities is presented here. Additional details are provided in the main text.

1. 1910 to 1962. From 1910 to 1962, over 200 timber and stone groins were constructed along Rockaway's beaches. Over this same time period, approximately 12 million cubic yards of sediment were placed along the beach. Beachfill operations were a mixture of either inlet maintenance dredging of East Rockaway and Rockaway Inlets or larger beach restoration projects with sediment dredged from offshore borrow areas.
2. WRDA 1974 Beach Erosion Control Project (1978 to 1988). The multiple purpose beach erosion control and hurricane protection project was authorized by the Flood Control Act of 26 October 1965. It was then modified by Section 72 of the Water Resources Development Act of 6 March 1974, which authorized the separate construction of the beach erosion control portion.

   The project provided for the restoration of a protective beach along 6.2 miles of Rockaway Beach, between Beach 19th Street and Beach 149th Street. The project authorization also

provided for Federal participation in the cost of periodic beach nourishment to stabilize the restored beach for a period not to exceed ten years after the completion of the initial beach fill. A post-authorization change allowed the construction of 380-foot long quarry stone groin at the western limit of the project in the vicinity of Beach 149th Street in 1982.

The initial nourishment was completed from 1975 to 1977. The authorized construction profile varied along Rockaway Beach with berm widths of between 100 and 200 feet. The storm damage reduction features of the authorized project consisted only of a 100-foot berm width. The top of the berm elevation was constructed to +9 feet NAVD88. A total of 6,634,000 cubic yards of fill were placed during initial construction.

Five renourishment operations and one emergency renourishment operation were performed over the 10 years following initial construction. Renourishment operations entailed constructing feeder beaches in the two most highly erosive areas in the project area. The expectation was that the material would be eroded from those areas and would supply, or feed, sand to the rest of the project area, thereby offsetting long-term erosion. However, monitoring of the shoreline positions between renourishment cycles showed the authorized beach dimensions were not maintained along the project area. A total of 6,364,000 cubic yards of fill were placed during these activities between 1978 and 1988.

3. Section 934 Beach Erosion Control Project (1996 to 2004). Additional erosion after the WRDA 1974 authorization expired led to a second major construction effort authorized through Section 934 of the Water Resources Development Act of 1986, which allowed continued Federal participation in periodic beach fill nourishment. A total of 2,685,000 million cubic yards of fill were placed as part of this project. Initial construction was completed in 1996 and two renourishment operations occurred in 2000 and 2004. The construction profile dimensions were the same as the WRDA 1974 Project except that all berm widths were 100 feet. Advance fill was placed during initial construction.

   The Section 934 Project placed renourishment along the entire project area during each renourishment operation. Inlet maintenance dredging operations also occurred four times over the project period (in 1998, 2000, and 2002; and again between 2004 and 2005). During each renourishment, the beach was restored to its authorized dimension plus advance fill. Including inlet maintenance dredging operations, approximately 354,000 cubic yards per year were placed in the project area in the eight years after initial construction between 1996 and 2004.

4. Flood Control and Coastal Emergencies (FCCE) Act (2013 to 2014). After Hurricane Sandy, the Corps of Engineers was authorized to repair the previously constructed project and return the project area to pre-storm conditions. Roughly 3.5 million cubic yards of sand were placed on the beaches building a wide berm and dune with a crest elevation of +16 feet NAVD88.

1.4 Description of the Study Area

1.4.1 Location

The Atlantic Shoreline planning reach of the study area extends the full length of the Rockaway Peninsula, from Rockaway Inlet on the west, to Beach 19th Street on the east. The Rockaway Peninsula is a narrow strip of land in the Atlantic Coastal Plain, stretching along the western end of the South Shore of Long Island. Located in in Queens County, New York, it is approximately 11 miles in length, averages less than 0.75 miles in width, and is about 7 square miles total . Jamaica Bay forms the northern border of the peninsula. **Figure 1-1** is a map of the study area, showing the 3-, 5- and 10-year food extents for the future condition. Across the bay are Kings County (Brooklyn) and the remainder of Queens County. At the west end of the peninsula, Rockaway Inlet connects Jamaica Bay to the Atlantic Ocean. On the south, the peninsula is bounded by the Atlantic Ocean. East of the peninsula, close to where it connects to the mainland, is Nassau County, including the barrier islands of Long Beach and Jones Beach. The Rockaway Peninsula encompasses multiple communities, including Breezy Point, Roxbury, Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammel, Arverne, Edgemere, and Far Rockaway.

The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, New York City, and a section at the eastern end, known as Head of Bay, lies in Nassau County. More than 41,000 residential and commercial structures in the study area fall within the Federal Emergency Management Agency (FEMA) regulated 100-year floodplain. The portions of New York City and Nassau County surrounding the waters of Jamaica Bay are urbanized, densely populated, and very susceptible to flooding.

Figure 1-1: Study Area Map – Rockaway Peninsula and Jamaica Bay

1.4.2 Physical Setting

The project area terrain is virtually flat across the peninsula. Development generally extends from the Atlantic Ocean beachfront north to Jamaica Bay, from Breezy Point on the far west end of the peninsula to Far Rockaway in the east, with the exception of Jacob Riis Park and Fort Tilden.

Historical records and existing topography indicate that most structures within the study area neighborhoods are susceptible to significant flooding. Nearly 7,200 buildings were identified as being susceptible to storm damage in the area of the peninsula considered in the shorefront analysis, with virtually all structures located in the one percent annual chance of exceedance (ACE) floodplain.

Jamaica Bay is the largest estuarine waterbody in the New York City metropolitan area covering an approximately 20,000 acres (17,200 of open water and 2,700 acres of upland islands and salt marsh). Jamaica Bay measures approximately 10 miles at its widest point east to west, and four miles at the widest point north to south, including approximately 26 square miles in total. The mean depth of the bay is approximately 13 feet with maximum depths of 60 feet in the deepest borrow pits. Navigation channels within the bay are authorized to a depth of 20 feet. Jamaica Bay has a typical tidal range of five to six feet.

1.4.3 Accessibility

The study area is secluded from the rest of the surrounding metropolitan area by the expanse of water that surrounds it. The peninsula connects to the mainland on the east, where the Rockaway Freeway and Beach Channel Drive provide access to the study area via Rockaway Boulevard and Seagirt Boulevard. From the north, two bridges connect Rockaway Peninsula to the mainland; one runs out of Kings County, the other from Queens County. From Kings County, the Gil Hodges Memorial Bridge connects Flatbush Avenue with Beach Channel Drive and Rockaway Boulevard in the study area. In addition to providing direct access from numerous local streets in Brooklyn, Flatbush Avenue runs northwest to Manhattan via the Manhattan Bridge. It also connects with the Brooklyn-Queens Expressway. From Queens, the Cross Bay Bridge connects Woodhaven Boulevard/Crossbay Boulevard with Beach Channel Drive in the study area. On the mainland, Woodhaven Boulevard runs north to connect to the east-west corridors of the Long Island Expressway, the Jackie Robinson Parkway, and the Belt Parkway. From an evacuation, and disaster response and recovery perspective, the water surrounding the Rockaway Peninsula and the area's limited vehicular access routes have the effect of hampering storm evacuation and recovery, a condition that is expected to worsen in the future as more and more of the peninsula is built-out.

The Rockaway area is served by various rail and bus transportation alternatives for those lacking vehicle access or preferring to use public transit. These include:

- MTA/ New York City Subway - A Train (IND Rockaway Line and Rockaway Shuttle)
- LIRR – Far Rockaway Branch

- Q35 – Rockaway Park - Brooklyn College
- Q52 – Elmhurst - Arverne Limited
- Q53 – Woodside - Rockaway Park Limited
- Q113 – Guy Brewer Boulevard - Rockaway Turnpike
- QM16 – Neponsit - Midtown
- QM17 – Far Rockaway – Midtown
- N31 – Far Rockaway – Lynbrook/Hempstead
- N32 – Far Rockaway – Lynbrook/Hempstead
- N33 – Long Beach – Far Rockaway
- NYC Beach Bus From Downtown Brooklyn or Williamsburg

After the A Train tracks through Jamaica Bay were washed out by Hurricane Sandy, the Rockaway Line was shut down for a period of seven months before it was restored in late May 2013. In response, New York City subsidized a temporary ferry service from Beach 108th Street to Wall Street, with stops at the Brooklyn Army Terminal and a free transfer to 34th Street. The ferry operated year round, Monday through Friday, to compensate for the damaged subway lines. Funding for the ferry was discontinued in October 2014. Ferry service has been reinstated with frequent trips between Wall Street/ Pier 11 and Rockaway (108th St). Trips take just under 1 hour and have a one-way fare of $2.75. As part of the Federal Transit Administration (FTA) Emergency Relief Program & Disaster Relief Appropriations following Hurricane Sandy, New York City and the Metropolitan Transportation Authority (MTA) have requested and received significant funding to improve the resiliency of the A-line and other evacuation routes in the study area.

Large scale mandatory evacuations in a disaster scenario in areas where a high proportion of residents lack access to a vehicle can be particularly problematic as public transit systems become overloaded with a sudden influx of riders. System capacity is often a constraint during evacuation, as sudden surges in ridership cannot be accommodated by the system in time to transport all riders out of harm's way before the event occurs. This is a particular vulnerability on the Rockaway Peninsula because it is surrounded by water and emergency evacuation on foot is severely limited.

While not evaluated in economic terms, the project is expected to provide some level of protection to the evacuation routes.

1.4.4 Socioeconomic Considerations

The New York State Department of Environmental Conservation (NYSDEC) identifies "Potential Environmental Justice Areas (PEJAs)" as census block groups meeting one or more of the following NYSDEC criteria in the 2000 U.S. Census:

- 51.1% or more of the population are members of minority groups in an urban area;
- 33.8% or more of the population are members of minority groups in a rural area, or;
- 23.59% or more of the population in an urban or rural area have incomes below the federal poverty level.

NYSDEC publishes county maps identifying PEJAs, including Kings, Queens, and Nassau counties. **Figure 1-2** identifies the proportion of persons below the poverty level for census blocks within project area communities.

The Jamaica Bay Planning Reach located in portions of Kings, Queens, and Nassau Counties contains several PEJAs identified by the NYSDEC. In Nassau County, a small PEJA is present the municipality of Hempstead, west of the Valley Stream neighborhood; however, the area south of Route 27 within the Jamaica Bay Planning Reach appears to contain few if any residences. In Queens County, the majority of the Jamaica Bay Planning Reach north and east of JFK airport is identified as a PEJA, while the neighborhoods west of JFK airport are not (Howard Beach, Lindenwood, Hamilton Beach). Likewise, the majority of the Jamaica Bay Planning Reach within Kings County is identified as a PEJA, including the communities surrounding the Gateway National Recreation Area, a large portion of Coney Island, and in and around the Fort Hamilton municipality.

Map created by the Science and Resilience Institute

Figure 1-2: Persons below Poverty Level

1.4.5 Economy

Table 1-1 shows income levels for the study area, which generally track those of Kings and Queens Counties. Study area incomes are low to moderate in comparison to Nassau County and the State. Study area median household income is $54,800 and per capita income is $25,500, both of which are lower than for the State. However, the percent of persons below the poverty line is 20.4 percent

in the study area, versus 23.4 percent in the Kings County, 15.4 percent in Queens County, 6.7 percent in Nassau County, and 15.9 percent in the State.

Table 1-1: Income Levels in the Study Area

	Study Area	Kings County	Queens County	Nassau County	NY State
Median Household Income	$54,800	$49,950	$57,200	$98,400	58,700
Per Capita Income, last 12 months	$25,500	$25,950	$26,600	$42,950	$32,850
Persons below poverty level	20.4%	23.4%	15.4%	6.7%	15.9%

Source: factfinder2.census.gov American Community Survey 5-Year Estimates

Table 1-2 shows the breakdown of civilian employment by industry in the study area, Kings, Queens, and Nassau Counties, and New York State. The largest employment industry for both is Educational Services, Health Care and Social Assistance, which employs 33 percent of persons in the study area and 28 to 29 percent of persons in the counties and state. The next largest employment industries in the study area are Professional, scientific, and management (10 percent) and Retail trade (10 percent).

Table 1-2: Percent of Civilian Employment by Industry for Study Area and Counties

	Study Area	Kings CO	Queens CO	Nassau CO	NY State
Agriculture, forestry, fishing and hunting, and mining	0	0	0	0	1
Construction	6	5	6	6	6
Manufacturing	4	4	5	5	7
Wholesale trade	3	2	3	3	2
Retail trade	9	10	11	11	11
Transportation and warehousing, and utilities	8	6	5	5	5
Information	2	4	3	3	3
Finance, insurance, real estate and rental and leasing	8	8	10	10	8
Professional, scientific, and management	10	12	13	13	11
Educational services/health care/social assistance	33	29	28	28	28
Arts, entertainment, recreation, accommodation, food services	7	10	7	7	9
Other services, except public administration	5	5	5	5	5
Public administration	5	4	5	5	5

Source: factfinder2.census.gov 2008-2012 American Community Survey 5-Year Estimates

1.4.6 Land Use

The majority of land in the immediate study area contains residential development with commercial development concentrated within residential areas and extensively in designated business zones. The majority of land development within the study area is more than 25 years old. **Figure 1-3** shows a map of land use within the study area, and **Table 1-3** shows land use in the

study area broken down by category and percent of land coverage. Open space and outdoor recreation is the most prevalent land use, at 33.6 percent of land coverage (which includes substantial terrestrial areas within Jamaica Bay itself). Residential land coverage is the next highest category with 31.9 percent of all acreage within the study area.

Table 1-3: Study Area Land Use

Residential	31.9%
Mixed Residential and Commercial	1.2%
Commercial and Office	2.5%
Public Facilities and Institutions	4.1%
Parking Facilities	1.2%
Industrial and Manufacturing	1.5%
Transportation and Utility	19.6%
Open Space and Outdoor Recreation	33.6%

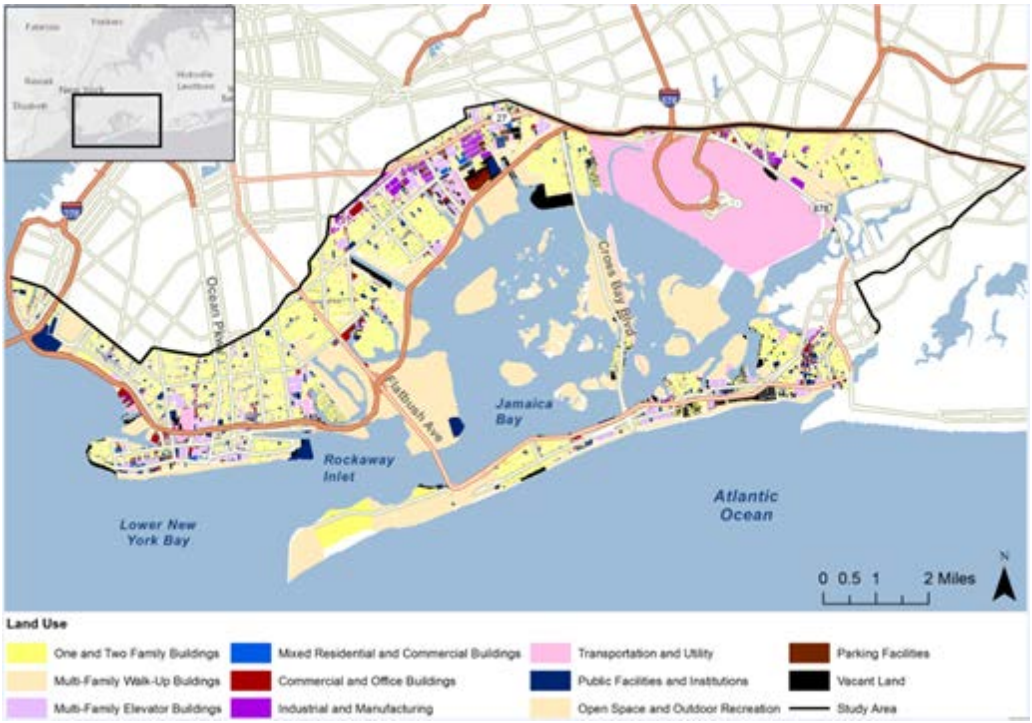


Figure 1-3: Land Use within Study Area

1.4.7 Parks and Recreation

Major parks on the Rockaway Peninsula include Rockaway Beach as well as parts of the Gateway National Recreation Area. Rockaway Beach, along the southern edge of the peninsula, is operated or under the authority of NYC Parks. Located along the last stops of the A-line, the beach stretches

from Beach 9th Street in Far Rockaway, to Beach 149th Street in Neponsit. It is open year round, but peak beach usage is between Memorial Day and Labor Day. During beach season, lifeguards are employed from 10 AM to 6 PM. Free parking is available in lots at Beach 11th to Beach 15th Street and Beach 95th Street. Street parking is also free. Amenities include concessions stands, mobile charging stations, a street hockey rink, a skate park, several play grounds, handball courts a boardwalk, and surf beaches. The City's only legal surfing beaches are on Rockaway Peninsula, between 67-69 Streets and 87-92 Streets.

Gateway National Recreation Area (GNRA) was established in 1972, and protects more than 26,000 acres of land and water in New York and New Jersey. Averaging about 7.6 million visitors per year, the recreation area is divided into three units: Jamaica Bay, Sandy Hook, and Staten Island. Each unit maintains its own managers and resources. Several parks on the western portion of Rockaway Peninsula are within the Jamaica Bay unit of GNRA. These are Fort Tilden, Jacob Riis Park, and Breezy Point Tip.

Breezy Point Tip is a secluded 200-acre oceanfront park on the tip of Rockaway Peninsula. In addition to a popular fishing spot, it is an important nesting area for threatened bird species, and a stopover point for migrating shorebirds. Fort Tilden is a decommissioned fortress that was erected to defend the New York City area from sea and air attack. Aside from a chapel that is currently used as a children's performing arts center, the buildings are unoccupied and in various states of decay. Visitors have access to the beach and picnic areas. Jacob Riis Park was constructed under Robert Moses during the New Deal. It features miles of beach and a historic Art Deco bathhouse. The park was designed to give New York City's growing immigrant population access to recreation and the beach. Jacob Riis Park is isolated from the city's public transportation system, so access is challenging for urban residents who lack personal vehicles. The ocean front beaches stretching from Riis Beach to Breezy Point provide nesting habitat for several federally listed, endangered and threatened species of birds, and are key migratory waystations for dozens of other shorebird species. Fort Tilden and Jacob Riis Park are thought to have a great potential as archeological and cultural resources. However, a lack of funding has prevented significant study.

Social benefits are provided by the existing parks and recreation areas on the Rockaway Peninsula. These areas provide various recreation benefits to residents and visitors alike. Furthermore, the continued preservation of these relatively undeveloped parcels also works to preclude future development upon them and, in turn, limit the exposure of people and property to natural disasters.

Beach attendance data provided by the Department of Parks and Recreation (DPR), City of New York, indicates that approximately 7,738,500 beach visits per year occur on the Rockaway Peninsula at Rockaway Beach.

2 DESCRIPTION OF THE PROBLEM

Storm damages on the Rockaway Peninsula and Jamaica Bay are directly related to the region's topography, location and development. Most of the Rockaway Peninsula's dense urban population and infrastructure is relatively low-lying and vulnerable to storm surge inundation from both the ocean and bay. Damage along the shorefront has been caused by wave action, erosion and storm surges. Inland areas incur damage when high storm surge enters Jamaica Bay, which is made worse when tidal floodwaters overtop shorefront dunes or structures and quickly spread over the broad, low-lying floodplain. In portions of the study area, erosion has removed much of the beachfront and expedited deterioration of the existing coastal protection.

Erosion rates are estimated to be as high as 20 feet per year in portions of the study area. Long term erosion, reflecting the combined effects of sediment deficits, storm erosion, and sea level change, has increased the frequency and extent of storm damages over time. The continued erosion of beaches and dunes increases the exposure of development to flooding, waves and erosion and reduces the extent of protective beach features and limits recreational uses. Protective beach features work to mitigate coastal storm impacts such as storm surge flooding, wave action, and erosion damaging shorefront buildings and infrastructure. Other less dramatic but more widespread damages are incurred as a result of backbay flooding as tides rise in Jamaica Bay, and cross-shore flows as the ocean and bay waters meet in extreme storm conditions.

In response, a long history of beach erosion and erosion control activities has been undertaken to replenish protective beach and dune systems. Between 1910 and 2004, over 25 million cubic yards of beach fill was placed on the Rockaway Peninsula's beaches and over 200 groins were constructed.

When Hurricane Sandy struck, it had been eight years since the last re-nourishment under the USACE Section 934 program and Rockaway Beach did not have a dune system to manage the risk of flooding and wave action. Hurricane Sandy's storm surge and waves devastated Rockaway Beach. The review of Hurricane Sandy impacts below helps to understand the coastal storm risk management problems for Rockaway Beach and Jamaica Bay.

Hurricane Sandy was one of the most damaging storms that have impacted the Rockaway Peninsula. On 29 October 2012, Hurricane Sandy made landfall approximately five miles south of Atlantic City, NJ, where it collided with a blast of arctic air from the north, creating conditions for an extraordinary and historic storm along the East Coast with the worst coastal impacts centered on the northern New Jersey, New York City, and the Long Island coastline. Hurricane Sandy's unusual track and extraordinary size generated record storm surges and offshore wave heights in the New York Bight. The maximum water level at The Battery, NY peaked at +11.3 feet NAVD88, exceeding the previous record by over 4 feet. The tide gauge at Sandy Hook, NJ reached +10.4 feet NAVD88 before failing. USGS deployed storm tide sensors and high water marks surveyed by the USGS after the storm indicate that the maximum water levels during Sandy varied between +12.9 feet NAVD88 and +10.3 feet NAVD88 within the Project Area (USGS, 2013).

The Rockaway Peninsula and Jamaica Bay were some of the hardest hit areas by Hurricane Sandy. An overview of the extent of flooding in the project area is shown in **Figure 2-1**. As the storm surge rose, the peninsula and bay side communities were flooded with water from the ocean and from the bay. Along the shorefront, strong ocean waves and currents carried water, sediment, and debris across the peninsula leaving behind a wake of destruction (**Figure 2-2**). Many homes and other buildings, including the boardwalk, were destroyed by waves or flooding and many more were severely damaged (**Figure 2-3** and **Figure 2-4**). At least four people are known to have died in this area. In addition to the direct effects of flooding, the storm caused the outbreak of multiple fires in Rockaway caused by the interaction of electricity and sea water, including one in Breezy Point that destroyed over 100 homes. Critical services like electricity and water were knocked out leading to dangerous conditions, particularly in high-rise structures. Every community along the bayfront suffered extensive flooding, damaging homes and infrastructure.

After the storm, Rockaway Beach was restored to an approximate width of 200 feet for recreation purposes. This restored beach is, however, eroding at an average rate of 10 feet per year and is expected to reach half of its present width by the year 2025. Erosion rates of as high as 20 feet per year have been observed in some portions of the study area, with episodic erosion during severe storms.

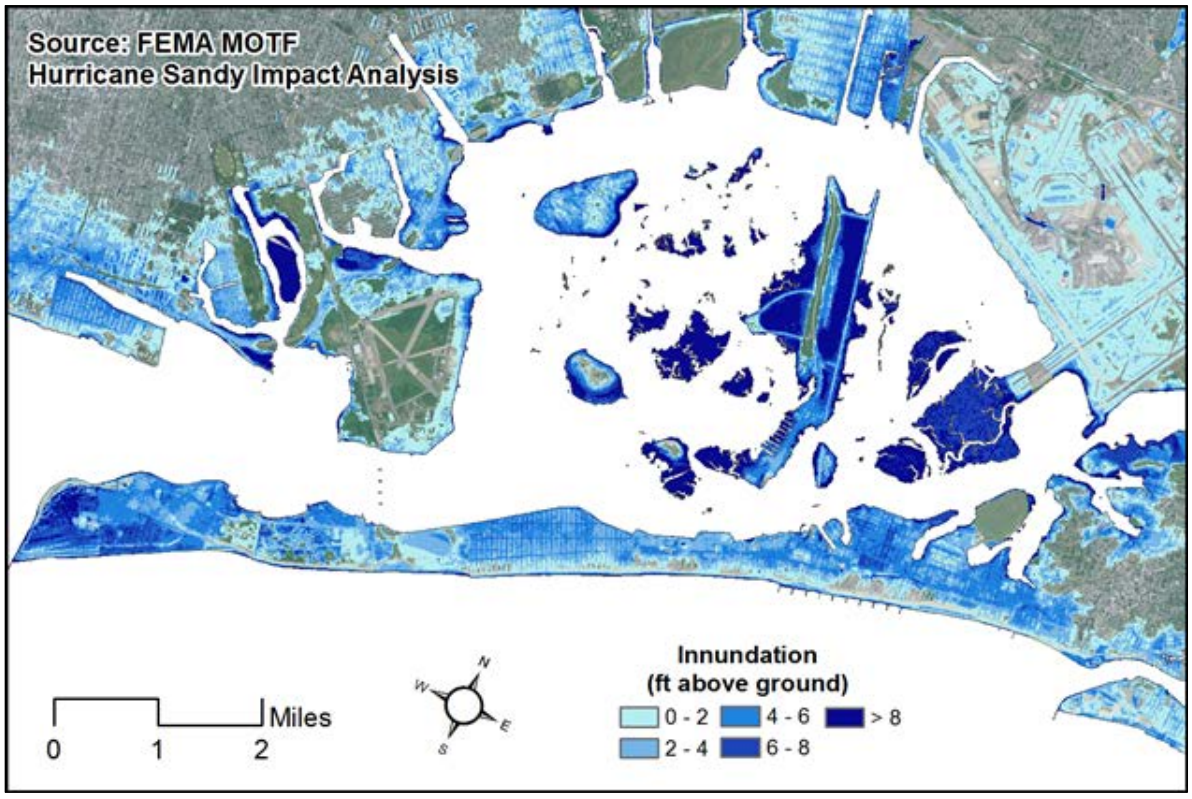


Figure 2-1: Hurricane Sandy Flood Inundation

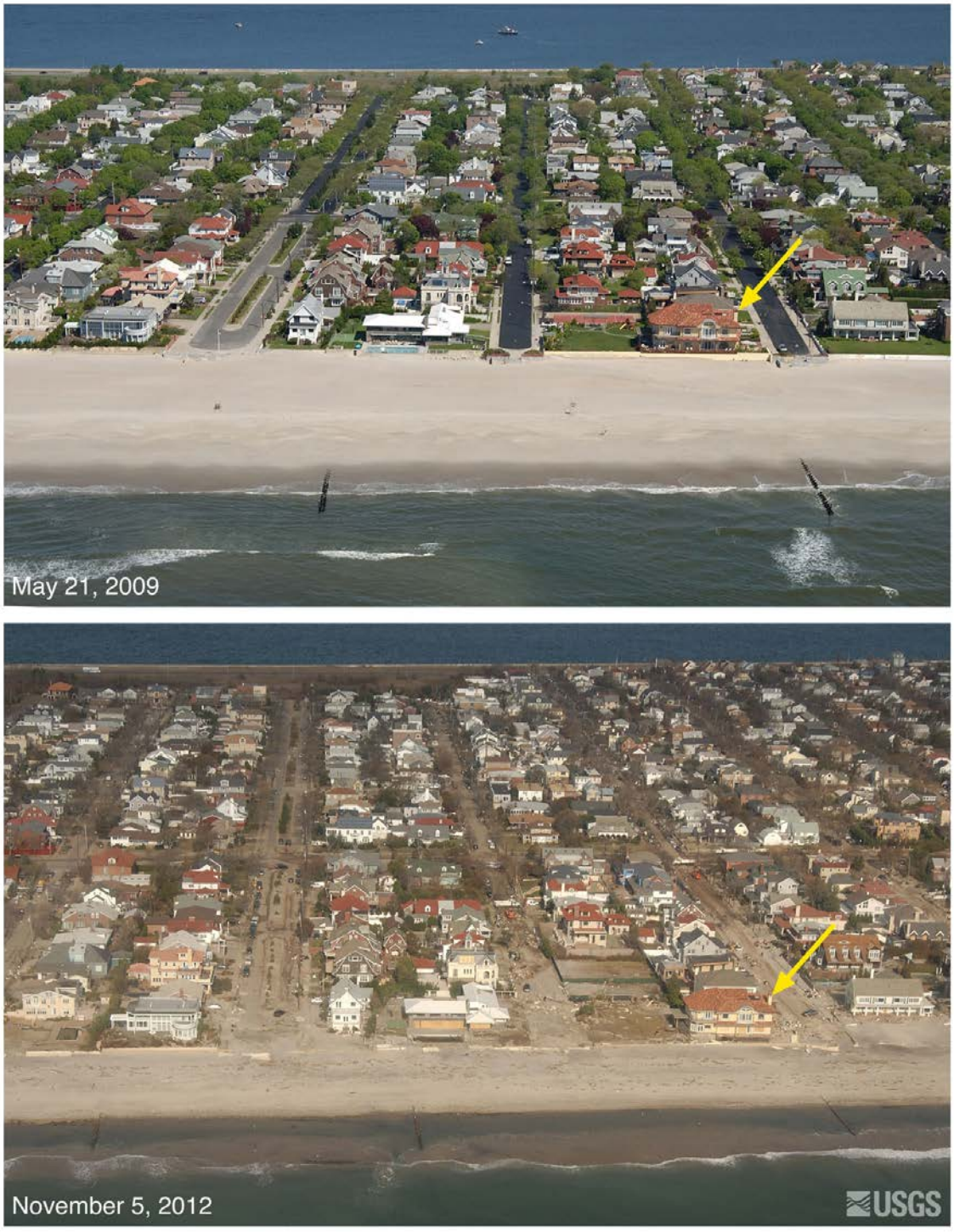


Figure 2-2: Pre- and Post-Sandy Comparison at Rockaway Beach

Figure 2-3: Rockaway Beach Structure Damaged by Hurricane Sandy

Figure 2-4: Before and After Photos of Rockaway Beach Structures Damaged by Hurricane Sandy

3 WITHOUT-PROJECT FUTURE CONDITIONS

The without-project future conditions for the Rockaway Peninsula and Jamaica Bay mainland have been identified as: (1) flooding and wave impacts from future storm events, (2) continued erosion of unprotected shorelines, and (3) continued development of low-lying flood prone areas.

Under the without-project future condition, erosion of beaches and dunes on the Rockaway Peninsula is expected to continue, with an associated increase in the vulnerability of people and property to the hazards of flooding, storm surge, wave action, and coastal erosion.

Future erosion rates under the without-project condition future are expected to mirror present-day rates of an average rate of about 10 feet per year. Rates as high as 20 feet per year are expected to continue in some portions of the study area. Rockaway Beach - which was restored to a width of approximately 200 feet following Hurricane Sandy and is presently estimated to be at that same width - is expected to experience erosion at an average rate of about 10 feet per year under without-project conditions, thereby reaching half of its present width by the year 2025. Visitation (estimated to be 7,738,500 visits per year at the 2015 survey year existing conditions) is expected to decrease with continued erosion, by almost 60% when the beach reaches half of its present width. In addition, the remaining visitors will experience a progressively smaller beach each year as erosion continues and the value of beach visits is expected to be substantially less under future without-project conditions. Additional information regarding the value of beach visits under the future without-project conditions is presented in Sub-Appendix C – NED Recreation Benefits Report.

Long-term erosion rates will be exacerbated by episodic erosion during severe storms. The combined effect of long-term erosion and storm erosion will result in narrower beaches and lower dunes under the future without-project condition and, in turn, an expected increase in the exposure of development to the hazards of flooding, waves and erosion as well as a reduced extent of beaches available for recreation use.

In the absence of a Federal project, it is expected that local sponsors will continue to implement the type and frequency of projects that they have historically undertaken over the last century in response to the erosion problem on the peninsula. These types of activities include limited and periodic placement of advance fill, and a limited response to rebuild dunes and beaches after storms. Lifecycle simulations estimate that, over time, an overall reduction in dune height and beach widths in the study area will still be observed despite implementation of small-scale local projects.

Tidal inundation is expected to increase gradually over time, in direct relation to the anticipated rise in relative sea level. Based upon NOAA tide gauge readings at Sandy Hook, relative sea level has been increasing at an average rate of 0.013 feet per year. This is equivalent to a 0.7-foot increase in tidal stage over the 50-year period of analysis. Predictions are that the rate of sea level rise will increase. In future years, this will result in more frequent and higher stages of flooding.

The analysis considers the impacts of an intermediate rate of sea level change, as well as the historic and a high rate of sea level change.

As part of the Federal Transit Administration (FTA) Emergency Relief Program & Disaster Relief Appropriations following Hurricane Sandy, New York City and the Metropolitan Transportation Authority (MTA) have requested and received significant funding to improve the resiliency of infrastructure and evacuation routes in the study area. These benefits are being addressed elsewhere, and are, therefore, not included in this analysis in order to avoid duplication of benefits across Federal programs.

4 ANALYSIS OF STORM DAMAGE

4.1 General

The following basic steps were used in the analysis of inundation damage:

- Assign evaluation reaches,
- Inventory floodplain development,
- Estimate depreciated replacement cost,
- Assign generalized damage functions, and
- Calculate aggregated stage versus damage relationships.
- Model storm events and damage
- Calculate average annual damage

Flood and other damage calculations for shorefront areas were performed using Version 1.0 of the Engineer Research and Development Center's Beach-*fx* coastal modeling tool, and flood damage calculations for the non-shorefront areas were calculated using Version 1.4.1 of the Hydrologic Engineering Center's Flood Damage Analysis computer program (HEC-FDA).

4.2 Economic Reaches

Flooding on the Rockaway Peninsula occurs under three main conditions: shorefront flooding along the Atlantic Ocean coastline due to storm surge; non-shorefront flooding attributed to storm surges in Jamaica Bay inundating the bay shorelines (backbay flooding); and storm surges that overtop the high elevations located near the Rockaway beachfront and flow across the peninsula to meet the surge in Jamaica Bay (cross-shore flooding).

In order to evaluate damages from these three main flood sources and develop appropriate stage versus damage relationships, the Rockaway Peninsula portion of the study area was divided into a total of twelve primary economic reaches (**Figure 4-1**): six reaches SFR-1 through SFR-6 to evaluate shorefront flooding conditions, and six reaches BB-1 through BB-6 to evaluate non-shorefront (backbay and cross-shore) flooding conditions. Reaches SFR-1 through SFR-6 were further subdivided for purposes of improving economic assessments. The alternative plans provide risk management up to the easternmost project limit at Beach 19th Street. The study area includes a handful of structures in an area immediately to the east of Beach 19th Street that would also be affected by the project. Information detailing the value and flood vulnerability of development in each subreach is provided in Sub-Appendix A.

Figure 4-1: Study Area Primary Economic Reaches

A total of 898 buildings or other facilities are located in the shorefront area potentially susceptible to erosion and wave action in addition to inundation; while an additional 6,263 buildings or other facilities were identified as potentially subject to damages from non-shorefront (backbay or cross-shore) flooding. A summary of the 7,161 structures in the study area by economic reach is presented in **Table 4-1** and **Table 4-2.** An additional 4,095 structures were identified in areas initially screened for possible implementation of High Frequency Flood Risk Reduction Features (HFFRRF) to reduce the residual damage due to backbay flooding. **Table 4-3** provides a summary of the number of structures in each of the areas considered for HFFRRF. **Figure 1-1** in Section 1 is a study area map showing the locations of the HFFRRF areas. For more detailed locations of individual HFFRRF areas, refer to Appendix A.

Table 4-1: Number of Structures, Shorefront Reaches

SF Project Reach	Number of Structures
SFR-1	0
SFR-2	7
SFR-3	492
SFR-4	266
SFR-5	86
SFR-6	47
Total, All SF Reaches	**898**

Table 4-2: Number of Structures, Backbay Reaches

BB Project Reach	Number of Structures
BB-1	2,310
BB-2	572
BB-3	827
BB-4	1,542
BB-5	670
BB-6	342
Total, All BB Reaches	**6,263**

Table 4-3: Number of Structures, HFFRRF Areas

HFFRRF Project Area	Number of Structures
Hammels	88
Arverne	715
Edgemere	702
Mid-Rockaway Peninsula Subtotal	**1,505**
Norton Basin	19
Bayswater	9
Motts Basin South	118
Motts Basin North	18
Inwood Marina	60
Cedarhurst-Lawrence	128
Rosedale	104
Meadowmere North	38
Meadowmere	99
Meadowmere East	25
Old Howard Beach	986
Canarsie	222
Broad Channel	764
Mainland Subtotal	**2,590**
Total, All Reaches	**4,095**

4.3 Economic Parameters

Estimates of damages for the Rockaway Peninsula were initially developed at a January 2015 price level and have been updated to an April 2018 price level, to be consistent with the costs presented in the TPCS. Damages were annualized over the 50-year analysis period using the fiscal year 2018 discount rate of 2.75 percent during the plan formulation process. However, since the FY 2019 discount rate was approved subsequent to the completion of the draft, these analyses were revised for the Selected Plan using the FY 2019 interest rate of 2.875 as per Economic Guidance Memorandum, 19-01 of 17 October2018.

4.4 Inventory Development

The shorefront and backbay structure inventory databases were generated by a "windshield survey" of the structures in the project area using topographic mapping with a 2-foot contour interval. The physical characteristics were used to categorize the structure population into groups having common physical features. Data pertaining to structure usage, condition, size and number of stories assisted in the structure value analysis. For each building, data was also gathered pertaining to its damage potential including ground and main floor elevations, lowest opening,

construction material, basement, and proximity to the shorefront. **Table 4-4** lists the physical characteristics obtained for the windshield building inventory or updated from aerial imagery.

Table 4-4: Information Recorded for Structures

1. Structure ID	9. Setback from Shoreline
2. Map Number	10. Midpoint from Shoreline
3. Type	11. Quality of Construction
4. Usage	12. Condition
5. Size	13. Ground Elevation (NAVD 1988)
6. Number of Stories	14. Main Floor Height Above Grade
7. Foundation/Basement Type	15. Low Opening
8. Exterior Construction	16. Number of Attached Garage Openings

The structure inventory was compiled in five stages; during the first stage a field survey was conducted to collect the data described above for every structure in the shorefront zone, and to subsequently format this data for import to Beach-*fx*, the computational model selected for estimation of shorefront damages. The shorefront zone was delineated as the area in which structures could be reasonably expected to be impacted by the coastal damage mechanisms of erosion and wave impact in addition to inundation. In addition to the physical characteristics described above, GIS shape files in the form of MapPLUTO data from the New York City Department of Planning was used to derive footprint square footages for use in structure value estimations and key additional Beach-*fx* input data including structure centroid coordinates, and structure length and width. MapPLUTO merges tax lot data with tax lot features and data maintained by various City agencies clipped to the shoreline. It contains extensive land use and geographic data at the tax lot level in ESRI shape file format and dBase (.dbf) table format.

During the shorefront field survey 42 structures included in the GIS shape files were found to be no longer in existence. These structures were mostly beachfront residences destroyed or damaged beyond repair by Hurricane Sandy. The final shorefront inventory compiled for input to the Beach-*fx* model ultimately consisted of 898 structures.

The second stage of the structure inventory compilation consisted of another windshield survey conducted to collect **Table 4-4** data for a representative sample of the more than 6,200 structures in the backbay portion of the Rockaway Peninsula portion of the study area. The backbay peninsula area includes those structures in the study area which are not in the shorefront zone but are potentially vulnerable to flooding from both Jamaica Bay and from cross-shore flooding following overtopping of the shorefront area. The representative sample consisted of 45 clusters of 10 structures, each centered on a "seed" structure chosen randomly from the full backbay population of more than 6,200, plus the 50 largest structures in the backbay area by footprint area, giving a total of 500 structures subject to the second windshield survey.

The third stage of the inventory compilation process required populating the inventory data for the approximately 5,700 structures in the backbay area which were not included in the representative sample due to schedule and budgetary constraints. During this exercise MapPLUTO data was used to determine structure use, foundation/basement type, and the number of floors for the non-surveyed structures. Additional key attributes such as the main floor height above grade were assigned based on the average values of the attribute for each structure usage type in the surveyed sample.

The fourth stage of the inventory was the development of a "desktop" inventory for the mainland areas evaluated as part of the HFFRRF analysis. This inventory utilized the data developed for the Draft GRR to capture the entire Jamaica Bay mainland floodplain. This approach used GIS-based structure location data and complete aerial imagery. The principal sources of data were used for the classification of structure types within the study area were assessor databases and geographic information system data obtained for Kings County, Queens County, and Nassau County. The GIS based data files were edited to extract just those structures located with the areas under consideration for HFFRRF.

The final stage of the inventory was to conduct a 100% field inventory for the 764 structures in the Broad Channel HFFRRF area located between the Rockaway Peninsula and the mainland. Initial assessment of providing any type of structural protection in this area raised life safety concerns due to potential for overtopping and the lack of any evacuation route. Because the risks and flood damages in Broad Channel are quite high, it was determined that non-structural measures at this site should be evaluated in more detail to develop a better understanding of the condition and elevation of each building.

Section 308 of the Water Resources Development Act of 1990 precludes capturing benefits for new or substantially improved structures built after July 1, 1991 in the 1% annual chance exceedance floodplain with a first floor elevation less than the effective base flood elevation. During compilation of the inventories for each component of the analysis it was assumed that all structures in the study area either predate July 1, 1991, or that local floodplain management regulations have been effectively enforced for more recent structures.

4.5 Structure Values

4.5.1 Approach

The depreciated structure replacement value was calculated for each structure residential structure surveyed in the field using a spreadsheet developed by USACE-NYD. The spreadsheet incorporates lookup tables of baseline square foot costs for residential structures of one to three stories with and without basements which vary with the total square footage of the structure. The spreadsheet uses this data to generate regression equations which enable the values to be calculated for residential structures of any combination of size, story, and basement type. The baseline square foot costs for finished living spaces and basements, plus unit costs for garages, were taken from

RS Means Square Foot Costs 2014 for average quality one to three story single-family residential structures and bi-level houses. All calculated values were adjusted for location using RS Means location factors and for depreciation using standard depreciation factors as applied in previous flood risk management projects for USACE-NYD.

The depreciated structure replacement value of non-residential structures in the windshield survey was also estimated using typical square foot costs for masonry and non-masonry construction from RS Means Square Foot Costs. Since the square foot costs developed by RS Means vary with structure size, the lookup table was populated for a typical size selected for each usage, based on a combination of the average size of structures of that usage in the study area database and previous experience developing structure inventories for other flood risk reduction studies. All calculated values were adjusted for depreciation and location. Following calculation of an initial depreciated replacement cost for each structure, structures with sizes that deviated greatly from the assumed typical size were manually adjusted using a more appropriate square foot cost from RS Means.

Structures on the Rockaway Peninsula for which attributes were assigned from the MapPLUTO data and extrapolated from surveyed averages were assigned depreciated replacement values by applying a conversion factor to equalized assessed improvement values from MapPLUTO. The conversion factor was based on the average ratio of the depreciated structure replacement value from RS Means to the MapPLUTO improvement value for the set of 500 surveyed structures. For structures on the mainland, it was assumed that the Assessed Valuation Rolls for New York City and Nassau County are representative of the full market value of improvements.

For the purposes of this analysis, content values were estimated in accordance with the standard practice associated with the assigned depth-damage function for each structure (see Section 4.7 for a detailed description of the assignment of depth-damage functions). Since most damage functions compute content damage as a percentage of the structure value, content values were assumed to be equal to structure values for the majority of structures in the inventory. Likewise, values on which "Other" damages are based (see also Section 4.7) were assumed equal to the structure value.

4.5.2 Shorefront and Peninsula Backbay Structures

A summary of the number of structures in the shorefront reaches and associated value is provided in **Table 4-5**. A breakdown of values by reach and stage is shown in **Table 4-6** through **Table 4-10**. These tables also present the total depreciated replacement value of boardwalks in each reach at a January 2015 price level. Stages are referenced to North Atlantic Vertical Datum of 1988 (NAVD88). While the values of structures and boardwalks are tabulated here at a 2015 price level, all damage analyses were conducted using values updated to a 2018 price level.

For the purposes of the analysis, each boardwalk section with a different setback distance from adjacent sections was considered to be a separate damage element in the Beach-*fx* model.

Table 4-5: Estimated Depreciated Structure Replacement Value in Shorefront Reaches

Shorefront Reaches	Structure Category						
	Residential		Non-Residential		Boardwalk	Total	
	Count	Value ($,000)	Count	Value ($,000)	Value ($,000)	Count	Value ($,000)
SFR-1	0	-	0	-	-	0	-
SFR-2	0	-	7	$19,342	-	7	$19,342
SFR-3	484	$425,466	8	$28,522	-	492	$453,988
SFR-4	258	$262,314	8	$13,228	$66,119	266	$341,661
SFR-5	84	$331,601	2	$16,591	$53,784	86	$401,975
SFR-6	45	$142,203	2	$30,556	$15,889	47	$188,648
Total	**871**	**$1,161,584**	**27**	**$108,238**	**$135,792**	**898**	**$1,405,613**

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-6: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-2, by Stage

Stage (feet, NAVD88)	Structure Category						
	Residential		Non-Residential		Boardwalk	Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Value ($,000)	Cumulative Count	Value ($,000)
10	0	$0	4	$6,954	$0	4	$6,954
11	0	$0	5	$11,271	$0	5	$11,271
12	0	$0	6	$16,271	$0	6	$16,271
13	0	$0	7	$19,342	$0	7	$19,342
14	0	$0	7	$19,342	$0	7	$19,342
15	0	$0	7	$19,342	$0	7	$19,342
16	0	$0	7	$19,342	$0	7	$19,342
17	0	$0	7	$19,342	$0	7	$19,342
18	0	$0	7	$19,342	$0	7	$19,342
19	0	$0	7	$19,342	$0	7	$19,342
20	0	$0	7	$19,342	$0	7	$19,342
21	0	$0	7	$19,342	$0	7	$19,342
22	0	$0	7	$19,342	$0	7	$19,342
23	0	$0	7	$19,342	$0	7	$19,342
24	0	$0	7	$19,342	$0	7	$19,342

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-7: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-3, by Stage

Stage (feet, NAVD88)	Structure Category						
	Residential		Non-Residential		Boardwalk	Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Value ($,000)	Cumulative Count	Value ($,000)
10	30	$74,602	1	$8,238	$0	31	$82,840
11	71	$148,194	4	$8,587	$0	75	$156,780
12	164	$241,341	7	$10,173	$0	171	$251,514
13	260	$281,706	8	$28,522	$0	268	$310,229
14	373	$357,572	8	$28,522	$0	381	$386,094
15	428	$377,008	8	$28,522	$0	436	$405,530
16	459	$398,016	8	$28,522	$0	467	$426,538
17	468	$404,854	8	$28,522	$0	476	$433,377
18	475	$418,490	8	$28,522	$0	483	$447,013
19	478	$419,879	8	$28,522	$0	486	$448,401
20	483	$422,653	8	$28,522	$0	491	$451,175
21	483	$422,653	8	$28,522	$0	491	$451,175
22	484	$425,466	8	$28,522	$0	492	$453,988
23	484	$425,466	8	$28,522	$0	492	$453,988
24	484	$425,466	8	$28,522	$0	492	$453,988

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-8: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-4, by Stage

Stage (feet, NAVD88)	Structure Category						
	Residential		Non-Residential		Boardwalk	Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Value ($,000)	Cumulative Count	Value ($,000)
10	16	$151,004	4	$9,890	$24,340	20	$185,234
11	45	$171,355	6	$11,373	$28,834	51	$211,562
12	162	$182,551	6	$11,373	$28,834	168	$222,757
13	182	$241,922	6	$11,373	$28,834	188	$282,128
14	195	$245,402	6	$11,373	$28,834	201	$285,609
15	217	$251,157	6	$11,373	$28,834	223	$291,364
16	225	$253,152	6	$11,373	$28,834	231	$293,358
17	230	$254,569	6	$11,373	$66,119	236	$332,061
18	236	$256,213	6	$11,373	$66,119	242	$333,705
19	245	$258,298	6	$11,373	$66,119	251	$335,790
20	250	$259,636	6	$11,373	$66,119	256	$337,128
21	251	$259,898	6	$11,373	$66,119	257	$337,391
22	251	$259,898	6	$11,373	$66,119	257	$337,391
23	253	$260,588	6	$11,373	$66,119	259	$338,081
24	258	$262,314	6	$11,373	$66,119	264	$339,806

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-9: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-5, by Stage

Stage (feet, NAVD88)	Structure Category						
	Residential		Non-Residential		Boardwalk	Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Value ($,000)	Cumulative Count	Value ($,000)
10	6	$168,981	1	$11,215	$0	7	$180,197
11	14	$206,989	1	$11,215	$0	15	$218,205
12	17	$207,433	1	$11,215	$0	18	$218,649
13	28	$210,452	2	$16,591	$0	30	$227,042
14	55	$225,591	2	$16,591	$0	57	$242,182
15	83	$331,470	2	$16,591	$0	85	$348,061
16	83	$331,470	2	$16,591	$0	85	$348,061
17	84	$331,601	2	$16,591	$53,784	86	$401,975
18	84	$331,601	2	$16,591	$53,784	86	$401,975
19	84	$331,601	2	$16,591	$53,784	86	$401,975
20	84	$331,601	2	$16,591	$53,784	86	$401,975
21	84	$331,601	2	$16,591	$53,784	86	$401,975
22	84	$331,601	2	$16,591	$53,784	86	$401,975
23	84	$331,601	2	$16,591	$53,784	86	$401,975
24	84	$331,601	2	$16,591	$53,784	86	$401,975

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-10: Estimated Depreciated Structure Replacement Value in Shorefront Reach SFR-6, by Stage

Stage (feet, NAVD88)	Structure Category						
	Residential		Non-Residential		Boardwalk	Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Value ($,000)	Cumulative Count	Value ($,000)
10	16	$2,264	1	$24,232	$0	17	$26,496
11	28	$46,400	1	$24,232	$0	29	$70,632
12	39	$62,179	2	$30,556	$0	41	$92,734
13	40	$62,207	2	$30,556	$0	42	$92,763
14	41	$91,344	2	$30,556	$0	43	$121,899
15	41	$91,344	2	$30,556	$0	43	$121,899
16	43	$91,949	2	$30,556	$0	45	$122,505
17	44	$127,801	2	$30,556	$15,889	46	$174,246
18	44	$127,801	2	$30,556	$15,889	46	$174,246
19	45	$142,203	2	$30,556	$15,889	47	$188,648
20	45	$142,203	2	$30,556	$15,889	47	$188,648
21	45	$142,203	2	$30,556	$15,889	47	$188,648
22	45	$142,203	2	$30,556	$15,889	47	$188,648
23	45	$142,203	2	$30,556	$15,889	47	$188,648
24	45	$142,203	2	$30,556	$15,889	47	$188,648

2015 price level, damages updated to 2018 price level using RSMeans update factor

4.5.3 Backbay Structures

A summary of the number of structures in the backbay reaches of the Rockaway Peninsula, with associated depreciated replacement values, are provided in **Table 4-11**. A breakdown of values by reach and stage for both the Peninsula Backbay reaches subject to cross-shore flooding and for the HFFRRF areas is shown in **Table 4-12** through **Table 4-17**.

Table 4-11: Estimated Depreciated Structure Replacement Value in Non-Shorefront (Backbay/Cross-Shore) Reaches

Cross-Shore/Backbay Flooding Reaches	Structure Category					
	Residential		Non-Residential		Total	
	Count	Value ($,000)	Count	Value ($,000)	Count	Value ($,000)
BB-1	2,265	881,970	45	120,443	2,310	$1,002,412
BB-2	470	300,551	102	297,965	572	$598,517
BB-3	729	845,274	98	378,158	827	$1,223,432
BB-4	1,457	1,250,598	85	290,240	1,542	$1,540,839
BB-5	620	5,595,684	50	245,915	670	$5,841,599
BB-6	330	817,140	12	962,028	342	$1,779,168
Total	**5,871**	**9,691,218**	**392**	**2,294,750**	**6,263**	**$11,985,968**

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-12: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-1, by Stage

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
2	0	$0	0	$0	0	$0
3	0	$0	0	$0	0	$0
4	0	$0	0	$0	0	$0
5	0	$0	0	$0	0	$0
6	0	$0	0	$0	0	$0
7	5	$10,045	3	$19,416	8	$29,460
8	15	$28,735	11	$28,156	26	$56,891
9	36	$39,536	28	$53,918	64	$93,454
10	173	$92,508	35	$75,834	208	$168,342
11	765	$309,362	38	$86,446	803	$395,808
12	1466	$575,536	41	$110,086	1507	$685,622
13	1785	$701,001	44	$116,596	1829	$817,598
14	1916	$751,502	45	$120,443	1961	$871,944
15	2086	$810,950	45	$120,443	2131	$931,393
16	2211	$858,510	45	$120,443	2256	$978,952
17	2254	$877,016	45	$120,443	2299	$997,459
18	2261	$879,844	45	$120,443	2306	$1,000,286
19	2263	$881,094	45	$120,443	2308	$1,001,537
20	2264	$881,659	45	$120,443	2309	$1,002,101
21	2264	$881,659	45	$120,443	2309	$1,002,101
22	2265	$881,970	45	$120,443	2310	$1,002,412
23	2265	$881,970	45	$120,443	2310	$1,002,412
24	2265	$881,970	45	$120,443	2310	$1,002,412

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-13: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-2, by Stage

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
2	0	$0	0	$0	0	$0
3	0	$0	0	$0	0	$0
4	0	$0	0	$0	0	$0
5	0	$0	0	$0	0	$0
6	1	$4,138	6	$9,622	7	$13,761
7	30	$108,118	31	$70,015	61	$178,134
8	72	$153,232	58	$151,622	130	$304,854
9	103	$181,587	73	$204,888	176	$386,475
10	153	$196,946	84	$229,905	237	$426,851
11	295	$237,283	94	$288,012	389	$525,295
12	395	$281,167	99	$292,710	494	$573,876
13	435	$291,780	102	$297,965	537	$589,745
14	452	$296,168	102	$297,965	554	$594,133
15	465	$299,255	102	$297,965	567	$597,220
16	469	$300,327	102	$297,965	571	$598,293
17	469	$300,327	102	$297,965	571	$598,293
18	469	$300,327	102	$297,965	571	$598,293
19	470	$300,551	102	$297,965	572	$598,517
20	470	$300,551	102	$297,965	572	$598,517
21	470	$300,551	102	$297,965	572	$598,517
22	470	$300,551	102	$297,965	572	$598,517
23	470	$300,551	102	$297,965	572	$598,517
24	470	$300,551	102	$297,965	572	$598,517

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-14: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-3, by Stage

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
2	1	$190	0	$0	1	$190
3	5	$1,010	0	$0	5	$1,010
4	6	$1,260	0	$0	6	$1,260
5	9	$22,251	3	$18,163	12	$40,414
6	29	$102,579	30	$57,983	59	$160,562
7	71	$244,504	61	$161,704	132	$406,209
8	108	$293,943	72	$187,013	180	$480,956
9	151	$433,834	81	$199,391	232	$633,225
10	239	$478,233	88	$221,623	327	$699,856
11	397	$721,109	90	$228,361	487	$949,469
12	555	$762,537	94	$279,458	649	$1,041,994
13	630	$781,449	97	$312,983	727	$1,094,433
14	672	$820,439	97	$312,983	769	$1,133,422
15	693	$832,685	98	$378,158	791	$1,210,843
16	720	$844,359	98	$378,158	818	$1,222,517
17	727	$845,003	98	$378,158	825	$1,223,161
18	729	$845,274	98	$378,158	827	$1,223,432
19	729	$845,274	98	$378,158	827	$1,223,432
20	729	$845,274	98	$378,158	827	$1,223,432
21	729	$845,274	98	$378,158	827	$1,223,432
22	729	$845,274	98	$378,158	827	$1,223,432
23	729	$845,274	98	$378,158	827	$1,223,432
24	729	$845,274	98	$378,158	827	$1,223,432

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-15: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-4, by Stage

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
2	0	$0	0	$0	0	$0
3	0	$0	1	$2,398	1	$2,398
4	0	$0	1	$2,398	1	$2,398
5	1	$221	6	$6,490	7	$6,711
6	4	$1,036	25	$63,528	29	$64,564
7	9	$19,568	49	$96,503	58	$116,071
8	34	$24,950	63	$139,452	97	$164,402
9	298	$83,456	74	$237,031	372	$320,487
10	616	$146,292	81	$254,808	697	$401,100
11	1020	$232,126	84	$260,016	1104	$492,142
12	1201	$490,681	84	$260,016	1285	$750,697
13	1292	$873,899	85	$290,240	1377	$1,164,139
14	1390	$1,239,446	85	$290,240	1475	$1,529,686
15	1423	$1,245,047	85	$290,240	1508	$1,535,288
16	1445	$1,249,063	85	$290,240	1530	$1,539,303
17	1453	$1,250,017	85	$290,240	1538	$1,540,257
18	1457	$1,250,598	85	$290,240	1542	$1,540,839
19	1457	$1,250,598	85	$290,240	1542	$1,540,839
20	1457	$1,250,598	85	$290,240	1542	$1,540,839
21	1457	$1,250,598	85	$290,240	1542	$1,540,839
22	1457	$1,250,598	85	$290,240	1542	$1,540,839
23	1457	$1,250,598	85	$290,240	1542	$1,540,839
24	1457	$1,250,598	85	$290,240	1542	$1,540,839

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-16: Estimated Depreciated Structure Replacement Value in Backbay/Cross-Shore Reach BB-5, by Stage

Stage (feet, NAVD88)	Structure Category					
	Residential*		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
2	0	$0	0	$0	0	$0
3	0	$0	0	$0	0	$0
4	0	$0	0	$0	0	$0
5	0	$0	4	$6,016	4	$6,016
6	1	$739	14	$63,902	15	$64,641
7	4	$26,094	28	$87,979	32	$114,073
8	30	$173,849	36	$212,259	66	$386,108
9	150	$333,368	40	$239,347	190	$572,715
10	370	$996,300	42	$243,449	412	$1,239,750
11	453	$1,345,124	47	$244,107	500	$1,589,231
12	491	$4,101,421	49	$244,370	540	$4,345,790
13	553	$4,850,425	49	$244,370	602	$5,094,795
14	606	$4,854,095	50	$245,915	656	$5,100,010
15	615	$5,440,226	50	$245,915	665	$5,686,142
16	616	$5,440,325	50	$245,915	666	$5,686,240
17	616	$5,440,325	50	$245,915	666	$5,686,240
18	618	$5,440,592	50	$245,915	668	$5,686,507
19	618	$5,440,592	50	$245,915	668	$5,686,507
20	618	$5,440,592	50	$245,915	668	$5,686,507
21	619	$5,493,395	50	$245,915	669	$5,739,310
22	619	$5,493,395	50	$245,915	669	$5,739,310
23	620	$5,595,684	50	$245,915	670	$5,841,599
24	620	$5,595,684	50	$245,915	670	$5,841,599

2015 price level, damages updated to 2018 price level using RSMeans update factor

*This reach includes numerous large apartment buildings with 6 to 12 stories, resulting in a noticeably higher average residential structure value than other reaches.

Table 4-17: Value of Development in Backbay/Cross-Shore Reach BB-6, by Stage

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
2	0	$0	0	$0	0	$0
3	0	$0	0	$0	0	$0
4	0	$0	0	$0	0	$0
5	0	$0	0	$0	0	$0
6	0	$0	0	$0	0	$0
7	6	$2,877	0	$0	6	$2,877
8	18	$10,932	3	$191,005	21	$201,937
9	44	$35,171	6	$393,577	50	$428,748
10	114	$72,442	11	$774,804	125	$847,246
11	194	$109,688	12	$962,028	206	$1,071,716
12	261	$230,525	12	$962,028	273	$1,192,553
13	299	$491,519	12	$962,028	311	$1,453,547
14	307	$591,842	12	$962,028	319	$1,553,870
15	309	$591,944	12	$962,028	321	$1,553,972
16	313	$592,187	12	$962,028	325	$1,554,215
17	317	$592,473	12	$962,028	329	$1,554,501
18	322	$592,880	12	$962,028	334	$1,554,908
19	323	$592,956	12	$962,028	335	$1,554,984
20	324	$593,029	12	$962,028	336	$1,555,057
21	325	$694,065	12	$962,028	337	$1,656,093
22	327	$694,221	12	$962,028	339	$1,656,249
23	330	$817,140	12	$962,028	342	$1,779,168
24	330	$817,140	12	$962,028	342	$1,779,168

2015 price level, damages updated to 2018 price level using RSMeans update factor

Table 4-18: Estimated Depreciated Structure Replacement Value in Project Area 1 Hammels

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	1	$154	0	$0	1	$154
6	16	$5,964	5	$24,579	21	$30,543
7	61	$28,020	27	$81,494	88	$109,514
8	173	$118,008	29	$88,477	202	$206,485
9	233	$332,757	30	$88,686	263	$421,442
10	252	$538,170	30	$88,686	282	$626,855
11	260	$932,938	31	$120,119	291	$1,053,056
12	265	$1,307,422	31	$120,119	296	$1,427,540
13	270	$1,317,242	31	$120,119	301	$1,437,360

2018 price level

Table 4-19: Estimated Depreciated Structure Replacement Value in Project Area 2 Arverne

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	23	$3,948	2	$804	25	$4,752
6	298	$52,216	13	$24,320	311	$76,536
7	674	$299,399	41	$133,299	715	$432,699
8	1099	$953,657	60	$194,302	1159	$1,147,960
9	1271	$1,209,623	68	$306,136	1339	$1,515,760
10	1348	$4,047,871	71	$313,372	1419	$4,361,244
11	1383	$4,859,409	73	$317,175	1456	$5,176,584
12	1387	$4,915,213	73	$317,175	1460	$5,232,388
13	1391	$5,552,467	73	$317,175	1464	$5,869,642
14	1392	$5,658,848	73	$317,175	1465	$5,976,023

2018 price level

Table 4-20: Estimated Depreciated Structure Replacement Value in Project Area 3 Edgemere

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	9	$1,559	1	$26,885	10	$28,444
6	275	$42,380	8	$39,769	283	$82,150
7	689	$129,566	22	$295,678	711	$425,246
8	849	$206,650	25	$318,680	874	$525,332
9	895	$498,330	29	$584,399	924	$1,082,732
10	912	$544,670	29	$584,399	941	$1,129,072
11	920	$545,940	30	$586,006	950	$1,131,949
12	934	$547,710	30	$586,006	964	$1,133,719
13	943	$548,985	30	$586,006	973	$1,134,994
14	949	$549,831	30	$586,006	979	$1,135,840
15	956	$550,918	30	$586,006	986	$1,136,927
16	957	$551,114	30	$586,006	987	$1,137,123

2018 price level

Table 4-21: Estimated Depreciated Structure Replacement Value in Project Area 4 Norton Basin

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	0	$0	0	$0	0	$0
6	10	$2,023	0	$0	10	$2,023
7	25	$6,067	0	$0	25	$6,067
8	50	$11,988	0	$0	50	$11,988
9	64	$14,969	0	$0	64	$14,969
10	80	$18,759	0	$0	80	$18,759
11	89	$20,874	0	$0	89	$20,874
12	100	$23,489	0	$0	100	$23,489
13	108	$25,630	0	$0	108	$25,630
14	112	$26,929	0	$0	112	$26,929
15	114	$27,328	0	$0	114	$27,328

2018 price level

Table 4-22: Estimated Depreciated Structure Replacement Value in Project Area 5 Bayswater

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	0	$0	0	$0	0	$0
6	0	$0	0	$0	0	$0
7	19	$3,615	0	$0	19	$3,615
8	47	$8,969	0	$0	47	$8,969
9	62	$12,425	0	$0	62	$12,425
10	77	$15,170	1	$116	78	$15,286
11	106	$20,533	1	$116	107	$20,649
12	116	$22,554	1	$116	117	$22,670
13	124	$24,629	1	$116	125	$24,745
14	127	$25,587	1	$116	128	$25,703
15	133	$27,274	1	$116	134	$27,390

2018 price level

Table 4-23: Estimated Depreciated Structure Replacement Value in Project Area 6 Motts Basin South

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	11	$2,051	2	$1,774	13	$3,825
6	69	$14,419	4	$4,470	73	$18,889
7	132	$27,825	8	$5,429	140	$33,254
8	213	$43,726	8	$5,429	221	$49,155
9	263	$55,021	9	$5,556	272	$60,577
10	292	$63,104	12	$7,795	304	$70,899
11	324	$71,788	13	$8,136	337	$79,924
12	354	$81,144	13	$8,136	367	$89,280
13	402	$95,656	14	$8,190	416	$103,846
14	426	$101,813	15	$8,387	441	$110,199
15	450	$109,704	16	$10,288	466	$119,991

2018 price level

Table 4-24: Estimated Depreciated Structure Replacement Value in Project Area 7 Motts Basin North

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	0	$0	1	$877	1	$877
6	3	$674	5	$3,781	8	$4,455
7	14	$3,494	7	$5,307	21	$8,801
8	19	$4,923	9	$9,398	28	$14,321
9	26	$7,023	10	$9,801	36	$16,824
10	27	$7,331	11	$11,681	38	$19,013
11	28	$7,494	12	$12,097	40	$19,592

2018 price level

Table 4-25: Estimated Depreciated Structure Replacement Value in Project Area 8 Inwood Marina

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	9	$1,580	0	$0	9	$1,580
6	29	$5,116	0	$0	29	$5,116
7	73	$14,748	0	$0	73	$14,748
8	112	$22,947	0	$0	112	$22,947
9	134	$28,215	0	$0	134	$28,215
10	152	$33,252	0	$0	152	$33,252
11	162	$35,639	0	$0	162	$35,639
12	172	$37,948	0	$0	172	$37,948
13	176	$38,743	0	$0	176	$38,743
14	178	$39,106	0	$0	178	$39,106

2018 price level

Table 4-26: Estimated Depreciated Structure Replacement Value in Project Area 9.1 Cedarhurst -Lawrence

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	2	$2,300	4	$3,555	6	$5,855
6	31	$10,430	15	$37,577	46	$48,007
7	139	$42,710	25	$44,218	164	$86,928
8	268	$82,444	40	$87,040	308	$169,484
9	348	$113,174	43	$88,303	391	$201,477
10	405	$134,240	51	$92,883	456	$227,123
11	443	$148,417	52	$94,723	495	$243,140
12	494	$168,699	56	$101,314	550	$270,013
13	544	$188,626	61	$104,528	605	$293,154
14	596	$206,338	61	$104,528	657	$310,866
15	672	$232,773	63	$109,072	735	$341,845
16	726	$252,741	63	$109,072	789	$361,813
17	775	$272,315	63	$109,072	838	$381,387
18	816	$287,910	66	$110,236	882	$398,146
19	851	$301,283	66	$110,236	917	$411,519
20	908	$320,107	67	$110,760	975	$430,867
21	994	$348,986	67	$110,760	1061	$459,746
22	1022	$358,741	68	$114,952	1090	$473,693
23	1052	$368,665	69	$120,101	1121	$488,766
24	1071	$375,661	69	$120,101	1140	$495,762
25	1085	$380,599	69	$120,101	1154	$500,700
26	1088	$381,866	70	$122,010	1158	$503,876
27	1091	$382,909	70	$122,010	1161	$504,919
28	1092	$383,236	70	$122,010	1162	$505,246

2018 price level

Table 4-27: Estimated Depreciated Structure Replacement Value in Project Area 9.2 Rosedale

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	27	$4,661	0	$0	27	$4,661
6	64	$13,648	0	$0	64	$13,648
7	106	$24,026	1	$246	107	$24,273
8	131	$30,904	1	$246	132	$31,151
9	157	$37,254	2	$642	159	$37,897
10	174	$41,592	3	$1,203	177	$42,795
11	193	$45,881	3	$1,203	196	$47,084
12	200	$47,903	3	$1,203	203	$49,106

2018 price level

Table 4-28: Estimated Depreciated Structure Replacement Value in Project Area 9.31 Meadowmere North

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	29	$3,889	1	$185	30	$4,074
6	37	$4,766	1	$185	38	$4,951
7	37	$4,766	1	$185	38	$4,951
8	37	$4,766	1	$185	38	$4,951
9	37	$4,766	1	$185	38	$4,951
10	37	$4,766	1	$185	38	$4,951
11	37	$4,766	1	$185	38	$4,951
12	37	$4,766	2	$2,425,738	39	$2,430,504

2018 price level

Table 4-29: Estimated Depreciated Structure Replacement Value in Project Area 9.32 Meadowmere

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	32	$5,783	2	$742	34	$6,525
6	77	$14,861	14	$20,588	91	$35,449
7	85	$16,834	14	$20,588	99	$37,422
8	89	$18,605	14	$20,588	103	$39,193

2018 price level

Table 4-30: Estimated Depreciated Structure Replacement Value in Project Area 9.33 Meadowmere East

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	16	$2,285	3	$798	19	$3,083
6	20	$2,881	5	$1,179	25	$4,060
7	20	$2,881	6	$1,467	26	$4,348
8	20	$2,881	7	$1,853	27	$4,734

2018 price level

Table 4-31: Estimated Depreciated Structure Replacement Value in Project Area 10 Old Howard Beach

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	265	$45,715	14	$19,680	279	$65,395
6	578	$124,811	44	$29,892	622	$154,704
7	998	$243,524	64	$53,175	1062	$296,700
8	1442	$375,778	88	$79,302	1530	$455,081
9	1762	$470,565	94	$96,612	1856	$567,178
10	1893	$507,522	97	$98,554	1990	$606,077
11	1918	$515,324	97	$98,554	2015	$613,879
12	1918	$515,324	97	$98,554	2015	$613,879
13	1918	$515,324	97	$98,554	2015	$613,879
14	1919	$515,827	97	$98,554	2016	$614,382

2018 price level

Table 4-32: Estimated Depreciated Structure Replacement Value in Project Area 11 Canarsie

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
5	58	$14,514	0	$0	58	$14,514
6	112	$31,216	0	$0	112	$31,216
7	240	$62,077	0	$0	240	$62,077
8	392	$101,241	1	$1,026	393	$102,268
9	482	$125,026	1	$1,026	483	$126,053
10	555	$143,864	1	$1,026	556	$144,891
11	603	$156,610	1	$1,026	604	$157,637
12	614	$159,560	1	$1,026	615	$160,587
13	615	$159,838	1	$1,026	616	$160,865

2018 price level

Table 4-33: Estimated Depreciated Structure Replacement Value in Project Area Broad Channel

Stage (feet, NAVD88)	Structure Category					
	Residential		Non-Residential		Total	
	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)	Cumulative Count	Value ($,000)
4	0	$0	0	$0	0	$0
5	444	$96,864,000	6	$3,133,000	450	$99,997,000
6	715	$156,789,000	17	$11,684,000	732	$168,473,000
7	817	$181,070,000	27	$18,085,000	844	$199,155,000
8	848	$189,998,000	33	$22,517,000	881	$212,515,000
9	848	$189,998,000	39	$28,669,000	887	$218,667,000
10	848	$189,998,000	39	$28,669,000	887	$218,667,000

2018 price level

4.6 Coastal Storm Data

4.6.1 Shorefront Reaches

Calculations of storm damage are specific to the physical conditions during the storm such a flood stage, wave height or the extent of erosion. Damages to shorefront structures were calculated using the USACE Certified Model Beach-*fx*. The Beach-*fx* Storm Response Database (SRD) is populated with SBEACH Global Export output data. A large number of storms are evaluated in SBEACH and specific information about profile change, flood stage and wave heights are collected for each storm. The data is imported after the creation of storms and profiles within a

Beach-*fx* project. By importing the data sequentially, Beach-*fx* sets up linkages between specific storms and the project's profiles.

Once the SBEACH data is imported, the SRD includes five tables, "tblSRDVersion", "tblStormResponse", "tblStormResponseDamageParameters", "tblStormResponseProfile", and "tblStormResponseProfileDescription". Together, these tables provide Beach-*fx* with the information necessary to link storms to the appropriate profile response, such as the post storm berm width, post storm dune width, post storm dune height, post storm upland width, eroded volume, and response type.

For the Rockaway Beach Project Beach-*fx* Analysis, three Beach-*fx* projects were created which utilized three distinct SRDs. The first SRD was built using the raw output data from the SBEACH Global Export. This SRD was used for the without-project scenario and the three beach fill alternative scenarios. The SBEACH Global Export data for profiles R1T1, R1T2, R1T3, R2T1, R2T2, R2T3, and R2T4 totaled 62.25 gigabytes. This extensive amount of data required over 93 hours of import time, and required the SRD to be compacted and repaired between profile imports to provide sufficient space for all profiles.

The second and third SRDs were built using data that was modified by a coastal engineer after the SBEACH Global Export to reflect the presence of a buried or composite seawall. These SRDs were used for the seawall alternative scenarios. Despite compacting and repairing the seawall SRDs, there was not sufficient space for all of the profiles. As a result of the lack of space within the SRD, the seawall SRDs were created using only the R2T2 profile, which is the only profile where the seawall was implemented. Since the SRDs did not contain other profiles, output from reaches that utilized the R1T1, R1T2, R1T3, R2T1, R2T3, and R2T4 profiles had to be copied from the without-project scenario and added to the seawall scenario damages manually in Microsoft Access after the simulation.

4.6.2 Backbay Reaches

The backbay reaches applied flood stage vs frequency relationships to assess the potential flood impacts. Flood depths for the backbay areas of the peninsula, which are subject to cross-shore flooding, were calculated using the XBeach wave and hydrodynamic model. Water surface elevation model boundary conditions along the Atlantic Ocean and Jamaica Bay were based on preliminary FIS prepared by FEMA. **Table 4-34** through **Table 4-39** summarize the baseline external ocean and backbay stage versus frequency relationships used in the Stage Frequency HEC-FDA analyses. The XBeach model developed a two-dimensional grid of flood depths across the peninsula for each storm frequency. For each reach the path of cross shore flooding was identified and input to the HEC-FDA model as a flood profile. Each structure in the reach was assigned a profile station to reproduce the actual flood elevation at that structure in the two-dimensional flood grid. The HFFRRF areas were analyzed using stillwater stage frequency data as documented in Appendix A.

Table 4-34: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-1

Return Period (years)	Elevation, Existing Atlantic Ocean (feet, NAVD88)	Elevation, Existing Jamaica Bay (feet, NAVD88)
3	5.90	4.30
5	7.70	5.50
10	9.00	6.60
25	10.20	7.90
50	11.40	8.80
100	12.70	9.80
250	15.00	11.10
500	16.70	12.30

Stillwater elevations obtained from FEMA (2015)

Table 4-35: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-2

Return Period (years)	Elevation, Existing Atlantic Ocean (feet, NAVD88)	Elevation, Existing Jamaica Bay (feet, NAVD88)
3	5.70	4.30
5	7.50	5.50
10	8.90	6.60
25	10.30	7.90
50	11.60	8.80
100	12.90	9.80
250	15.10	11.10
500	16.70	12.30

Stillwater elevations obtained from FEMA (2015)

Table 4-36: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-3

Return Period (years)	Elevation, Existing Atlantic Ocean (feet, NAVD88)	Elevation, Existing Jamaica Bay (feet, NAVD88)
3	7.40	4.30
5	8.90	5.50
10	10.10	6.60
25	11.00	7.90
50	12.00	8.80
100	13.00	9.80
250	15.10	11.10
500	16.60	12.30

Stillwater elevations obtained from FEMA (2015)

Table 4-37: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-4

Return Period (years)	Elevation, Existing Atlantic Ocean (feet, NAVD88)	Elevation, Existing Jamaica Bay (feet, NAVD88)
3	5.20	4.30
5	7.20	5.50
10	8.70	6.60
25	10.70	7.90
50	12.20	8.80
100	13.70	9.80
250	15.70	11.10
500	17.20	12.30

Stillwater elevations obtained from FEMA (2015)

Table 4-38: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-5

Return Period (years)	Elevation, Existing Atlantic Ocean (feet, NAVD88)	Elevation, Existing Jamaica Bay (feet, NAVD88)
3	4.30	4.30
5	6.20	5.50
10	7.80	6.60
25	9.90	7.90
50	11.40	8.80
100	13.00	9.80
250	15.20	11.10
500	16.90	12.30

Stillwater elevations obtained from FEMA (2015)

Table 4-39: Stage vs. Frequency Data in Backbay/Cross-Shore Reach BB-6

Return Period (years)	Elevation, Existing Atlantic Ocean (feet, NAVD88)	Elevation, Existing Jamaica Bay (feet, NAVD88)
3	4.30	4.30
5	5.50	5.50
10	6.60	6.60
25	8.60	7.90
50	10.50	8.80
100	12.30	9.80
250	14.80	11.10
500	16.60	12.30

Stillwater elevations obtained from FEMA (2015)

4.7 Damage Functions

The estimation of storm damages for this analysis was based on two sets of generalized damage functions that were selected to suit the modeling approach for the two components of the damage estimation, i.e. shorefront and backbay.

For the shorefront component of the analyses, appropriate damage functions for inundation, wave and erosion damages were selected from a range of available sources. These sources are listed in brief below, and their assignment to structure usages and types is presented in **Table 5-1**:

- US Army Corps of Engineers (USACE) generic depth-damage functions for single-family residential and similar structures (see below for more details).
- Generic functions developed by the ERDC Coastal and Hydraulics Laboratory (CHL) and the US Army Engineer Institute for Water Resources (IWR) specifically for Beach-*fx* and provided with the download version of the model.
- Coastal storm damage relationships based on an expert opinion elicitation exercise facilitated by USACE/IWR in June 2002.
- Coastal storm damage relationships based on an expert opinion elicitation exercise facilitated by USACE/URS in April 2014 as part of the North Atlantic Coastal Comprehensive Study (NACCS).
- Custom location-specific functions based on detailed investigation of recent storm damage to distinct individual structure types in the study area.

The inundation, erosion, and wave damage functions used for the shorefront component of this analysis and listed in Table 4-40 are presented in detail in Sub-Appendix B.

While depreciated structure replacement values were estimated as described in Section 4.5.1 above, content values were allocated according to guidance and specific requirements associated with the individual depth-damage functions assigned. For PRB and USACE generic functions for single-family residences content values were input as 100% of structure value as per the applicable electronic guidance memoranda (EGMs 01-03 and 04-01), since the depth-damage curves calculate damage as a percentage of the structure value.

For Structures assigned damage functions from the IWR and NACCS expert elicitations, the content-structure value ratio (CSVR) varied with the structure usage and type, and was applied in accordance with guidance found in the reports resulting from the elicitations:

IWR: Coastal Storm Damage Relationships Based on Expert Opinion Elicitation, July 2002

NACCS: Physical Depth Damage Function Summary Report, January 2015

Table 4-40: Sources and Assignment of Damage Functions in Beach-*fx*

Damage Component		Structure Category/Usage	Source for Damage Function
Erosion	Contents	Apartments (Prototype 1A-3)	2015 NACCS Expert Opinion Solicitation
Erosion	Contents	High Rises (Prototype 4B)	2015 NACCS Expert Opinion Solicitation
Erosion	Contents	Single-Family Residences, Multi-Family Residences, Commercial	Beach-*fx* Generic
Erosion	Structure	Apartments (Prototype 1A-3)	2015 NACCS Expert Opinion Solicitation
Erosion	Structure	Single-Family Residences, Multi-Family Residences, Commercial	Beach-*fx* Generic
Erosion	Structure	High Rises (Prototype 4B)	2015 NACCS Expert Opinion Solicitation
Inundation	Contents	Apartments (Prototype 1A-3)	2015 NACCS Expert Opinion Solicitation
Inundation	Contents	High Rises	2015 NACCS Expert Opinion Solicitation
Inundation	Contents	Multi-Family Residences, Commercial	2002 IWR Expert Opinion Solicitation
Inundation	Contents	Single-Family Residences - no basement	USACE Generic
Inundation	Contents	Single-Family Residences - with basement	USACE Generic
Inundation	Structure	Multi-Family Residences, Commercial	Beach-*fx* Generic
Inundation	Structure	Single-Family Residences - no basement	USACE Generic
Inundation	Structure	Single-Family Residences - with basement	USACE Generic
Inundation	Structure	High Rises (Prototype 4B)	2015 NACCS Expert Opinion Solicitation
Inundation	Structure	Apartments (Prototype 1A-3)	2015 NACCS Expert Opinion Solicitation
Wave	Contents	Single-Family Residences, Multi-Family Residences, Commercial	Beach-*fx* Generic
Wave	Contents	Apartments (Prototype 1A-3)	2015 NACCS Expert Opinion Solicitation
Wave	Contents	High Rises (Prototype 4B)	2015 NACCS Expert Opinion Solicitation
Wave	Structure	Apartments (Prototype 1A-3)	2015 NACCS Expert Opinion Solicitation
Wave	Structure	Boardwalk	Custom: Project/Location Specific
Wave	Structure	High Rises (Prototype 4B)	2015 NACCS Expert Opinion Solicitation
Wave	Structure	Single-Family Residences, Multi-Family Residences, Commercial	Beach-*fx* Generic

For structures assigned the generic damage functions pre-loaded into Beach-*fx*, the CSVR was assumed to be consistent with that assigned to the majority of other structures of the same usage.

For the backbay component of the damage estimation, since the structures in the inventory are only vulnerable to inundation, HEC-FDA was used to compute the damages, and hence only inundation damage functions that calculate damage by depth relative to the main floor elevation of the structure were required. For this component of the analysis, two separately developed classes of depth versus percent damage functions were used for all structures in the backbay area:

- US Army Corps of Engineers generic damage functions for single-family residential and similar structures. These functions have been in widespread use for many projects and are generally similar to the functions developed as part of the NACCS.
- Passaic River Basin (PRB) Study damage functions for other residential structures and all non-residential structures evaluated for cross shore flooding on the Rockaway Peninsula. These non-residential inundation damage functions have content damage relationships that allow the building occupancy to be more closely aligned with the selected damage function than would be possible if the NACCS damage functions were applied.
- Galveston District functions for backbay mainland non-residential structures. The mainland area has a large number of different business and public uses. Galveston maintains 145 different types of nonresidential flood damage functions, 85 of which are business curves, the remainder are public and institutional properties and was determined to be the most appropriate source of damage functions for this portion of the study area.

The USACE depth versus damage functions for residential backbay structures were sourced from Economics Guidance Memoranda EGM 01-03 (December 2000) and EGM 04-01 (October 2003). The PRB damage functions were originally developed in 1982 and were derived from approximately 3,500 interviews with owners of flood-damaged properties in the floodplain. These damage functions were found to be applicable as originally formulated and no adjustments to the damage functions are recommended.

The PRB damage functions were also used for non-residential backbay structures on the Rockaway Peninsula; there are numerous PRB damage functions for specific non-residential usages, including commercial, industrial, municipal, and utility structures.

Galveston District, USACE began keeping a large file of flood damage records in 1968 under a contract with the Federal Insurance Administration, using FIA claim forms. The initial survey was very comprehensive, with 10,000 properties included. A thorough room-by-room survey was made for every building. The damage functions that were computed have been continuously kept up-to-date with new flood damage information, including a survey of the 1979 study of flood damages from Hurricane Claudette. There are separate functions for structure, fixtures and inventory. The condition and age of all property is considered in application of all damage functions. These functions are segmented by the classification codes (2-digit SIC).

The backbay analysis also included a category of damage in addition to Structure and Contents, which for the backbay area on the Rockaway Peninsula was classified as "Other" damage. This category covers damage to property external to each structure, such as motor vehicles, ancillary buildings and landscaping, and also captures costs associated with evacuation and post-flood cleanup. Depth-damage functions to capture other damages were drawn from those originally developed for the Passaic River Basin Study as described above.

For the HFFRRF areas, this additional category directly captured damages to motor vehicles associated with residential structures. The average value of pre-owned motor vehicles was determined from publicly available internet sources, and the number of vehicles available to each household was derived from the most recent U.S. Census Bureau data for the study area. For structures containing multiple households, the number of vehicles associated with the structure was generated by dividing the total square footage of the structure by an assumed average square footage of an individual apartment.

The approach then followed the guidance provided in EGM 09-04 (June 2009) "Generic Depth-Damage Relationships for Vehicles" in that the value of the exposed vehicles was adjusted to account for the probability that vehicle owners would move their vehicles to higher ground. In the absence of any specific information regarding local warning times, this probability was assumed to be 73%, based on an average of the probabilities given in Table 5 of EGM 09-04. In the absence of more detailed data, sedans were assumed to be the predominant vehicle type in the study area; hence the Sedan depth-damage function in Table 4 of EGM 09-04 was assigned to all vehicles in the inventory.

5 AVERAGE ANNUAL DAMAGES

5.1 General

The two damage components of the study (shorefront and backbay) were analyzed using two different software models, with the selection of modeling tool driven by the nature of the expected damage mechanisms and the available data for each component. The impacts of three different projections of sea level rise were also evaluated for each component of the study, also in accordance with current planning policy. **Table 5-1** provides a summary of the equivalent annual without-project damages for all damage components in the study area.

5.1.1 Damage to Shorefront Structures

Damages to structures in the shorefront section of the study area were calculated using the USACE Certified Model Beach-*fx*. The model and supporting documentation are available at: (http://hera.pmcl.com/beachfx/default.aspx). For application to this study, the model developers have incorporated several refinements and revisions as Version 1.1. The Beach-*fx* model uses an event-driven Monte Carlo approach, Geographic Information System (GIS) inventory of

infrastructure and a comprehensive database of morphological responses to historically-based storm events. The model also evaluates limitations on rebuilding after storms. The maximum number of times a structure will be rebuilt over the 50 year period is assumed to be 5. The analysis evaluates three damage mechanisms: inundation, wave-action and erosion, as well as how beach profile and damages change in response to long-term shoreline changes. Under without project conditions wave impacts and inundation are the primary sources of average annual damage until about year 2040. At that point continued shoreline change has increased vulnerability to the point that the greatest source of annual damage is erosion. In areas where the proposed dunes are implemented the predominant residual damages are inundation and wave impact and in areas where the proposed seawalls are implemented the predominant residual damages are inundation. As the plan features become larger, inundation damages become an increasingly larger proportion of the residual damages.

5.1.2 Damage to Backbay Structures

Flood inundation damages for the backbay section of the study area (i.e. due to cross-shore flooding from the ocean and from backbay flooding) were initially calculated using the USACE Model HEC-FDA Version 1.2.5a and then updated to the current Certified Version 1.4.1. Water surface profiles and flood depths for cross-shore flooding were derived using the XBeach wave and hydrodynamic model. The analysis of flooding of mainland structures from Jamaica Bay was limited to the areas evaluated for HFFRRF. The comprehensive evaluation of flood risk management in Jamaica Bay is now part of the New York and New Jersey Harbor and Tributaries Study.

Table 5-1: Equivalent Annual Without-Project Damage, Intermediate Sea Level Rise Scenario

Damage Component	Annual Damage
Shorefront Damages (Flooding, Erosion, Waves)	$18,512,000
Jamaica Bay Planning Reach (Cross-shore Flooding)	$27,384,000
Jamaica Bay Planning Reach (Jamaica Bay Flooding)	$149,162,000
Total Damages	**$195,058,000**

Price Level 2018, Interest rate 2.75%, Period of Analysis 50 years

Note that in Table 5-1, the stillwater flooding from Jamaica Bay in the Jamaica Bay Planning Reach comprises two components: flooding on the bay side of the Rockaway Peninsula and flooding on the northern and eastern shores of Jamaica Bay ($70,5050,000 and $78,657,000, respectively)

The scenario analysis considers two additional sea level change conditions, a low scenario based on the historic rate of relative sea level change and high (Modified NRC Curve 3) scenario, as required under current USACE guidance (ER 1100-2-8162, December 2013).

5.2 Uncertainty

Backbay Reaches. Under current Corps' guidance, risk and uncertainty must be incorporated into flood risk management studies. The following areas of uncertainty were incorporated into the HEC-FDA models used to compute inundation damages in the non-shorefront sections of the study area.

- Stage versus frequency relationships
- Structure main floor elevation
- Structure value
- Inundation depth-damage functions

Uncertainty was applied to the stage-frequency relationship in HEC-FDA during the assignment of exceedance-probability functions within the model. On entering an equivalent record length for the hydrologic data, HEC-FDA generates confidence bands from which the stage/frequency in each iteration of the Monte-Carlo process is sampled. Based on available information, the equivalent record length was assumed to be 30 years for all backbay/cross-shore flooding reaches on the Rockaway Peninsula. For the other backbay areas, the equivalent record length was assumed to be 75 years: The cross shore models used a shorter equivalent record length to reflect the higher uncertainties associated with the XBeach model calculation of overtopping flows and the resolution of the two dimensional flow grid which was used to derive the stage-frequency relationships for the cross-shore flood damage analysis.

Uncertainty was assigned to structure elevation and value parameters via normal distributions. In the cross-shore flooding model, the structure elevation was assumed to have a variance of 1 foot, while the structure value was assumed to have a variance of 50% of the expected value. Both of these assumptions reflect the variance observed in the sample inventory.

The uncertainty associated with depth-damage functions was applied via normal distributions, with the variance at each depth ordinate taken directly from the original publication of these functions.

Shorefront Reaches. The Beach-*fx* model allows uncertainty to be applied to numerous parameters within the analysis, most notably

- Structure main floor elevation
- Structure value
- Contents value
- Rebuilding times
- Inundation depth-damage functions
- Wave impact damage functions

- Erosion-distance damage functions

Uncertainty was assigned to these parameters via triangular probability distributions, with an expected value, a minimum, and a maximum value entered for each structure in Beach-*fx*.

For structure values and elevations, the triangular distributions used to reflect the uncertainty were derived by assuming the minimum and maximum values differed from the expected value by two standard deviations of the normal distribution appropriate for the accuracy of the survey from which the shorefront inventory was compiled. For simplicity of input, it was assumed that the same uncertainty associated with value and elevation was applied to all structures in the shorefront inventory. The minimum and maximum values of structure main floor elevation are hence assumed to be +/-1.2 feet from the expected value, while the structure value is assumed to be +/-20% of the expected value.

Uncertainty associated with rebuilding time was derived from local knowledge and information published following significant storms including Hurricane Sandy. It was assumed that for all building types the expected rebuild time is 1.5 years, with lower and upper bounds of one year and 2.5 years respectively.

The uncertainty associated with damage functions was applied via triangular distributions, with the range of values at each depth or erosion distance ordinate taken directly from the original publication of these functions, and presented in the tables in Sub-Appendix B.

The uncertainty applied to some key parameters for structures in the shorefront dataset differed from that in the backbay dataset to reflect the different methodologies used to generate the two inventories. The shorefront inventory was derived from a full field survey of all 900 or so structures in the zone anticipates to be vulnerable to waves and erosion, including estimations of elevation and height above grade and depreciated replacement values that were driven by the specific field observations at each individual structure. The inventory used for analyses of the backbay areas was derived from a sample survey of approximately 500 structures, with typical characteristics extrapolated to the remaining structures in the backbay area.

5.3 Estimated Without-Project Damages

Estimated total equivalent annual damages are $18,512,000 for the shorefront reaches under the intermediate sea level change scenario. The sub-reach with the highest damages is R3S2b, which accounts for 26% of total damages. Other significantly damaged sub-reaches include R4S1 at 20% of total damages, R4S2 at 12% of total damages, R4S3 at 11% of total damages, and R2S2a at 7% of total damages. The structure types with the highest damages are high-rises susceptible to wave damages, which account for 40.1% of total damages. A summary of equivalent annual shorefront damages by sub-reach is provided in **Table 5-2**, and by Damage category / Sea Level Rise scenario in **Table 5-3.** Under a high sea level rise scenario damage risk increases for both residential and

non-residential structures. For residential structures, the increased potential for structure failure actually results in a reduction in future damages as repetitively damaged structures are not rebuilt.

Table 5-2: Summary of Without-Project Condition/ Base Year Average Annual Damage - Shorefront Reaches

Economic Reach	Annual Damage	% of Total
R2S2a	$1,235,000	7%
R2S2b	$210,000	1%
R3S1a	$308,000	2%
R3S1b	$399,000	2%
R3S1c	$272,000	1%
R3S1d	$223,000	1%
R3S2a	$319,000	2%
R3S2b	$4,798,000	26%
R4S1	$3,634,000	20%
R4S2	$2,234,000	12%
R4S3	$2,034,000	11%
R5S1a	$452,000	2%
R5S1b	$168,000	1%
R5S1c	$175,000	1%
R5S1d	$167,000	1%
R5S2a	$424,000	2%
R5S1e	$458,000	2%
R6S2	$11,000	0%
R6S3a	$701,000	4%
R6S3b	$290,000	2%
Total	**$18,512,000**	**100%**

2015 price level, aggregated damages updated to 2018

Table 5-3: Summary of Without-Project Condition/ Base Year Average Annual Damage – Damage Categories

Damage Category	Equivalent Annual Damage, Without Project		
	Low SLR	Intermediate SLR	High SLR
Residential	$13,708,000	$14,573,000	$14,189,000
Non-Residential	$3,794,000.00	$3,939,000	$4,112,000
Total	$17,502,000	$18,512,000	$18,301,000

2015 price level, aggregated damages updated to 2018

Table 5-4 and **Table 5-5** present an overview of the sources of expected total annual damages for the without-project/base year condition, and for the without-project/future year conditions for the non-shorefront reaches on Rockaway Peninsula. These values are based on the initial assessments conducted using HEC-FDA version 1.2.5a and are illustrative of the sources of damage. Damages and benefits presented in Chapter 8 have been updated using HEC-FDA version 1.4.1. A summary

of the equivalent annual damages for the non-shorefront Rockaway Peninsula reaches is provided in **Table 5-6**. The summary of damages presents the total damages in these reaches from cross-shore flooding and flooding from Jamaica Bay. These two sources of flooding were evaluated in separate HEC-FDA models. This allowed the residual back bay flood damages to be netted out of the calculated benefits from cross shore flooding. The damage from these two sources is subsequently presented separately in Table 8-1 later in this Appendix.

Damages for the backbay HFFRRF areas were also evaluated using HEC-FDA. **Table 5-7** provides a summary of the without-project damages for each of the areas considered in the initial screening of the HFFRRF areas. It should be noted that damages in the Mid-Rockaway HFFRRF area (Hammels, Arverne, and Edgemere reaches) are reflected in both the BB reach summaries and the HFFRRF reach summaries. The overall project area damage summaries have been adjusted to eliminate any duplication in damages. Damage reduction benefits in this area are not duplicated since the flooding from the backbay is only considered as a residual damage in the BB reach damage analyses.

Table 5-4: Summary of Without-Project Condition/ Base Year Average Annual Damage – Backbay/Cross-Shore Reaches

Economic Reach	Damage Categories					Total
	Apartment	Commercial	Industrial	Municipal	Residential	
BB-1	$245,380	$526,900	$0	$136,710	$7,234,730	$8,143,720
BB-2	$1,652,570	$2,132,440	$0	$511,120	$2,353,070	$6,649,200
BB-3	$5,031,520	$2,146,560	$994,010	$603,390	$2,586,790	$11,362,270
BB-4	$3,021,110	$1,693,280	$830,750	$121,560	$5,036,200	$10,702,900
BB-5	$28,757,910	$2,013,820	$0	$888,330	$6,627,630	$38,287,690
BB-6	$2,869,370	$106,230	$0	$7,392,580	$1,958,930	$12,327,110
Total	**$41,577,860**	**$8,619,230**	**$1,824,760**	**$9,653,690**	**$25,797,350**	**$87,472,890**

2015 price level, low sea level rise scenario

Table 5-5: Summary of Without-Project Condition/ Future Year Average Annual Damage – Backbay/Cross-Shore Reaches

Economic Reach	Damage Categories					Total
	Apartment	Commercial	Industrial	Municipal	Residential	
BB-1	$317,900	$647,380	$0	$148,460	$9,209,610	$10,323,350
BB-2	$2,220,180	$2,685,100	$0	$628,230	$2,902,390	$8,435,900
BB-3	$7,031,490	$2,907,910	$1,402,450	$838,960	$3,393,130	$15,573,940
BB-4	$3,483,810	$2,024,490	$1,028,080	$132,910	$6,104,750	$12,774,040
BB-5	$32,659,710	$2,551,010	$0	$1,074,620	$7,619,920	$43,905,260
BB-6	$3,454,420	$135,920	$0	$9,265,140	$2,426,780	$15,282,260
Total	**$49,167,510**	**$10,951,810**	**$2,480,530**	**$12,088,320**	**$31,656,580**	**$106,294,750**

2015 price level, low sea level rise scenario

Table 5-6: Summary of Without-Project Equivalent Annual Damage – Backbay/Cross-Shore Reaches

Reach	Residential	Non-Residential
BB-1	$8,156,000	$708,000
BB-2	$4,381,000	$2,864,000
BB-3	$8,507,000	$4,182,000
BB-4	$8,601,000	$2,830,000
BB-5	$37,146,000	$3,154,000
BB-6	$5,199,000	$8,140,000
Total	**$71,990,000**	**$21,878,000**
Grand Total	***$93,868,000***	

2015 price level, low sea level rise scenario. Intermediate SLR scenario damages were updated ro 2018 Price Level
2.75% discount rate,

Table 5-7: Summary of HFFRRF Without-Project Damages

Project Area	Annual Damage, $,000		
	Without-Project Damage (Base Year)	Without-Project Damage (Future Year)	Without-Project EAD
Hammels	$5,220	$9,517	$6,921
Arverne	$17,944	$32,260	$23,613
Edgemere	$10,246	$19,052	$13,733
Norton Basin	$336	$643	$458
Bayswater	$229	$438	$312
Motts Basin South	$1,873	$3,482	$2,510
Motts Basin North	$536	$974	$709
Inwood Marina	$1,286	$2,303	$1,689
Cedarhurst-Lawrence	$9,575	$17,338	$12,649
Rosedale	$697	$1,407	$978
Meadowmere North	$5,119	$9,659	$6,917
Meadowmere	$2,060	$3,742	$2,726
Meadowmere East	$528	$917	$682
Old Howard Beach	$25,318	$43,652	$32,578
Canarsie	$4,048	$7,071	$5,245
Broad Channel	$8,588	$15,196	$11,204

2018 price level, intermediate sea level rise scenario, 2.75% discount rate, 50-year project life

5.4 Sea Level Change

Tidal inundation is expected to increase gradually over time, in direct relation to the anticipated rise in relative sea level. Based upon historic NOAA tide gauge readings at Sandy Hook, sea level has been increasing at an average rate of 0.013 feet per year. This is equivalent to a 0.7-foot

increase in tidal stage over the 50-year period of analysis. In future years, this will result in more frequent and higher stages of flooding, as shown in **Table 5-8**.

Table 5-8: Sea Level Rise - Low Historic Sea Level Changes

Year	SLR Historic Surcharge (feet)	Historic Curve Jamaica Backbay Stages (feet NAVD88)							
		Return Period (Years)							
		3	5	10	25	50	100	250	500
2015	0.0	**4.3**	**5.5**	**6.6**	**7.9**	**8.8**	**9.8**	**11.1**	**12.3**
2019	0.1	4.4	5.6	6.7	8.0	8.9	9.9	11.2	12.4
2029	0.2	4.5	5.7	6.8	8.1	9.0	10.0	11.3	12.5
2039	0.3	4.6	5.8	6.9	8.2	9.1	10.1	11.4	12.6
2049	0.5	4.8	6.0	7.1	8.4	9.3	10.3	11.6	12.8
2059	0.6	4.9	6.1	7.2	8.5	9.4	10.4	11.7	12.9
2069	0.7	5.0	6.2	7.3	8.6	9.5	10.5	11.8	13.0

In future years, more frequent and higher-stage flooding is likely. The resulting reduction in protective beach features combined with continued increases in sea level is expected to increase the frequency and extent of future storm damages. Sea level rise is potentially a significant factor contributing to future impacts of tidal inundation and wave action.

Two additional accelerated sea level change scenarios have been evaluated as required in accordance with USACE guidance (ER 1100-2-8162 and ETL 1100-2-1). Accelerated sea level rise has been assessed under intermediate (Curve 1) and high (Curve 3) scenarios, as shown in **Table 5-9** and **Table 5-10**, respectively. The relationship between Low Historic, Intermediate (Curve1) and High (Curve3) Sea Level Rise surcharge is presented in **Figure 5-1**.

Table 5-9: Accelerated Sea Level Rise - Intermediate (Curve1) Sea Level Changes

Year	RSLR Curve 1 Surcharge (feet)	RSLR Curve 1 Jamaica Backbay Stages (feet NAVD88)							
		Return Period (Years)							
		3	5	10	25	50	100	250	500
2015	0.0	4.3	5.5	6.6	7.9	8.8	9.8	11.1	12.3
2019	0.1	4.4	5.6	6.7	8.0	8.9	9.9	11.2	12.4
2029	0.3	4.6	5.8	6.9	8.2	9.1	10.1	11.4	12.6
2039	0.5	4.8	6.0	7.1	8.4	9.3	10.3	11.6	12.8
2049	0.7	5.0	6.2	7.3	8.6	9.5	10.5	11.8	13.0
2059	0.9	5.2	6.4	7.5	8.8	9.7	10.7	12.0	13.2
2069	1.2	5.5	6.7	7.8	9.1	10.0	11.0	12.3	13.5

Table 5-10: Accelerated Sea Level Rise - High (Curve3) Sea Level Changes

Year	RSLR Curve 3 Surcharge (feet)	RSLR Curve 3 Jamaica Backbay Stages (feet NAVD88)							
		Return Period (Years)							
		3	5	10	25	50	100	250	500
2015	0.0	4.3	5.5	6.6	7.9	8.8	9.8	11.1	12.3
2019	0.1	4.4	5.6	6.7	8.0	8.9	9.9	11.2	12.4
2029	0.5	4.8	6.0	7.1	8.4	9.3	10.3	11.6	12.8
2039	1.0	5.3	6.5	7.6	8.9	9.8	10.8	12.1	13.3
2049	1.5	5.8	7.0	8.1	9.4	10.3	11.3	12.6	13.8
2059	2.1	6.4	7.6	8.7	10.0	10.9	11.9	13.2	14.4
2069	2.7	7.0	8.2	9.3	10.6	11.5	12.5	13.8	15.0

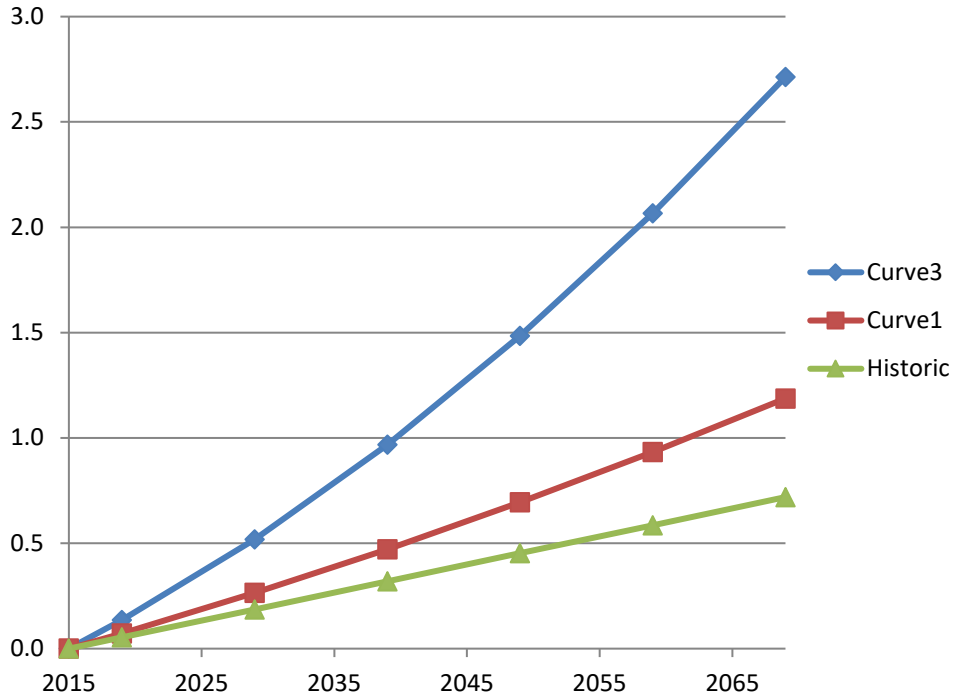


Figure 5-1: Sea Level Rise Relationships at Rockaway Beach NY

5.5 Shoreline Change Calibration

Beach Fill and Seawall Calibration

The Rockaway Beach Project Beach-*fx* Analysis included three Beach-*fx* projects. The first Beach-*fx* project was used for the without-project scenario and the three beach fill alternative scenarios. The project was calibrated to each reach's target erosion rate, which were equal to the project area's historic erosion rates, to reflect realistic average erosion rates in the without-project scenario (**Table 5-11**).

Table 5-3: Without-Project and Beach Fill Calibration (feet/year)

Profiles	Reaches	Target Historical Rate	Storm Induced - Average Erosion Rate	Applied Erosion Rate	Average Erosion Rate	Differential from Target Historical Rate
R1T1	R1S1	10	-0.5	10.7400	10.0	0.0
R1T2	R1S2a	10	-0.5	10.7470	10.0	0.0
R1T3	R1S2b	10	-1.6	10.4540	10.0	0.0
R2T1	R2S2a	0	-2.5	1.3880	0.0	0.0
	R2S2b	0	-2.5	1.3880	0.0	0.0
R2T2	R3S1a	-2	-2.2	-0.7850	-2.0	0.0
	R3S1b	-2	-2.2	-0.7850	-2.0	0.0
	R3S1c	-2	-2.2	-0.7850	-2.0	0.0
	R3S1d	-2	-2.2	-0.7850	-2.0	0.0
	R3S2a	-2	-2.2	-0.7850	-2.0	0.0
	R3S2b	-10	-2.2	-9.0140	-10.1	0.1
	R4S1	-20	-2.2	-19.2655	-20.0	0.0
	R4S2	-20	-2.2	-19.2655	-20.0	0.0
	R4S3	-20	-2.2	-19.2655	-20.0	0.0
	R5S1a	-3	-2.2	-1.6890	-3.0	0.0
	R5S1b	-3	-2.2	-1.6890	-3.0	0.0
	R5S1c	-3	-2.2	-1.6890	-3.0	0.0
	R5S1d	-3	-2.2	-1.6890	-3.0	0.0
	R5S2b	-3	-2.2	-1.6890	-3.0	0.0
	R5S2a	-3	-2.2	-1.6890	-3.0	0.0
	R5S1e	-3	-2.2	-1.6890	-3.0	0.0
	R6S1a	-3	-2.2	-1.6890	-3.0	0.0
	R6S1b	-3	-2.2	-1.6890	-3.0	0.0
	R6S2	-3	-2.2	-1.6890	-3.0	0.0
	R6S3a	-3	-2.2	-1.6890	-3.0	0.0
	R6S3b	10	-2.2	11.2840	10.0	0.0
R2T3	R2S1	0	-2.5	1.2310	0.0	0.0
R2T4	R1S3	10	-2.5	10.9490	10.0	0.0

The remaining two Beach-*fx* projects were used for the seawall alternative scenarios. The calibrated applied erosion rates from the without-project scenario were used for each seawall Beach-*fx* project. However, the projects were not re-calibrated as project engineers determined that it would be inappropriate to re-calibrate after modifying the storm response inputs. Despite reusing the initial applied erosion rates, the Beach-*fx* results for the seawall alternatives produced average erosion rates that compare reasonably well with the historic rates (**Table 5-12**).

Table 5-12: Comparison of Erosion Rates in Seawall Models (feet/year)

Profiles	Reaches	Target Historical Rate	Storm Induced - Average Erosion Rate	Applied Erosion Rate	Buried Seawall		Composite Seawall	
					Average Erosion Rate	Differential from Target Historical Rate	Average Erosion Rate	Differential from Target Historical Rate
R1T1	R1S1	10	-0.5	10.7400	N/A	N/A	N/A	N/A
R1T2	R1S2a	10	-0.5	10.7470	N/A	N/A	N/A	N/A
R1T3	R1S2b	10	-1.6	10.4540	N/A	N/A	N/A	N/A
R2T1	R2S2a	0	-2.5	1.3880	N/A	N/A	N/A	N/A
	R2S2b	0	-2.5	1.3880	N/A	N/A	N/A	N/A
R2T2	R3S1a	-2	-2.2	-0.7850	-1.5	-0.5	-1.4	-0.6
	R3S1b	-2	-2.2	-0.7850	-1.5	-0.5	-1.4	-0.6
	R3S1c	-2	-2.2	-0.7850	-1.5	-0.5	-1.4	-0.6
	R3S1d	-2	-2.2	-0.7850	-1.5	-0.5	-1.4	-0.6
	R3S2a	-2	-2.2	-0.7850	-1.5	-0.5	-1.4	-0.6
	R3S2b	-10	-2.2	-9.0140	-8.6	-1.4	-8.6	-1.4
	R4S1	-20	-2.2	-19.2655	-18.1	-1.9	-18.1	-1.9
	R4S2	-20	-2.2	-19.2655	-18.1	-1.9	-18.1	-1.9
	R4S3	-20	-2.2	-19.2655	-18.1	-1.9	-18.1	-1.9
	R5S1a	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R5S1b	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R5S1c	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R5S1d	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R5S2b	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R5S2a	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R5S1e	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R6S1a	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R6S1b	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R6S2	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R6S3a	-3	-2.2	-1.6890	-2.3	-0.7	-2.2	-0.8
	R6S3b	10	-2.2	11.2840	9.9	0.1	9.9	0.1
R2T3	R2S1	0	-2.5	1.2310	N/A	N/A	N/A	N/A
R2T4	R1S3	10	-2.5	10.9490	N/A	N/A	N/A	N/A

Planform Rates

After calibration, planform rates, or project-induced shoreline rates of change, were used to adjust the average erosion rate to consider planned nourishment efforts. For the Rockaway Beach Project, it was determined that there should be a zero feet per year erosion rate in Reach 3a after planned nourishment has occurred. Additionally, the erosion rates in Reaches 3b, 4, 5, and 6a should be adjusted by -1.7 feet per year. There should be no change to the erosion rates in Reach 6b. The project's planform rates adjust the applied erosion rates according to the cycle of planned nourishment. Beach fill planform rates are shown in **Table 5-13**.

Table 5-13: Beach Fill Planform Rates (feet/year)

Profiles	Reaches	Without-Project Target Historical Rate	With-Project Target	Planform Rates: Differential from Without-Project
R1T1	R1S1	10	10	0
R1T2	R1S2a	10	10	0
R1T3	R1S2b	10	10	0
R2T1	R2S2a	0	0	0
	R2S2b	0	0	0
R2T2	R3S1a	-2	0	2
	R3S1b	-2	0	2
	R3S1c	-2	0	2
	R3S1d	-2	0	2
	R3S2a	-2	0	2
	R3S2b	-10	-11.7	-1.7
	R4S1	-20	-21.7	-1.7
	R4S2	-20	-21.7	-1.7
	R4S3	-20	-21.7	-1.7
	R5S1a	-3	-4.7	-1.7
	R5S1b	-3	-4.7	-1.7
	R5S1c	-3	-4.7	-1.7
	R5S1d	-3	-4.7	-1.7
	R5S2b	-3	-4.7	-1.7
	R5S2a	-3	-4.7	-1.7
	R5S1e	-3	-4.7	-1.7
	R6S1a	-3	-4.7	-1.7
	R6S1b	-3	-4.7	-1.7
	R6S2	-3	-4.7	-1.7
	R6S3a	-3	-3	0
	R6S3b	10	10	0
R2T3	R2S1	0	0	0
R2T4	R1S3	10	10	0

6 COASTAL RISK MANAGEMENT BENEFITS

6.1 Introduction

Five coastal storm risk management alternative plans were formulated and analyzed for the study area, including three design beach profiles and two reinforced dune concepts. Alternative plans considered are listed below.

- 16 Foot Dune. Beach restoration and construction of a dune to a height of +16 feet NAVD88, with a design berm width of 60 feet.
- 18 Foot Dune. Beach restoration and construction of a dune to a height of +18 feet NAVD88, with a design berm width of 80 feet.
- 20 Foot Dune. Beach restoration and construction of a dune to a height of +20 feet NAVD88, with a design berm width of 100 feet.
- Buried Seawall. Beach restoration and construction of a dune to a height of +18 feet NAVD88 with a reinforced rubble mound core of +16 feet NAVD88 and a design berm width of 60 feet.
- Composite Seawall. Beach restoration and construction of a dune to a height of +18 feet NAVD88 with an impermeable core (i.e., steel sheet pile protected by armor stone) and a design berm width of 60 feet.

Continued backbay flooding with the shorefront risk management plans listed above presents a significant residual flood risk. To help manage these risks areas of high residual risk were identified and HFFRRF were developed. The HFFRRF include a series of berms, floodwall and bulkheads to serve local barriers to reduce the frequency of inundation from the back bays. For areas meeting the initial BCR/Federal interest screening criteria the plans were refined to incorporate interior drainage outlets and pump stations as needed.

The evaluation includes shorefront, cross-shore, and backbay benefits of each alternative plan. Additional information on each alternative plan can be found in the Engineering Appendix.

6.2 Approach and Assumptions

Benefits from the five alternative shorefront plans of improvement were estimated by evaluating the shorefront, cross-shore, and backbay damages with and without the alternative measures in place, under existing and future conditions. Benefit categories that were considered include flood damage reduction, emergency nourishment costs avoided, recreation benefits, and reduced FIA administrative costs. Benefit categories such as infrastructure benefits, reoccupation benefits, evacuation benefits, etc. were not evaluated in economic terms at this stage; however, qualitatively, the proposed plans of improvement are each expected to provide some benefit in these categories.

For each of the five alternative shorefront plans of improvement, three alternative future condition scenarios were considered in the analysis based on varying assumptions of the rate of future sea level rise as compared to observed historic conditions. Low, intermediate, and high sea level rise

rates were used to calculate the impact of these potential future conditions on both net benefits and overall cost effectiveness, for each of the proposed plans of improvement.

The assessment of sea level rise impacts included a technical analysis of the adaptability of each of the five coastal risk management alternatives to accommodate sea level rise under low (historic), intermediate (Curve 1), and high (Curve 3) scenarios. Annual costs and benefits under these scenarios were calculated to allow an assessment of the plans under each sea level rise scenario. The HFFRRFs are limited in areal extent and elevation and are not intended for adaptation to accelerated sea level rise. The expected adaptation would be to construct regional protection such as the storm surge barriers under consideration under the Harbor and Tributaries Study.

The analysis of sea level rise included the average annual costs of future plan adaptations and the change in with- and without- project damage and benefits associated with higher water levels and higher rates of shoreline change. Shorefront benefits under these scenarios were recalculated in Beach-*fx*. Backbay inundation damages were estimated to increase in response to higher flood levels in Jamaica Bay. Because of the higher flood levels in Jamaica Bay, the area subject to cross-shore flooding becomes smaller in the accelerated sea level rise scenarios. As a result, **the damages and benefits associated with cross-shore flooding become smaller as sea level rise increases.**

6.3 Storm Damage Without Project

The analysis of without-project storm damages reflects future conditions based on the low sea level rise scenario assumes a continuation of historic sea level changes (0.013 feet per year). The scenario analysis considers two additional accelerated sea level change conditions, under intermediate (Curve 1) and high (Curve 3) scenarios, as required under USACE guidance (ER 1100-2-8162 and ETL 1100-2-1).

After severe storms, relevant local authorities provide limited emergency nourishment to the Rockaway beaches. It is estimated that the average annual cost of emergency nourishment is $943,000

6.4 Storm Damage with Shorefront Risk Management Plans

The storm damage reduction plans evaluated as part of this study included construction of a dune (16, 18, and 20 foot dune height alternatives), as well as a buried seawall alternative and composite seawall alternative. Alternative storm damage reduction plans do not provide 100 percent damage reduction for all properties. The residual damages of each alternative have been evaluated for the low, intermediate, and high sea level rise scenarios.

Residual damages range from a low of $78.9 million for the composite seawall under the low sea level rise scenario to a high of $121.3 million for the 16 foot dune under the high sea level rise scenario.

6.5 Reduced FIA Administrative Costs

Due to the remaining risk with structural measures, it is anticipated that a significant portion of the population will continue to purchase flood insurance under each of the five alternative plans, with no significant decrease in policyholders as a result of project implementation. As such, Flood Insurance Administration (FIA) administrative costs under the with-project condition are assumed to be equal to the costs incurred under the without-project condition, with no net benefits from the FIA benefits point of view.

6.6 Emergency Nourishment Costs Avoided

After severe storms, relevant local authorities provide emergency nourishment to the Rockaway beaches. It is estimated that the average annual cost of emergency nourishment is $943,000 and it is anticipated that relevant local authorities will continue to provide emergency nourishment under these circumstances in the future without-project condition. Under each of the five with-project conditions, the emergency nourishment cost becomes a cost avoided, as scheduled nourishment activities become part of the maintenance of any approved plan of protection.

6.7 High Frequency Risk Reduction Feature Benefits

The HFFRRF were evaluated in a two-phase process as described in the Engineering Appendix. The without-project annual and equivalent annual damage for areas initially identified as potential HFFRRF locations were calculated in HEC-FDA assuming the intermediate sea level change scenario. For Phase 1 screening purposes, the Coastal Storm Risk Management (CSRM) benefits were estimated based on truncation all damages below the design still water level and there was no analysis of residual interior flooding. The Phase 1 screening as presented in **Table 6-1** identified a limited number of areas to bring forward into more detailed engineering and benefit analyses. The screening also considered if Natural and Nature-Based Features (NNBF) should be considered as part of the more detailed plan assessments. NNBFs were considered as a cost effective means for attenuating wave action and thus reducing erosion on a proposed berm. Since the HFFRRFs are designed to be overtopped frequently unless the proposed storm surge barrier is built, they must be designed to withstand the wave action and overtopping. Earthen berms, which are made of erodible material, particularly benefit from a wetland and rock sill complex in front of them to help reduce erosion and the required maintenance over time. The berm and NNBF design was demonstrated to be more cost effective than a comparably sized floodwall, which is less erodible.

At the more detailed Phase 2 level of analysis the building inventory was refined to address several unique situations related to the building elevation data extracted from LiDAR. In Canarsie, it was noted that for a significant number of structures the first floor elevations are located below the street grades, with driveways that provide a pathway for floodwaters to enter the lower level of the structure. The start of flooding of these structures from Jamaica Bay is limited by the elevation of 108th Street. Detailed survey elevation developed as part of the Fresh Creek resiliency project

was obtained and used to define the initial point of damage. In Edgemere, it was discovered that the Lidar-generated elevation of a school was lower that appropriate and the structure elevation and start of damage was adjusted.

The Phase 2 analysis also considered the actual design elevation of the proposed structures and residual interior damages. Benefits for each of the areas were recalculate to reflect both design still water elevation (considered 100% no failure) and the minimum crest elevation (considered to have no effectiveness) of the floodwalls, berms and bulkheads. Residual damages were increased to reflect interior flooding. The residual interior flooding analysis and damages are described as part of the Interior Drainage Sub-Appendix to the Engineering Appendix. The interior drainage analysis indicated that given the lack of flood storage in this highly developed area, storm tides such as the design flood level, would trap enough runoff from a 50% AEP rainfall to inundate the interior area to levels approaching the exterior storm tides. In most locations, this condition required the addition of pump stations to achieve effective flood risk reduction.

Table 6-1: HFFRRF Phase 1 Screening Results. Benefits and Costs in 1,000 of Dollars

Project	Without-Project EAD[1]	With-Project EAD	Annual Benefits	Total Project Cost	Annual Cost	Net Benefits	BCR	Passed (Y/N)	Reason for Screening Out	# of Structures
Canarsie	$5,245	$4,001	$1,244	$8,403	$367	$877	3.4	YES		222
Hammels	$6,921	$5,358	$1,563	$17,215	$733	$830	2.1	YES		88
Arverne	$23,613	$17,525	$6,088	$58,082	$2,460	$3,628	2.5	NO	Best buy is with NNBF	715
Arverne with NNBF	$23,613	$17,525	$6,088	$69,616	$2,899	$3,189	2.1	YES		715
Motts Basin North	$709	$572	$137	$1,707	$77	$60	1.8	YES		18
Motts Basin North with NNBF	$1,689	$572	$1,117	$5,897	$235	$882	4.8	NO	As integrated CSRM, NNBF not justified.	18
Edgemere with NNBF	$13,733	$12,298	$1,435	$34,204	$1,408	$27	1.0	YES	Best buy is with NNBF	702
Edgemere	$13,733	$12,298	$1,435	$25,777	$1,092	$343	1.3	NO		702
Old Howard Beach	$32,578	$21,686	$10,892	$259,395	$10,719	$173	1.0	NO	Cost negates objective→ would recommend if barrier is not built	986
Bayswater with NNBF	$312	$296	$16	$5,239	$225	-$209	0.1	NO	BCR <1	9
Bayswater	$312	$296	$16	$1,259	$76	-$60	0.2	NO	BCR <1	9
Norton Basin	$458	$429	$29	$13,005	$537	-$508	0.1	NO	BCR <1	19
Norton Basin With NNBF	$458	$429	$29	$20,703	$828	-$799	0.0	NO	BCR <1	19
Motts Basin South	$2,510	$2,229	$281	$21,888	$905	-$624	0.3	NO	BCR <1	118

[1] Equivalent Annual Damage: This is the annualized damage accounting for changes in expected damage over time – in this case due to sea level change between the base year and the final year of the analysis period.

Project	Without-Project EAD[1]	With-Project EAD	Annual Benefits	Total Project Cost	Annual Cost	Net Benefits	BCR	Passed (Y/N)	Reason for Screening Out	# of Structures
Motts Basin South with NNBF	$2,510	$2,229	$281	$25,826	$1,055	-$774	0.3	NO	BCR <1	118
Inwood Marina	$1,689	$1,346	$343	$13,059	$553	-$210	0.6	NO	BCR <1	60
Head of Bay Gate	$115,378	$100,956	$14,422	$787,940	$32,423	-$18,001	0.4	NO	BCR <1	1,368
Cedarhurst-Lawrence	$12,649	$9,713	$2,936	$8,401	$352	$2,584	8.3	YES		128
Meadowmere	$2,726	$2,203	$523	$44,330	$1,814	-$1,291	0.3	NO	BCR <1	99
Meadowmere North	$6,917	$6,338	$579	$34,841	$1,399	-$820	0.4	NO	BCR <1	38
Meadowmere East	$682	$358	$324	$14,135	$565	-$241	0.6	NO	BCR <1	25
Rosedale	$978	$630	$348	$10,316	$423	-$75	0.8	NO	BCR <1	104
Broad Channel	$11,204	$7,967	$3,237	$287,842	$10,622	-$7,385	0.3	NO	BCR <1	764

Price level 2018, Interest Rate 2.75%, 50-year project life

7 RECREATION BENEFITS

The National Economic Development (NED) Recreation Benefit Report for Rockaway Beach, NY (included herein as Sub-Appendix C) evaluated recreation benefits by estimating the number of beach visits under with-project conditions where the beach is maintained at a width of 200 feet, versus the number of beach visits under without-project future conditions where the beach experiences continued erosion. The Public Access Plan for the project area is included as Appendix F

Under existing conditions, Rockaway Beach is approximately 200 feet in width. Based on twice daily visual inspections conducted by NYC Department of Parks, a total of 7,738,500 total beach visits are estimated to occur per year at this beach width. Based on survey results, users pay $4.94 in travel cost per visit under these conditions.

Under the with-project conditions, implementation of a beach restoration project maintains the width of existing beaches within the study area that were restored after Hurricane Sandy. Each of the alternative design templates will provide at least a 200 feet average beach width as measured from the toe of dune to mean high water. Maintaining a 200-foot wide beach creates an enhanced recreation experience, which is reflected in an increase in willingness to pay (WTP) for the recreation experience and an increase in visitation. The number of annual beach visits will continue at 7,738,500 per year, with an average travel cost per visit of $4.94.

The benefits analysis calculates the NED recreation benefits by assuming a ten-year period during which the beach erodes to the without-project condition of half its present width. The analysis has conservatively assumed that the beach usage in 2015 will continue to the project base year (2020) despite ongoing erosion that has limited access to some beaches. In year 10, 50% of the beach width is lost and based on the user surveys, 4,512,512 annual visits are lost. The remaining 3,225,988 annual visits are assumed to provide a reduced value for the user because of the depleted beach width. The 4,512,512 lost annual visits at year 10 are assumed to be distributed linearly over the ten-year timeline for the purposes of this analysis with 10% (451,251 visits) lost in year 1, 20% (902,502 visits) lost in year 2, 30% (1,353,754 visits) lost in year 3, and so on. The 3,224,988 remaining visits in year 10 that are assumed to provide a reduced value are also distributed linearly over the ten-year timeline, with 90% of existing visitors attending in year 1 (7,287,249), 80% attending in year 2 (6,835,998), 70% attending in year 3 (6,384,746), and so on.

The without-project future condition assumes the lack of beach maintenance against erosion. Rockaway Beach would continue to experience erosion at a rate of about 10 feet per year. Based on responses to beach surveys completed in the summer of 2015, it is estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by 4,512,512 visits. Beach visits per year were interpolated between these two points based on survey responses. The reduced beach width would, in turn, reduce the user willingness to pay for the remaining 3,225,988 visits to a substantially lower $3.03 per visit. The user willingness to pay was also interpolated between these two points.

Present worth factors applied were calculated using the following formula (where 'n' is the number of years and 'i' represents a fiscal year 2018 discount rate of 2.75%):

present worth factor = present worth/ future worth = 1/(1+i)n

The present value and equivalent annual value of lost visits are shown in **Table 7-1**, while **Table 7-2** shows the present value and equivalent annual value of remaining reduced-value visits.

Table 7-1: Present Value of Lost Visits by Year, Rockaway Beach, Without-Project

Year	Number of Lost Visits	Value Per Lost Visit	Value of all Visits Lost	Present Worth Factor	Present Value of Lost Visits
1	451,251	$4.94	$2,229,180	0.97324	$2,169,519
2	902,502	$4.94	$4,458,360	0.94719	$4,222,908
3	1,353,754	$4.94	$6,687,545	0.92184	$6,164,830
4	1,805,005	$4.94	$8,916,725	0.89717	$7,999,779
5	2,256,256	$4.94	$11,145,905	0.87315	$9,732,091
6	2,707,507	$4.94	$13,375,085	0.84978	$11,365,946
7	3,158,758	$4.94	$15,604,265	0.82704	$12,905,373
8	3,610,010	$4.94	$17,833,450	0.80491	$14,354,255
9	4,061,261	$4.94	$20,062,630	0.78336	$15,716,338
10	4,512,512	$4.94	$22,291,810	0.76240	$16,995,229
11-	*Years 11-49 not reproduced here; trend shown above continues.*				
50	4,512,512	$4.94	$22,291,810	0.25758	$5,741,876
				Sum of present values of reduced value visits, Years 1 through 50	$445,813,371
				Capital Recovery Factor	0.0370409
				Equivalent Annual Value of Lost Visits [1]	**$18.922,000**
				Equivalent Annual Value of Lost Visits [2]	**$19,924,000**

1. 2015 Price Level, 2.750% Interest Rate
2. 2018 Price Level, 2.750% Interest Rate

Table 7-2: Present Value of Reduced Value Visits by Year, Rockaway Beach, Without-Project

Year	Number of Reduced Value Visits	Loss in Value Per Remaining Visit	Value of Reduced Value Visits	Present Worth Factor	Present Value of Reduced Value Visits
1	7,287,249	$0.30	$2,208,036	0.97324	$2,148,941
2	6,835,998	$0.61	$4,142,615	0.94719	$3,923,836
3	6,384,746	$0.91	$5,803,734	0.92184	$5,350,102
4	5,933,495	$1.21	$7,191,396	0.89717	$6,451,874
5	5,482,244	$1.52	$8,305,600	0.87315	$7,252,068
6	5,030,993	$1.82	$9,146,345	0.84978	$7,772,426
7	4,579,742	$2.12	$9,713,632	0.82704	$8,033,575
8	4,128,490	$2.42	$10,007,461	0.80491	$8,055,069
9	3,677,239	$2.73	$10,027,831	0.78336	$7,855,441
10	3,225,988	$3.03	$9,774,744	0.76240	$7,452,244
11-49	*Years 11-49 not reproduced here; trend shown above continues.*				
50	3,225,988	$3.03	$9,774,744	0.25758	$2,517,757
			Sum of present values of reduced value visits, Years 1 through 50		$218,440,210
				Capital Recovery Factor	0.0370409
				Equivalent Annual Value of Lost Visits [1]	**$9,028,037**
				Equivalent Annual Value of Lost Visits [2]	**$9,506,000**

1. 2015 Price Level, 2.750% Interest Rate
2. 2018 Price Level, 2.750% Interest Rate

NED recreation benefits over each year of the project timeline were calculated as the sum of the present value of lost visits plus the present value of the remaining reduced-value visits. **Table 7-3** documents the present value of NED recreation benefits by year, as well as equivalent annual NED recreation benefits.

Table 7-3: NED Recreation Benefits, Rockaway Beach, Without-Project

Year	Present Value of Lost Visits	Present Value of Reduced Value Visits	NED Recreation Benefits
1	$2,169,519	$2,148,941	$4,318,460
2	$4,222,908	$3,923,836	$8,146,744
3	$6,164,830	$5,350,102	$11,514,931
4	$7,999,779	$6,451,874	$14,451,653
5	$9,732,091	$7,252,068	$16,984,159
6	$11,365,946	$7,772,426	$19,138,372
7	$12,905,373	$8,033,575	$20,938,947
8	$14,354,255	$8,055,069	$22,409,324
9	$15,716,338	$7,855,441	$23,571,778
10	$16,995,229	$7,452,244	$24,447,473
11-49	*Years 11-49 not reproduced here; trend shown above continues.*		
50	$5,741,876	$2,517,757	$8,259,633
Sum of present values of NED Benefits, Years 1 through 50			$754,570,562
Capital Recovery Factor			0.0370409
Equivalent Annual Value of Lost Visits [1]			**$27,950,000**
Equivalent Annual Value of Lost Visits [2]			**$29,430,000,**

1. 2015 Price Level, 2.750% Interest Rate
2. 2018 Price Level, 2.750% Interest Rate

8 SUMMARY OF COASTAL RISK MANAGEMENT BENEFITS AND COSTS

8.1 Summary of Formulation Results

Flood damage reduction benefits for the shorefront protection features were calculated based on a comparison of annual damages under the without-project future condition and five alternative with-project conditions under low, intermediate, and high sea level rise scenarios. Costs, damages, and benefits for the low, intermediate, and high sea level rise scenarios are summarized in **Table 8-1** through **Table 8-3**. All analyses were based on a 50-year period and an interest rate of 2.75%.

Each of the five alternative shorefront plans of improvement is cost effective under all three sea level rise scenarios that were evaluated. Because of the high cost of modifying the structural alternatives as an adaptive management measure and the reduction in cross-shore flood benefits, under the high sea level rise scenario the difference in net benefits between the seawall alternatives and the beach and dune restoration alternatives is less pronounced. Under the intermediate sea level rise scenario, the composite seawall plan provides the overall highest net benefits, while the highest net benefits of the dune and beach restoration plans is provided by the 20 foot dune alternative. Under the high sea level rise scenario, the composite seawall plan and the 20 foot dune alternative provide nearly identical net benefits.

Based on ER 1105-2-100 Chapter 3 Paragraph 3-7(7), the recreation benefits that are required for justification must be less than an amount equal to 50 percent of the project costs. Because each alternative plan of improvement is cost-justified based on storm damage reduction benefits alone, the full value of the recreation benefits have been included to calculate the BCRs.

Detailed costs of the each alternative plan of improvement, maintenance, and renourishment can be found in the Cost Appendix.

The Phase 2 analysis of HFFRRF Projects included refinement of the project designs and updating of benefits modeling to accurately capture the changes in the project design and to reflect interior drainage features as described earlier. In addition to these refinements, the Phase 2 analysis also modeled the line of protection for each area incorporating the geotechnical failure function in HEC-FDA. In general, no levee should be assumed to be completely reliable up to the highest crest elevation, since failure may occur prior to stillwater overtopping due to seepage, waves, and erosion. The phase two analysis assumed that the performance of the HFFRRF line of protection is 100% reliable up to the design still water elevation, while for higher stages, wave overtopping may result in flooding of the protected areas. The analysis of the performance of the line of protection has assumed that the line of protection becomes less effective as the still water elevations approach the lowest crest elevation along the alignment. The crest elevations for the HFFRRF levees vary based on calculated wave exposure as documented in the Engineering Appendix.

After completion of the HFFRRF benefits modeling and interior drainage assessments the Benefit Cost Ratio (BCR) was re-calculated for each plan. Information on the costs of each alternative are documented in the Engineering Appendix. Summary results for the Phase 2 projects are presented in **Table 8-4** and indicate that three (3) out of the four (4) HFFRRF projects are cost effective. The Canarsie and Motts Basin North projects have a BCR below unity and are not part of the Recommended Plan. The other project alternatives are included within the Recommended Plan. **Table 8-5** provides a summary of the cost-effective HFFRRF projects under the high sea level rise scenarios. **Table 8-6** presents the overall Selected Plan including the composite seawall plan for the shorefront and the cost justified elements of the HFFRRF under both the intermediate and high sea level rise scenarios. Tables 8-1 through 8-6 were generated based on a Price Level of 2018, interest rate of 2.75%, and a 50-year period of analysis.

Table 8-1: Cost, Damages and Benefits Summary for Low Sea Level Rise Scenario

Rockaway Beach Formulation Summary		Low SLR					
		Without-Project	**16 Foot Dune**	**18 Foot Dune**	**20 Foot Dune**	**Buried Seawall**	**Composite Seawall**
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	IDC	$0	$1,307,000	$2,129,000	$3,462,000	$3,752,000	$6,760,000
	Investment Cost	**$0**	**$72,324,000**	**$97,626,000**	**$150,661,000**	**$159,235,000**	**$227,748,000**
Annualized Cost	Initial Construction	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/Emergency)	$867,000	$5,950,000	$6,392,000	$6,829,000	$5,950,000	$5,950,000
	O&M	$0	$579,000	$598,000	$621,000	$727,000	$836,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaptation	$0	$0	$0	$0	$0	$0
	Total Annual Cost	**$867,000**	**$9,540,000**	**$10,938,000**	**$13,363,000**	**$12,907,000**	**$15,554,000**
Damages	Damages – Shorefront	$17,502,000	$8,389,000	$5,180,000	$2,752,000	$5,097,000	$1,986,000
	Damages – Cross-Shore Flood Damages	$31,661,000	$29,720,000	$24,019,000	$20,366,000	$24,019,000	$16,218,000
	Backbay Damages	$59,406,000	$59,406,000	$59,406,000	$59,406,000	$59,406,000	$59,406,000
	Total Damages	**$108,569,000**	**$97,515,000**	**$88,605,000**	**$82,524,000**	**$88,522,000**	**$77,610,000**
Benefits	Reduced Shorefront Damages	-	$9,113,000	$12,322,000	$14,750,000	$12,405,000	$15,516,000
	Cost Avoided (Emergency Nourishment)	-	$867,000	$867,000	$867,000	$867,000	$867,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$9,980,000	$13,189,000	$15,617,000	$13,272,000	$16,383,000
	Cross-Shore Flood Damage Reduced	-	$1,941,000	$7,642,000	$11,295,000	$7,642,000	$15,443,000
	Total Storm Damage Reduction Benefits	-	$11,921,000	$20,831,000	$26,912,000	$20,914,000	$31,826,000
	Recreation Benefits	-	$29,430,000	$29,430,000	$29,430,000	$29,430,000	$29,430,000
	Total Benefits	-	**$41,351,000**	**$50,261,000**	**$56,342,000**	**$50,344,000**	**$61,256,000**
	Net Benefits (Damage Reduction Only)	**-**	**$2,381,000**	**$9,893,000**	**$13,549,000**	**$8,007,000**	**$16,272,000**
BCR		-	**4.3**	**4.6**	**4.2**	**3.9**	**3.9**
BCR (CSRM Damage Reduction Only)			**1.2**	**1.9**	**2.0**	**1.6**	**2.0**

2018 Price Level, 2.75% Interest Rate

Table 8-2: Cost, Damages and Benefits Summary for Intermediate Sea Level Rise Scenario

Rockaway Beach Formulation Summary		Intermediate SLR					
		Without-Project	**16 Foot Dune**	**18 Foot Dune**	**20 Foot Dune**	**Buried Seawall**	**Composite Seawall**
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	IDC	$0	$1,307,000	$2,129,000	$3,462,000	$3,752,000	$6,760,000
	Investment Cost	**$0**	**$72,324,000**	**$97,626,000**	**$150,661,000**	**$159,235,000**	**$227,748,000**
Annualized Cost	Initial Construction	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/Emergency)	$943,000	$6,364,000	$6,801,000	$7,243,000	$6,364,000	$6,364,000
	O&M	$0	$579,000	$598,000	$621,000	$728,000	$836,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaptation	$0	$210,000	$373,000	$377,000	$1,020,000	$1,453,000
	Total Annual Cost	**$943,000**	**$10,164,000**	**$11,720,000**	**$14,154,000**	**$14,342,000**	**$17,421,000**
Damages	Damages – Shorefront	$18,512,000	$8,644,000	$5,405,000	$2,916,000	$5,296,000	$2,494,000
	Damages – Cross-Shore Flood Damages	$30,234,000	$28,432,000	$23,019,000	$19,580,000	$23,019,000	$15,651,000
	Backbay Damages	$64,137,000	$64,137,000	$64,137,000	$64,137,000	$64,137,000	$64,137,000
	Total Damages	**$112,883,000**	**$101,213,000**	**$92,561,000**	**$86,633,000**	**$92,452,000**	**$82,282,000**
Benefits	Reduced Shorefront Damages	-	$9,868,000	$13,107,000	$15,596,000	$13,216,000	$16,018,000
	Cost Avoided (Emergency Nourishment)	-	$943,000	$943,000	$943,000	$943,000	$943,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$10,811,000	$14,050,000	$16,539,000	$14,159,000	$16,961,000
	Cross-Shore Flood Damage Reduced	-	$1,802,000	$7,215,000	$10,654,000	$7,215,000	$14,583,000
	Total Storm Damage Reduction Benefits	-	$12,613,000	$21,265,000	$27,193,000	$21,374,000	$31,544,000
	Recreation Benefits	-	$29,430,000	$29,430,000	$29,430,000	$29,430,000	$29,430,000
	Total Benefits	-	**$42,043,000**	**$50,695,000**	**$56,623,000**	**$50,804,000**	**$60,974,000**
	Net Benefits (Damage Reduction Only)	**-**	**$2,449,000**	**$9,545,000**	**$13,039,000**	**$7,032,000**	**$14,123,000**
BCR		**-**	**4.1**	**4.3**	**4.0**	**3.5**	**3.5**
BCR (CSRM Damage Reduction Only)			**1.2**	**1.8**	**1.9**	**1.5**	**1.8**

2018 Price Level, 2.75% Interest Rate

Table 8-3: Cost, Damages and Benefits Summary for High Sea Level Rise Scenario

Rockaway Beach Formulation Summary		High SLR					
		Without-Project	**16 Foot Dune**	**18 Foot Dune**	**20 Foot Dune**	**Buried Seawall**	**Composite Seawall**
Initial Cost	Initial Construction	$0	$71,017,000	$95,497,000	$147,199,000	$155,483,000	$220,988,000
	IDC	$0	$1,307,000	$2,129,000	$3,462,000	$3,752,000	$6,760,000
	Investment Cost	**$0**	**$72,324,000**	**$97,626,000**	**$150,661,000**	**$159,235,000**	**$227,748,000**
Annualized Cost	Initial Construction	$0	$2,679,000	$3,616,000	$5,581,000	$5,898,000	$8,436,000
	Renourishment (Planned/Emergency)	$1,299,000	$7,666,000	$8,108,000	$8,544,000	$7,666,000	$7,666,000
	O&M	$0	$579,000	$598,000	$621,000	$554,000	$417,000
	Major Rehab	$0	$332,000	$332,000	$332,000	$332,000	$332,000
	SLR Adaptation	$0	$564,000	$849,000	$859,000	$2,197,000	$2,288,000
	Total Annual Cost	**$1,266,000**	**$11,820,000**	**$13,503,000**	**$15,937,000**	**$16,647,000**	**$19,139,000**
Damages	Damages – Shorefront	$18,302,000	$9,559,000	$6,321,000	$3,728,000	$6,114,000	$3,330,000
	Damages – Cross-Shore Flood Damages	$25,304,000	$24,222,000	$19,913,000	$17,224,000	$19,913,000	$13,887,000
	Backbay Damages	$83,499,000	$83,499,000	$83,499,000	$83,499,000	$83,499,000	$83,499,000
	Total Damages	**$127,105,000**	**$117,280,000**	**$109,733,000**	**$104,451,000**	**$109,526,000**	**$100,716,000**
Benefits	Reduced Shorefront Damages	-	$8,743,000	$11,981,000	$14,574,000	$12,188,000	$14,972,000
	Cost Avoided (Emergency Nourishment)	-	$1,266,000	$1,266,000	$1,266,000	$1,266,000	$1,266,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	-	$10,009,000	$13,247,000	$15,840,000	$13,454,000	$16,238,000
	Cross-Shore Flood Damage Reduced	-	$1,082,000	$5,391,000	$8,080,000	$5,391,000	$11,417,000
	Total Storm Damage Reduction Benefits	-	$11,091,000	$18,638,000	$23,920,000	$18,845,000	$27,655,000
	Recreation Benefits	-	$29,430,000	$29,430,000	$29,430,000	$29,430,000	$29,430,000
	Total Benefits	-	**$40,521,000**	**$48,068,000**	**$53,350,000**	**$48,275,000**	**$57,085,000**
	Net Benefits (Damage Reduction Only)	**-**	**-$729,000**	**$5,135,000**	**$7,983,000**	**$2,198,000**	**$8,516,000**
BCR		**-**	**3.4**	**3.6**	**3.3**	**2.9**	**3.0**
BCR (CSRM Damage Reduction Only)			**0.94**	**1.4**	**1.5**	**1.1**	**1.4**

2018 Price Level, 2.75% Interest Rate

Table 8-4: Jamaica Bay HFFRRF Project Annual Damages and Benefits, Intermediate Sea Level Rise Scenario

Damage Component	Mid-Rockaway	Canarsie	Lawrence	Motts Basin North (no Pumps)
Without-Project Annual Damage	$44,303,520	$4,424,000	$12,655,000	$710,000
With-Project Annual				
Line of Protection Damages	$30,584,590	$3,557,000	$6,858,000	$484,000
Interior Drainage Damages	$1,844,780	$692,000	$643,000	$86,000
Total With-Project Annual Damage	*$32,429,370*	*$4,249,000*	*$7,501,000*	*$570,000*
Annual Benefits	$11,874,150	$175,000	$5,154,000	$140,000
Costs				
Total Cost	$ 194,009,467	$ 27,674,833	$ 13,572,705	$ 2,596,437
Annual Cost	$8,507,000	$1,262,000	$607,000	$111,000
Net Annual Benefits	$3,367,150	($1,087,000)	$4,547,000	$29,000
BCR	**1.4**	**0.1**	**8.5**	**1.3**

2018 Price Level, 2.75% Interest Rate

Table 8-5: Jamaica Bay HFFRRF Project Annual Damages and Benefits, High Sea Level Rise Scenario

Damage Component	Mid-Rockaway	Lawrence	Motts Basin North (no Pumps)
Without-Project Annual Damage	$79,820,010	$22,951,000	$1,333,000
With-Project Annual			
Line of Protection Damages	$59,267,240	$13,212,000	$961,000
Interior Drainage Damages	$1,844,780	$643,000	$86,000
Total With-Project Annual Damage	*$61,312,020*	*$13,855,000*	*$1,047000*
Annual Benefits	$18,507,990	$9,096,000	$286000
Costs			
Total Cost	$194,009,000	$13,573,000	$2,596,000
Annual Cost	$8,507,000	$607,000	$111,000
Net Annual Benefits	$10,000,990	$8,489,000	$175,000
BCR	**2.2**	**15.0**	**2.6**

2018 Price Level, 2.75% Interest Rate

Table 8-6: Rockaway Beach Combined Formulation Summary

Rockaway Beach Combined Formulation Summary		Composite Seawall HFFRRF	
		Intermediate SLR	**High SLR**
Initial Cost	Initial Construction - Shorefront	$220,988,000	$220,988,000
	Initial Construction - HFFRRF	$210,179,000	$210,179,000
	IDC	$12,312,000	$12,312,000
	Investment Cost	$443,479,000	$443,479,000
Annualized Cost	Total Initial Construction	$16,427,000	$16,427,000
	Renourishment (Planned/Emergency)	$6,364,000	$7,666,000
	O&M	$2,071,000	$1,652,000
	Major Rehab	$332,000	$332,000
	SLR Adaptation	$1,453,000	$2,288,000
	Total Annual Cost	$26,647,000	$28,365,000
Benefits	Shorefront Damage Reduced	$16,018,000	$14,972,000
	Cost Avoided (Emergency Nourishment)	$943,000	$1,266,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	$16,961,000	$16,238,000
	Cross-Shore Flood Damage Reduced	$16,437,000	$12,848,000
	HFFRRF Damage Reduced	$17,168,000	$27,889,990
	Total Storm Damage Reduction Benefits	$50,566,150	$56,975,990
	Recreation Benefits	$29,430,000	$29,430,000
	Total Benefits	$79,996,150	$86,405,990
	Net Benefits (Damage Reduction Only)	$23,919,150	$28,610,990
BCR		**3.0**	**3.0**
BCR (CSRM Damage Reduction Only)		**1.9**	**2.0**

2018 Price Level, 2.75% Interest Rate

8.2 Final Cost and Interest Rate Updates

The Recommended Plan identified based on the analyses above includes the Composite Seawall, which was identified as the NED component for the shorefront, and the HFFRRF features at Mid Rockaway, Lawrence/ Cedarhurst, and Motts Basin North. As part of the continuing engineering efforts, these designs and costs were further refined. The revised design requirements resulted in a significant increase in costs at Motts Basin, making it apparent that the BCR would fall below unity. Motts Basin North has therefore been eliminated as a feature in the Recommended Plan. Details of the assessment are available in Section 5 of the Main Text and in the Engineering Appendix.

The Revised Draft Report was completed prior to release of the updated Fiscal Year 2019 discount rate. The costs and BCR for FY18 are displayed in **Table 8-7**. Applying the revised FY19 rate to the benefits and costs of the revised selected plan results in minimal changes in the net benefits and BCR. Additionally, as a result of the HQ Policy Review, Real Estate Costs were increased and re-certified, and renourishment costs were added to the cost certification. The BCRs for all separable elements remain above unity and the updated numbers can be found in Section 6 of the Final Report.

Table 8-7: Rockaway Beach Selected Plan Summary

Rockaway Beach Combined Formulation Summary		Composite Seawall HFFRRF
		Mean Value
Initial Cost	Initial Construction - Shorefront	$336,282,000
	Initial Construction - HFFRRF	$236,466,000
	IDC	$33,688,000
	Investment Cost	$606,436,000
Annual Cost	Total Initial Construction	$23,013,000
	OMRR&R*	$10,158,000
	Total Annual Cost	$33,171,000
Benefits	Shorefront Damage Reduced	$15,808,000
	Cost Avoided (Emergency Nourishment)	$942,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	$16,750,000
	Cross-Shore Flood Damage Reduced	$14,583,000
	HFFRRF Damage Reduced	$16,997,140
	Total Storm Damage Reduction Benefits	$48,330,000
	Recreation Benefits	$29,342,000
	Total Benefits	$77,672,000
	Net Benefits (Damage Reduction Only)	$15,159,000
BCR		**2.3**
BCR (CSRM Damage Reduction Only)		**1.5**

Price Level 2018, 2.875 % Interest Rate
*Includes Renourishment (Planned/Emergency) and Major rehab as per main text

8.3 Benefit Uncertainty

Uncertainty in the expected benefits and overall economic performance of the recommended plan were also evaluated. **Table 8-8** presents a summary of the benefits by category and estimated uncertainty bands. The shorefront benefit uncertainty was calculated by post processing the Beach-fx results to identify the lifecycle iterations associated with the 75th percentile and 25th percentile of benefits. The HFFRRF line of protection benefits, including adjustments for residual interior drainage, were computed by HEC-FDA.

For cross shore flood analysis there are multiple HEC-FDA models reflecting different sources of flooding. For consistency, the uncertainty in reduced cross shore flood damages for a selected year of the lifecycle analysis was calculated. The 75th percentile and 25th percentile of benefits, including adjustments for residual back bay flooding, were estimated based on the percent increase or decrease in benefits calculated for the cross shore flood reduction. Table 8-8 table indicates there is a 75 percent chance that net benefits and the BCR will exceed the values shown for the 25 percent confidence limit, and that there is only a 25 percent chance that net benefits and the BCR will exceed the values shown for the 75 percent confidence limit

The greatest uncertainty in the recreation benefits was identified as the potential that some of the decreased beach usage predicted in the future without project conditions could be transferred to another location. Based on review of the recreation survey results it was estimated that visitation transfers could reduce the overall recreation benefits by 31%. Uncertainty in the benefits as presented in Table 8-7 indicates that the project BCR ranges between 1.5 and 2.9.

Table 8-8: Uncertainty in Economic Performance

Rockaway Beach Combined Formulation Summary		Composite Seawall HFFRRF 25th Percentile (Probability Damage Reduced Exceeds Indicated Values)	Composite Seawall HFFRRF Mean Value	Composite Seawall HFFRRF 75th Percentile (Probability Damage Reduced Exceeds Indicated Values)
Initial Cost	Initial Construction - Shorefront	$336,282,000	$336,282,000	$336,282,000
	Initial Construction - HFFRRF	$236,466,000	$236,466,000	$236,466,000
	IDC	$33,688,000	$33,688,000	$33,688,000
	Investment Cost	$606,436,000	$606,436,000	$606,436,000
Annual Cost	Total Initial Construction	$23,013,000	$23,013,000	$23,013,000
	OMRR&R*	$910,158,000	$10,158,000	$10,158,000
	Total Annual Cost	$33,171,000	$33,171,000	$33,171,000
Benefits	Shorefront Damage Reduced	$9,303,000	$15,808,000	$21,323,000
	Cost Avoided (Emergency Nourishment)	$554,000	$942,000	$1,271,000
	Shorefront Benefit (Reduced Damage Plus Cost Avoided)	$9,857,000	$16,750,000	$22,594,000
	Cross-Shore Flood Damage Reduced	$5,667,000	$14,583,000	$25,024,000
	HFFRRF Damage Reduced	$14,255,000	$16,997,000	$20,609,000
	Total Storm Damage Reduction Benefits	$29,779,000	$48,330,000	$68,226,000
	Recreation Benefits	$20,246,000	$29,342,000	$29,342,000
	Total Benefits	$50,025,000	$77,672,000	$97,568,000
	Net Benefits (Damage Reduction Only)	($3,392,000)	$15,159,000	$35,055,000
BCR		**1.5**	**2.3**	**2.9**
BCR (CSRM Damage Reduction Only)		**0.90**	**1.5**	**2.1**

Price Level 2018, 2.875 % Interest Rate 2.875%
*Includes Renourishment (Planned/Emergency) and Major rehab as per main text

SUB-APPENDIX A - VALUE OF DEVELOPMENT BY SUB-REACHES

Value of Development by Subreaches

The location of shorefront subreaches is shown in Table A-1. The value of development in each sub-reach is shown in Table A-2. A breakdown of values by sub-reach and stage (feet, NAVD88) is shown in Table A-3 through Table A-25. These tables also present the total depreciated replacement value of boardwalks in each reach. Each boardwalk section with a different setback distance from adjacent sections was considered to be a separate damage element in the Beach-*fx* model.

Table A-1: Location of Shorefront Reaches and Subreaches

Reach	Sub-Reach	Description
SFR-2	R2S2a	Jacob Riis Park
	R2S2b	Old Neponsit HC Center
SFR-3	R3S1a	Beach 142 Street - Beach 149 Street
	R3S1b	Beach 135 - Beach 142
	R3S1c	Beach 130 - Beach 135
	R3S1d	Beach 126 - Beach 130
	R3S2a	Beach 121 - Beach 126
	R3S2b	Beach 109 - Beach 121
SFR-4	R4S1	Beach 102 - Beach 109
	R4S2	Beach 92 - Beach 102
	R4S3	Beach 86 - Beach 92
SFR-5	R5S1a	Beach 84 - Beach 86
	R5S1b	Beach 81 - Beach 84
	R5S1c	Beach 77 - Beach 81
	R5S1d	Beach 74 - Beach 77
	R5S1e	Beach 60 - Beach 74
	R5S2a	Beach 56 - Beach 60
	R5S2b	Beach 43 - Beach 56
SFR-6	R6S1a	Beach 36 - Beach 43
	R6S1b	Beach 32 - Beach 36
	R6S2	Beach 29 - Beach 32
	R6S3a	Beach 24 - Beach 28
	R6S3b	Beach 19 - Beach 24

Table A-2: Value of Development in Shorefront Sub-Reaches

Reach	Sub-Reach	Residential		Nonresidential		Boardwalk	*Total*	
		No.	Value	No.	Value	Value	No.	*Value*
SFR-2	**R2S2a**	0	$0	4	$6,953,977	$0	*4*	*$6,953,977*
	R2S2b	0	$0	3	$12,387,784	$0	*3*	*$12,387,784*
SFR-2 Total		**0**	**$0**	**7**	**$19,341,761**	**$0**	**7**	**$19,341,761**
SFR-3	**R3S1a**	83	$30,612,000	0	$0	$0	*83*	*$30,612,002*
	R3S1b	**124**	$38,684,772	0	$0	$0	*124*	*$38,684,772*
	R3S1c	95	$27,743,620	0	$0	$0	*95*	*$27,743,620*
	R3S1d	74	$21,909,548	0	$0	$0	*74*	*$21,909,548*
	R3S2a	59	$103,114,949	0	$0	$0	*59*	*$103,114,949*
	R3S2b	49	$203,401,055	8	$28,522,290	$0	*57*	*$231,923,345*
SFR-3 Total		**484**	**$425,465,946**	**8**	**$28,522,290**	**$0**	**492**	**$453,988,236**
SFR-4	**R4S1**	133	$142,269,885	2	$809,738	$23,209,000	*135*	*$166,288,623*
	R4S2	98	$39,414,039	4	$10,563,177	$24,340,000	*102*	*$74,317,216*
	R4S3	27	$80,629,835	0	$0	$18,570,300	*27*	*$99,200,135*
SFR-4 Total		**258**	**$262,313,759**	**6**	**$11,372,915**	**$66,119,300**	**264**	**$339,805,974**
SFR-5	**R5S1a**	1	$26,407,567	2	$16,590,520	$5,752,100	*3*	*$48,750,187*
	R5S1b	2	$55,853,400	0	$0	$2,184,000	*2*	*$58,037,400*
	R5S1c	2	$58,041,761	0	$0	$4,235,000	*2*	*$62,276,761*
	R5S1d	2	$58,280,240	0	$0	$2,520,000	*2*	*$60,800,240*
	R5S1e	63	$31,277,875	0	$0	$15,916,500	*63*	*$47,194,375*
	R5S2a	14	$101,739,951	0	$0	$6,523,100	*14*	*$108,263,051*
	R5S2b	0	$0	0	$0	$16,653,000	*0*	*$16,653,000*
SFR-5 Total		**84**	**$331,600,794**	**2**	**$16,590,520**	**$53,783,700**	**86**	**$401,975,014**
SFR-6	**R6S1a**	0	$0	0	$0	$9,105,000	*0*	*$9,105,000*
	R6S1b	0	$0	0	$0	$4,404,400	*0*	*$4,404,400*
	R6S2	3	$852,582	0	$0	$2,379,600	*3*	*$3,232,182*
	R6S3a	35	$42,442,111	1	$24,231,965	$0	*36*	*$66,674,076*
	R6S3b	7	$98,908,396	1	$6,323,703	$0	*8*	*$105,232,099*
SFR-6 Total		**45**	**$142,203,089**	**2**	**$30,555,668**	**$15,889,000**	**47**	**$188,647,757**
Grand Total		**871**	**$1,161,583,588**	**25**	**$106,383,154**	**$135,792,000**	**896**	**$1,403,758,742**

Price Level: 2018

Table A-3: Value of Development in R2S2a, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	4	$6,953,977	$0	4	$6,953,977
11	0	$0	4	$6,953,977	$0	4	$6,953,977
12	0	$0	4	$6,953,977	$0	4	$6,953,977
13	0	$0	4	$6,953,977	$0	4	$6,953,977
14	0	$0	4	$6,953,977	$0	4	$6,953,977
15	0	$0	4	$6,953,977	$0	4	$6,953,977
16	0	$0	4	$6,953,977	$0	4	$6,953,977
17	0	$0	4	$6,953,977	$0	4	$6,953,977
18	0	$0	4	$6,953,977	$0	4	$6,953,977
19	0	$0	4	$6,953,977	$0	4	$6,953,977
20	0	$0	4	$6,953,977	$0	4	$6,953,977
21	0	$0	4	$6,953,977	$0	4	$6,953,977
22	0	$0	4	$6,953,977	$0	4	$6,953,977
23	0	$0	4	$6,953,977	$0	4	$6,953,977
24	0	$0	4	$6,953,977	$0	4	$6,953,977

Price Level: 2018

Table A-4: Value of Development in R2S2b, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	0	$0	$0	0	$0
11	0	$0	1	$4,317,343	$0	1	$4,317,343
12	0	$0	2	$9,317,275	$0	2	$9,317,275
13	0	$0	3	$12,387,784	$0	3	$12,387,784
14	0	$0	3	$12,387,784	$0	3	$12,387,784
15	0	$0	3	$12,387,784	$0	3	$12,387,784
16	0	$0	3	$12,387,784	$0	3	$12,387,784
17	0	$0	3	$12,387,784	$0	3	$12,387,784
18	0	$0	3	$12,387,784	$0	3	$12,387,784
19	0	$0	3	$12,387,784	$0	3	$12,387,784
20	0	$0	3	$12,387,784	$0	3	$12,387,784
21	0	$0	3	$12,387,784	$0	3	$12,387,784
22	0	$0	3	$12,387,784	$0	3	$12,387,784
23	0	$0	3	$12,387,784	$0	3	$12,387,784
24	0	$0	3	$12,387,784	$0	3	$12,387,784

Price Level: 2018

Table A-5: Value of Development in R3S1a, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	1	$326,123	0	$0	$0	1	$326,123
11	3	$1,073,437	0	$0	$0	3	$1,073,437
12	10	$3,267,569	0	$0	$0	10	$3,267,569
13	27	$9,622,670	0	$0	$0	27	$9,622,670
14	64	$23,081,819	0	$0	$0	64	$23,081,819
15	74	$26,335,373	0	$0	$0	74	$26,335,373
16	78	$28,171,987	0	$0	$0	78	$28,171,987
17	80	$29,126,408	0	$0	$0	80	$29,126,408
18	82	$30,134,943	0	$0	$0	82	$30,134,943
19	82	$30,134,943	0	$0	$0	82	$30,134,943
20	83	$30,612,002	0	$0	$0	83	$30,612,002
21	83	$30,612,002	0	$0	$0	83	$30,612,002
22	83	$30,612,002	0	$0	$0	83	$30,612,002
23	83	$30,612,002	0	$0	$0	83	$30,612,002
24	83	$30,612,002	0	$0	$0	83	$30,612,002

Price Level: 2018

Table A-6: Value of Development in R3S1b, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	3	$814,244	0	$0	$0	3	$814,244
11	15	$4,110,930	0	$0	$0	15	$4,110,930
12	37	$11,010,383	0	$0	$0	37	$11,010,383
13	78	$22,836,839	0	$0	$0	78	$22,836,839
14	103	$31,414,993	0	$0	$0	103	$31,414,993
15	117	$36,483,642	0	$0	$0	117	$36,483,642
16	123	$38,277,279	0	$0	$0	123	$38,277,279
17	124	$38,684,772	0	$0	$0	124	$38,684,772
18	124	$38,684,772	0	$0	$0	124	$38,684,772
19	124	$38,684,772	0	$0	$0	124	$38,684,772
20	124	$38,684,772	0	$0	$0	124	$38,684,772
21	124	$38,684,772	0	$0	$0	124	$38,684,772
22	124	$38,684,772	0	$0	$0	124	$38,684,772
23	124	$38,684,772	0	$0	$0	124	$38,684,772

Price Level: 2018

Table A-7: Value of Development in R3S1c, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	0	$0	$0	0	$0
11	1	$337,602	0	$0	$0	1	$337,602
12	35	$9,793,444	0	$0	$0	35	$9,793,444
13	55	$15,495,109	0	$0	$0	55	$15,495,109
14	82	$23,164,858	0	$0	$0	82	$23,164,858
15	90	$26,067,438	0	$0	$0	90	$26,067,438
16	94	$27,285,028	0	$0	$0	94	$27,285,028
17	94	$27,285,028	0	$0	$0	94	$27,285,028
18	94	$27,285,028	0	$0	$0	94	$27,285,028
19	95	$27,743,620	0	$0	$0	95	$27,743,620
20	95	$27,743,620	0	$0	$0	95	$27,743,620
21	95	$27,743,620	0	$0	$0	95	$27,743,620
22	95	$27,743,620	0	$0	$0	95	$27,743,620
23	95	$27,743,620	0	$0	$0	95	$27,743,620
24	95	$27,743,620	0	$0	$0	95	$27,743,620

Price Level: 2018

Table A-8: Value of Development in R3S1d, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	6	$2,648,574	0	$0	$0	6	$2,648,574
11	17	$5,155,193	0	$0	$0	17	$5,155,193
12	37	$9,869,704	0	$0	$0	37	$9,869,704
13	48	$13,411,628	0	$0	$0	48	$13,411,628
14	59	$17,077,150	0	$0	$0	59	$17,077,150
15	66	$19,098,007	0	$0	$0	66	$19,098,007
16	71	$20,702,167	0	$0	$0	71	$20,702,167
17	71	$20,702,167	0	$0	$0	71	$20,702,167
18	71	$20,702,167	0	$0	$0	71	$20,702,167
19	73	$21,632,169	0	$0	$0	73	$21,632,169
20	74	$21,909,548	0	$0	$0	74	$21,909,548
21	74	$21,909,548	0	$0	$0	74	$21,909,548
22	74	$21,909,548	0	$0	$0	74	$21,909,548
23	74	$21,909,548	0	$0	$0	74	$21,909,548
24	74	$21,909,548	0	$0	$0	74	$21,909,548

Price Level: 2018

Table A-9: Value of Development in R3S2a, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	5	$17,672,854	0	$0	$0	5	$17,672,854
11	17	$25,647,893	0	$0	$0	17	$25,647,893
12	19	$44,812,825	0	$0	$0	19	$44,812,825
13	20	$45,222,481	0	$0	$0	20	$45,222,481
14	30	$86,437,959	0	$0	$0	30	$86,437,959
15	42	$90,948,755	0	$0	$0	42	$90,948,755
16	51	$93,972,113	0	$0	$0	51	$93,972,113
17	56	$99,131,688	0	$0	$0	56	$99,131,688
18	57	$99,370,576	0	$0	$0	57	$99,370,576
19	57	$99,370,576	0	$0	$0	57	$99,370,576
20	58	$100,301,569	0	$0	$0	58	$100,301,569
21	58	$100,301,569	0	$0	$0	58	$100,301,569
22	59	$103,114,949	0	$0	$0	59	$103,114,949
23	59	$103,114,949	0	$0	$0	59	$103,114,949
24	59	$103,114,949	0	$0	$0	59	$103,114,949

Price Level: 2018

Table A-10: Value of Development in R3S2b, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	15	$53,139,982	1	$8,237,980	$0	16	$61,377,962
11	18	$111,868,531	4	$8,586,715	$0	22	$120,455,246
12	26	$162,587,108	7	$10,172,691	$0	33	$172,759,799
13	32	$175,117,766	8	$28,522,290	$0	40	$203,640,056
14	35	$176,395,399	8	$28,522,290	$0	43	$204,917,689
15	39	$178,074,345	8	$28,522,290	$0	47	$206,596,635
16	42	$189,607,114	8	$28,522,290	$0	50	$218,129,404
17	43	$189,924,431	8	$28,522,290	$0	51	$218,446,721
18	47	$202,312,970	8	$28,522,290	$0	55	$230,835,260
19	47	$202,312,970	8	$28,522,290	$0	55	$230,835,260
20	49	$203,401,055	8	$28,522,290	$0	57	$231,923,345
21	49	$203,401,055	8	$28,522,290	$0	57	$231,923,345
22	49	$203,401,055	8	$28,522,290	$0	57	$231,923,345
23	49	$203,401,055	8	$28,522,290	$0	57	$231,923,345
24	49	$203,401,055	8	$28,522,290	$0	57	$231,923,345

Price Level: 2018

Table A-11: Value of Development in R4S1, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	3	$74,205,376	1	$599,400	$0	4	$74,804,776
11	6	$74,435,071	2	$809,738	$0	8	$75,244,809
12	114	$83,938,860	2	$809,738	$0	116	$84,748,598
13	128	$141,620,714	2	$809,738	$0	130	$142,430,452
14	128	$141,620,714	2	$809,738	$0	130	$142,430,452
15	131	$142,039,072	2	$809,738	$0	133	$142,848,810
16	133	$142,269,885	2	$809,738	$0	135	$143,079,623
17	133	$142,269,885	2	$809,738	$23,209,000	135	$166,288,623
18	133	$142,269,885	2	$809,738	$23,209,000	135	$166,288,623
19	133	$142,269,885	2	$809,738	$23,209,000	135	$166,288,623
20	133	$142,269,885	2	$809,738	$23,209,000	135	$166,288,623
21	133	$142,269,885	2	$809,738	$23,209,000	135	$166,288,623
22	133	$142,269,885	2	$809,738	$23,209,000	135	$166,288,623
23	133	$142,269,885	2	$809,738	$23,209,000	135	$166,288,623
24	133	$142,269,885	2	$809,738	$23,209,000	135	$166,288,623

Price Level: 2018

Table A-12: Value of Development in R4S2, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	10	$4,720,777	3	$9,290,797	$24,340,000	13	$38,351,574
11	32	$21,152,051	4	$10,563,177	$24,340,000	36	$56,055,228
12	35	$21,914,728	4	$10,563,177	$24,340,000	39	$56,817,905
13	41	$23,603,801	4	$10,563,177	$24,340,000	45	$58,506,978
14	51	$26,231,658	4	$10,563,177	$24,340,000	55	$61,134,835
15	65	$30,026,916	4	$10,563,177	$24,340,000	69	$64,930,093
16	69	$31,274,976	4	$10,563,177	$24,340,000	73	$66,178,153
17	73	$32,345,408	4	$10,563,177	$24,340,000	77	$67,248,585
18	77	$33,415,841	4	$10,563,177	$24,340,000	81	$68,319,018
19	85	$35,397,893	4	$10,563,177	$24,340,000	89	$70,301,070
20	90	$36,735,945	4	$10,563,177	$24,340,000	94	$71,639,122
21	91	$36,998,608	4	$10,563,177	$24,340,000	95	$71,901,785
22	91	$36,998,608	4	$10,563,177	$24,340,000	95	$71,901,785
23	93	$37,688,730	4	$10,563,177	$24,340,000	97	$72,591,907
24	98	$39,414,039	4	$10,563,177	$24,340,000	102	$74,317,216

Price Level: 2018

Table A-13: Value of Development in R4S3, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	3	$72,078,041	0	$0	$0	3	$72,078,041
11	7	$75,768,103	0	$0	$4,493,500	7	$80,261,603
12	13	$76,697,477	0	$0	$4,493,500	13	$81,190,977
13	13	$76,697,477	0	$0	$4,493,500	13	$81,190,977
14	16	$77,550,018	0	$0	$4,493,500	16	$82,043,518
15	21	$79,091,112	0	$0	$4,493,500	21	$83,584,612
16	23	$79,606,730	0	$0	$4,493,500	23	$84,100,230
17	24	$79,953,618	0	$0	$18,570,300	24	$98,523,918
18	26	$80,526,844	0	$0	$18,570,300	26	$99,097,144
19	27	$80,629,835	0	$0	$18,570,300	27	$99,200,135
20	27	$80,629,835	0	$0	$18,570,300	27	$99,200,135
21	27	$80,629,835	0	$0	$18,570,300	27	$99,200,135
22	27	$80,629,835	0	$0	$18,570,300	27	$99,200,135
23	27	$80,629,835	0	$0	$18,570,300	27	$99,200,135
24	27	$80,629,835	0	$0	$18,570,300	27	$99,200,135

Price Level: 2018

Table A-14: Value of Development in R5S1a, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	1	$26,407,567	1	$11,215,498	$0	2	$37,623,065
11	1	$26,407,567	1	$11,215,498	$0	2	$37,623,065
12	1	$26,407,567	1	$11,215,498	$0	2	$37,623,065
13	1	$26,407,567	2	$16,590,520	$0	3	$42,998,087
14	1	$26,407,567	2	$16,590,520	$0	3	$42,998,087
15	1	$26,407,567	2	$16,590,520	$0	3	$42,998,087
16	1	$26,407,567	2	$16,590,520	$0	3	$42,998,087
17	1	$26,407,567	2	$16,590,520	$5,752,100	3	$48,750,187
18	1	$26,407,567	2	$16,590,520	$5,752,100	3	$48,750,187
19	1	$26,407,567	2	$16,590,520	$5,752,100	3	$48,750,187
20	1	$26,407,567	2	$16,590,520	$5,752,100	3	$48,750,187
21	1	$26,407,567	2	$16,590,520	$5,752,100	3	$48,750,187
22	1	$26,407,567	2	$16,590,520	$5,752,100	3	$48,750,187
23	1	$26,407,567	2	$16,590,520	$5,752,100	3	$48,750,187
24	1	$26,407,567	2	$16,590,520	$5,752,100	3	$48,750,187

Price Level: 2018

Table A-15: Value of Development in R5S1b, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	2	$55,853,400	0	$0	$0	2	$55,853,400
11	2	$55,853,400	0	$0	$0	2	$55,853,400
12	2	$55,853,400	0	$0	$0	2	$55,853,400
13	2	$55,853,400	0	$0	$0	2	$55,853,400
14	2	$55,853,400	0	$0	$0	2	$55,853,400
15	2	$55,853,400	0	$0	$0	2	$55,853,400
16	2	$55,853,400	0	$0	$0	2	$55,853,400
17	2	$55,853,400	0	$0	$2,184,000	2	$58,037,400
18	2	$55,853,400	0	$0	$2,184,000	2	$58,037,400
19	2	$55,853,400	0	$0	$2,184,000	2	$58,037,400
20	2	$55,853,400	0	$0	$2,184,000	2	$58,037,400
21	2	$55,853,400	0	$0	$2,184,000	2	$58,037,400
22	2	$55,853,400	0	$0	$2,184,000	2	$58,037,400
23	2	$55,853,400	0	$0	$2,184,000	2	$58,037,400
24	2	$55,853,400	0	$0	$2,184,000	2	$58,037,400

Price Level: 2018

Table A-16: Value of Development in R5S1c, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	2	$58,041,761	0	$0	$0	2	$58,041,761
11	2	$58,041,761	0	$0	$0	2	$58,041,761
12	2	$58,041,761	0	$0	$0	2	$58,041,761
13	2	$58,041,761	0	$0	$0	2	$58,041,761
14	2	$58,041,761	0	$0	$0	2	$58,041,761
15	2	$58,041,761	0	$0	$0	2	$58,041,761
16	2	$58,041,761	0	$0	$0	2	$58,041,761
17	2	$58,041,761	0	$0	$4,235,000	2	$62,276,761
18	2	$58,041,761	0	$0	$4,235,000	2	$62,276,761
19	2	$58,041,761	0	$0	$4,235,000	2	$62,276,761
20	2	$58,041,761	0	$0	$4,235,000	2	$62,276,761
21	2	$58,041,761	0	$0	$4,235,000	2	$62,276,761
22	2	$58,041,761	0	$0	$4,235,000	2	$62,276,761
23	2	$58,041,761	0	$0	$4,235,000	2	$62,276,761
24	2	$58,041,761	0	$0	$4,235,000	2	$62,276,761

Price Level: 2018

Table A-17: Value of Development in R5S1d, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	1	$28,678,621	0	$0	$0	1	$28,678,621
11	2	$58,280,240	0	$0	$0	2	$58,280,240
12	2	$58,280,240	0	$0	$0	2	$58,280,240
13	2	$58,280,240	0	$0	$0	2	$58,280,240
14	2	$58,280,240	0	$0	$0	2	$58,280,240
15	2	$58,280,240	0	$0	$0	2	$58,280,240
16	2	$58,280,240	0	$0	$0	2	$58,280,240
17	2	$58,280,240	0	$0	$2,520,000	2	$60,800,240
18	2	$58,280,240	0	$0	$2,520,000	2	$60,800,240
19	2	$58,280,240	0	$0	$2,520,000	2	$60,800,240
20	2	$58,280,240	0	$0	$2,520,000	2	$60,800,240
21	2	$58,280,240	0	$0	$2,520,000	2	$60,800,240
22	2	$58,280,240	0	$0	$2,520,000	2	$60,800,240
23	2	$58,280,240	0	$0	$2,520,000	2	$60,800,240
24	2	$58,280,240	0	$0	$2,520,000	2	$60,800,240

Price Level: 2018

Table A-18: Value of Development in R5S1e, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	0	$0	$0	0	$0
11	7	$8,406,048	0	$0	$0	7	$8,406,048
12	8	$8,543,903	0	$0	$0	8	$8,543,903
13	18	$11,372,819	0	$0	$0	18	$11,372,819
14	44	$24,001,093	0	$0	$0	44	$24,001,093
15	62	$31,147,507	0	$0	$0	62	$31,147,507
16	62	$31,147,507	0	$0	$0	62	$31,147,507
17	63	$31,277,875	0	$0	$15,916,500	63	$47,194,375
18	63	$31,277,875	0	$0	$15,916,500	63	$47,194,375
19	63	$31,277,875	0	$0	$15,916,500	63	$47,194,375
20	63	$31,277,875	0	$0	$15,916,500	63	$47,194,375
21	63	$31,277,875	0	$0	$15,916,500	63	$47,194,375
22	63	$31,277,875	0	$0	$15,916,500	63	$47,194,375
23	63	$31,277,875	0	$0	$15,916,500	63	$47,194,375
24	63	$31,277,875	0	$0	$15,916,500	63	$47,194,375

Price Level: 2018

Table A-19: Value of Development in R5S2a, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	0	$0	$0	0	$0
11	0	$0	0	$0	$0	0	$0
12	2	$306,395	0	$0	$0	2	$306,395
13	3	$495,774	0	$0	$0	3	$495,774
14	4	$3,007,243	0	$0	$0	4	$3,007,243
15	14	$101,739,951	0	$0	$0	14	$101,739,951
16	14	$101,739,951	0	$0	$0	14	$101,739,951
17	14	$101,739,951	0	$0	$6,523,100	14	$108,263,051
18	14	$101,739,951	0	$0	$6,523,100	14	$108,263,051
19	14	$101,739,951	0	$0	$6,523,100	14	$108,263,051
20	14	$101,739,951	0	$0	$6,523,100	14	$108,263,051
21	14	$101,739,951	0	$0	$6,523,100	14	$108,263,051
22	14	$101,739,951	0	$0	$6,523,100	14	$108,263,051
23	14	$101,739,951	0	$0	$6,523,100	14	$108,263,051
24	14	$101,739,951	0	$0	$6,523,100	14	$108,263,051

Price Level: 2018

Table A-20: Value of Development in R5S2b, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	0	$0	$0	0	$0
11	0	$0	0	$0	$0	0	$0
12	0	$0	0	$0	$0	0	$0
13	0	$0	0	$0	$0	0	$0
14	0	$0	0	$0	$0	0	$0
15	0	$0	0	$0	$0	0	$0
16	0	$0	0	$0	$0	0	$0
17	0	$0	0	$0	$16,653,000	0	$16,653,000
18	0	$0	0	$0	$16,653,000	0	$16,653,000
19	0	$0	0	$0	$16,653,000	0	$16,653,000
20	0	$0	0	$0	$16,653,000	0	$16,653,000
21	0	$0	0	$0	$16,653,000	0	$16,653,000
22	0	$0	0	$0	$16,653,000	0	$16,653,000
23	0	$0	0	$0	$16,653,000	0	$16,653,000
24	0	$0	0	$0	$16,653,000	0	$16,653,000

Price Level: 2018

Table A-21: Value of Development in R6S1a, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	0	$0	$0	0	$0
11	0	$0	0	$0	$0	0	$0
12	0	$0	0	$0	$0	0	$0
13	0	$0	0	$0	$0	0	$0
14	0	$0	0	$0	$0	0	$0
15	0	$0	0	$0	$0	0	$0
16	0	$0	0	$0	$0	0	$0
17	0	$0	0	$0	$9,105,000	0	$9,105,000
18	0	$0	0	$0	$9,105,000	0	$9,105,000
19	0	$0	0	$0	$9,105,000	0	$9,105,000
20	0	$0	0	$0	$9,105,000	0	$9,105,000
21	0	$0	0	$0	$9,105,000	0	$9,105,000
22	0	$0	0	$0	$9,105,000	0	$9,105,000
23	0	$0	0	$0	$9,105,000	0	$9,105,000
24	0	$0	0	$0	$9,105,000	0	$9,105,000

Price Level: 2018

Table A-22: Value of Development in R6S1b, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	0	$0	$0	0	$0
11	0	$0	0	$0	$0	0	$0
12	0	$0	0	$0	$0	0	$0
13	0	$0	0	$0	$0	0	$0
14	0	$0	0	$0	$0	0	$0
15	0	$0	0	$0	$0	0	$0
16	0	$0	0	$0	$0	0	$0
17	0	$0	0	$0	$4,404,400	0	$4,404,400
18	0	$0	0	$0	$4,404,400	0	$4,404,400
19	0	$0	0	$0	$4,404,400	0	$4,404,400
20	0	$0	0	$0	$4,404,400	0	$4,404,400
21	0	$0	0	$0	$4,404,400	0	$4,404,400
22	0	$0	0	$0	$4,404,400	0	$4,404,400
23	0	$0	0	$0	$4,404,400	0	$4,404,400
24	0	$0	0	$0	$4,404,400	0	$4,404,400

Price Level: 2018

Table A-23: Value of Development in R6S2, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	0	$0	$0	0	$0
11	1	$246,985	0	$0	$0	1	$246,985
12	1	$246,985	0	$0	$0	1	$246,985
13	1	$246,985	0	$0	$0	1	$246,985
14	1	$246,985	0	$0	$0	1	$246,985
15	1	$246,985	0	$0	$0	1	$246,985
16	3	$852,582	0	$0	$0	3	$852,582
17	3	$852,582	0	$0	$2,379,600	3	$3,232,182
18	3	$852,582	0	$0	$2,379,600	3	$3,232,182
19	3	$852,582	0	$0	$2,379,600	3	$3,232,182
20	3	$852,582	0	$0	$2,379,600	3	$3,232,182
21	3	$852,582	0	$0	$2,379,600	3	$3,232,182
22	3	$852,582	0	$0	$2,379,600	3	$3,232,182
23	3	$852,582	0	$0	$2,379,600	3	$3,232,182
24	3	$852,582	0	$0	$2,379,600	3	$3,232,182

Price Level: 2018

Table A-24: Value of Development in R6S3a, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	16	$2,264,293	1	$24,231,965	$0	17	$26,496,258
11	23	$4,695,547	1	$24,231,965	$0	24	$28,927,512
12	33	$6,561,667	1	$24,231,965	$0	34	$30,793,632
13	34	$6,590,377	1	$24,231,965	$0	35	$30,822,342
14	34	$6,590,377	1	$24,231,965	$0	35	$30,822,342
15	34	$6,590,377	1	$24,231,965	$0	35	$30,822,342
16	34	$6,590,377	1	$24,231,965	$0	35	$30,822,342
17	35	$42,442,111	1	$24,231,965	$0	36	$66,674,076
18	35	$42,442,111	1	$24,231,965	$0	36	$66,674,076
19	35	$42,442,111	1	$24,231,965	$0	36	$66,674,076
20	35	$42,442,111	1	$24,231,965	$0	36	$66,674,076
21	35	$42,442,111	1	$24,231,965	$0	36	$66,674,076
22	35	$42,442,111	1	$24,231,965	$0	36	$66,674,076
23	35	$42,442,111	1	$24,231,965	$0	36	$66,674,076
24	35	$42,442,111	1	$24,231,965	$0	36	$66,674,076

Price Level: 2018

Table A-25: Value of Development in R6S3b, by Stage

Stage	Structure Category						
	Residential		Nonresidential		Boardwalk	Total	
	Number	Value	Number	Value	Value	Number	Value
10	0	$0	0	$0	$0	0	$0
11	4	$41,457,869	0	$0	$0	4	$41,457,869
12	5	$55,370,015	1	$6,323,703	$0	6	$61,693,718
13	5	$55,370,015	1	$6,323,703	$0	6	$61,693,718
14	6	$84,506,216	1	$6,323,703	$0	7	$90,829,919
15	6	$84,506,216	1	$6,323,703	$0	7	$90,829,919
16	6	$84,506,216	1	$6,323,703	$0	7	$90,829,919
17	6	$84,506,216	1	$6,323,703	$0	7	$90,829,919
18	6	$84,506,216	1	$6,323,703	$0	7	$90,829,919
19	7	$98,908,396	1	$6,323,703	$0	8	$105,232,099
20	7	$98,908,396	1	$6,323,703	$0	8	$105,232,099
21	7	$98,908,396	1	$6,323,703	$0	8	$105,232,099
22	7	$98,908,396	1	$6,323,703	$0	8	$105,232,099
23	7	$98,908,396	1	$6,323,703	$0	8	$105,232,099
24	7	$98,908,396	1	$6,323,703	$0	8	$105,232,099

Price Level: 2018

SUB-APPENDIX B – SHOREFRONT DAMAGE FUNCTIONS

See Section 4.7 for the sources from which applied shorefront damage functions were drawn.

Table B-1: Erosion Contents Apartment

X	YMin	YMostLikely	YMax
0	0	0	0
0.1	0.05	0.17	0.3
0.2	0.15	0.32	0.5
0.3	0.3	0.5	0.75
0.4	0.4	0.7	1
0.5	0.5	0.86	1
0.6	0.6	0.89	1
0.7	0.7	0.92	1
0.8	0.8	0.94	1
0.9	0.9	0.97	1
1	1	1	1

Table B-2: Erosion Contents High-Rise

X	YMin	YMostLikely	YMax
0	0	0	0
0.1	0	0	0.005
0.2	0.005	0.01	0.0225
0.3	0.005	0.0175	0.045
0.4	0.005	0.047	0.055
0.5	0.0075	0.048	0.065
0.6	0.0075	0.05	0.08
0.7	0.0075	0.0725	0.09
0.8	0.01	0.0785	0.1
0.9	0.02	0.08	0.11
1	0.035	0.08	0.11

Table B-3: Erosion Contents Single Family Residence, Multi Family Residence, Commercial Buildings

X	YMin	YMostLikely	YMax
0	0	0	0
0.1	0.05	0.2	0.25
0.2	0.2	0.4	0.6
0.3	0.3	0.6	1
0.4	0.5	0.8	1
0.5	0.7	1	1
0.6	0.8	1	1
0.7	0.9	1	1
0.8	1	1	1
0.9	1	1	1
1	1	1	1

Table B-4: Erosion Structure Apartments

X	YMin	YMostLikely	YMax
0	0	0	0
0.1	0.05	0.17	0.3
0.2	0.15	0.32	0.5
0.3	0.3	0.5	0.75
0.4	0.4	0.7	1
0.5	0.5	0.86	1
0.6	0.6	0.89	1
0.7	0.7	0.92	1
0.8	0.8	0.94	1
0.9	0.9	0.97	1
1	1	1	1

Table B-5: Erosion Structure Single Family Residence, Multi Family Residence, Commercial Buildings

X	YMin	YMostLikely	YMax
0	0	0	0
0.1	0.05	0.2	0.25
0.2	0.2	0.4	0.6
0.3	0.3	0.6	1
0.4	0.5	0.8	1
0.5	0.7	1	1
0.6	0.8	1	1
0.7	0.9	1	1
0.8	1	1	1
0.9	1	1	1
1	1	1	1

Table B-6: Erosion Structure High Rise

X	YMin	YMostLikely	YMax
0	0	0	0
0.1	0.0005	0.01025	0.025
0.2	0.0015	0.035	0.04
0.3	0.01	0.03	0.05
0.4	0.02	0.045	0.065
0.5	0.03	0.058	0.075
0.6	0.0325	0.065	0.075
0.7	0.035	0.081	0.087
0.8	0.035	0.083	0.09
0.9	0.04	0.09	0.1
1	0.04	0.095	0.11

Table B-7: Inundation Contents Apartment

X	YMin	YMostLikely	YMax
-0.5	0	0	0
0	0.003333	0.02	0.065
0.5	0.05	0.1	0.15
1	0.075	0.135	0.19
2	0.125	0.2	0.245
3	0.19	0.245	0.29
5	0.233333	0.293333	0.313333
7	0.3	0.335	0.4

Table B-8: Inundation Contents High-Rise

X	YMin	YMostLikely	YMax
-0.5	0	0	0
0	0	0	0.015
0.5	0.005	0.02	0.05
1	0.01	0.04	0.055
2	0.015	0.045	0.065
3	0.02	0.055	0.08
5	0.02	0.07	0.095
7	0.02	0.085	0.1
10	0.025	0.09	0.1

Table B-9: Inundation Contents Multi Family Residence, Commercial Buildings

X	YMin	YMostLikely	YMax
-2	0	0	0
-1	0.0075	0.06	0.1125
0	0.165	0.2025	0.24
1	0.3025	0.3275	0.3625
2	0.4175	0.4475	0.4775
3	0.515	0.55	0.585
4	0.605	0.6425	0.68
5	0.68	0.72	0.76
6	0.7475	0.7875	0.8275
7	0.8025	0.845	0.8875
8	0.8475	0.8925	0.9375
9	0.8825	0.93	0.9775
10	0.9075	0.96	1
11	0.9225	0.98	1
12	0.9275	0.9925	1
13	0.9275	1	1
14	0.9275	1	1
15	0.9275	1	1
16	0.9275	1	1

Table B-10: Inundation Contents Single Family Residence, NB (No Basement)

X	YMin	YMostLikely	YMax
-2	0	0	0
-1	0.01	0.01	0.0625
0	0.0065	0.05	0.0935
1	0.048	0.087	0.126
2	0.0845	0.122	0.1595
3	0.1175	0.155	0.1925
4	0.1445	0.185	0.2255
5	0.168	0.213	0.258
6	0.191	0.239	0.287
7	0.2135	0.263	0.3125
8	0.233	0.284	0.335
9	0.2505	0.303	0.3555
10	0.2675	0.32	0.3725
11	0.2815	0.334	0.3865
12	0.2945	0.347	0.3995
13	0.3035	0.356	0.4085
14	0.31	0.364	0.418
15	0.312	0.369	0.426
16	0.309	0.372	0.435

Table B-11: Inundation Contents Single Family Residence, WB (With Basement)

X	YMin	YMostLikely	YMax
-4	0	0	0
-3	0.04865	0.068	0.08735
-2	0.06585	0.084	0.10215
-1	0.08405	0.101	0.11795
0	0.10265	0.119	0.13535
1	0.12135	0.138	0.15465
2	0.13855	0.157	0.17545
3	0.15555	0.177	0.19845
4	0.17295	0.198	0.22305
5	0.1912	0.22	0.2488
6	0.21075	0.243	0.27525
7	0.2316	0.267	0.3024
8	0.2526	0.291	0.3294
9	0.2756	0.317	0.3584
10	0.2984	0.344	0.3896
11	0.3201	0.372	0.4239
12	0.3382	0.4	0.4618
13	0.3538	0.43	0.5062
14	0.36515	0.461	0.55685
15	0.3718	0.493	0.6142
16	0.37375	0.526	0.67825

Table B-12: Inundation Structure Multi Family Residence, Commercial Buildings

X	YMin	YMostLikely	YMax
-2	0	0	0
-1	0	0.02	0.05
0	0.1	0.11	0.12
1	0.2	0.28	0.41
2	0.3	0.38	0.47
3	0.35	0.43	0.53
4	0.39	0.46	0.54
5	0.49	0.56	0.73
6	0.53	0.59	0.73
7	0.56	0.61	0.73
8	0.59	0.63	0.73

Table –B13: Inundation Structure Single Family Residence, NB (No Basement)

X	YMin	YMostLikely	YMax
-2	0	0	0
-1	0.03	0.03	0.0915
0	0.042	0.093	0.144
1	0.107	0.152	0.197
2	0.167	0.209	0.251
3	0.2195	0.263	0.3065
4	0.266	0.314	0.362
5	0.311	0.362	0.413
6	0.3515	0.407	0.4625
7	0.3905	0.449	0.5075
8	0.428	0.488	0.548
9	0.4625	0.524	0.5855
10	0.494	0.557	0.62
11	0.524	0.587	0.65
12	0.551	0.614	0.677
13	0.575	0.638	0.701
14	0.5945	0.659	0.7235
15	0.608	0.677	0.746
16	0.617	0.692	0.767

Table B-14: Inundation Structure Single Family Residence, WB (With Basement)

X	YMin	YMostLikely	YMax
-4	0	0	0
-3	0.0486	0.072	0.0954
-2	0.07995	0.102	0.12405
-1	0.11845	0.139	0.15955
0	0.1592	0.179	0.1988
1	0.20275	0.223	0.24325
2	0.2475	0.27	0.2925
3	0.29275	0.319	0.34525
4	0.3384	0.369	0.3996
5	0.3839	0.419	0.4541
6	0.42955	0.469	0.50845
7	0.47465	0.518	0.56135
8	0.51705	0.564	0.61095
9	0.5573	0.608	0.6587
10	0.59235	0.648	0.70365
11	0.6207	0.684	0.7473
12	0.6387	0.714	0.7893
13	0.64415	0.737	0.82985
14	0.63715	0.754	0.87085
15	0.6164	0.764	0.9116
16	0.5786	0.764	0.9494

Table B-15: Inundation Structure High-Rise

X	YMin	YMostLikely	YMax
0	0	0	0
0.5	0.0075	0.0225	0.0425
1	0.02	0.045	0.075
2	0.035	0.07	0.12
3	0.045	0.0775	0.14
5	0.055	0.115	0.15
7	0.065	0.1275	0.1725
10	0.075	0.165	0.2

Table B-16: Inundation Structure Apartment

X	YMin	YMostLikely	YMax
-0.5	0	0	0
0	0	0.05	0.075
0.5	0.045	0.075	0.11
1	0.065	0.17	0.225
2	0.1	0.225	0.27
3	0.165	0.245	0.3
5	0.2	0.315	0.42
7	0.3	0.45	0.5

Table B-17: Wave Damage Contents Single Family Residence, Multi Family Residence, Commercial Buildings

X	YMin	YMostLikely	YMax
0	0	0	0
0.5	0.2	0.33	0.5
1	0.4	0.66	1
1.5	0.6	1	1
2	0.8	1	1
2.5	0.9	1	1
3	1	1	1
3.5	1	1	1
4	1	1	1

Table B-18: Wave Contents Apartment

X	YMin	YMostLikely	YMax
-0.5	0	0	0
0	0.05	0.2	0.25
1	0.2	0.3	0.35
2	0.35	0.5	1
3	0.4	0.8	1
5	0.6	1	1

Table B-19: Wave Contents High-Rise

X	YMin	YMostLikely	YMax
-1	0	0	0
0	0	0.005	0.02
1	0.0125	0.02	0.04
2	0.0175	0.05	0.06
3	0.02	0.06	0.09
5	0.02	0.08	0.1
7	0.02	0.08	0.1
10	0.035	0.1	0.115

Table B-20: Wave Structure Apartment

X	YMin	YMostLikely	YMax
-0.5	0	0	0
0	0.05	0.1	0.15
1	0.15	0.2	0.3
2	0.25	0.35	0.5
3	0.4	0.7	1
5	0.5	1	1

Table B-21: Wave Structure Boardwalk

X	YMin	YMostLikely	YMax
0	0	0	0
15	0	0	0
16	0	0	0.25
17	0	0.25	0.5
18	0.25	0.5	0.75
19	0.5	0.75	1
20	0.75	0.75	1

Table B-22: Wave Structure High-Rise

X	YMin	YMostLikely	YMax
-1	0	0	0
0	0	0.015	0.025
1	0.0175	0.05	0.1
2	0.025	0.075	0.12
3	0.035	0.11	0.14
5	0.05	0.14	0.175
7	0.06	0.16	0.24
10	0.06	0.205	0.3

Table B-23: Wave Structure Single Family Residence, Multi Family Residence, Commercial Buildings

X	YMin	YMostLikely	YMax
0	0	0	0
0.5	0.2	0.33	0.5
1	0.4	0.66	1
1.5	0.6	1	1
2	0.8	1	1
2.5	0.9	1	1
3	1	1	1
3.5	1	1	1
4	1	1	1

SUB-APPENDIX C – NED RECREATION BENEFITS REPORT

I. PURPOSE AND OVERVIEW

1. Project Description

Location.

The study area are the municipal public recreation beach facilities located on the peninsula commonly referred to as the Rockaways, located entirely with the Borough of Queens, New York City. The peninsula extends from Rockaway Inlet to East Rockaway Inlet, approximately 10 miles in length, and separates the Atlantic Ocean from Jamaica Bay immediately to the north. The municipal recreation facilities evaluated in this study are located on the ocean side of the peninsula, and are under the authority of the City of New York, Department of Parks and Recreation.

The communities located on the Rockaway Peninsula from west to east include Breezy Point, Roxbury, Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammel, Arverne, Edgemere and Far Rockaway. The former Fort Tilden Military Reservation and the Jacob Riis Park (part of the National Park Service's Gateway National Recreation Area) are located in the western half of the peninsula between Breezy Point and Neponsit. The characteristics of nearly all of the communities on the Rockaway Peninsula are similar. Ground elevations rarely exceed 10 feet, except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from 5 feet, increasing to 10 feet further south toward the Atlantic coast. An estimated 7,900 residential and commercial structures on the peninsula fall within the Special Flood Hazard Area (SFHA) floodplain regulated by the National Flood Insurance Program (NFIP).

Figure 1: Study Area

Recreation Usage.

2. Purpose of the analysis

The purpose of this study is to develop estimates of National Economic Development (NED) recreational benefits produced by a beach restoration project that covers Rockaway Beach, New York.

Implementation of the project will maintain the beaches within the study area that were restored and renourished after Superstorm Sandy in 2012. Maintaining the width of existing beaches will create an enhanced recreation experience (relative to the future condition of the beach without maintenance) which is reflected in an increase in willingness to pay (WTP) for the recreation experience and an increase in visitation.

3. Statement of the 'future without-project condition' and 'with-project' condition

The "future without-project condition", or FWOPC, is to not maintain the beaches at present beach widths. The beach will experience erosion and eventually be half the width of the existing beach. The "with-project" condition is to maintain the beaches in the study area against erosion, to a width of approximately 200 feet of beach.

4. Recreation Market for Rockaway Beach.

The impact of beach nourishment relates to the geographic recreation "market". The market is defined by the location of the potential user population. The potential user population is delineated as people now using the beach parks in Rockaway Beach, New York.

5. Introduction to Methodology

Travel Cost Method

The Travel Cost Method (TCM) is used to estimate economic use values associated with sites that are used for recreation. The basic premise of the TCM is that the time and travel cost expenses that people incur to visit a site represent the 'price' of access to the site. Thus, peoples' willingness to pay to visit the site can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples' willingness to pay for marketed goods based on the quantity demanded at different prices.

An individual TCM approach is used, based on survey data from individual users at Rockaway Beach. Data was gathered on the location of the visitor's home ZIP Code, how far they traveled to the site, how many times they visited the site during the season, the length of the trip, travel expenses, the method of travel to the site, the person's income and other socioeconomic characteristics. The questionnaire is attached in Appendix A.

Using the survey data about visitors, a regression model is estimated between the number of visits and travel costs and other relevant variables. The regression equation gives us the demand function of the 'average' visitor to the site, and the area below this demand curve gives the average consumer surplus. Consumer surplus is the amount a buyer is willing to pay for a good minus the amount the buyer actually pays for it. In the case of visitors to Rockaway Beach, the use of the beach is free, so the amount the buyer actually pays is zero. Consumer surplus is thus the entire area under the demand curve. The consumer surplus for the average visitor is divided by the number of visits at the zero price to give consumer surplus per visit. This is multiplied by the total number of visits to the site to estimate total consumer surplus. The model estimated with existing visits to Rockaway beach is used to estimate the 'with-project' condition value. The model estimated with reduced visits to the site under the 'future without-project' condition is used to estimate the 'without-project' value.

The TCM assumes that people perceive and respond to changes in travel costs in the same way that they would respond to changes in admission price. The TCM may not be well suited for sites

like Rockaway Beach near major population centers where many visitations are from origin zones that are quite close to one another. This may limit the differences in travel costs to affect the number of trips made, and thus understating the impact of travel costs on visits. Further, some visitors to Rockaway Beach may choose to live nearby. In this instance, they will have low travel costs, but high values for the site that are not captured.

The information necessary to develop a simulated demand curve was obtained from a survey conducted during June through August, 2015. Respondents were asked about their 'without' and 'with-project' beach visitation.

II. SAMPLE DESIGN AND EVALUATION

The sample design specifies the location and number of questionnaires completed, and how respondents are selected. Respondents on the beach were selected using random numbers. The number of questionnaires completed and dates are displayed in Table II-A.

Table II-B provides the number of interviews conducted on weekdays and weekends.

Table II-A: Completion Rate: The Number of Questionnaires by Date

Dates (2015)	Number of Interviews
July 2	22
July 5	25
July 6	47
July 10	53
July 12	52
July 13	21
July 14	21
July 17	28
July 19	26
July 20	27
July 22	26
July 24	48
July 25	51
July 27	20
July 28	19
July 31	50
August 1	25
August 2	25
August 8	25
August 9	52
TOTAL	**663**

Table II-B: Completion Rate: The Number of Interviews by Day

Location	Total # of Interviews Completed	
	Weekday	Weekend
Rockaway Beach	360 [54%]	303 [46%]

III. DESCRIPTIVE STATISTICS

1. Trip Bias and Weighting Corrections

The sample distribution of visits (from the survey) does not correspond to the population distribution of visits (actual visits). Persons going to the beach more often are more likely to be selected as survey respondents, a factor which is known as 'trip bias'.

The correction for the trip bias is to estimate the population's average visitation from the sample data. The procedure is to divide the sample size by the sum of the inverse of visits for each case across all respondents in the sample.

The formula is:

$$Avg = [n / \sum (1 / v_i)]$$

Where Avg is the average number of visits corrected for trip bias

n is the sample size

v_i is the number of visits for respondent i.

The correction for trip bias is presented in Table III-A. The adjustment for trip bias was performed based on a respondent's summer 2015 visitation to Rockaway Beach. The sample mean visitation, as expected due to trip bias, is substantially larger than the mean visitation corrected for trip bias (the estimate of the population mean visits).

Table III-A: Mean Number of Visits per Person to Rockaway Beach (Summer of 2015)

Rockaway Beach Mean Visits	
From Survey	16.07
Corrected for Trip Bias	5.63

The existence of trip bias required that the survey information be adjusted for over-representation of respondents that visit frequently. The correction was to weight the data items from each respondent by the inverse of visitation [1/vi], where vi is the summer 2015 visitation to Rockaway Beach for each respondent. The weighting by the inverse of the summer 2015 visitation to Rockaway Beach corrects the sample data for over representation of respondents that visit the beach frequently.

2. Descriptive Statistics

Descriptive statistics, sample means, standard deviations, and demographic characteristics for the respondents are displayed in Table III-B.

Table III-B: Summary Statistics for Travel Cost Method Survey at Rockaway Beach

Beach Trip Characteristics & Visitation

TYPE OF QUESTION	Sample means adjusted for trip bias with standard deviation in parenthesis
% Drove a Car/Passenger in Car	61.2%
% Bus/Subway	31.6%
% Walked/Rode a Bike	7.2%
% Visit Weekdays	46.6%
% Visit Weekends	24.8%
% Visit Both Weekdays & Weekends	28.6%
Travel Time to Beach	46.1 Minutes [32.7]
Tolls or Bus/Subway Fees	$3.99 [3.24]
Summer 2015 Visits to Rockaway Beach	5.63 [7.698]
Visits to Rockaway Beach if Beach Not Maintained	2.44 [6.227]
% Certain of Answers	97.7%

Demographic Characteristics of Survey Respondents

TYPE OF QUESTION	Sample means adjusted for trip bias with standard deviation in parenthesis
% Female	62.2%
% Completed College	54.3%
% Employed Full-time	65.8%
% Household Income > $ 100,000	29.2%
% With Children at Beach	25.8%
Age	37.6 [13.5]

IV. BEACH ATTENDANCE

1. Estimated Beach Usage.

Beach attendance data was provided by the Department of Parks and Recreation (DPR), City of New York. The methodology provided by DPR is as follows: The protocol for all City beaches is to take two crowd estimates daily – at 11 a.m. and 4 p.m. – then add the two together to get the daily number. Beach, boardwalk, concessions, adjacent playgrounds are all included in the count. Counts are made at various beach sections that tend to draw similar crowds. Counts at various beach locations for a single block are multiplied by the number of similar blocks.

Based on the total Rockaway Beach visitation provided by DPR, and information from the survey (corrected for trip bias), 2015 beach attendance by method of travel to the beach is provided below using the following algorithms:

Beach Attendance by Method of Travel = (% of respondents arriving by method of travel from survey)* (DPR Rockaway Beach Attendance Estimate for 2015).

# of Visitors = Visits/Average Visits.

Table IV-A :2015 Beach Attendance at Rockaway Beach

METHOD OF TRAVEL	VISITS	AVERAGE # OF VISITS FROM SURVEY	# OF VISITORS
WALK/BIKE	557,172	12.85	43,360
CAR	4,735,962	5.72	827,965
BUS/SUBWAY	2,445,366	4.05	603,794
TOTAL	7,738,500		1,475,119

The results above in Table IV-A are consistent with reasonable expectations about visits to Rockaway Beach. Those visitors who walk or bike to the beach and live close to the beach visit substantially more frequently than those that drive or take the subway/bus. These visitors make up 3 percent of visitors and 7.2 percent of visits, which is reasonable, given the larger number of potential visitors who can drive or take the bus/subway to Rockaway Beach compared to those that are within walking or biking distance.

Beach attendance under the without-project condition is estimated using responses from the survey regarding expected beach attendance if Rockaway Beach is not maintained against erosion resulting in a beach width approximately half to the existing beach width. The following algorithms are used:

Beach Attendance by Method of Travel for Without-Project Condition = [(% of respondents arriving by method of travel from survey that will have positive visits under without-project condition)* (Number of Visitors from Table IV-A)] * (Average # of Visits).

Table IV-B: Percentage of Current Rockaway Beach Users that will Visit Under Future Without-Project Condition

METHOD OF TRAVEL	% VISITING
WALK/BIKE	84%
CAR	47%
BUS/SUBWAY	45%

Table IV-C: Without-Project Beach Attendance at Rockaway Beach

METHOD OF TRAVEL	VISITS	AVERAGE # OF VISITS	# OF VISITORS
WALK/BIKE	397,364	10.91	36,422
CAR	1,891,235	4.86	389,143
BUS/SUBWAY	937,389	3.45	271,707
TOTAL	3,225,988		697,272

The without-project condition of not maintaining Rockaway Beach against erosion results in a substantial number of existing beach goers not willing to visit. Beach visitors arriving by walking or biking have the highest percentage continuing to visit under the without-project condition at 84 percent. More than 50 percent of visitors arriving by car or subway/bus are not willing to visit Rockaway Beach under the without-project condition. Those willing to visit under the without-project condition slightly reduce their number of beach visits compared with their existing beach visits. The number of visits not taking place under the without-project condition at Rockaway Beach is 4,512,512. Some of these visits will likely take place at alternative beaches such as Long Beach, Jones Beach and Coney Island.

Table IV-D: County of Residence of Rockaway Beach Users

COUNTY	PERCENTAGE OF BEACH VISITORS	AVERAGE VISITS
Bronx, N.Y.	2.8%	4.32
Brooklyn, N.Y.	18.9%	4.94
Nassau, N.Y.	3.1%	5.83
New York, N.Y.	12.7%	3.85
Queens, N.Y.	54.0%	6.99
Other	8.5%	2.65

Visitors to Rockaway Beach currently use other beaches in the area: Coney Island, Long Beach, and Jones Beach. Table IV-E shows the use of other beaches by origin county of Rockaway Beach users.

TABLE IV-E: Rockaway Beach Visitors Using Other Beaches [Percentage of Respondents Visiting other Beaches and Average Number of Visits]

	Other Beaches Visited		
Origin of Rockaway Beach Visitor	Coney Island	Long Beach	Jones Beach
New York, NY	20% 2.3 visits	20% 3.8 visits	27% 1.9 visits
Brooklyn	36% 4.0 visits	32% 3.5 visits	24% 1.8 visits
Queens	26% 2.0 visits	40% 3.7 visits	18% 2.5 visits

V. PROJECT BENEFITS

Simulated Demand Curves

The procedure for estimating the use value at Rockaway Beach is to develop "simulated" demand curves. These demand curves are referred to as "simulated" since they are not based on actual market behavior, but on behavior using travel cost to simulate price. The concept of demand describes the relationship between the number of yearly visits (quantity demanded) that people are willing to make at each travel cost (price). The approach used to obtain the relationship between travel costs and annual visits is a regression model.

With-Project Condition Use Value

The regression model estimated for the with-project benefits is:

Equation 1:

Existing Annual Visits = 12.573 – 2.159 [ln Travel Cost]

2.787) (.847)

The regression model in Equation 1 estimates the existing annual visits to Rockaway Beach for the average person using the beach. The constant term is 12.573, which is interpreted as the estimated number of visits if travel costs (price) are zero. The estimated coefficient for travel cost is -2.159 which shows the change in annual visits when travel cost increases. The natural logarithm of travel costs is used since the relationship between travel costs and annual visit is not linear. The standard errors of the regression coefficients are in parenthesis. The travel cost estimated regression coefficient is statistically different from zero at the 5-percent level or better, and has the expected negative sign. The R-square for equation 1 is .071. The number of observations are 86.

Annual visits are those reported by respondents adjusted for trip bias.

Travel cost is composed of three components discussed below.

First is the opportunity cost of travel time to Rockaway Beach. It is estimated as the travel time to the beach in hours times the hourly income of the respondent. The average travel time to the beach is 46 minutes; the median travel time is 40 minutes. Hourly income of respondent is estimated by taking the mid-point of the income categories from the questionnaire and dividing by 2,080, or the annual number of hours for a full-time employee (52 weeks x 40 hours/week). The average hourly income is $41.85; the median is $36.06. The value of hourly family income for a recreation trip is 60 percent of family income (ER 1105-2-100; Appendix D, Amendment #1; 30

June 2004). Note that adjusting the opportunity cost of travel time by a constant amount (.6) will have minimal impact on the resulting travel cost regression coefficient because the variation in travel cost per respondent is not substantially altered. The average opportunity cost of travel time to Rockaway Beach is $19.25.

Second is the cost associated with driving a vehicle. Travel time to Rockaway Beach from the survey was converted to mileage at the rate of 40 miles per hour. The IRS mileage charge of $.56 a mile was used. The average vehicle costs of driving to Rockaway Beach is $14.49; the median is $13.06. This driving cost is applied only to those visitors that drove a car to Rockaway Beach. The driving cost is divided by the number of passengers in the vehicle to arrive at driving costs per person.

Third, the tolls and bus/subway fees are included, and tolls are divided by the number of passengers in a vehicle to arrive at tolls and bus/subway fees on a per person basis. The total combined cost of components 2 and 3 is $11.99.

The total average travel costs to Rockaway Beach (the sum of opportunity cost of travel time, driving costs per person, and tolls/fees per person) is $31.24.

The number of observations available for the analysis is 513 rather than 663, as some respondents are lost from the sample pool, due to refusing to report their income. Income is necessary in the calculation of travel cost. The regression model uses the trip bias adjusted information, weighting all variables by the inverse of 2015 beach visitation. This statistical procedure reduces the number of observations in the regression to 86, but importantly removes trip bias from the analysis. Adding other variables to the model improves the overall performance but diminishes the statistical significance of travel cost.

Travel cost in this model is likely understated due to fact that most visitors to Rockaway Beach come from locations that are near and equal distanced, and those within walking distance or biking travel costs do not accurately reflect their beach valuation. These individuals beach value will be understated by travel costs, their valuation is more likely reflected in real estate values for owners or rental rates for those on vacation.

The use value for the existing condition at Rockaway Beach is calculated by measuring the area under the demand curve represented by regression equation 1. The estimated demand curve is displayed in Figure 1. A demand curve is shown by varying Travel Cost and calculating how annual visits change (Table V-A).

In making this calculation, we used the actual average trip bias adjusted visits to Rockaway Beach in 2015 to set the number of visits at zero price, or 5.63. Equation 1 then becomes:

Existing Average Annual Visits to Rockaway Beach = 5.63 – 2.159 [ln Travel Costs]. [Equation 1A]

The calculated area under the demand curve is $27.85, or $4.94 per average visit in use value or consumer surplus. For example, at a price of $5, the estimated number of visits is:

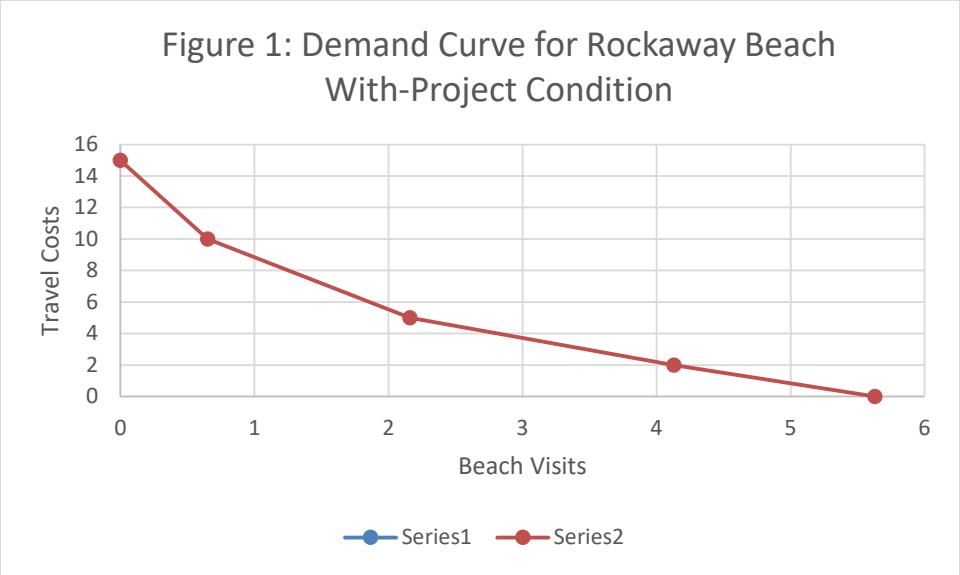
Existing Average Annual Visits to Rockaway Beach = 5.63 – 2.159[ln $5].

Taking the antilog of $5, this equation becomes:

Existing Average Annual Visits to Rockaway Beach = 5.63 –2.159 [1.609]; or 5.63 – 3.473; resulting in existing annual average visits to Rockaway Beach of 2.16 at a price (travel cost) of $5.

Table V-A: With-Project Condition: Estimated Demand Curve & Consumer Surplus

Change in Travel Costs	Estimated Number of Visits	Area Under Demand Curve
$20.00	0	0
$15.00	0	0
$10.00	.65	8.125
$5.00	2.16	11.325
$2.00	4.13	6.895
$0.00	5.63	1.5
	Consumer Surplus	$27.845
	Consumer Surplus per Visit	$4.94



Without-Project Condition Use Value

The without-project condition use value is estimated using a travel cost regression model similar to Equation 1, substituting visits under the without-project condition for existing visits as the dependent variable. Only respondents that had positive without-project visits can be used; reducing the number of observations to 38.

Equation 2:

Without-Project Annual Visits = 10.537 – 1.797 [ln Travel Cost]

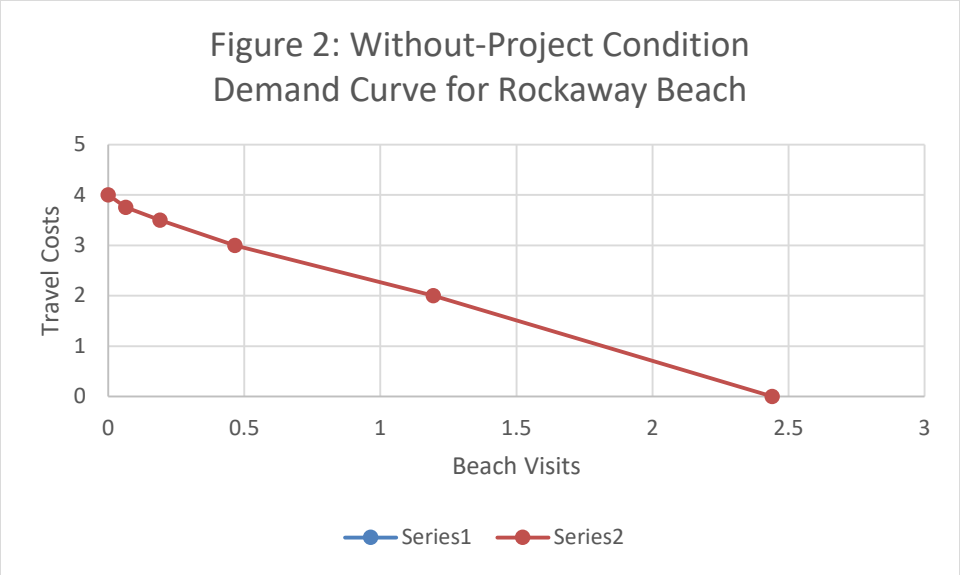
(3.525) (1.135)

R-square =.064

Following the procedure used in calculating the with-project use value, we substitute the actual without-project average visits, 2.44, for the constant in equation 2. The calculation of the demand curve and consumer surplus is presented below.

TABLE V-B: Without-Project Condition: Estimated Demand Curve & Consumer Surplus

Change in Travel Costs	Estimated Number of Visits	Area Under Demand Curve
$4.00	0.00	0.00
$3.75	0.07	0.25
$3.50	0.19	0.45
$3.00	0.47	0.90
$2.00	1.20	1.82
$0.00	2.44	1.25
	Consumer Surplus	**$4.67**
	Consumer Surplus per Visit	**$1.91**



The with- and without-project use values are summarized in Table V-C.

TABLE V-C: With and Without-Project Use Values for Rockaway Beach

Use Value	With-Project Value	Without-Project Value	Difference
Reduction in Annual Visits (visits not taken)	$4.94 per visit (from TCM)	$0	$4.94
Reduced Value for Visits	$4.94	$1.91 (from TCM)	$3.03

An alternative to the travel cost model for the without-project condition difference in use value is to use the incremental use value per visits from the Long Beach, NY and Orchard Beach, NY contingent valuation studies. Both Orchard Beach and Long Beach projects used incremental contingent valuation rather than travel cost to arrive at a project use value of $3.31 per visit for Orchard Beach and $3.17 per visit for Long Beach. These figures are the area under the demand curve or consumer surplus divided by the number of annual visits from those studies, and are presented below. The average of those two estimates is $3.24. This estimate is close to the travel cost estimate of $3.03.

TABLE V-D*:* Alternative Use Value per Visit: Without-Project Condition

Beach	Year	Method	Incremental Use Value per Visit
Orchard Beach, NY	2001	Contingent Valuation	$3.31
Long Beach, NY	1992	Contingent Valuation	$3.17

Annual Rockaway Beach Project Benefits

The annual Rockaway Beach project benefits are estimated by applying the with-project use value per visit of $4.94 to the reduction in annual visitation under the With- and Without-Project conditions from Tables IV-A and IV-C, or 4,512,512.

The increase in visits to Rockaway Beach if the beach is maintained in its present condition, compared with erosion occurring that reduces the beach width by about half, is 4,512,512 visits. Using the average use value or consumer surplus per visit of $4.94, results in an annual project benefit of $22.3 million dollars. These annual benefits would be reduced if those people currently using Rockaway Beach and not willing to use it under the without-project benefit used alternative beaches such as Long Beach and Coney Island.

In addition, the remaining visits under the without-project condition of 3,225,988 will have a lower value per visit than under the with-project condition. Applying the incremental value from Table V-C of $3.03, these continuing visits to Rockaway Beach under the without-project condition have an annual value of $9.8 million dollars.

The total annual Rockaway Beach project recreation benefits are $32 million dollars. The annual benefits are summarized in Table V-E.

TABLE V-E: Maximum Annual Rockaway Beach NED Benefits

Benefit Category	With – Without Project Use Value	Annual Visits	Annual NED Benefits
Reduction in Annual Visits	$4.94	4,512,512	$22 million
Reduced Value for Visits	$3.03	3,225,988	$10 million
Total		**7,738,500**	**$32 million**

VI. IMPACT OF ROCKAWAY BEACH EROSION TIMELINE

Recreation benefits have been evaluated by estimating the number of beach visits under with-project conditions where the beach is maintained at an approximate width of 200 feet, versus the number of beach visits under without-project future conditions where the beach would experience continued erosion.

Under existing conditions, Rockaway Beach is approximately 200 feet in width. A total of 7,738,500 total beach visits are estimated to occur per year at this beach width. Based on survey results, users are willing to pay $4.94 per visit under these conditions.

Under the with-project conditions, implementation of a beach restoration project maintains the width of existing beaches within the study area that were restored after Superstorm Sandy. Maintaining a 200 foot wide beach creates an enhanced recreation experience, which is reflected in an increase in willingness to pay (WTP) for the recreation experience and an increase in visitation. The number of annual beach visits will continue at 7,738,500 per year, with an average value per visit of $4.94.

The benefits analysis calculates the NED recreation benefits by assuming a ten-year period during which the beach erodes to the without-project condition of half its present width. In year 10, 50% of the beach width is lost and based on the user surveys, 4,512,512 annual visits are lost. The remaining 3,225,988 annual visits are assumed to provide a reduced value for the user because of the depleted beach width. The 4,512,512 lost annual visits at year 10 are assumed to be distributed linearly over the ten-year timeline for the purposes of this analysis with 10% (451,251 visits) lost in year 1, 20% (902,502 visits) lost in year 2, 30% (1,353,754 visits) lost in year 3, and so on. The 3,224,988 remaining visits in year 10 that are assumed to provide a reduced value are also distributed linearly over the ten-year timeline, with 90% of existing visitors attending in year 1(7,287,249), 80% attending in year 2 (6,835,998), 70% attending in year 3 (6,384,746), and so on.

The without-project future condition assumes the lack of beach maintenance against erosion. Rockaway Beach would continue to experience erosion at a rate of about 10 feet per year. Based on responses to beach surveys completed in the summer of 2015, it is estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by 4,512,512 visits. Beach visits per year were interpolated between these two points based on survey responses. The reduced beach width would, in turn, reduce the user willingness to pay for the remaining 3,225,988 visits to a substantially lower $3.03 per visit. The user willingness to pay was also interpolated between these two points.

Present worth factors applied were calculated using the following formula (where 'n' is the number of years from 2015 and 'i' represents a fiscal year 2015 discount rate of 2.75%):

$$\textit{present worth factor} = \textit{present worth/ future worth} = 1/(1+i)^n$$

The present value and equivalent annual value of lost visits are shown in **Table VI.A**, while **Table VI.B** shows the present value and equivalent annual value of remaining reduced-value visits.

Table VI.A – Present Value of Lost Visits by Year, Rockaway Beach, Without-Project

Year	Number of Lost Visits	Value Per Lost Visit	Value of all Visits Lost	Present Worth Factor	Present Value of Lost Visits
1	451,251	$4.94	$2,229,180	0.97324	$2,169,519
2	902,502	$4.94	$4,458,360	0.94719	$4,222,908
3	1,353,754	$4.94	$6,687,545	0.92184	$6,164,830
4	1,805,005	$4.94	$8,916,725	0.89717	$7,999,779
5	2,256,256	$4.94	$11,145,905	0.87315	$9,732,091
6	2,707,507	$4.94	$13,375,085	0.84978	$11,365,946
7	3,158,758	$4.94	$15,604,265	0.82704	$12,905,373
8	3,610,010	$4.94	$17,833,450	0.80491	$14,354,255
9	4,061,261	$4.94	$20,062,630	0.78336	$15,716,338
10	4,512,512	$4.94	$22,291,810	0.76240	$16,995,229
11-49	*Years 11-49 not reproduced here; trend shown above continues.*				
50	4,512,512	$4.94	$22,291,810	0.25758	$5,741,876
Sum of present values of reduced value visits, Years 1 through 50					$445,813,371
Capital Recovery Factor					0.0370409
Equivalent Annual Value of Lost Visits [1]					**$18.922,000**
Equivalent Annual Value of Lost Visits [2]					**$19,924,000**

3. 2015 Price Level, 2.750% Interest Rate
4. 2018 Price Level, 2.750% Interest Rate

Table VI.B – Present Value of Reduced Value Visits by Year, Rockaway Beach, Without-Project					
Year	**Number of Reduced Value Visits**	**Loss in Value Per Remaining Visit**	**Value of Reduced Value Visits**	**Present Worth Factor**	**Present Value of Reduced Value Visits**
1	7,287,249	$0.30	$2,208,036	0.97324	$2,148,941
2	6,835,998	$0.61	$4,142,615	0.94719	$3,923,836
3	6,384,746	$0.91	$5,803,734	0.92184	$5,350,102
4	5,933,495	$1.21	$7,191,396	0.89717	$6,451,874
5	5,482,244	$1.52	$8,305,600	0.87315	$7,252,068
6	5,030,993	$1.82	$9,146,345	0.84978	$7,772,426
7	4,579,742	$2.12	$9,713,632	0.82704	$8,033,575
8	4,128,490	$2.42	$10,007,461	0.80491	$8,055,069
9	3,677,239	$2.73	$10,027,831	0.78336	$7,855,441
10	3,225,988	$3.03	$9,774,744	0.76240	$7,452,244
11-49	*Years 11-49 not reproduced here; trend shown above continues.*				
50	3,225,988	$3.03	$9,774,744	0.25758	$2,517,757
Sum of present values of reduced value visits, Years 1 through 50					$218,440,210
Capital Recovery Factor					0.0370409
Equivalent Annual Value of Lost Visits [1]					**$9,028,037**
Equivalent Annual Value of Lost Visits [2]					**$9,506,000**

3. 2015 Price Level, 2.750% Interest Rate
4. 2018 Price Level, 2.750% Interest Rate

NED recreation benefits over each year of the project timeline were calculated as the sum of the present value of lost visits plus the present value of the remaining reduced-value visits. **Table VI.C** documents the present value of NED recreation benefits by year, as well as equivalent annual NED recreation benefits.

Table VI.C – NED Recreation Benefits, Rockaway Beach, Without-Project			
Year	**Present Value of Lost Visits**	**Present Value of Reduced Value Visits**	**NED Recreation Benefits**
1	$2,169,519	$2,148,941	$4,318,460
2	$4,222,908	$3,923,836	$8,146,744
3	$6,164,830	$5,350,102	$11,514,931
4	$7,999,779	$6,451,874	$14,451,653
5	$9,732,091	$7,252,068	$16,984,159
6	$11,365,946	$7,772,426	$19,138,372
7	$12,905,373	$8,033,575	$20,938,947
8	$14,354,255	$8,055,069	$22,409,324
9	$15,716,338	$7,855,441	$23,571,778
10	$16,995,229	$7,452,244	$24,447,473
11-49	*Years 11-49 not reproduced here; trend shown above continues.*		
50	$5,741,876	$2,517,757	$8,259,633
Sum of present values of NED Benefits, Years 1 through 50			$754,570,562
Capital Recovery Factor			0.0370409
Equivalent Annual Value of Lost Visits [1]			**$27,950,000**
Equivalent Annual Value of Lost Visits [2]			**$29,430,000,**

3. 2015 Price Level, 2.750% Interest Rate
4. 2018 Price Level, 2.750% Interest Rate

ATTACHMENT A: INTERVIEW FORM

ROCKAWAY BEACH –SURVEY 1- OMB# 0710-00001 Expires: 12/31/2016 ID
DATE INTERVIEWER START TIME
LOCATION

---READ INTRO on NARRATIVE---
SECTION A – BEACH TRIP CHARACTERISTICS
1. HOW DID YOU GET TO ROCKAWAY BEACH TODAY?
1. □ DROVE A CAR 3. □ RODE A BIKE 5. □ BUS/SUBWAY
2. □ WALKED 4. □ PASSENGER IN A CAR 6. □ OTHER_____

1A. HOW MUCH TIME DID THE TRIP TO THE BEACH TAKE TODAY (record in minutes)? _____
1B. HOW MUCH DID YOU PAY IN TOLLS OR BUS/SUBWAY FEES TO GET TO THE BEACH TODAY? $_____
2. IF ARRIVED BY CAR, HOW MANY PASSENGERS, INCLUDING YOU, WERE IN THE CAR? ___

3. WHERE IS THE CAR PARKED?

1. □ FREE PARKING LOT 2. □ ON THE STREET

4. WHEN DO YOU NORMALLY VISIT ROCKAWAY BEACH?
1. □ WEEKDAYS 2. □ WEEKENDS 3. □ BOTH
SECTION B: BEACH VISITATION PER SUMMER AND WTP
See Narrative for Question 5

5. Existing (#)
[ ] ROCKAWAY BEACH _____
See Narrative for Question 6

6. W-out/Project Reduced Visits (#)
Yes □ No □
If Yes - _____
Total RB Visitation w-out/Project
(Sum #5 and #6)

7. WHICH OF THE FOLLOWING OTHER BEACHES DO YOU VISIT IN THE SUMMER AND HOW MANY VISITS DO YOU TYPICALLY MAKE?
[ ] CONEY ISLAND _____
[ ] LONG BEACH _____

8. WHICH OF THE FOLLOWING STATEMENTS BEST DESCRIBES YOUR ANSWERS TO THE QUESTIONS ABOUT BEACH VISITATION?
1. □ THERE WAS SOME UNCERTAINTY IN MY ANSWERS
2. □ I WAS CERTAIN OF MY ANSWERS.
3. □ I WAS UNCERTAIN OF MY ANSWERS.

SECTION C: BACKGROUND INFORMATION: THE FOLLOWING INFORMATION WILL HELP OUR RESEARCH STAFF PROPERLY ANALYZE THE RESULTS OF THE STUDY.

9. WHAT IS YOUR HOME ZIP CODE? _____

10. WHAT IS YOUR AGE? _____

11. HOW MANY CHILDREN UNDER THE AGE OF 13 ARE WITH YOU AT THE BEACH TODAY? _____

12. WHICH OF THE FOLLOWING BEST DESCRIBES YOUR PRESENT EMPLOYMENT STATUS (REFER TO FLIP CARD 1)?
1. □ EMPLOYED FULL TIME 4. □ NOT EMPLOYED 6. □ A HOMEMAKER
2. □ EMPLOYED PART TIME 5. □ A STUDENT 7. □ OTHER _____
3. □ RETIRED 8. □ REFUSED

13. WHAT WAS THE LAST GRADE OF REGULAR SCHOOL THAT YOU COMPLETED (REFER TO FLIP CARD 2)?
1. □ NO FORMAL EDUCATION 6. □ SOME COLLEGE
2. □ SOME GRADE SCHOOL 7. □ COMPLETED COLLEGE
3. □ COMPLETED GRADE SCHOOL 8. □ SOME GRADUATE SCHOOL
4. □ SOME HIGH SCHOOL 9. □ COMPLETED GRADUATE SCHOOL
5. □ COMPLETED HIGH SCHOOL 10. □ REFUSED

14. WHAT BEST DESCRIBES YOUR COMBINED HOUSEHOLD INCOME LAST YEAR (REFER TO FLIP CARD 3)?

A. Less than $15,000

B. $15,000-$19,999

C. $20,000-$24,999

D. $25,000-$29,999

E. $30,000-$34,999

F. $35,000-$39,999

G. $40,000-$44,999

H. $45,000-$49,999

I. $50,000-$54,999

J. $55,000-$59,999

K. $60,000-$64,999

L. $65,000-$69,999

M. $70,000-$79,999

N. $80,000-$99,999

O. $100,000 - $149,999

P. $150,000 - $199,999

Q. $200,000 - $249,999

R. $250,000 or more

S. Refused / did not know

16. RECORD LANGUAGE OF INTERVIEW □ ENGLISH □ SPANISH
17. RECORD GENDER OF RESPONDENT □ MALE □ FEMALE

THANK YOU FOR YOUR PARTICIPATION! STOP TIME_____

Notes and References

http://www.nyc.gov/html/dcp/pdf/neigh_info/profile/qn14_profile.pdf
[1] http://www.nyc.gov/html/dcp/pdf/lucds/qn14profile.pdf
[1] http://www.nycgovparks.org/pagefiles/71/Conceptual-Plan-Final-Report.pdf, B13
[1] http://www.nycgovparks.org/parks/rockaway-beach-and-boardwalk
[1] http://www.npca.org/about-us/center-for-park-research/stateoftheparks/gateway/Gateway_CSOTP_NPCA.pdf, p2
https://irma.nps.gov/Stats/Reports/Park
[1] http://www.npca.org/about-us/center-for-park-research/stateoftheparks/gateway/Gateway_CSOTP_NPCA.pdf, 10
[1] http://www.nyharborparks.org/visit/brpo.html
[1] http://www.npca.org/about-us/center-for-park-research/stateoftheparks/gateway/Gateway_CSOTP_NPCA.pdf, 12
[1] http://www.npca.org/about-us/center-for-park-research/stateoftheparks/gateway/Gateway_CSOTP_NPCA.pdf, 18
[1] http://www.npca.org/about-us/center-for-park-research/stateoftheparks/gateway/Gateway_CSOTP_NPCA.pdf, 18

US Army Corps of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix C

Cost Engineering Appendix

July 2019

TABLE OF CONTENTS

1 INTRODUCTION 2
2 PROJECT DESCRIPTION 3
2.1 Location 3
2.2 Feature Descriptions 3
3 RECOMMENDED PLAN FOR EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY 4
3.1 Introduction 4
3.2 HFFRRF for Jamaica Bay 4
3.2.1 Description of Tasks 4
3.2.2 30 - Planning, Engineering, and Design 5
3.2.3 31 - Construction Management 5
3.2.4 Cost Summary 5
3.2.5 MII Estimate 8
3.2.6 Schedule 8
3.3 Rockaway Shorefront 8
3.3.1 Description of Tasks 8
3.3.2 Markups 9
3.3.3 18 – Cultural Resource Preservation 9
3.3.4 30 - Planning, Engineering, and Design 9
3.3.5 31 - Construction Management 9
3.3.6 Cost Summary 9
3.3.7 MII Estimate 13
3.3.8 Schedule 13
3.4 Recommended Plan Cost Summary 13
3.4.1 Operations and Maintenance (O&M) Costs 15
3.5 Interest During Construction 15
3.6 Beach Renourishment 15
3.7 Annualized Costs 16
4 COST AND SCHEDULE RISK ANALYSIS 17
4.1 Introduction 17
4.2 Background 17
4.3 Report Scope 17
4.4 USACE Risk Analysis Process 17
4.5 Methodology / Process 18
4.5.1 Identify and Assess Risk Factors 18

4.5.2 Quantify Risk Factor Impacts 19
4.5.3 Analyze Cost Estimate and Schedule Contingency 20
4.6 RISK ANALYSIS RESULTS 20
4.6.1 Risk Register – Cost Risk Analysis 20
4.6.1 Risk Register – Schedule Risk Analysis 24
4.7 Cost Risk Analysis - Cost Contingency Results 26
5 SCHEDULE RISK ANALYSIS 29
5.1 Results 29
6 MAJOR FINDINGS/OBSERVATIONS 31
7 RECOMMENDATIONS 32
A. SUB-APPENDIX A: MII ESTIMATE – JAMAICA BAY 33
B. SUB-APPENDIX B: PROJECT SCHEDULE 34
C. SUB-APPENDIX C: MII ESTIMATE - SHOREFRONT 35
D. SUB-APPENDIX D: RISK REGISTER 36
E. SUB-APPENDIX E: COST RISK ANALYSIS 37
F. SUB-APPENDIX F: SCHEDULE RISK ANALYSIS 38
G. SUB-APPENDIX G: PUMP COST CURVE 39

LIST OF TABLES

Table 3-1: Mid-Rockaway HFFRRF Costs 6
Table 3-2: Cedarhurst Lawrence HFFRRF Costs 7
Table 3-3: Shorefront Costs 10
Table 3-4: TPCS for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay 14
Table 3-5: Interest During Construction 15
Table 3-6: Annualized Project Costs 16
Table 4-1: Key Cost Risks Identified 21
Table 4-2: Key Schedule Risks Identified 24
Table 4-3: Confidence Table of Total Cost 28
Table 4-4: Project Contingencies (Base Cost Plus Cost and Contingencies) 28

LIST OF FIGURES

Figure 4-1: Risk Level Matrix 19
Figure 4-2: Cost Distribution with the 80% Confidence Interval Shown 26
Figure 4-3: Sensitivity Analysis for Cost Risk 27
Figure 5-1: Schedule Risk Analysis Results 29
Figure 5-2: Schedule Risk Analysis Sensitivity 30

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
Reformulation Study

Integrated Hurricane Sandy General Reevaluation Report
and Environmental Impact Statement

Appendix C

Cost Engineering Appendix

1 INTRODUCTION

This Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet Hurricane Sandy General Revaluation Report Cost Engineering Appendix summarizes the cost engineering methods used to calculate project costs for features for each planning reach within the study area. There were initially three reaches within the study area, but one reach, Motts Basin North was removed during the Recommended Plan as its benefit-to-cost ratio dropped below 1.0. The remaining two reaches within the study area: 1) the Atlantic Shorefront and 2) Jamaica Bay. Since each planning reach is exposed to different risk mechanisms, two engineering appendices are included within this GRR/EIS: Appendix A1 - Shorefront Engineering and Design Appendix, and Appendix A2 - Jamaica Bay High Frequency Flood Risk Reduction Features Engineering and Design Appendix.

This Cost Engineering Appendix provides an overview of the cost analyses supporting both the development of the High Frequency Flood Risk Reduction Features (HFFRRF) for Jamaica Bay and the shorefront reach. This appendix describes the development of MII Cost Estimate for the Recommended Plan for these two reaches. Lastly, this appendix details the cost and schedule risk analysis (CSRA), with the recommended contingency value for the MII estimate and Total Project Cost Summary (TPCS) determined from the CSRA analysis.

The initial study was initially limited to the Atlantic Ocean Shoreline Planning Reach and was conducted as a legacy study. The engineering analyses were conducted to satisfy a more rigorous design level and the Atlantic Ocean shorefront summary engineering documents were written to satisfy those study requirements. The Jamaica Bay Planning Reach analysis was added following Hurricane Sandy and was conducted to broaden the recommended plan to the entire authorized study area and was conducted under SMART planning guidelines.

As a result of the Agency Decision Milestone, the storm surge barrier component of the Tentatively Selected Plan was moved into the New York and New Jersey Harbor and Tributaries Study for further study and possible recommendation. Without the barrier, the communities surrounding Jamaica Bay still experience substantial risk for coastal flooding. Therefore, the study team sought to identify stand-alone features that could complement a potential future storm surge barrier, but also be economically justified on their own. Residents in many parts of the Back-Bay experience regular flooding due to rainfall events and high tides that occur frequently. Since the proposed barrier would not be closed at every high tide or rainfall event, there is an opportunity to recommend features to mitigate flood risk for high frequency flooding events where the proposed storm surge barrier would remain open yet inundation still occurs.

2 PROJECT DESCRIPTION

2.1 Location

Please refer to Figure 2-4 in the HFFRRF Engineering Appendix A2 and Figure 1-1 of the Shorefront Engineering Appendix A1 for details relating to the project location.

2.2 Feature Descriptions

The high frequency flood risk reduction features are detailed in Section 4 of the Engineering Appendix (A2), including typical sections for all features. The alternative development options for the shorefront are detailed in Section 7 of the Shorefront Appendix (A1).

3 RECOMMENDED PLAN FOR EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY

3.1 Introduction

The Recommended Plan (RP) for the East Rockaway inlet to Rockaway inlet and Jamaica Bay includes the shorefront sections along Rockaway beach that feature beach fill, groin construction and composite seawall construction. Typical sections and plan views are included in Sub Appendix A1-C of the shorefront Engineering Appendix. The Jamaica Bay section of the project includes various features to reduce flooding in the area including berms, bulkheads, and floodwalls. The Jamaica Bay reach consists of two HFFRRF sites: Mid-Rockaway and Cedarhurst Lawrence. Costs for these areas were developed in MCACES II (MII) in accordance with USACE guidelines and contingency was calculated via the cost and schedule risk analysis using Crystal Ball software.

All labor is assumed to be from prevailing wage rates for New York City and equipment rates estimated from published Blue Book Rates for equipment and supplemented with USACE Region 1 equipment data.

3.2 HFFRRF for Jamaica Bay

The HFFRRF for Jamaica Bay recommended plan initially included three locations, Mid-Rockaway, Motts Basin North, and Cedarhurst Lawrence. However, during the recommended plan phase, increases to the costs of the Motts Basin North location without any corresponding increases in the benefits caused its benefit-to-cost ratio to drop below 1.0, removing it from the recommended plan. The recommended plan described below consists only of Mid-Rockaway and Cedarhurst Lawrence.

3.2.1 Description of Tasks

3.2.1.1 01 – Lands & Damages

Real Estate costs have been provided by the USACE for this project.

3.2.1.2 11 – Floodwalls

Floodwalls were designed using steel sheet pile walls with a concrete cap, with excavation of material and fill material compacted on site. It was assumed that pavement demolition was required, as well as utility relocations, although no location information for utilities was provided. Three different heights of floodwalls were considered, low, medium, and high, but they all contain the same construction features and materials, just varying quantities of each. All steel shapes were assumed to be shapes that are domestically supplied. A description of the individual elements are included in the MII estimate.

3.2.1.1 13 - Pump Stations

Pump stations were estimated using pump cost curves for the New York Metropolitan area. Costs are estimated based off of the size and number of pumps in a given HFFRRF site. Please refer to Sub-appendix G for further information on pump cost development.

3.2.1.2 18 – Cultural Resource Preservation

Costs for the cultural resource preservation were estimated using data provided by the USACE on November 20, 2018. These costs include Phase 1 and Phase II surveys, historic structure documentation and Phase II data recovery efforts. The Phase III data recovery costs do not exceed the 1% threshold.

3.2.2 30 - Planning, Engineering, and Design

Code of Account 30, Planning, Engineering, and Design (PED) was estimated at 12% of construction costs for the Jamaica Bay sections that require additional survey, utility location, and further site specific design.

3.2.3 31 - Construction Management

Code of Account 31, Construction management costs were estimated using the USACE Supervision and Administration cost formula [% = 17 – 2.1 * log (subtotal / 1000) / 100]. This calculated to a 6.11% construction management percentage for the Jamaica Bay project.

3.2.4 Cost Summary

The Summary of costs for the Jamaica Bay portion of the project including the 28.36% contingency calculated in the CSRA (see section 4) are included in Tables 3-1 and 3-2 below.

Table 3-1: Mid-Rockaway HFFRRF Costs

**** CONTRACT COST SUMMARY ****

PROJECT: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
LOCATION: Queens, NY
This Estimate reflects the scope and schedule in report; East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

DISTRICT: NY District
POC: CHIEF, COST ENGINEERING, Mukesh Kumar
PREPARED: 6/20/2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 20-Aug-18 Effective Price Level: 1-Oct-17				Program Year (Budget EC): 2019 Effective Price Level Date: 1 OCT 18								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	Mid-Rockaway													
02	RELOCATIONS	$4,155	$1,178	28.4%	$5,333	2.1%	$4,240	$1,203	$5,443	2020Q4	3.5%	$4,390	$1,245	$5,636
11	LEVEES & FLOODWALLS	$91,240	$25,876	28.4%	$117,116	2.1%	$93,113	$26,407	$119,519	2022Q2	6.7%	$99,309	$28,164	$127,473
13	PUMPING PLANT	$33,824	$9,592	28.4%	$43,416	2.1%	$34,518	$9,789	$44,307	2022Q2	6.7%	$36,815	$10,441	$47,256
18	CULTURAL RESOURCE PRESERVATION	$1,250	$355	28.4%	$1,605	2.1%	$1,276	$362	$1,637	2022Q2	6.7%	$1,361	$386	$1,746
	CONSTRUCTION ESTIMATE TOTALS:	$130,469	$37,001	28.4%	**$167,470**		$133,146	$37,760	$170,907			$141,875	$40,236	$182,111
01	LANDS AND DAMAGES	$28,649	$5,730	20.0%	$34,379	2.1%	$29,237	$5,847	$35,084	2020Q4	3.5%	$30,272	$6,054	$36,327
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$1,305	$370	28.4%	$1,675	3.9%	$1,355	$384	$1,739	2019Q3	2.1%	$1,383	$392	$1,775
0.5%	Planning & Environmental Compliance	$652	$185	28.4%	$837	3.9%	$677	$192	$870	2019Q3	2.1%	$691	$196	$888
6.0%	Engineering & Design	$7,828	$2,220	28.4%	$10,048	3.9%	$8,130	$2,306	$10,436	2019Q3	2.1%	$8,297	$2,353	$10,650
0.5%	Reviews, ATRs, IEPRs, VE	$652	$185	28.4%	$837	3.9%	$677	$192	$870	2019Q3	2.1%	$691	$196	$888
0.5%	Life Cycle Updates (cost, schedule, risks)	$652	$185	28.4%	$837	3.9%	$677	$192	$870	2019Q3	2.1%	$691	$196	$888
0.5%	Contracting & Reprographics	$652	$185	28.4%	$837	3.9%	$677	$192	$870	2019Q3	2.1%	$691	$196	$888
1.0%	Engineering During Construction	$1,305	$370	28.4%	$1,675	3.9%	$1,355	$384	$1,739	2022Q2	14.0%	$1,545	$438	$1,984
1.0%	Planning During Construction	$1,305	$370	28.4%	$1,675	3.9%	$1,355	$384	$1,739	2022Q2	14.0%	$1,545	$438	$1,984
0.5%	Adaptive Management & Monitoring	$652	$185	28.4%	$837	3.9%	$677	$192	$870	2022Q2	14.0%	$773	$219	$992
0.5%	Project Operations	$652	$185	28.4%	$837	3.9%	$677	$192	$870	2019Q3	2.1%	$691	$196	$888
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$5,219	$1,480	28.4%	$6,699	3.9%	$5,420	$1,537	$6,957	2022Q2	14.0%	$6,181	$1,753	$7,934
1.0%	Project Operation:	$1,305	$370	28.4%	$1,675	3.9%	$1,355	$384	$1,739	2022Q2	14.0%	$1,545	$438	$1,984
1.1%	Project Management	$1,448	$411	28.4%	$1,859	3.9%	$1,504	$427	$1,931	2022Q2	14.0%	$1,715	$486	$2,202
	CONTRACT COST TOTALS:	$182,746	$49,432		$232,178		$186,922	$50,567	**$237,489**			$198,589	$53,789	**$252,378**

Table 3-2: Cedarhurst Lawrence HFFRRF Costs

**** CONTRACT COST SUMMARY ****

PROJECT: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
LOCATION: Queens, NY
This Estimate reflects the scope and schedule in report; East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

DISTRICT: NY District
POC: CHIEF, COST ENGINEERING, Mukesh Kumar
PREPARED: 6/20/2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: / Effective Price Level:			20-Aug-18 / 1-Oct-17	Program Year (Budget EC): / Effective Price Level Date:			2019 / 1 OCT 18					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	Cedarhurst Lawrence													
02	RELOCATIONS	$175	$50	28.4%	$225	2.1%	$179	$51	$230	2020Q4	3.5%	$185	$53	$238
11	LEVEES & FLOODWALLS	$6,694	$1,898	28.4%	$8,592	2.1%	$6,831	$1,937	$8,768	2021Q3	5.1%	$7,178	$2,036	$9,214
13	PUMPING PLANT	$2,753	$781	28.4%	$3,534	2.1%	$2,809	$797	$3,606	2021Q4	5.6%	$2,967	$841	$3,809
18	CULTURAL RESOURCE PRESERVATION	$750	$213	28.4%	$963	2.1%	$765	$217	$982	2021Q3	5.1%	$804	$228	$1,032
	CONSTRUCTION ESTIMATE TOTALS:	$10,372	$2,941	28.4%	**$13,314**		$10,585	$3,002	$13,587			$11,135	$3,158	$14,293
01	LANDS AND DAMAGES	$725	$145	20.0%	$870	2.1%	$740	$148	$888	2020Q3	3.0%	$762	$152	$915
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$104	$29	28.4%	$133	3.9%	$108	$31	$138	2019Q3	2.1%	$110	$31	$141
0.5%	Planning & Environmental Compliance	$52	$15	28.4%	$67	3.9%	$54	$15	$69	2019Q3	2.1%	$55	$16	$71
6.0%	Engineering & Design	$622	$176	28.4%	$799	3.9%	$646	$183	$830	2019Q3	2.1%	$660	$187	$847
0.5%	Reviews, ATRs, IEPRs, VE	$52	$15	28.4%	$67	3.9%	$54	$15	$69	2019Q3	2.1%	$55	$16	$71
0.5%	Life Cycle Updates (cost, schedule, risks)	$52	$15	28.4%	$67	3.9%	$54	$15	$69	2019Q3	2.1%	$55	$16	$71
0.5%	Contracting & Reprographics	$52	$15	28.4%	$67	3.9%	$54	$15	$69	2019Q3	2.1%	$55	$16	$71
1.0%	Engineering During Construction	$104	$29	28.4%	$133	3.9%	$108	$31	$138	2021Q3	10.7%	$119	$34	$153
1.0%	Planning During Construction	$104	$29	28.4%	$133	3.9%	$108	$31	$138	2021Q3	10.7%	$119	$34	$153
0.5%	Adaptive Management & Monitoring	$52	$15	28.4%	$67	3.9%	$54	$15	$69	2021Q3	10.7%	$60	$17	$77
0.5%	Project Operations	$52	$15	28.4%	$67	3.9%	$54	$15	$69	2019Q3	2.1%	$55	$16	$71
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$415	$118	28.4%	$533	3.9%	$431	$122	$553	2021Q3	10.7%	$477	$135	$612
1.0%	Project Operation:	$104	$29	28.4%	$133	3.9%	$108	$31	$138	2021Q3	10.7%	$119	$34	$153
1.1%	Project Management	$115	$33	28.4%	$148	3.9%	$120	$34	$153	2021Q3	10.7%	$132	$38	$170
	CONTRACT COST TOTALS:	$12,975	$3,619		**$16,595**		$13,276	$3,703	**$16,979**			$13,968	$3,898	**$17,866**

3.2.5 MII Estimate

The MII Estimate for Jamaica Bay is included in Sub-Appendix A.

3.2.6 Schedule

The Project Schedule is included in Sub-Appendix B.

3.3 Rockaway Shorefront

3.3.1 Description of Tasks

Beach fill is planned for construction starting in December 2019. Since it is impossible to predict the exact shoreline position for the point in time that construction is to start, beach fill quantities required for initial construction are estimated based on the expected shoreline position in December 2019. The unknown quantities are due to the fact that wave conditions vary from year to year and affect shoreline change rates. The assumptions utilized in the quantity estimate are detailed in the Shorefront Engineering and Design Appendix (Appendix A1).

3.3.1.1 17 - Beach Fill

Beach fill was estimated by a USACE provided CEDEP estimate for this project using a hydraulic cutterhead dredge. Mobilization and Demobilization for this dredge was also provided by the USACE using a CEDEP.

3.3.1.2 10 - Groin Extensions

Five groins in Reaches 5 & 6 have been proposed to be extended to reduce erosion and improve overall project performance. These groins will have a layer of bedding stone that is 30 – 130 lbs. The core layer of the groin will be the same size, with a larger layer of underlayer stone that will serve as a dividing layer between the armor and the core stone. The underlayer stone is proposed as 500 – 1500 lbs stone. The top layer of armor stone is estimated as 7-10 tons in weight. A diagram showing the cross section of the groin extensions is located on Sheet CS-407 of Sub-Appendix C of Appendix A1, the Shorefront Engineering Appendix (A1).

3.3.1.3 10 - New Groin Construction

16 total groins are to be constructed in addition to the five groin extensions discussion previously. These groins range from 298 feet - 498 feet long. These groins have the same design as the groin extensions with a layer of bedding stone, core stone, underlayer stone, and armor stone on top. A typical section of the new groin construction is located in Figure 7-6 of the Shorefront Engineering Appendix (A1). The new groin construction had the same components as the groin extensions, and are described below.

3.3.1.4 10 - Composite Seawall

Construction of a 32,450 foot composite wall has been proposed along the beach to protect the boardwalk and residential homes adjacent to the beach, including a taper to connect the seawall with other flood protection features. The composite wall consists of steel sheet piles with a concrete cap. The wall is then protected using large armor stone with an underlayer stone to separate the armor from the sand beneath. A significant amount of sand must also be excavated for the placement of the underlayer and armor stone.

3.3.2 Markups

Markups for the shorefront work included sales tax on materials and overtime. It was assumed that the composite wall was constructed 6 days a week, with a single shift per day. This resulted in an 8.875% markup in the MII file. Profit was estimated at 10.0% using the USACE profit weighted guidelines.

3.3.3 18 – Cultural Resource Preservation

Costs for the cultural resource preservation were estimated using data provided by the USACE on November 20, 2018. These costs include Phase 1 and Phase II surveys, historic structure documentation and Phase II data recovery efforts. The Phase III data recovery costs do not exceed the 1% threshold.

3.3.4 30 - Planning, Engineering, and Design

Code of Account 30, Planning, Engineering, and Design (PED) was estimated at 8% for the shorefront portions, with detailed survey and further refinement required for the design near the boardwalk.

3.3.5 31 - Construction Management

Code of Account 31, Construction management costs were estimated using the USACE Supervision and Administration cost formula [% = 17 – 2.1 * log (subtotal / 1000) / 100]. This calculated to a 5.8% construction management percentage for the shorefront project.

3.3.6 Cost Summary

The summary of costs for the shorefront including the 28.36% contingency calculated from the CSRA (See section 4) is included in Table 3-3 below. The additional costs for the beach replenishment over the 50 year life cycle is included in Tables 3-4 & 3-5 below.

Table 3-3: Shorefront Costs

**** CONTRACT COST SUMMARY ****

PROJECT: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
LOCATION: Queens, NY
This Estimate reflects the scope and schedule in report; East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

DISTRICT: NY District
POC: CHIEF, COST ENGINEERING, Mukesh Kumar

PREPARED: 6/20/2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: / Effective Price Level:			20-Aug-18 / 1-Oct-17	Program Year (Budget EC): / Effective Price Level Date:			2019 / 1 OCT 18	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	Shorefront													
10	BREAKWATER & SEAWALLS	$187,704	$53,233	28.4%	$240,936	2.1%	$191,556	$54,325	$245,881	2022Q1	6.1%	$203,281	$57,650	$260,931
17	BEACH REPLENISHMENT	$26,966	$7,648	28.4%	$34,614	2.1%	$27,519	$7,804	$35,324	2020Q3	3.0%	$28,353	$8,041	$36,393
18	CULTURAL RESOURCE PRESERVATION	$10,000	$2,836	28.4%	$12,836	2.1%	$10,205	$2,894	$13,099	2021Q3	5.1%	$10,724	$3,041	$13,766
	CONSTRUCTION ESTIMATE TOTALS:	$224,670	$63,716	28.4%	**$288,386**		$229,280	$65,024	$294,304			$242,358	$68,733	$311,090
01	LANDS AND DAMAGES	$528	$106	20.0%	$634	2.1%	$539	$108	$647	2019Q3	1.0%	$545	$109	$654
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$2,247	$637	28.4%	$2,884	3.9%	$2,333	$662	$2,995	2019Q1	0.0%	$2,333	$662	$2,995
0.5%	Planning & Environmental Compliance	$1,123	$319	28.4%	$1,442	3.9%	$1,167	$331	$1,498	2019Q1	0.0%	$1,167	$331	$1,498
2.0%	Engineering & Design	$4,493	$1,274	28.4%	$5,768	3.9%	$4,667	$1,323	$5,990	2019Q1	0.0%	$4,667	$1,323	$5,990
0.5%	Reviews, ATRs, IEPRs, VE	$1,123	$319	28.4%	$1,442	3.9%	$1,167	$331	$1,498	2019Q1	0.0%	$1,167	$331	$1,498
0.5%	Life Cycle Updates (cost, schedule, risks)	$1,123	$319	28.4%	$1,442	3.9%	$1,167	$331	$1,498	2019Q1	0.0%	$1,167	$331	$1,498
0.5%	Contracting & Reprographics	$1,123	$319	28.4%	$1,442	3.9%	$1,167	$331	$1,498	2019Q1	0.0%	$1,167	$331	$1,498
1.0%	Engineering During Construction	$2,247	$637	28.4%	$2,884	3.9%	$2,333	$662	$2,995	2022Q1	12.9%	$2,635	$747	$3,382
1.0%	Planning During Construction	$2,247	$637	28.4%	$2,884	3.9%	$2,333	$662	$2,995	2022Q1	12.9%	$2,635	$747	$3,382
0.5%	Adaptive Management & Monitoring	$1,123	$319	28.4%	$1,442	3.9%	$1,167	$331	$1,498	2019Q3	2.1%	$1,191	$338	$1,528
0.5%	Project Operations	$1,123	$319	28.4%	$1,442	3.9%	$1,167	$331	$1,498	2019Q1	0.0%	$1,167	$331	$1,498
31	CONSTRUCTION MANAGEMENT													
4.0%	Construction Management	$8,987	$2,549	28.4%	$11,535	3.9%	$9,333	$2,647	$11,980	2022Q1	12.9%	$10,539	$2,989	$13,528
1.0%	Project Operation:	$2,247	$637	28.4%	$2,884	3.9%	$2,333	$662	$2,995	2022Q1	12.9%	$2,635	$747	$3,382
0.8%	Project Management	$1,797	$510	28.4%	$2,307	3.9%	$1,867	$529	$2,396	2022Q1	12.9%	$2,108	$598	$2,706
	CONTRACT COST TOTALS:	$256,202	$72,615		**$328,817**		$262,019	$74,264	**$336,282**			$277,478	$78,647	**$356,125**

Table 3-4: Shorefront Beach Replenishment Costs

**** CONTRACT COST SUMMARY ****

PROJECT: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
LOCATION: Queens, NY
This Estimate reflects the scope and schedule in report; East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

DISTRICT: NY District
POC: CHIEF, COST ENGINEERING, Mukesh Kumar
PREPARED: 6/20/2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 20-Aug-18 Effective Price Level: 1-Oct-17				Program Year (Budget EC): 2019 Effective Price Level Date: 1 OCT 18				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	RENOURISHMENT COSTS (EVERY 4 YRS)													
17	BEACH REPLENISHMENT - CYCLE 1	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2024Q3	11.5%	$21,932	$6,220	$28,152
17	BEACH REPLENISHMENT - CYCLE 2	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2028Q3	20.7%	$23,740	$6,733	$30,473
17	BEACH REPLENISHMENT - CYCLE 3	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2032Q3	30.7%	$25,697	$7,288	$32,984
17	BEACH REPLENISHMENT - CYCLE 4	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2036Q3	41.4%	$27,815	$7,888	$35,703
17	BEACH REPLENISHMENT - CYCLE 5	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2040Q3	53.1%	$30,108	$8,539	$38,646
17	BEACH REPLENISHMENT - CYCLE 6	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2044Q3	65.7%	$32,590	$9,242	$41,832
17	BEACH REPLENISHMENT - CYCLE 7	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2048Q3	79.4%	$35,276	$10,004	$45,281
17	BEACH REPLENISHMENT - CYCLE 8	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2052Q3	94.2%	$38,184	$10,829	$49,013
17	BEACH REPLENISHMENT - CYCLE 9	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2056Q3	110.2%	$41,332	$11,722	$53,053
17	BEACH REPLENISHMENT - CYCLE 10	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2060Q3	127.5%	$44,739	$12,688	$57,426
17	BEACH REPLENISHMENT - CYCLE 11	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2064Q3	146.2%	$48,427	$13,734	$62,160
17	BEACH REPLENISHMENT - CYCLE 12	$19,271	$5,465	28.4%	$24,736	2.1%	$19,666	$5,577	$25,244	2068Q3	166.5%	$52,419	$14,866	$67,285
	CONSTRUCTION ESTIMATE TOTALS:	$231,251	$65,583	28.4%	$296,833		$235,995	$66,928	$302,923			$422,257	$119,752	$542,009
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2023Q3	20.0%	$2,401	$681	$3,082
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2027Q3	42.1%	$2,843	$806	$3,650
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2031Q3	70.0%	$3,402	$965	$4,367
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2035Q3	105.6%	$4,115	$1,167	$5,282
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2039Q3	151.2%	$5,028	$1,426	$6,454
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2043Q3	207.7%	$6,158	$1,747	$7,905
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2047Q3	276.9%	$7,543	$2,139	$9,682
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2051Q3	361.6%	$9,238	$2,620	$11,858
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2055Q3	465.4%	$11,315	$3,209	$14,524
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2059Q3	592.4%	$13,859	$3,930	$17,789
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	2063Q3	748.1%	$16,974	$4,814	$21,788
30	PLANNING, ENGINEERING & DESIGN	$1,927	$547	28.4%	$2,474	3.9%	$2,001	$568	$2,569	19270.8838	938.8%	$20,789	$5,896	$26,685
	PLANNING, ENGINEERING & DESIGN TOTAL	$23,125	$6,558	28.4%	$29,683		$24,017	$6,811	$30,828			$103,666	$29,400	$133,066
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2024Q3	25.0%	$1,451	$412	$1,863
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2028Q3	48.5%	$1,723	$489	$2,212
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2032Q3	78.0%	$2,067	$586	$2,653
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2036Q3	115.9%	$2,507	$711	$3,218
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2040Q3	164.3%	$3,068	$870	$3,938
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2044Q3	223.7%	$3,758	$1,066	$4,823
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2048Q3	296.5%	$4,602	$1,305	$5,907
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2052Q3	385.6%	$5,637	$1,599	$7,235
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2056Q3	494.8%	$6,904	$1,958	$8,862
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2060Q3	628.5%	$8,456	$2,398	$10,854
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2064Q3	792.2%	$10,357	$2,937	$13,294
31	CONSTRUCTION MANAGEMENT	$1,118	$317	28.4%	$1,435	3.9%	$1,161	$329	$1,490	2068Q3	992.8%	$12,685	$3,597	$16,282
	CONSTRUCTION MANAGEMENT TOTAL	$13,413	$3,804	28.4%	$17,216		$13,930	$3,950	$17,880			$63,214	$17,928	$81,142
	CONTRACT COST TOTALS:	$267,788	$75,945		$343,733		$273,941	$77,690	$351,631			$589,137	$167,079	$756,217

Table 3-5: Shorefront Beach Replenishment Monitoring Costs

****** CONTRACT COST SUMMARY ******

PROJECT: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
LOCATION: Queens, NY
This Estimate reflects the scope and schedule in report; East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

DISTRICT: NY District
POC: CHIEF, COST ENGINEERING, Mukesh Kumar
PREPARED: 6/20/2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			20-Aug-18	Program Year (Budget EC):			2019					
		Effective Price Level:			1-Oct-17	Effective Price Level Date:			1 OCT 18	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	ENVIRONMENTAL MONITORING (EVERY 4 YRS)													
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2024Q3	11.5%	$1,406	$399	$1,804
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2028Q3	20.7%	$1,521	$431	$1,953
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2032Q3	30.7%	$1,647	$467	$2,114
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2036Q3	41.4%	$1,783	$506	$2,288
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2040Q3	53.1%	$1,930	$547	$2,477
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2044Q3	65.7%	$2,089	$592	$2,681
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2048Q3	79.4%	$2,261	$641	$2,902
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2052Q3	94.2%	$2,447	$694	$3,141
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2056Q3	110.2%	$2,649	$751	$3,400
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2060Q3	127.5%	$2,867	$813	$3,680
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2064Q3	146.2%	$3,104	$880	$3,984
06	FISH & WILDLIFE FACILITIES	$1,235	$350	28.4%	$1,585	2.1%	$1,260	$357	$1,618	2068Q3	166.5%	$3,359	$953	$4,312
	CONSTRUCTION ESTIMATE TOTALS:	$14,820	$4,203	28.4%	**$19,023**		$15,124	$4,289	$19,413			$27,061	$7,675	$34,736
	CONTRACT COST TOTALS:	$14,820	$4,203		**$19,023**		$15,124	$4,289	**$19,413**			$27,061	$7,675	**$34,736**

3.3.7 MII Estimate

The MII Estimate for the Rockaway Shorefront is included in Sub-Appendix C.

3.3.8 Schedule

The Project Schedule is included in Sub-Appendix B.

3.4 Recommended Plan Cost Summary

A summary table showing the total cost without contingency and with the calculated 28.36% contingency for both the Shorefront and Jamaica Bay project locations is included below in Table 3-6. In addition, Table 3-6 displays the Total Project Cost Summary (TPCS) sheet for the project based on the anticipated Project Schedule as shown in Appendix B.

Table 3-6: TPCS for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

**** TOTAL PROJECT COST SUMMARY ****

Printed:6/24/2019
Page 1 of 7

PROJECT: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay
PROJECT NO: P2 403429
LOCATION: Queens, NY

DISTRICT: NY District
POC: CHIEF, COST ENGINEERING, Mukesh Kumar
PREPARED: 6/20/2019

This Estimate reflects the scope and schedule in report; East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2019 Effective Price Level Date: 1 OCT 18									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 1-Oct-17 ($K)	TOTAL FIRST COST ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J		K	L	M	N	O
02	RELOCATIONS	$4,330	$1,228	28.4%	$5,559	2.1%	$4,419	$1,253	$5,673	$0	$5,673	3.5%	$4,576	$1,298	$5,874
10	BREAKWATER & SEAWALLS	$187,704	$53,233	28.4%	$240,936	2.1%	$191,556	$54,325	$245,881	$0	$245,881	6.1%	$203,281	$57,650	$260,931
11	LEVEES & FLOODWALLS	$97,934	$27,774	28.4%	$125,707	2.1%	$99,944	$28,344	$128,288	$0	$128,288	6.5%	$106,487	$30,200	$136,687
13	PUMPING PLANT	$36,577	$10,373	28.4%	$46,950	2.1%	$37,327	$10,586	$47,913	$0	$47,913	6.6%	$39,783	$11,282	$51,065
17	BEACH REPLENISHMENT	$26,966	$7,648	28.4%	$34,614	2.1%	$27,519	$7,804	$35,324	$0	$35,324	3.0%	$28,353	$8,041	$36,393
18	CULTURAL RESOURCE PRESERVATION	$12,000	$3,403	28.4%	$15,403	2.1%	$12,246	$3,473	$15,719	$0	$15,719	5.3%	$12,889	$3,655	$16,545
	CONSTRUCTION ESTIMATE TOTALS:	$365,511	$103,659		$469,169	2.1%	$373,011	$105,786	$478,797	$0	$478,797	6.0%	$395,368	$112,126	$507,495
01	LANDS AND DAMAGES	$29,903	$5,981	20.0%	$35,883	2.1%	$30,516	$6,103	$36,619	$0	$36,619	3.5%	$31,579	$6,316	$37,895
30	PLANNING, ENGINEERING & DESIGN	$34,874	$9,890	28.4%	$44,765	3.9%	$36,219	$10,272	$46,491	$0	$46,491	3.9%	$37,636	$10,673.57	$48,310
31	CONSTRUCTION MANAGEMENT	$21,636	$6,136	28.4%	$27,772	3.9%	$22,470	$6,373	$28,843	$0	$28,843	13.3%	$25,452	$7,218	$32,670
	PROJECT COST TOTALS:	$451,924	$125,666	27.8%	$577,590		$462,217	$128,534	**$590,750**	$0	**$590,750**	6.0%	$490,035	$136,334	$626,369
	Renourishment/Monitoring/Breach Closure Costs														
06	FISH & WILDLIFE FACILITIES	$14,820	$4,203	28.4%	$19,023	2.1%	$15,124	$4,289	$19,413	$0	$19,413	78.9%	$27,061	$7,675	$34,736
17	BEACH REPLENISHMENT	$231,251	$65,583	28.4%	$296,833	2.1%	$235,995	$66,928	$302,923	$0	$302,923	78.9%	$422,257	$119,752	$542,009
		$246,071	$69,786		$315,856	2.1%	$251,119	$71,217	$322,336	$0	$322,336	78.9%	$449,318	$127,427	$576,745
	E&D AND S&A														
30	PLANNING, ENGINEERING & DESIGN	$23,125	$6,558	28.4%	$29,683	3.9%	$24,017	$6,811	$30,828	$0	$30,828	331.6%	$103,666	$29,400	$133,066
31	CONSTRUCTION MANAGEMENT	$13,413	$3,804	28.4%	$17,216	3.9%	$13,930	$3,950	$17,880	$0	$17,880	353.8%	$63,214	$17,928	$81,142
	RENOURISHMENT COST TOTALS:	$282,608	$80,148	28.4%	$362,756		$289,065	$81,979	**$371,044**	$0	**$371,044**	113.2%	$616,198	$174,754	$790,952
	PROJECT COST TOTALS	$734,532	$205,813	28.0%	$940,345		$751,282	$210,512	**$961,794**	$0	**$961,794**	47.4%	**$1,106,234**	**$311,088**	**$1,417,321**

CHIEF, COST ENGINEERING, Mukesh Kumar

PROJECT MANAGER, Daniel Falt

CHIEF, REAL ESTATE, xxx

ESTIMATED TOTAL PROJECT COST: **$626,369**

ESTIMATED RENOURISHMENT PROJECT COST: **$790,952**

ESTIMATED TOTAL PROJECT COST: **$1,417,321**

3.4.1 Operations and Maintenance (O&M) Costs

Operations and maintenance costs were estimated as $19 / linear foot of feature per year. The vehicular gates were estimated separately at 0.5% of the initial gate cost, and pump stations were assumed to have an O&M cost of 2% of the initial construction cost. These values were estimated from other flood protection and pump cost data for the NYC metropolitan area.

3.5 Interest During Construction

The interest during construction calculated for the project based on the project schedule and project first costs are included below in Table 3-7: Interest During Construction.

Table 3-7: Interest During Construction

Recommended Plan Component	Project First Costs	Duration (Months)	Interest During Construction
Shorefront Element	336,282,000	44	20,147,000
Mid-Rockaway HFFRRF	237,489,000	41	15,055,000
Cedarhurst-Lawrence HFFRRF	16,979,000	12	293,000
TOTAL			**35,495,000**

3.6 Beach Renourishment

Renourishment of the shorefront is anticipated to be placed at 4-year cycles subsequent to commencement of construction and throughout the 50-year economic life. The renourishment beach fill cost has been estimated by the USACE using CEDEP and is assumed to be placed in the same manner as the beach fill for the main contracts; with a 30" cutterhead dredge pumping the fill onto the shore, and a shore crew placing the material. Annualized renourishment costs, including environmental monitoring have been included in the annualized costs included for the Shorefront in Table 3-8.

3.7 Annualized Costs

The annualized costs for the Shorefront, Cedarhurst-Lawrence, and Mid-Rockaway Components are shown in Table 3-8: Annualized Project Costs below.

Table 3-8: Annualized Project Costs

Recommended Plan Component	Annual Project Costs
Shorefront Element (First Costs)	23,010,000
Shorefront (Beach Renourishment)	7,598,000
Mid-Rockaway HFFRRF	10,737,000
Cedarhurst-Lawrence HFFRRF	744,000
TOTAL	**42,089,000**

4 COST AND SCHEDULE RISK ANALYSIS

4.1 Introduction

The United States Army Corps of Engineers (USACE) requires a risk analysis for projects over $40 million. Preliminary estimates for the East Rockaway to Rockaway Inlet and Jamaica Bay Project is over $400 million, exceeding the $40 million limit, requiring this risk analysis to be completed.

4.2 Background

The project's cost estimate is prepared using MCACES MII software in accordance with USACE policy and can be found in Sub-Appendix A and Sub-Appendix C. MII uses existing or custom unit cost databases and allows contingency, taxes, insurance, and profit to be added to each item as needed to create an accurate construction cost estimate. Dredging unit costs were created using USACE's CEDEP spreadsheets and provided by the USACE NY District. Low, middle, and high unit costs were evaluated and a median unit cost was typically selected for the cost estimate.

4.3 Report Scope

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes as mandated by USACE Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works.

4.4 USACE Risk Analysis Process

The risk analysis process follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Directory of Expertise for Civil Works (Cost Engineering DX). The risk analysis process uses probabilistic cost and schedule risk analysis methods within the framework of the *Crystal Ball* software. The risk analysis results are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analyses should be considered as an ongoing process conducted concurrent to, and along with, other important project processes such as scope

and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, the risk analysis is performed to meet the recommendations of the following documents and sources:

- ER 1110-2-1150, Engineering and Design for Civil Works Projects.
- ER 1110-2-1302, Civil Works Cost Engineering.
- ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works.
- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering DX.

4.5 Methodology / Process

The purpose of the risk analysis process is to determine what can be expected for the project as a whole, allowing variation within the individual project components. Natural variation allows the simulation to mimic real-world scenarios more closely, accounting for unforeseen changes that could affect a project, but within reason for the given distributions.

As recommended in the above references, *Crystal Ball* Risk Analysis Software was selected to run the risk analysis for the project. *Crystal Ball* uses a mathematical modeling technique called a Monte Carlo Simulation that takes distributions of assumed unit costs, quantities and production rates and runs thousands of trials, taking one input from each distribution in each simulation, adding in natural variation when selecting the points. The input data was based on the Risk Register, MII Cost Estimate, Project schedule, and PDT involvement.

Crystal Ball allows multiple trials, 5,000 trials were used for the analysis, in order to model the distribution given to that assumption. All of the individual assumptions (i.e. cost, volumes, etc.) are then summed for each trial and plotted to show cost and schedule versus probability. The median is the most likely project cost/schedule and, based on USACE policy, the 80% confidence value is the probable upper bound cost/schedule. The software is also used to create sensitivity plots that show which risk items have the greatest impacts in the overall project cost distribution.

4.5.1 Identify and Assess Risk Factors

Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from the entire PDT is obtained using creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is

desirable and is considered. Identifying the risk factors is considered a qualitative process that results in establishing a list of risks that serves as the document for the further study using the Crystal Ball risk software.

The risk analysis process, for this project, began by gathering input from the PDT. The PDT identified potential risks associated with each part of the project and designated each risk. In accordance with the current *Cost and Schedule Risk Analysis Guidance* (May 2009), all risks were then identified as low, moderate, or high risks based on their respective likelihoods and overall effects, as defined in the risk matrix shown below (Figure 4-1: Risk Level Matrix). These were used to identify what the PDT considered to be the key risks of the project and the degree that these risks might affect the final cost and schedule.

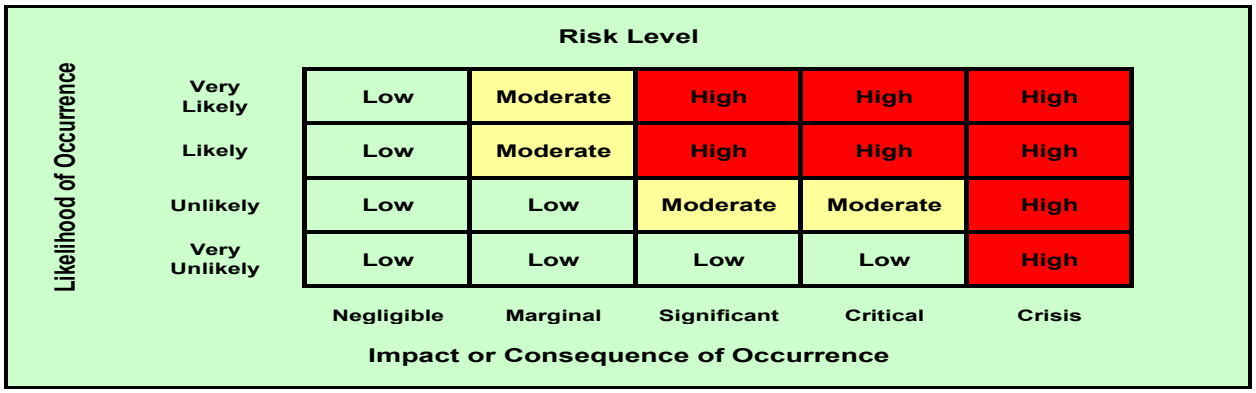


Figure 4-1: Risk Level Matrix

The risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.5.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions), because risk factors are entered into the *Crystal Ball* software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involved multiple project team disciplines. For each of the risks identified, quantifying risk factor impacts were determined to include:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.

- Mathematical correlations between risk factors.
- Affected cost estimate and schedule elements.

The resulting risk register includes discussion of the above.

4.5.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the *Crystal Ball* software, an add-in to the *Microsoft Excel* format of the cost estimate and schedule. Monte Carlo simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying risks identified.

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the base cost estimate. P80 is the value that with 80% confidence one can conclude the project cost will not exceed, or 80% of the Monte Carlo simulations were less than or equal to that number. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by Monte Carlo simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

Schedule contingency is calculated as the difference between the P80 option duration forecast and the base schedule duration.

Schedule contingency is analyzed only on the basis of each option and not allocated to specific tasks. Based on Cost Engineering DX guidance, only critical path and near critical path tasks are considered to be uncertain for the purposes of schedule contingency analysis.

4.6 RISK ANALYSIS RESULTS

This section discusses the major components of the risk register, data used to develop the distributions for the risk analysis and results.

4.6.1 Risk Register – Cost Risk Analysis

During development of the risk register, risk items were discussed and evaluated by the PDT. A risk register is a tool commonly used in project planning and risk analysis and serves as the basis for the risk studies and *Crystal Ball* risk models. The risk register reflects the results of risk factor identification and assessment, risk factor quantification, and contingency analysis. From this process, 16 items were determined by the PDT to warrant inclusion in the final risk register for the cost risk analysis. Each of the risks was then evaluated in detail to determine the variability and distribution in quantities, cost and schedule so they could be evaluated in *Crystal Ball*. The detailed risk register is provided in Sub-Appendix D to this report and summarized in Table 4-1 below.

Table 4-1: Key Cost Risks Identified

Risk No.	PDT-Developed Risk/Opportunity Event
PM-3	Project Scope Definition
CA-1	Beach Fill Bidding Climate
CA-3	Rock Source for Groin Construction
CA-5	Composite Wall Rock Source
TL-4	Additional Groins Added to Project
TL-9	Design of Pumps for Saltwater
TL-15	Armor Stone Required for Floodwalls
TL-18	Drainage Improvements for Bulkheads
TL-19	Additional Fill for Bulkheads
TL-21	Baffle Wall Repairs / Replacement
LD-1	Additional Real Estate Relocations Required
CO-6	Additional Utility Relocations Required
ET-1	Beach Fill Bidding Climate
PR-1	Extreme Weather
PR-3	Quarry Monopoly
PR-4	Similar Projects Reducing Contractor Supply
PR-5	Stakeholders Requesting Mechanical Cleaning of Trash Racks

Based on the above, 21 different variables were used in the Crystal Ball Cost Risk analysis to model the above risks, with 14 variables for unit costs and 7 for quantities. These assumptions consider values from the MII cost estimate, historical data and PDT recommendations on individual risk items.

Following is a discussion of the more significant risks shown above, and assumptions used in developing the analysis. Crystal ball reports show details on ranges and distributions.

PM-3. Project Scope Definition

Some of the non-federal sponsors are not in favor of adding pump stations, as they increase maintenance costs for the local jurisdictions. This is expected to add $7 million to the project on the high end if a significant amount of resources must be utilized to review alternatives to appease the non-federal sponsors.

CA-1. Beach Fill Bidding Climate

An additional 25% cost was added for the high end to account for a bidding climate where only one contractor bids on a beach fill contract. 10% was reduced on the low end to account for a highly competitive bidding environment.

CA-3 Rock Source for Groin Construction

The low rock material cost was reduced 10% to account for new quarries opening up that could increase competition. A 50% increase was included for the high end to account for only one quarry having the capability to supply the project and having to spend a considerable amount of resources to produce the correct size armor stone.

CA-5 Composite Seawall Rock Source

The low rock material cost was reduced 10% to account for new quarries opening up that could increase competition. A 50% increase was included for the high end to account for only one quarry having the capability to supply the project and having to spend a considerable amount of resources to produce the correct size armor stone.

TL-4 Additional Groins Required

No change in the low cost of the groins was considered. The weight of the rock was increased by 19,700 tons to account for additional groins being required.

TL-9 Pumps Designed for Saltwater

A $5 million fee was associated with providing all pumps with parts designed for pumping saltwater. No change in low prices to the pump stations was considered.

TL-15 Armor Stone Required for Floodwalls

The high quantity for armor stone was calculated assuming a 7' wide, 1' deep section of stone on the protected side of the floodwalls was required. No change in low quantity was considered, as the current design does not have stone on the floodwalls.

TL-18 Drainage Improvements for Bulkheads

High costs for drainage improvements increased by $1.5 million to account for additional improvements needed in the tight areas near many of the bulkheads.

TL-19 Additional Fill Required for Bulkheads

The uneven nature of the existing bulkheads may require that the proposed bulkhead be a few feet away from some of the existing bulkheads, requiring fill. Additional volume assumes 18 square feet of additional fill per foot of bulkhead.

TL-21 Baffle Wall Repairs / Replacement

The existing baffle wall may require repairs and / or upgrades. Although no known issues existing for the wall, any repairs or replacement would add a critical amount of cost to the project. A unit cost of $4,500 / lf was estimated for full replacement of the wall on the high end. No cost was assumed for the low end.

LD-1 Real Estate

Real estate is a significant unknown for this project. Low prices were reduced 50%, while high prices were increased 300%.

CO-6 Utility Relocations

Utilities have not been located and are a significant unknown for the project. A 50% decrease was considered for the low end and a 500% increase for the high end.

ET-1 Beach Fill Bidding Climate

Mobilization price decreased by $1.3 million to $2 million on the low end and increased $1.8 million to $5.1 million on the high end. These limits were determined from historical beach fill bids in the area.

PR-1 Weather Issues

Weather impacts can cause quantities of sand and groin rock to increase as a storm erodes away the existing materials. A 20% increase was considered in quantities on the high end.

PR-3 Quarry Monopoly

Some of the quarries in the area have been purchased by the same company. If this trend continues, an increase of 25% higher was considered to account for this lack of competition.

PR-4 Other Similar Projects

Since there are other coastal storm risk management (CSRM) projects in the area, it may be possible that the quarries and contractors do not have enough supply to complete this project with the other work going on. To account for this, the profit was considered to be as high as 18% (instead of 10%), or as low as 6%.

PR-5 NFS Request Mechanical Cleaning Trash Racks

An additional cost of $1 million was included to account for the potential of the mechanical cleaning trash racks on the drainage structures.

Distributions

For this analysis, most quantities were assumed to be triangular distributions since minimum, maximum, and expected quantities have been determined. Unit costs were typically modeled as triangular functions. The triangular distribution was used as expected, low, and high values were known for all major variables. However, some items were modeled as uniform if the expected value was not a confidence value and the range of possible outcomes was broad. The Crystal Ball Software Output contains all of the assumptions and distributions used for each element in the analysis, as well as descriptive statistics for the distributions.

The full risk register and Crystal Ball reports are included in Sub-Appendix D, E, and F and contain additional details.

4.6.1 Risk Register – Schedule Risk Analysis

Although this schedule risk register was completed at the same time for both the cost and schedule risk analysis, the key risks are displayed separately, as different risks impact the cost and schedule differently. Below in Table 4-2 is the list of key schedule risks determined for the project.

Table 4-2: Key Schedule Risks Identified

Risk No.	PDT-Developed Risk/Opportunity Event
PM-2	Groin Scope Growth
PM-4	Coordination of Plan with NFS
PM-5	Timely Response from NFS
PM-6	Local Agency / Permit Issues
PM-7	NFS Priorities Change
CA-4	Composite Wall Construction Access
TL-1	Beach fill – Quantity Changes
TL-4	Additional Groins Added
TL-7	Energy Dissipation may impact wetlands
TL-15	Riprap Required for Floodwalls
LD-1	Delays in Real Estate
LD-2	Additional RW Access Needed
LD-4	Relocation Delays
CO-2	Beach fill – Equipment Availability
ET-2	Groin Construction Methods
ET-3	Groin and Seawall Construction Timing
ET-5	Groin Extensions Turn into Rebuilds

Based on the above risks, 14 different variables were used in the *Crystal Ball* Schedule Risk analysis to model the identified risks.

Following is a discussion of the more significant risks shown above, and assumptions used in developing the analysis. Crystal ball reports show details on ranges and distributions.

PM-2. Groin Scope Growth

An additional 40 days was added to the schedule to account for the possibility of additional groins added to the project.

PM-4. Coordination of Plan with NFS

An additional 120 days was added to coordinate with NFS.

PM-5 Timely Response from NFS

The 120 days included in PM-4 addressed this delay as well.

PM-6 Local Agency / Permit Issues

An additional 120 days was added to the Notice to Proceed of the project to account for permit delays.

PM-7 NFS Priorities Change

The 120 days included in PM-4 addressed this delay as well.

CA-4 Composite Wall Construction Access

An additional 40 days was added to the composite wall construction duration to account for potential delays due to limited construction access.

TL-1 Beach fill – Quantity Changes

A 20% increase in days was added on the high end and a decrease of 10% was added to the low end to account for volume changes since the survey utilized for this project quantity calculations.

TL-4 Additional Groins Added

60 days was added on the high end construction duration o account for construction of the additional groins.

TL-7 Energy Dissipation may impact wetlands

The notice to proceed duration high value was increased by 80 days to account for mitigation delays.

TL-15 Riprap Required for Floodwalls

An additional 30 days was added to the floodwall construction high value to account for the riprap.

LD-1 Delays in Real Estate

The notice to proceed duration high value duration was increased by 260 days to account for mitigation delays.

LD-2 Additional RW Access Needed

The notice to proceed duration high value duration was increased by 180 days to account for RW access delays.

LD-4 Relocation Delays

The notice to proceed duration high value duration was increased by 180 days to account for utility relocation delays.

CO-2 Beach fill – Equipment Availability

An additional 120 days was added on the high value for the beach fill construction duration to account for a delay in mobilization.

ET-2 Groin Construction Methods

An additional 50 days on the high end construction duration was added to account for slower construction methods.

ET-3 Groin and Seawall Construction Timing

An additional 80 days was added to the high value construction duration to account for summer windows when the local cities may not want limitations on the beach access.

ET-5 Groin Extensions Turn into Rebuilds

An additional 60 days on the high end construction duration was added to account for the additional quantities required to rebuild the groins instead of only extending them.

4.7 Cost Risk Analysis - Cost Contingency Results

Using an initial base cost of $355.8 million (not including beach renourishment, real estate, engineering, or construction management) a distribution of costs was calculated in *Crystal Ball*. Based on the *Crystal Ball* Analysis of the 100% Design Estimate, the most probable project cost (50 percentile) is $435.5 million. The project cost at the 80% confidence interval is $456.8 million. The confidence interval and total project distribution are shown in Figure 4-2 below. Detailed figures and statistical analysis from the simulation are contained in Sub-Appendix E. The range from the minimum total cost to the maximum cost is approximately $157.6 million and the range from the 80% upper limit to the minimum value is approximately $102.4 million. Please note that these are not Project First Costs or Total Project Costs as this analysis is done on the expected costs without contingency.

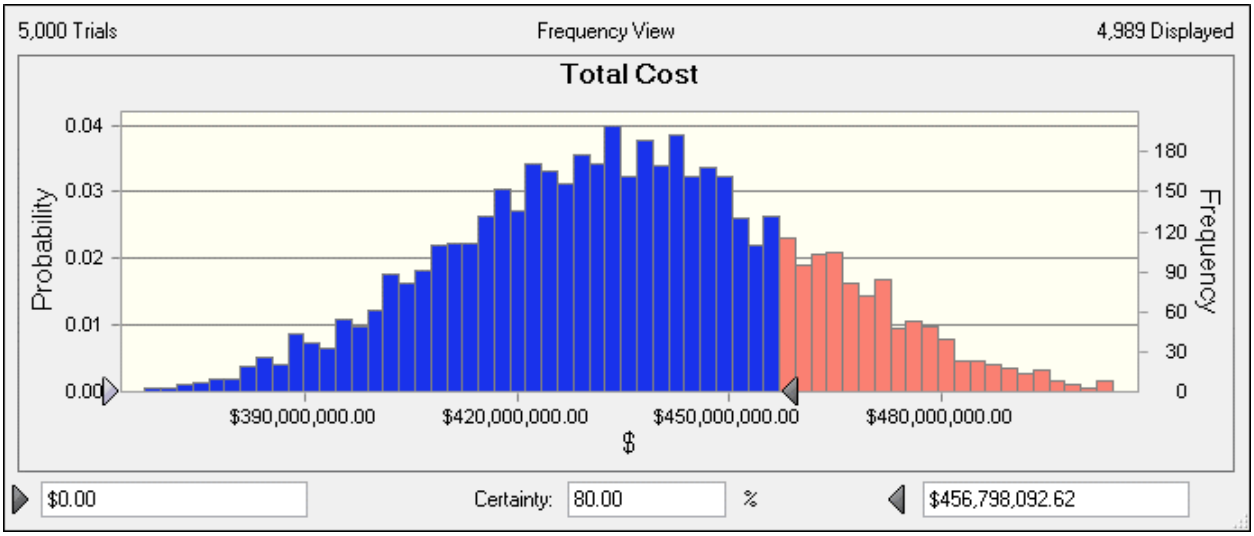


Figure 4-2: Cost Distribution with the 80% Confidence Interval Shown

A sensitivity analysis was conducted to determine which items cause the greatest change in overall project cost. The results are displayed in Figure 4-3 below. The two most significant items were the real estate costs and the limited competition of contractors, which both represented

approximately 26% of the cost variance and is a significant unknown for the project. These are identified in risks LD1 and PR-4, respectively. The third major risk is the quarry competition relating to rock supply and availability at the time of the job (Risks CA-5 and PR-3). It represents approximately 21% of the variation in the project. Two other risks represented about 10% of the total project variation, the baffle wall repairs / replacement along the shorefront and the utilities, relating to risks TL-21 and CO, respectively. Those items have significant unknowns at this time and will be narrowed down in final design.

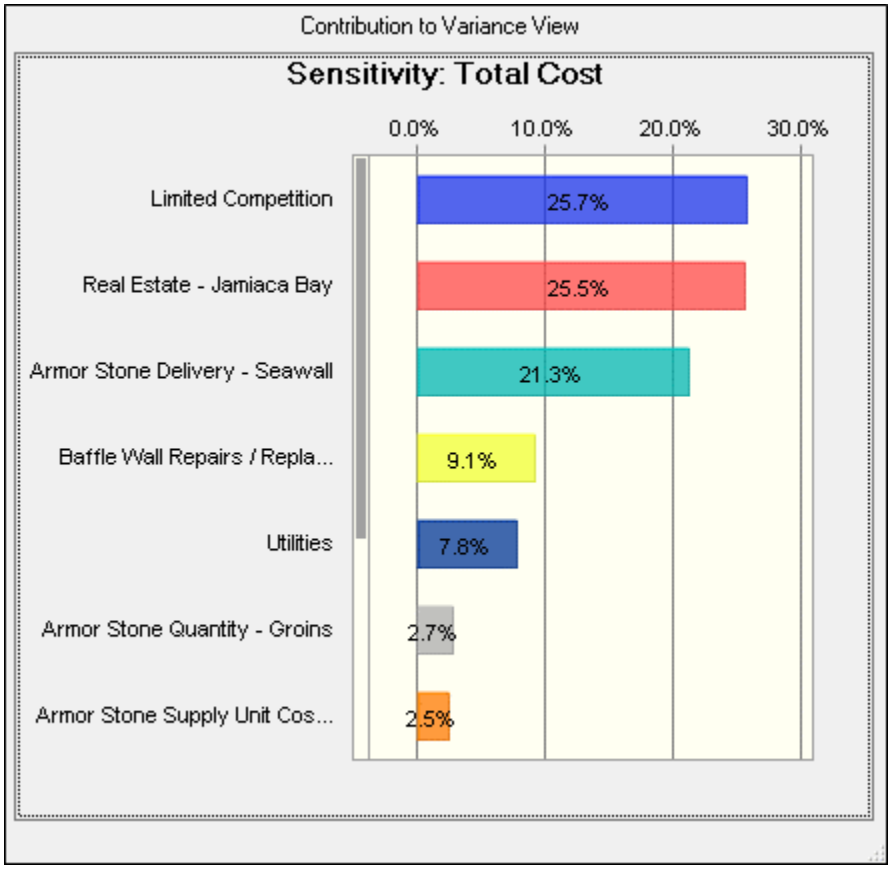


Figure 4-3: Sensitivity Analysis for Cost Risk

Note that these results reflect only those contingencies established from the cost risk analysis.

Table 4-3: Confidence Table of Total Cost

Percentiles:	Forecast values ($)
0%	$354,392,835.80
10%	$404,101,189.97
20%	$414,924,691.45
30%	$422,372,011.90
40%	$429,329,968.13
50%	$435,488,722.73
60%	$441,691,565.03
70%	$448,323,726.59
80%	$456,798,092.62
90%	$467,933,686.11
100%	$512,055,589.86

The cost risk analysis determined that a 28.36% contingency (calculated as the difference from the 80% to the base case divided by the base case of $355.8 million) should be expected for the project as a whole. This percentage represents the funds that should be allocated to complete this project based on the risks developed by the PDT. Table 4-4: Project Contingencies (Base Cost Plus Cost and Contingencies) shows the change in contingency with different confidence levels of the cost estimate.

Table 4-4: Project Contingencies (Base Cost Plus Cost and Contingencies)

Confidence Level	Project Cost ($)	Contingency ($)	Contingency (%)
P0	$354,392,835.80	($1,472,540.62)	-0.41%
P10	$404,101,189.97	$48,235,813.56	13.55%
P20	$414,924,691.45	$59,059,315.04	16.60%
P30	$422,372,011.90	$66,506,635.49	18.69%
P40	$429,329,968.13	$73,464,591.72	20.64%
P50	$435,488,722.73	$79,623,346.32	22.37%
P60	$441,691,565.03	$85,826,188.62	24.12%
P70	$448,323,726.59	$92,458,350.18	25.98%
P80	**$456,798,092.62**	**$100,932,716.21**	**28.36%**
P90	$467,933,686.11	$112,068,309.70	31.49%
P100	$512,055,589.86	$156,190,213.45	43.89%

5 SCHEDULE RISK ANALYSIS

The schedule risk analysis was very dependent on many issues relating to getting the construction started, including permitting, real estate acquisitions, and coordination with local sponsors. The results are included below.

5.1 Results

The Monte Carlo Simulation results indicate to an 80% certainty that it would be unlikely for the project delay to exceed 630 working days, a delay of approximately 2.4 years. The results are shown in Figure 5-1 below.

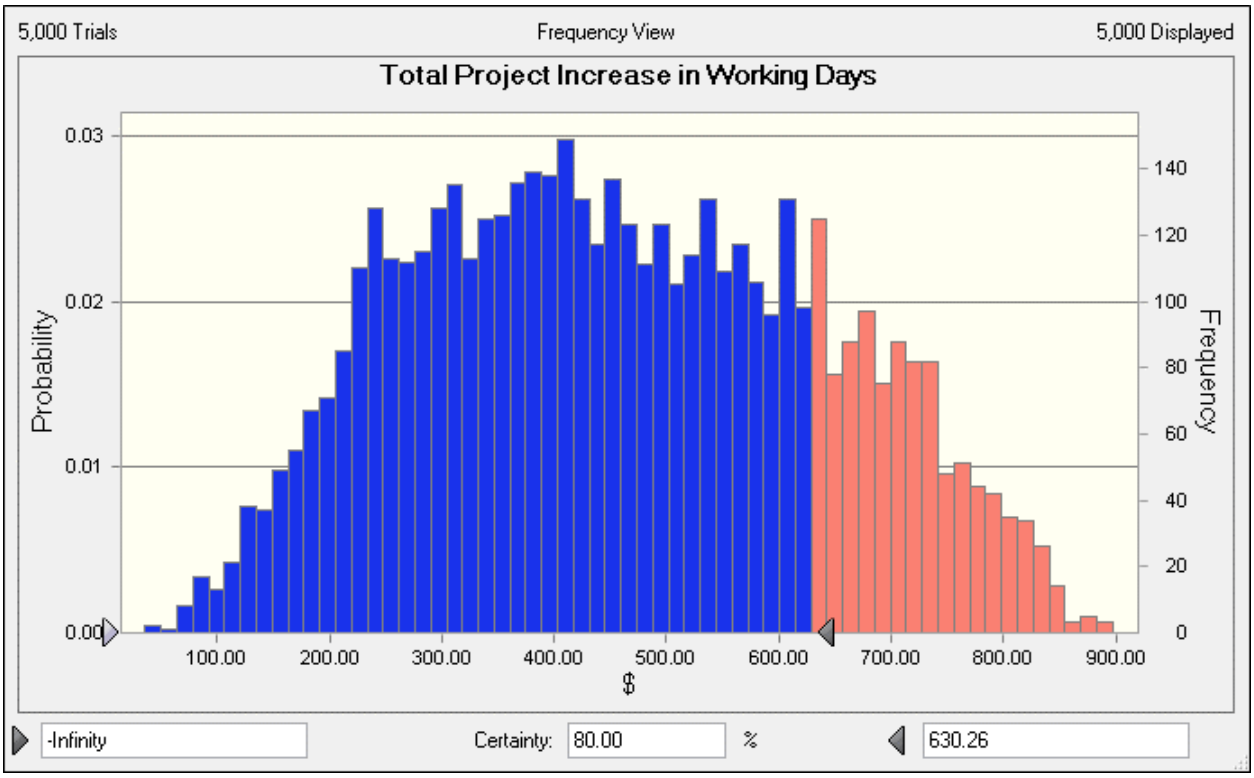


Figure 5-1: Schedule Risk Analysis Results

A sensitivity analysis was also completed for the schedule risk analysis and included in Figure 5-2. It indicated that issuing the notice to proceed for the construction contracts in Arverne, and Edgemere were the most important factors relating to the schedule by a significant margin. These are relating to delays with regards to permitting, utilities, real estimate, and non-federal sponsors identified in risks PM4, PM5, PM6, PM7, TL7, LD1, LD2 and LD4 of the risk register.

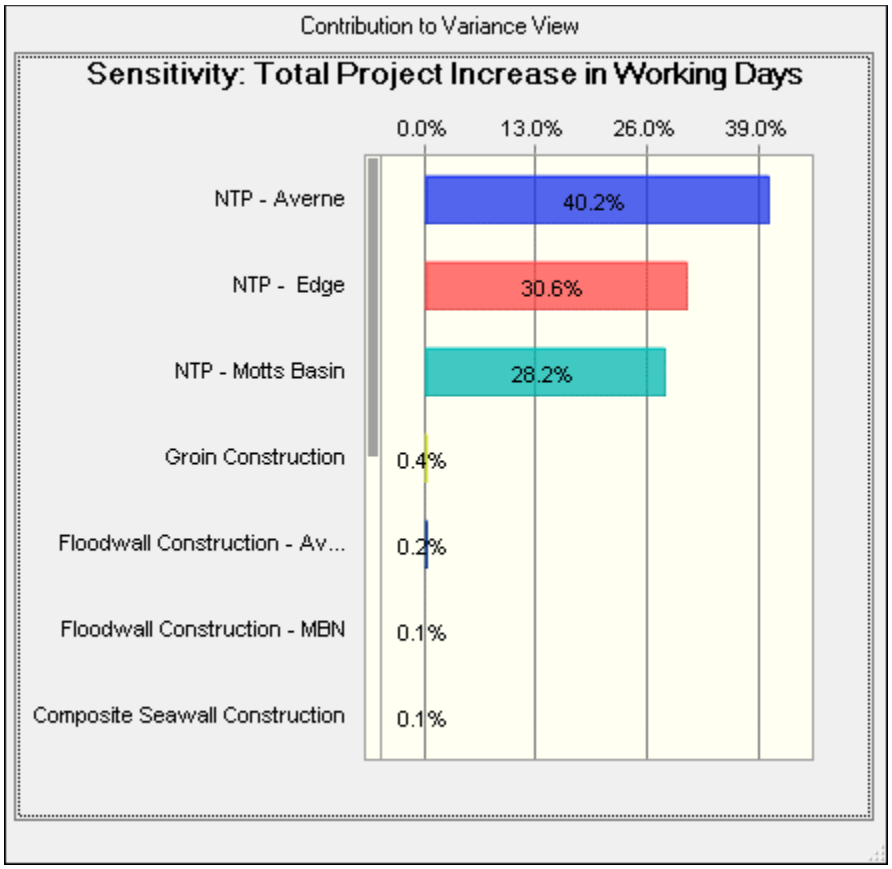


Figure 5-2: Schedule Risk Analysis Sensitivity

6 MAJOR FINDINGS/OBSERVATIONS

Based on analysis of the 100% design, the most probable project cost is currently estimated to be $435.5 million with an 80% confidence interval for the cost to not exceed $456.8 million. These are for the project first costs and do not include costs for the beach renourishment costs. This means the contingency to be utilized for the project is 28.36%. The project schedule is anticipated to be completed in approximately 3.5 years based upon the expected schedule, but is likely to be delayed due to permitting and other relocation issues, with an 80% confidence that the project schedule will be completed within 2.4 years of the expected completion date. The total project schedule duration is expected to be approximately 5.9 years instead of 3.5 years due to these delays, although this may not impact the duration of actual construction, as many of the key risks are to the notice to proceed for construction and not relating to construction activities' durations themselves.

7 RECOMMENDATIONS

The identified risks for the project may be unavoidable, but identifying ways to mitigate their effect on the final project cost is essential to the success of the project and has been pursued through project development by the PDT. Efforts to reduce risk continue as described below.

Contractor Outreach – An extensive contractor outreach program is recommended to maintain interest in the projects, especially with potential armor stone suppliers so that they can prepare for the large volumes of stone required for the project.

Coordination with State and NFS – A significant amount of delays are anticipated due to not getting the NTP issued, which can be mitigated if the NFS and other state agencies are in support of the project.

A. SUB-APPENDIX A: MII ESTIMATE – JAMAICA BAY

The MII Estimate for the Jamaica Bay section of the project.

B. SUB-APPENDIX B: PROJECT SCHEDULE

The anticipated schedule for the project.

C. SUB-APPENDIX C: MII ESTIMATE - SHOREFRONT

The MII Estimate for the Shorefront section of the project.

D. SUB-APPENDIX D: RISK REGISTER

The Risk Register was developed during the risk workshop on June 13, 2018.

E. SUB-APPENDIX E: COST RISK ANALYSIS

F. SUB-APPENDIX F: SCHEDULE RISK ANALYSIS

G. SUB-APPENDIX G: PUMP COST CURVE

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D
Environmental Compliance

Attachment D1—USFWS Coordination Act Report
Attachment D2—Endangered Species Act Coordination with USFWS and NMFS
Attachment D3—Essential Fish Habitat Assessment
Attachment D4—404(b)(1)
Attachment D5—Coastal Zone Management Act
Attachment D6—Programmatic Agreement
Attachment D7—General Conformity
Attachment D8—Monitoring Plan

December 2018, amended as of July 2019
to include Attachment D2c, the USFWS Biological Opinion

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D1

USFWS Final Coordination Act Report

FINAL FISH AND WILDLIFE COORDINATION ACT SECTION 2(b) REPORT

ATLANTIC COAST OF NEW YORK, EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY REFORMULATION STUDY

KINGS, QUEENS, AND NASSAU COUNTY, NEW YORK

Prepared for:

U.S. Army Corps of Engineers
New York District
New York, New York

Prepared by:

Department of the Interior
U.S. Fish and Wildlife Service
Long Island Field Office
Shirley, New York

Preparers: Kerri Dikun, Terra Willi

Field Supervisor: David A. Stilwell

December 2018

EXECUTIVE SUMMARY

This final Fish and Wildlife Coordination Act (FWCA) Report has been prepared at the request of the U.S. Army Corps of Engineers (Corps) in partial fulfillment of section 2(b) of the FWCA (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq*.). The purpose of the FWCA is to ensure equal consideration of fish and wildlife conservation. This FWCA report provides the U.S. Fish and Wildlife Service's (Service) comments on the biological issues relevant to the Corps' *Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study*. Section 2(b) of the FWCA requires that the final report of the Secretary of the Interior: (1) determine the magnitude of the direct, indirect, and cumulative impacts of the proposed projects on fish and wildlife resources, and (2) make specific recommendations as to measures that should be taken to conserve those resources.

The Corps' Recommended Plan includes a suite of measures along the shoreline of the Atlantic Ocean and Jamaica Bay. These measures include construction of a composite seawall and artificial dune; beach nourishment; construction of thirteen new groins and the modification of five existing groins; the construction of floodwalls, berms, and bulkheads along the Jamaica Bay shoreline; and the construction of nature-based features on the bay shoreline. The Study Area provides ecologically significant habitat for a number of regional and state important species. In recognition of this, the Service identified this area as a Significant Habitat and Habitat Complex. At the state and local levels, New York State Department of State identified it as a State Significant Coastal Fish and Wildlife Habitat, and Audubon New York designated it as an Audubon Important Bird Area. Portions of the Feasibility Study Area are included in the National Park Service's Gateway National Recreation Area.

In the short-term, the Corps' Recommended Plan will have direct and indirect impacts on fish and wildlife resources and their supporting ecosystems. The initial construction of the project will affect approximately 10 miles (mi) of subaerial, intertidal, nearshore, and subtidal marine habitats. Beach nourishment volumes for initial beachfill is estimated at 804,000 cubic yards, to be dredged from a sand borrow area located approximately 2 mi off the Rockaway Atlantic Coast shoreline. Project impacts include habitat modification, disturbance to fish and wildlife, turbidity, and burial of benthic organisms. Over the long-term, the composite seawall, floodwalls, berms, and bulkheads will permanently alter the habitat, resulting in potentially in long-term impacts to fish and wildlife trust resources.

In the course of its review, the Service has determined that the proposed project could have significant ecological impacts to fish and wildlife communities and habitats including the maritime dune and beach, estuarine bay shoreline, intertidal areas, wetlands, and bottom habitats. The Service has provided a number of recommendations that if implemented would assist the Corps in mitigating the potential adverse impacts identified in this report. The Corps has indicated that certain components of the project require further development and coordination with Federal, State, and local agencies and public review. Consequently, the Service requests continued coordination with the Corps as project designs are further developed so that any necessary revisions or supplements to the 2(b) report can be provided.

Finally, this report does not constitute a Biological Opinion under section 7 of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq*.). The Corps prepared a Biological Assessment (BA) in Appendix D2-A of the Revised Draft Hurricane Sandy General Reevaluation Report and Environmental Impact Statement dated August 2018. The Service will review the BA and transmit their findings in a separate document.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I

TABLE OF CONTENTS III

LIST OF FIGURES VIII

LIST OF TABLES VIII

LIST OF APPENDICES VIII

I. INTRODUCTION 1

II. PURPOSE, SCOPE AND AUTHORITY 1

A. PURPOSE 1

B. SCOPE 1

C. AUTHORITY 2

III. RELEVANT STUDIES, PROJECTS, AND REPORTS 3

A. RELEVANT STUDIES, PROJECTS, AND REPORTS WITHIN, AND ADJACENT TO, THE STUDY AREA 3

1. Federal Projects 3

2. Federally-Authorized/Funded, State, or Local Actions 3

3. Completed and Ongoing Studies and Reports 4

IV. THE STUDY AND FWCA ANALYSIS AREA 4

A. DESCRIPTION OF THE STUDY AREA 4

B. ECOLOGICAL SIGNIFICANCE OF THE STUDY AREA 8

1. Significant Habitat and Habitat Complex 8

2. Gateway National Recreation Area (GNRA) 8

a) Refuge District 8

b) Breezy Point District 8

c) North Shore District 9

3. Audubon Important Bird Areas (IBA) 9

4. New York State Department of State Significant Coastal Fish and Wildlife Habitats 9

5. NYSDEC Critical Environmental Area 10

C. HABITAT AND ECOSYSTEM CLASSIFICATIONS 10

1. Estuarine System 10

a) Estuarine Subtidal 11

b) Estuarine Intertidal 11

c) Estuarine Cultural 11

2. Marine System 12

a) Marine Subtidal 12
b) Marine Intertidal 12
c) Marine Cultural 13
3. Terrestrial System 13
a) Open Uplands 13
b) Terrestrial Cultural 14
V. FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES 14
A. Fish and Wildlife Resource Concerns 14
1. Habitat Loss, Alteration, and Degradation 14
2. Invasive Species 15
3. Wildlife and Habitat Management Related to the Federal Aviation Administration (FAA) Memorandum of Agreement (MOA) 15
4. Environmental Contaminants 16
5. Supply of Genetic Stock of Native Plantings 17
B. Planning Objectives 18
VI. EVALUATION METHODOLOGY 18
VII. DESCRIPTION OF FISH AND WILDLIFE RESOURCES 19
A. Plants 19
1. Plant Communities 19
a) Estuarine Communities 19
b) Terrestrial Communities 20
2. Rare Plants and Plants of Ecological Significance 21
B. Wildlife 21
1. AVIAN SPECIES 21
a) Shorebirds and Seabirds 22
b) Saltmarsh Birds 23
c) Waterfowl 24
d) Neotropical Migratory Landbirds 25
2. Amphibians and Reptiles 25
3. Mammals 26
C. FISH 26
1. ESSENTIAL FISH HABITAT (EFH) 26
2. FINFISH 27
D. INVERTEBRATES 28
1. Marine Invertebrates 28
Horseshoe Crabs 29
2. Insects, Moths, and Butterflies 30

E. THREATENED AND ENDANGERED SPECIES AND SPECIES UNDER REVIEW 30
1. FEDERALLY-LISTED THREATENED AND ENDANGERED SPECIES 30
a) Piping Plover 30
b) Red Knot 31
c) Roseate Tern 32
d) Seabeach Amaranth 32
e) Sea Turtles 32
f) Sturgeon 33
g) Atlantic Large Whales 33
2. Species under Review for Federal Listing 33
F. SPECIES OF GREATEST CONSERVATION NEED 34
G. WETLANDS 34
1. Saltwater Marshes 35
2. Freshwater Wetlands 36
VIII. FUTURE WITHOUT PROJECT CONDITIONS 36
IX. OTHER ENVIRONMENTAL CONDITIONS: CLIMATE CHANGE AND SEA-LEVEL RISE 38
X. DESCRIPTION OF THE RECOMMENDED PLAN 39
A. Atlantic Shorefront 39
1. Composite Seawall and Berm Description 40
2. Beachfill Description 41
3. New Groins and Groin Extension Description 41
4. Beachfill Tapers 42
B. Jamaica Bay High Frequency Flooding Risk Reduction Features 42
1. Cedarhurst-Lawrence 42
2. Motts Basin North 43
3. Mid-Rockaway 43
a) Edgemere Area 43
b) Arverne Area 44
c) Hammels Area 44
XI. DESCRIPTION OF PROJECT IMPACTS ON FISH AND WILDLIFE RESOURCES 45
A. IMPACTS 45
1. Habitat Loss and Modification 45
a) Beachfill/Berm 45
b) Composite Seawall 46
c) Artificial Dunes and Dune Plantings 47

d) Construction and Modification of Groins 49
e) HFFRRFs: Shoreline Armoring 49
f) HFFRRFs: Natural and Nature Based Features 50
g) Borrow Area Dredging 51
2. Disturbance and Mortality 53
a) Shorebirds and Seabirds 53
b) Saltmarsh Birds and Neotropical Migrants 54
c) Diamondback Terrapins 54
d) Fish and Aquatic Invertebrates 54
e) Federally-Listed Species 54
3. Turbidity and Suspended Sediment 55
4. Burial of Marine Intertidal and Marine Beach Invertebrate Species 56
B. CUMULATIVE IMPACTS 57
XII. SERVICE PLANNING AND MITIGATION RECOMMENDATIONS 58
A. Corps Proposed Mitigation Measures/Best Management Practices 59
B. PLANNING RECOMMENDATIONS 60
1. Habitat Loss, Degradation, and Fragmentation 60
2. Invasive Species 60
3. Wildlife Management 61
4. Environmental Contaminants 61
5. Supply of Genetic Stock of Native Plantings 62
C. MITIGATION RECOMMENDATIONS 62
1. Habitat Loss and Modification 62
a) Beachfill/Berm Creation 62
b) Composite Seawall 62
c) Artificial Dunes and Dune Planting 63
d) Construction and Modification of Groins 63
e) HFFRRFs: Shoreline Armoring 64
f) HFFRRFs: Natural and Nature Based Features 64
g) Borrow Area Dredging 66
2. Disturbance and Mortality 66
a) Shorebirds and Seabirds 66
b) Saltmarsh Birds and Neotropical Songbirds 67
c) Diamondback Terrapins 67
d) Fish and Aquatic Invertebrates 67
3. Turbidity and Suspended Sediment 68
4. Burial of Invertebrates 68

D. ENHANCEMENT OPPORTUNITIES 69
E. THREATENED AND ENDANGERED SPECIES RECOMMENDATIONS 69
XIII. SERVICE CONCLUSIONS 70
XIV. REFERENCES 70

LIST OF FIGURES

Figure — Page

1. Study Area including the Land and Waters of the Rockaway Peninsula, Jamaica Bay, and Coney Island.....6
2. Location of the East Rockaway Borrow Area……....9
3. National Wetlands Inventory Map of the Study Area……..……..……..46
4. Historic Wetland Losses in Jamaica Bay from 1951 – 2008……....47
5. Atlantic Shorefront Project Elements……...52
6. Composite Seawall Beach 19th Street to Beach 126th Street…… 53
7. Composite Seawall Beach 126th Street to Beach 149th Street…..……. 53

LIST OF TABLES

Table — Page

1. Birds of Conservation Concern in the Study Area……...29
2. Initial Construction Beachfill Quantities ……..54
3. Summary of Groin Lengths……. 55

LIST OF APPENDICES

Appendix A. Relevant Studies, Projects, and Reports Within, and Adjacent to, the Study Area
Appendix B. Rockaway Peninsula Bird Species
Appendix C. Jamaica Bay Fish Species
Appendix D. Marine Nearshore and Offshore Fish Species
Appendix E. Jamaica Bay Aquatic Invertebrate Species
Appendix F. Jamaica Bay Insects, Moths, and Butterflies
Appendix G. Army Corps of Engineers' Responses to Draft Fish and Wildlife Coordination Act Report
Appendix H: NOAA Fisheries Comments on Draft Fish and Wildlife Coordination Act Report
Appendix I: NYSDEC Comments on Draft Fish and Wildlife Coordination Act Report

I. INTRODUCTION

This Final Fish and Wildlife Coordination Act (FWCA) Report was prepared pursuant to the FWCA of 1958, as amended (48 Stat. 401, as amended 661 *et seq*.) and provides conservation and planning assistance to the U.S. Army Corps of Engineers' (Corps) *Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study (Reformulation Study)*.

This Final FWCA Report builds on the U.S. Fish and Wildlife Service's (Service) Planning Aid Letter dated August 18, 2016, the Draft FWCA Report dated October 2018, and contains information on fish and wildlife resources (including threatened and endangered species), an assessment of project impacts, recommendations to avoid and minimize project-related impacts, and recommendations for additional monitoring and investigations over the 50-year life of the proposed project. The information provided herein is based on site visits conducted by the Service, current and ongoing studies, and literature review.

The Draft FWCA Report was sent to the Corps, the National Park Service (NPS), the New York State Department of Environmental Conservation (NYSDEC), and the National Oceanic and Atmospheric Administration (NOAA) for their review and comments. Comments from the Corps, the NOAA, the NPS, and the NYSDEC, the Service were incorporated into this Final FWCA Report.

II. PURPOSE, SCOPE AND AUTHORITY

A. PURPOSE

The Corps' primary objective of the proposed study is to examine coastal storm risk management problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Study Area (Study Area). The goal is to identify solutions that will reduce Atlantic Ocean shoreline and Jamaica Bay vulnerability to storm damage over time, in a way that is sustainable over the long-term, both for the natural coastal ecosystem and for communities (U.S. Army Corps of Engineers 2018).

The purpose of this FWCA consultation is to document the potential impacts upon fish and wildlife resources expected from the implementation of the proposed project, recommend measures to mitigate impacts of the project, and to conserve and protect fish and wildlife resources.

B. SCOPE

The Corps identified the Study Area as "the Atlantic Coast of New York City between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York. The Study Area also includes the low-lying Coney Island section of Brooklyn, which can be overtopped by floodwaters that flood the Brooklyn neighborhoods surrounding Jamaica Bay" (U.S. Army Corps of Engineers 2018). In order to delineate the FWCA analysis

area, the Service identified all areas within, and adjacent to, the Corps' identified Study Area that would be directly or indirectly impacted by the Recommended Plan.

Therefore, the Service has identified the FWCA analysis area as extending in a westerly direction approximately 11 miles (mi) from the East Rockaway Inlet to the Rockaway Inlet. The beaches west of the project footprint have been included as sediment transport may be impacted by the creation and extension of groins in the Study Area. The southern boundary extends 500 meters (m) into the nearshore waters of the Atlantic Ocean south of the Rockaway Peninsula shoreline in consideration of the turbidity, which will occur as a result of the beach nourishment. The northern boundary of the FWCA analysis area extends 500 m into the waters of Jamaica Bay north of the Rockaway Peninsula shoreline in consideration of turbidity that will occur as a result of the construction of high frequency flooding risk reduction features (HFFRRF) on the bay side of the Rockaway Peninsula. Additionally, the FWCA analysis area includes the waters of Motts Basin and approximately 700 feet (ft) of its shoreline, located in the eastern reach of Jamaica Bay, and approximately 1000 ft of shoreline and adjacent waters in Lawrence, NY, just east of the Rockaway Turnpike. Lastly, the borrow area and a 600-m buffer is included in the FWCA analysis area.

The scope of temporal effects includes short- to long-term impacts on a time scale from months to years due to the construction and the 50-year life and maintenance period of the proposed project. Many of the proposed elements of the project include the construction of hardened structures (*i.e.*, composite seawall, bulkhead, etc.). Impacts from these elements may extend well beyond the 50-year project life, especially once maintenance and renourishment efforts have ceased and in light of sea-level change projections.

C. AUTHORITY

The Reformulation Effort for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay was authorized by the House of Representatives, dated September 27, 1997, as stated within the Congressional Record for the U.S. House of Representatives. It states, in part:

> "*With the funds provided for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York project, the conferees direct the Corps of Engineers to initiate a reevaluation report to identify more cost-effective measures of providing storm damage protection for the project. In conducting the reevaluation, the Corps should include consideration of using dredged material from maintenance dredging of East Rockaway Inlet and should also investigate the potential for ecosystem restoration within the project area*."

Further, the Disaster Relief Appropriations Act (DRAA) of 2013 (Public Law [PL] 113-2) was enacted in part to "improve and streamline disaster assistance for Hurricane Sandy, and for other purpose". The DRAA directed the Corps to:

> "*…reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the*

Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy" (PL 113-2).

III. RELEVANT STUDIES, PROJECTS, AND REPORTS

Additional proposed or constructed federal projects within the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Study Area are described below. As per the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 *et seq*.), these actions should be considered in the Corps' cumulative effects analysis for the proposed project.

A. RELEVANT STUDIES, PROJECTS, AND REPORTS WITHIN, AND ADJACENT TO, THE STUDY AREA

1. Federal Projects

Numerous federal projects have been funded, authorized, and carried out along the Rockaway shoreline and within Jamaica Bay. The names of these projects are listed below. Descriptions of the projects are provided in Appendix A.

- Rockaway Beach Erosion Control and Hurricane Protection Project
- East Rockaway Inlet Federal Navigation Channel Project
- Rockaway Inlet Federal Navigation Channel Project
- Atlantic Coast of New York City (NYC) – Rockaway Inlet to Norton Point, Shore Protection Project
- Atlantic Coast of Long Island, Jones Inlet to East Rockaway Inlet, Long Beach Island, NY, Storm Damage Reduction Project
- Hudson Raritan Estuary Project, Ecosystem Restoration Feasibility Study
- Jamaica Bay, Marine Beach, and Plumb Beach Ecosystem Restoration Feasibility Study
- Spring Creek Park (North) Ecosystem Restoration Project
- Gerritsen Creek – Marine Park Ecosystem Restoration Project
- West Pond Breach Repair
- Fort Tilden Shore Access and Resiliency Project
- Jamaica Bay Marsh Island Restoration: Elders East, Elders West, Yellow Bar Hassock, Black Wall, and Rulers Bar
- North Atlantic Coast Comprehensive Study
- New York New Jersey (NY NJ) Harbor and Tributaries Coastal Storm Risk Feasibility Study

2. Federally-Authorized/Funded State or Local Actions

Additional projects, which are proposed or currently underway, that are relevant to the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay are listed below. Descriptions of the projects are provided in Appendix A.

- Arverne Urban Renewal Development
- Spring Creek (South) Storm Resilience and Ecosystem Restoration Project
- Jamaica Bay Self-Sustaining Oyster Population Project
- Rockaway Boardwalk Project
- Plumb Beach Coastal Storm Management Project
- Breezy Point Risk Mitigation System

3. Completed and Ongoing Studies and Reports

New York City Department of Environmental Protection's (NYCDEP) *"Jamaica Bay Watershed Protection Plan 2016 Update"* (New York City Department of Environmental Protection 2016) provides a summary of the completed and ongoing projects being carried out within Jamaica Bay. A list of these projects is found below. Project descriptions are provided in Appendix A.

- Ribbed Mussel Pilot Project at Fresh Creek Tributary
- Oyster Reef Pilot Project at Jamaica Bay
- Head of Bay Oyster Project
- Jamaica Bay Wastewater Treatment Plant Upgrades
- Long-term Control Plan for Jamaica Bay and Tributaries
- Area-wide Sewer Improvements
- Floating Wave Attenuator Study
- Spring Creek South Storm Resilience and Ecosystem Restoration Project
- Paerdegat Basin Natural Area and Ecology Park
- Green Infrastructure – Jamaica Bay Watershed

The Science and Resilience Institute at Jamaica Bay is a partnership among academic institutions, nongovernmental organizations, and community groups that is active in research and other efforts pertaining to Jamaica Bay. More information about this institute can be found in Appendix A.

IV. THE STUDY AND FWCA ANALYSIS AREA

A. DESCRIPTION OF THE STUDY AREA

The Study Area is located at the southwestern end of Long Island within the embayed section of the Atlantic Coastal Plain Province. As a result of the weight of the last ice sheet and subsequent postglacial rebound, or rise, of the land, the embayed section is the area of most recent submergence, and is characterized by broad peninsular tracts, drowned river estuaries, and a series of coastal terraces. The width of the Coastal Plain proper, not including the Continental Shelf, is narrowest in the north near the NY Bight Study Area. The Coastal Plain Province of the Bight includes all of Long Island. Low topographic relief characterizes the region with most of the area being less than 30 m in elevation but ranging from sea level to nearly 120 m above (U.S. Fish and Wildlife Service 1997).

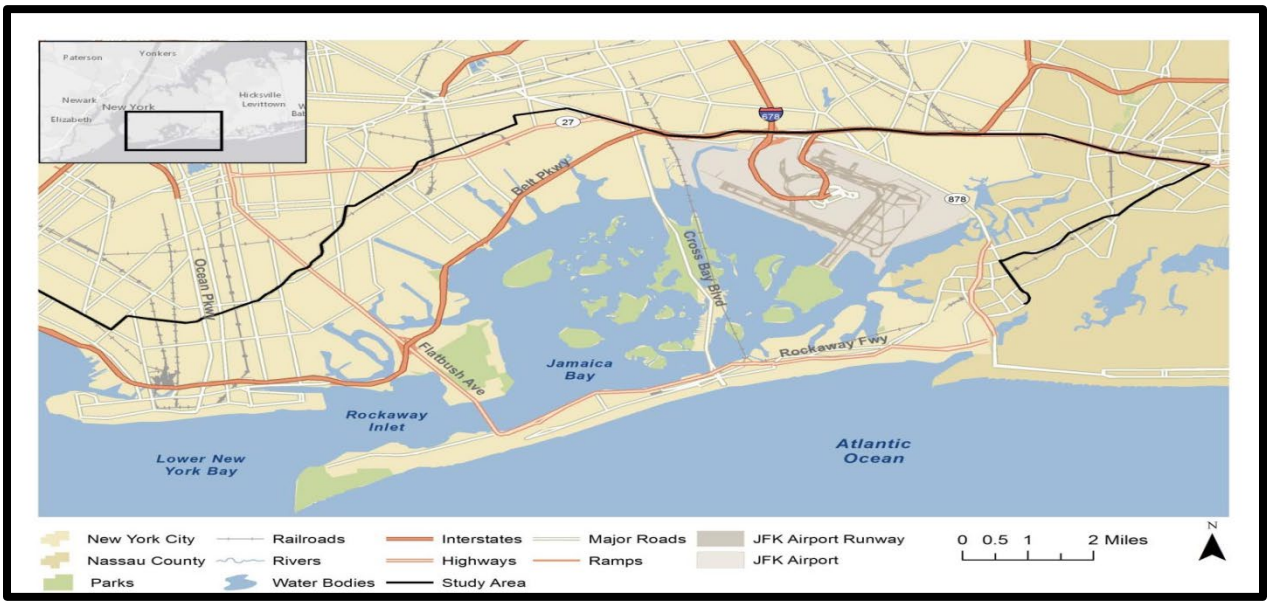


Figure 1. Study Area including the land and waters of the Rockaway Peninsula, Jamaica Bay, and Coney Island. (U.S. Army Corps of Engineers 2016a).

Rockaway Peninsula

Rockaway Peninsula is a developed barrier peninsula comprised of extensive residential and commercial development and associated infrastructure, NYC-owned/managed beaches, a private beach community, private beach clubs, and NPS beaches including upland parcels that are part of the Gateway National Recreation Area (GNRA). The Rockaway Peninsula is flanked by Jamaica Bay to the north and the Atlantic Ocean to the south. It is approximately 10 mi in length and varies between 0.4 mi and 0.9 mi in width. The Rockaway Peninsula is characteristically low-lying and flat. Ground elevations rarely exceed +10 ft North American Vertical Datum of 1988 (NAVD88), except within the existing dune field. Elevations along the Jamaica Bay shoreline generally range from +5 ft NAVD88, increasing to +10 ft NAVD88 further south toward the Atlantic coast (U.S. Army Corps of Engineers 2018).

Approximately 6 mi of the 10-mi long Rockaway Peninsula are characterized as urban development, consisting of residential, commercial, industrial development, high-rise buildings, boardwalks, subways, and roads. The ocean beach is bordered to the north by the boardwalk and other structures. To the east, the beach narrows and contains numerous groins (U.S. Fish and Wildlife Service 1997).

The remaining 4 mi of the peninsula consist of a mix of relatively undeveloped barrier island areas comprised of units of the GNRA, and residential developments including Breezy Point Cooperative and Roxbury. The GNRA property contains an approximately 200-acre (ac) natural area at the western tip of the Rockaway Peninsula with an accreting wide ocean beach, beachgrass dunes, grassland/shrub thicket, and fringing saltmarshes on the bayside (U.S. Fish and Wildlife Service 1997).

Jamaica Bay

Jamaica Bay connects with Lower NY Bay to the west through Rockaway Inlet. Jamaica Bay is a saline to brackish, eutrophic (nutrient-rich) estuary. The bay measures approximately 10 mi at its widest point east to west and approximately 4 mi at its widest point north to south. The mean depth of the bay is approximately 13 ft with maximum depths reaching 30 to 50 ft in the navigation channels and borrows pit areas, historically created to obtain fill material for various development projects around Jamaica Bay. The bay has a semidiurnal tidal range averaging 5-6 feet.

Heavily urbanized areas of Queens, Kings, and Nassau Counties surround the bay. As a result, the bay's bottom and shorelines have been modified over time and its ecological functions and values have been significantly altered. About 12,000 of the original 16,000 ac of wetlands in the bay, mostly around the perimeter of the bay, have been filled. As noted above, extensive areas of the bay have been dredged for navigation channels and to provide fill for the local airports and other construction projects; there have also been extensive modifications to the freshwater and brackish creeks. Specifically, an estimated 125 million cubic yards (cy) of material was removed from the bay and substantial modifications to the tidal inlet connections with Atlantic Ocean (New York City Department of Environmental Protection 2007) were made. The majority of the bay's freshwater inputs are now from the sewage treatment facilities, which contribute between 259 and 287 million gallons of treated effluent per day (New York City Department of Environmental Protection 2007; Waldman 2008).

The bay experiences annual algal blooms, depressed dissolved oxygen levels in select areas, and increased nutrient levels. Water quality sampling and modeling show that Jamaica Bay is a eutrophic system, but, in spite of this, dissolved oxygen and fecal coliform levels suggest water quality of the bay is improving, although high levels of nitrogen and chlorophyll-*a* continue to persist and prove problematic in the estuary (New York City Department of Environmental Protection 2007).

The primary sediments found within the eastern and northern portions of the bay are characterized as muddy fine sands while the southern and western portions of the bay are characterized as fine to medium sands (U.S. Fish and Wildlife Service 1997). As discussed in more detail in the following sections, Jamaica Bay contains large quantities of chemicals, including heavy metals, pesticides, polychlorinated biphenyl (PCB), dichlorodiphenyl-trichloroethane (DDT), and 2,3,7,8,-tetrachlordibenzo-*p*-dioxin (2,3,7,8-TCDD) (U.S. Army Corps of Engineers 2016b). Concentrations of many of these contaminants exceed New York State regulatory thresholds throughout the bay (Steinberg *et al.* 2004; New York State Department of Environmental Conservation 2014a). Additionally, portions of Jamaica Bay, including some of the northern basins and eastern Jamaica Bay, were on the New York State (NYS) 2016 section 303(d) impaired waterbodies list due to pathogens and low dissolved oxygen (New York State Department of Environmental Conservation 2016). However, these areas are proposed for delisting in the draft NYS 2018 section 303(d) list (New York State Department of Environmental Conservation 2018).

The surrounding shoreline of Jamaica Bay is characterized as urban, containing residential, commercial, industrial, and associated infrastructure. Other features located along the Jamaica Bay shoreline include the John F. Kennedy (JFK) International Airport, the former Pennsylvania Avenue and Fountain Avenue landfills, and wastewater treatment facilities. Many of the creeks have been modified, channelized, filled with sediment, or diverted. Some remnant creeks are present along the shoreline.

Offshore Borrow Area

Figure 2. Location of the East Rockaway Borrow Area.

The offshore dredging/borrow area is located approximately 2 mi south of Rockaway Peninsula and approximately 6 mi east of the Rockaway Inlet. The borrow area is approximately 2.6 mi long and 1.1 mi wide, with depths between 36 and 58 feet. The borrow area covers approximately 1,830 ac of marine subtidal habitat, including the water column and ocean bottom habitats.

Coney Island

Coney Island is attached to Long Island and is approximately 4 mi long and 1 mi wide. This area is comprised of extensive residential and commercial developments and associated infrastructure, NYC-owned/managed beaches, and a wastewater treatment plant.

B. ECOLOGICAL SIGNIFICANCE OF THE STUDY AREA

As described below, the Study Area provides habitats of regional and ecological significance to a suite of migratory birds, threatened and endangered species, and species of special concern, despite the negative influences of the surrounding urbanization. Jamaica Bay, the Rockaway Peninsula, and offshore waters provide habitat to various fish and wildlife species and have received special designations from multiple agencies and organizations.

The purpose of this section is to establish and identify significant fish and wildlife resources in the Study Area with a focus on the FWCA analysis areas. This information provides the basis for the more detailed discussion of the ecological communities and significant habitats upon which the impacts of the Corps' Recommended Plan and the fish and wildlife enhancement opportunities are subsequently evaluated.

1. Significant Habitat and Habitat Complex

The Jamaica Bay and Breezy Point Complex (Complex) encompasses the entire Jamaica Bay estuarine lagoon, part of the Rockaway Inlet, the western part of the Rockaway barrier beach, Plumb Beach, and most of the tidal creeks and undeveloped uplands adjacent to the Bay (U.S. Fish and Wildlife Service 1997). This Complex is of regional importance due to the location and rich food resources found within the complex. The Complex contains: beach and dune habitat for nesting bird and rare plant species; foraging areas for waterfowl, shorebirds, and colonial nesting waterbirds; important breeding and juvenile nursery habitat for finfish and shellfish; nesting habitats for gulls, terns, waterfowl, and herons; upland breeding habitat for grassland bird nesting and foraging areas; and butterfly concentration areas (U.S. Fish and Wildlife Service 1997).

2. Gateway National Recreation Area (GNRA)

The GNRA is comprised of 27,000 ac located in NY and New Jersey. Within NY, the park is broken into three distinct districts: Refuge District, Breezy Point District, and North Shore District, which are described below:

a) Refuge District

The Jamaica Bay Wildlife Refuge (Refuge) is a 9,155-ac refuge located on a marsh island in the middle of Jamaica Bay. The Refuge provides diverse habitat to many species of birds, reptiles, and amphibians, and marine and aquatic species. The Refuge is identified as a critical stopover area on the Eastern Flyway migration route with more than 325 bird species having been observed at the Refuge. Within the Refuge, the following habitats are present: saltmarsh, freshwater, brackish ponds, upland woods, fields, beach, open water, and bay islands.

b) Breezy Point District

The Breezy Point District includes the following units: Breezy Point Tip, West Beach, Fort Tilden, and Jacob Riis, which are located along the Atlantic Coast of Rockaway Peninsula. The

Breezy Point Tip is comprised of more than 200 ac of sand dunes, salt and brackish marshes, and grasslands. The site hosts a number of breeding species including the federally-listed piping plover (*Charadrius melodus*; threatened) and roseate tern (*Sterna dougallii dougallii*; endangered), as well as NYS-listed species such as least tern (*Sterna antillarum*; threatened), common tern (*Sterna hirundo*; threatened), black skimmer (*Rynchops niger*), and American oystercatcher (*Haematopus palliatus*). West Beach provides some limited grassland habitat to nesting killdeer (*Charadrius vociferous*) and eastern cottontail rabbit *(Sylvilagus floridanus*). Fort Tilden provides habitat for nesting species of piping plover and American oystercatcher.

c) North Shore District

The North Shore District includes the following units: Floyd Bennett Field, Canarsie Pier, Dead Horse Bay, Plum Beach, and Bergen Beach. Previously a municipal airport, Floyd Bennett Field provides 140 ac of grassland habitat for grasshopper sparrow (*Ammodramus savannarum*), eastern meadowlark (*Sturnella magna*), American kestrel (*Falco sparverius*), and northern harrier (*Circus cyaneus*). Canarsie Pier is surrounded by valuable saltmarsh habitat. Plumb Beach provides important foraging habitat to shorebirds and spawning habitat for horseshoe crab (*Limulus polyphemus*). The habitat at Plumb Beach includes tidal mudflats, low saltmarsh areas, a tidal lagoon, and a fragile dune system.

3. Audubon Important Bird Areas (IBA)

The IBA program identifies, monitors, and protects habitats critical to the success of bird populations (More information about Audubon IBA can be found at http://ny.audubon.org/conservation/what-important-bird-area). The Jamaica Bay complex is a designated IBA and, therefore, critical for wintering, resident, and breeding bird populations found there. The habitats present within the complex include the marine and tidal wetland portions of the bay itself, as well as the barrier beach/dune system and some adjoining upland shrub and grassland. Sensitive species or species of special concern that have been observed in the complex include: black-bellied plover (*Pluvialis squatarola*), red knot (*Calidris canutus rufa*; federally threatened), piping plover, laughing gull (*Leucophaeus atricilla*), roseate terns, common tern, Forster's tern (*Sterna forsteri*), least tern, black skimmer, brant (*Branta bernicula*), greater scaup (*Aythya marila*), and peregrine falcon (*Falco peregrinus; NYS endangered*) (Burger and Liner 2005).

4. New York State Department of State Significant Coastal Fish and Wildlife Habitats

Jamaica Bay is designated as a New York State Department of State (NYSDOS) Significant Coastal Fish and Wildlife Habitat. The designated area includes the entire bay, salt marsh, fringing tidal marsh, tidal flats, dredge spoil islands, and adjacent upland areas, which include open field, shrub thicket, developing woodlands, and beachgrass dune (New York State Department of State 1992). The designated habitat is of great significance as one of the largest coastal wetland ecosystems in New York. The area provides nesting and foraging habitat for a number of NYS threatened and endangered species, and NYS-designated species of special concern including: piping plover, common tern, northern harrier, diamondback terrapin (*Maclemys t. terrapin*), upland sandpiper (*Bartramia longicauda*), barn owl (*Tyto alba*), short-

eared owl (*Asio flammeus*), and grasshopper sparrow. The area also serves as a regionally-important recreational fishing and birdwatching site, hosting a wintering waterfowl concentration of statewide importance, including the only population of breeding laughing gulls in New York.

5. NYSDEC Critical Environmental Area

The NYSDEC designates Critical Environmental Areas (CEA) due to their exceptional or unique character with respect to one or more of the following (More information about NYSDEC CEA can be found at http://www.dec.ny.gov/permits/6184.html):

- a benefit or threat to human health;
- a natural setting (*e.g.*, fish and wildlife habitat, forest and vegetation, open space, and areas of important aesthetic or scenic quality);
- agricultural, social, cultural, historic, archaeological, recreational, or educational values; or
- an inherent ecological, geological, or hydrological sensitivity to change that may be adversely affected by any change.

Jamaica Bay, including the tributaries, tidal wetlands, and regulated adjacent areas, is a NYSDEC-designated CEA, and was designated as such in order to protect the ecosystem and the large number of wildlife present within the site.

C. HABITAT AND ECOSYSTEM CLASSIFICATIONS

As described above, the Study Area includes portions of Jamaica Bay, the Rockaway Peninsula, and offshore areas of the Atlantic Ocean adjacent to the Rockaway Peninsula. Within these areas, three major ecological systems (Estuarine, Marine, and Terrestrial), each with their respective subsystems and communities, can be identified using the classification system in Edinger *et al.* (2014). Below is a discussion of these three systems, and the subsystems and communities that are found within the Study Area, with a focus on those communities that occur within the FWCA analysis area of the project.

1. Estuarine System

The Estuarine System is defined by Edinger *et al.* (2014), as "deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed but have open, partly obstructed, or sporadic access to open ocean or tidal fresh waters, and in which ocean water is at least occasionally diluted by freshwater runoff." The Estuarine System is further subdivided into the following subsystems: estuarine subtidal, estuarine intertidal, and estuarine cultural, which can be further divided into community types. Below is a description of the estuarine subsystems found within the Study Area and the communities (as defined by Edinger *et al*. 2014) likely to be found within the FWCA analysis area:

a) Estuarine Subtidal

The Estuarine Subtidal subsystem is comprised of the area below the lowest tide. The substrate in this subsystem is continuously submerged by tidal water. This subsystem is found within the Study Area within Jamaica Bay. Estuarine subtidal communities that are likely to occur within the Analysis Area include:

Saltwater Tidal Creek: This is an aquatic community that is continuously tidally flooded with saline water that averages less than 2 m deep at low tide.

b) Estuarine Intertidal

The Estuarine Intertidal subsystem encompasses the area between the highest tide level and the lowest tide level and is periodically exposed and flooded by semidiurnal tides. Regularity of exposure at low tide and flooding at high tide varies throughout the intertidal. Within the Study Area, the estuarine intertidal subsystem is found within Jamaica Bay. Estuarine Intertidal communities occur within the FWCA analysis area primarily along the north shore of the Rockaway Peninsula and in the basins in eastern Jamaica Bay. The communities that are likely to be found in the FWCA analysis area include:

High Salt Marsh: A community dominated by a single graminoid species that occurs in sheltered areas from mean high tide up to the limit of spring tides. This community is flooded by spring tides and flood tides. Small remnant areas of high marsh are present on the north shore of the Rockaway Peninsula and within Motts Basin.

Low Salt Marsh: A coastal marsh community that forms in sheltered areas between mean high tide and mean sea level. The low marsh is regularly flooded by semidiurnal tides and is largely comprised of a stand of smooth cordgrass (*Spartina alterniflora*).

Salt Shrub: This shrubland community is often found on the upper edge of high marsh. It is an ecotone community between saltmarsh and upland vegetation.

Salt Panne: A poorly-drained shallow depression within high or low marsh.

Brackish Interdunal Swales: This is a brackish marsh community that occurs in interdunal swales and is infrequently flooded by extreme high tides.

c) Estuarine Cultural

This subsystem is comprised of communities that are created or maintained by human activities and/or modified by human activities to an extent that the physical substrate or biological community is substantially different from what would occur there naturally without human influence. Within the Study Area, Estuarine Cultural Communities are found within Jamaica Bay. Within the FWCA analysis area, these communities are found along the north shore of the Rockaway Peninsula and within the basins of eastern Jamaica Bay. Estuarine Cultural communities likely to be found within the FWCA analysis area include:

Estuarine Riprap/Artificial Shore: This is a constructed wetland community of the estuarine shore in which the substrate consists of broken rocks, wooden bulkheads, or concrete.

Estuarine Common Reed Marsh: This is a tidal marsh community that is dominated by common reed (*Phragmites australis*).

2. Marine System

The Marine System is described by Edinger *et al.* (2014) as "open ocean overlying the continental shelf, the associated coastline that is exposed to wind and waves, and shallow coastal bays that are saline because they lack significant freshwater inflow. The limits extend from mean high water seaward, beyond the limits of rooted vascular vegetation." The Marine System is further subdivided into the following subsystems: Marine Subtidal, Marine Intertidal, and Marine Cultural, all which are further divided into community types. Within the Study Area the Marine System occurs at the interface of the southern shoreline of the Rockaway Peninsula and the Atlantic Ocean and out to the offshore waters of the borrow area. Below is a description of the Marine subsystems and communities that can be found within the FWCA analysis area:

a) Marine Subtidal

The Marine Subtidal subsystem is the area below the lowest tide that is permanently flooded with tidal water. Within the Study Area, this subsystem occurs south of the Rockaway Peninsula and out to the offshore borrow area. The Marine Subtidal communities within the FWCA analysis area include:

Marine Deepwater Community: This community includes the waters of the open ocean, encompassing both the water column and all underlying benthic substrate (*e.g.*, rock bottom, unconsolidated bottom), from below the lowest tide level and beyond the seaward extent of rooted vascular vegetation.

b) Marine Intertidal

Edinger *et al.* (2014) describes the Marine Intertidal subsystem as "the area between the highest tide level and the lowest tide level; the substrate is periodically flooded and exposed by semidiurnal tides." Within the Analysis Area, this subsystem and its communities occur along the south shore of the Rockaway Peninsula. The following Marine Intertidal community is found within the FWCA analysis area:

Marine Intertidal Gravel/Sand Beach: This is a community that is composed of well-drained sand or gravel substrate that is washed by high-energy waves.

c) Marine Cultural

This subsystem is made up of communities that are created or maintained by human activities, or are modified by human activities to an extent that the physical or biological attributes of these communities are substantially different from what would naturally occur (Edinger *et al.* 2014). The marine cultural communities likely to occur within the FWCA analysis area include:

> *Marine Dredge Excavation Pit/Channel:* This community consists of the benthic community and the adjacent aquatic community that is created when ocean sediments are dredged.

3. Terrestrial System

The Terrestrial System as defined by Edinger *et al*. (2014) includes all areas that are not aquatic, wetland, or subterranean communities. The terrestrial system consists of upland habitats that are well drained and that do not support hydrophytic vegetation. The Terrestrial System is further subdivided into a number of subsystems. The terrestrial subsystems that occur within the Study Area are Open Uplands and Terrestrial Cultural, both of which can be further divided into community types. Below is a description of the Terrestrial communities that can be found within the FWCA analysis area on the Rockaway Peninsula between the boundaries of the Estuarine and Marine Systems:

a) Open Uplands

The open uplands subsystem is comprised of those communities that are dominated by shrubs, herbs, or mosses and lichens, and that have less than 25 percent tree canopy cover. They fall into three main categories: grasslands, meadows, and shrublands. Within the FWCA analysis area, the open upland subsystem is found on the southern side of the Rockaway Peninsula. The open upland communities that are likely to be found within the FWCA analysis area include:

> *Maritime Beach:* This community occurs above mean high tide on unstable cobble, sand, or gravel ocean shores. It is sparsely-vegetated and it is subject to modification by storm waves and wind erosion.
>
> *Maritime Dunes:* This community is comprised of active and stabilized dunes that support grasses and low shrubs.
>
> *Maritime Shrubland:* This is a shrubland community that is exposed to offshore winds and salt spray and that occurs on dry seaside bluffs and headlands.
>
> *Maritime Grassland:* This is a grassland community that grows near the ocean, within the influence of offshore winds and salt spray on the glaciated Atlantic coastal plain.

b) Terrestrial Cultural

This subsystem is made up of communities that are created or maintained by human activities, or are modified by human activities to an extent that the physical or biological attributes of these communities are substantially different from what would naturally occur (Edinger *et al.* 2014). Terrestrial cultural communities are found throughout the FWCA analysis area. Terrestrial cultural communities that are likely to be found within the FWCA analysis area include (but are not limited) to the following: mowed lawn, mowed lawn with trees, mowed roadside, unpaved road, paved road, landfill, urban vacant lot, and urban structure exterior.

V. FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES

The purpose of coordination between the Corps and the Service under the FWCA is to ensure equal consideration of fish and wildlife resources in the planning of water resource development projects. The Service's emphasis for the reformulation study is to mitigate the potential adverse impacts during construction activities, and operation and maintenance of the study.

The term "fish and wildlife resources" as used herein includes birds, fish, mammals, and all other classes of native animals and all types of aquatic and land vegetation upon which fish and wildlife are dependent. Marine and aquatic habitats, marshes, bay bottoms, and maritime beaches are of primary importance to the Service because these habitats are limited in availability, rich in species, and support some of the rarest species in New York.

A. FISH AND WILDLIFE RESOURCE CONCERNS

The Service has several fish and wildlife resource concerns, as identified in this section. Recommendations to address these concerns are found in Section XII, *"Service Planning and Mitigation Recommendations."*

1. Habitat Loss, Alteration, and Degradation

The Study Area is located in one of the most developed areas of the country and, as a result, many natural habitats have been lost and degraded over time. The terrestrial and aquatic habitats in the Study Area have been significantly altered to accommodate extensive residential and industrial development (U.S. Army Corps of Engineers and Port Authority of New York and New Jersey 2016; O'Neil *et al.* 2016). Diminishment of the natural vegetative communities has fragmented habitat and limited food, cover, and nesting for fish and wildlife in the Study Area.

Jamaica Bay, including the north shore of the Rockaway Peninsula, once supported more saltmarsh habitat than exists today but thousands of acres were lost due to filling. Sea-level rise continues to contribute to marsh loss in Jamaica Bay. In addition to the loss of saltmarsh habitat, the bayside shoreline of the Rockaway Peninsula is heavily armored with bulkhead, revetments, and riprap leaving very little natural shoreline for fish and wildlife resources. The armoring of shorelines is an ongoing threat as communities attempt to increase protection from erosion, storms, and sea-level rise.

The Rockaway Peninsula once experienced natural morphological changes, such as the westward growth of the peninsula and the westward migration of East Rockaway Inlet (U.S. Army Corps of Engineers 2016a). However, the Rockaway Peninsula has been stabilized with a number of bulkheads, groins and jetties over the past century. The extensive roads, infrastructure, and development found there also stabilize the Rockaway Peninsula and preclude natural processes, such as overwash and rollover, from occurring. Loss of natural processes due to shoreline stabilization and development inhibits the formation of early successional habitats and will continue to prevent any natural migration of the Rockaway Peninsula as sea-level rises.

2. Invasive Species

Invasive plants can be problematic as they can have negative impacts on native species and ecosystems. Invasive plant species may lower plant diversity by outcompeting native species (Hejda *et al.* 2009; Charles and Dukes 2007). The presence of invasive species may also lower wildlife diversity and species composition can be different in areas of high densities of invasive plants than in areas with native plants (Benoit and Askins 1999; Herrera and Dudley 2003; and Burghardt *et al.* 2009). Invasive plants may have other ecosystem effects, such as alterations of energy, nutrient, and hydrological cycles; changes to disturbance regimes; alterations to physical habitat; and impacts on climate and atmospheric composition (Charles and Dukes 2007).

A number of invasive plant species have been identified in Jamaica Bay and the Rockaway Peninsula. The following sixteen invasive species were identified and listed as "plants of concern" within the Jamaica Bay Wildlife Refuge: Tree-of-Heaven (*Ailanthus altissima*), garlic mustard (*Alliaria petiolata*), porcelain berry (*Ampelopsis brevipendunculata*), mugwort (*Artemisia vulgaris*), Oriental bittersweet (*Celastrus orbiculatus*), spotted knapweed (*Centaurea biebersteinii* [*maculosa*]), cypress spurge (*Chamaesyce* [*Euphorbia*] *cyparissias*), crown vetch (*Coronilla varia*), Russian and autumn olives (*Elaegnus umbellate* and *E. angustifolia*), Japanese honeysuckle (*Lonicera japonica*), purple loosestrife (*Lythrum salicaria*), common reed, Japanese knotweed (*Polygonum cuspidatum* [*Fallopia japonica*]), buckthorn (*Rhamnus frangula*), and multiflora rose (*Rosa multiflora*) (Stalter *et al.* 2009).

Common reed may be of particular concern within the Study Area. Common reed is a perennial wetland grass that is aggressive and outcompetes native plants and displaces native wildlife, as it provides little food or shelter for most saltmarsh-dependent species. Common reed may have other impacts including raising surface elevation of the marsh and altering hydrology and nutrient flows (U.S. Fish and Wildlife Service 2007a). Site visits revealed that common reed is prevalent along the north shore of the Rockaway Peninsula.

3. Wildlife and Habitat Management Related to the Federal Aviation Administration (FAA) Memorandum of Agreement (MOA)

Wildlife management is a significant issue, particularly near JFK International Airport. Aircraft colliding with wildlife, particularly birds, can pose a risk to air travel on and around airports. Restoring and managing habitat within the vicinity of airports can have impacts on overall bird populations in the area, which may contribute to the likelihood of bird strikes. As a result, the FAA has developed a MOA with the Service to guide restoration and management efforts such

that they do not create conditions that would result in dangers to air travel. Additionally, the U.S. Department of Agriculture's (USDA) Wildlife Services undertakes gull and geese population control measures within the Jamaica Bay Wildlife Refuge near JFK International Airport and gull and coyote control near LaGuardia Airport.

4. Environmental Contaminants

Contaminants that have been identified in Jamaica Bay include, but are not limited to: metals, polycyclic aromatic hydrocarbons (PAH), pesticides, chlorinated dioxins and furans, PCBs, solvents, and wastewater-related pharmaceuticals and healthcare products, derived from point and non-point sources. The presence of legacy contaminants in Jamaica Bay sediments poses a significant challenge in performing habitat restoration (U.S. Army Corps of Engineers and Port Authority of New York and New Jersey 2016; U.S. Army Corps of Engineers 2016b). Concentrations of many of these contaminants exceed NYS regulatory thresholds throughout the bay (Steinberg *et al.* 2004; New York State Department of Environmental Conservation 2014a). Additionally, chemicals from wastewater treatment plants discharges, combined sewer overflows, non-point source discharges, and chemical and oil spills are also known to be in the sediments (U. S. Army Corps of Engineers 2016b). A study by Benotti and Brownawell (2007) identified fifteen environmental contaminants in Jamaica Bay at least once, including 12 that were identified in most or all of the 24 sites that were surveyed. These compounds included pharmaceutical compounds and major human metabolites including: caffeine, cotinine, nicotine, paraxanthine, acetaminophen, carbamazepine, cimetidine, codeine, diltiazem, ketoprofen, metformin, ranitidine and salbutamol. Laboratory and field studies have shown that various classes of pharmaceuticals can have negative effects, such as reduced health and reproduction, on fish and other aquatic organisms (Corcoran *et al*. 2010; Gaw *et al.* 2014; Overturf *et al*. 2015; Fabbri and Franzellitti 2016). There is growing concern especially about pharmaceuticals in aquatic environments and their impacts on aquatic organisms, marine ecosystems, and human health (Corcoran *et al*. 2010; Gaw *et al*. 2014; Overturf *et al*. 2015; Fabbri and Franzellitti 2016).

The reformulation study is located within the boundaries Army Corps of Engineer's Hudson and Raritan Estuary (HRE) Restoration Study. A number of studies listed in the passage below which is excerpted from the Service's HRE Final FWCA Report (U.S. Fish and Wildlife Service 2018c) have specifically evaluated the biological effects of environmental contamination within the HRE and may, therefore, be applicable to this Reformulation Study.

> *The Corps mapped predicted concentrations of PCBs and 2,3,7,8-TCDD in the top 10 cm of sediment throughout the HRE (U.S. Army Corps of Engineers, Port Authority of New York and New Jersey 2016). Approximately 62 percent of the HRE had sediment concentrations exceeding a remediation goal for 2,3,7,8-TCDD of 3.17 parts per trillion (ppt), a value calculated by the Service (Kubiak et al. 2007), using an effects concentration for successful oyster reproduction and oyster lipid content reported by Wintermyer and Cooper (2003), in conjunction with measured organic carbon contents of sediment in the HRE (Contaminant Assessment and Reduction Project [CARP], 1999-2000). The Corps (2009) also mapped predicted concentrations of total PCBs in sediment and compared those concentrations to the ER-L and ER-M values reported by Long et al. (1995). Approximately 90 percent of the HRE had expected sediment PCB*

concentrations exceeding the ER-M, while 99 percent had sediment PCB concentrations exceeding the ER-L. These evaluations reveal the difficulties in finding potential restoration sites without environmental contaminant issues within in the HRE. However, the difficulty may actually be even greater, given that a similar exercise has not been conducted for mercury.

Dredging sediments can resuspend contaminants, making them more bioavailable (Knott *et al*. 2009). Adverse effects can begin at the base of the food chain, accounting for toxicity to phytoplankton and autotrophic bacteria (Nayer *et al.* 2004). Dredging can also result in sediment resuspension, which can enhance the growth of water column bacteria and protozoa through release of nutrients. This establishes a pathway for organic contaminants to be accumulated by microorganisms and higher trophic animals such as filter feeding organisms (Latimer *et al.* 1999; Zarull *et al.* 1999). The degree of contaminant bioavailability is determined by *'the reactivity of each contaminant with the biological interface, the presence of other chemicals that may antagonize or stimulate uptake, and external factors such as temperature that affect the rate of biological or chemical reactions'* (Luoma 1983, as quoted in Eggleton and Thomas 2004).

Contaminants may also limit oyster restoration efforts that are proposed for natural and nature based features (NNBF) in the Recommended Plan. Wintermeyer and Cooper (2003) studied the effects of dioxin and dioxin-like compounds on egg development and fertilization of the eastern oyster (*Crassostrea virginica*) in Newark Bay and the Arthur Kill, New Jersey. They found that bioavailable contaminants in the water impaired gonadal development, egg viability, and larval production in oysters.

5. Supply of Genetic Stock of Native Plantings

Contracting for native plant material under the current paradigm (*e.g.*, at the time of construction award) delays the initiation of procurement and production of plants and results in compromised material selection, variety, and source. In restoring natural systems, plant materials must be carefully sourced to avoid the negative genetic consequences of introducing maladapted genotypes into local plant populations. Founder effects, genetic swamping, and outbreeding depression are all well-established, negative consequences of translocating maladapted non-local genetic plant materials into restoration sites (Hufford and Mazer 2003).

Numerous coastal resiliency projects are proposed in the Tri-state area over the next decade for construction by the Corps, the Federal Emergency Management Agency, the Housing and Urban Development, the New York State Governor's Office of Storm Recovery, and other federal, state, and municipal agencies. The cumulative effect of these projects will likely further exacerbate the current shortage of locally-sourced and genetically-diverse plants for the Study Area.

The needs for acquiring appropriate plant material over the next ten years cannot be met without the Corps' involvement in assembling a regional team to collect, store, and produce sufficient quantities of genetically-diverse plant material – similar to what the Bureau of Land Management (BLM) is undertaking with numerous stakeholders, seed collectors, farmers, and commercial growers. The problem of native plant procurement for these post-hurricane Sandy

projects has recently been further identified by the Rockefeller Foundation in the just-released study entitled, *"Challenges in Supplying Native Plants for Resilience (for the NYC Region)"* (Taedoki B.V. and The Rockefeller Foundation 2016).

B. PLANNING OBJECTIVES

The purpose of consultation under the FWCA is to ensure equal consideration of fish and wildlife resources in the planning of water resource development projects. The Service's emphasis in this regard is to identify means and measures to mitigate the potential adverse impacts of the proposed project and to make positive contributions to fish and wildlife resource problems and opportunities.

From the Service's perspective, a desired output of the proposed project is to ensure the healthy marine, estuarine, and terrestrial ecological communities. Specifically, the Service recommends that conservation of fish and wildlife resources be accomplished by:

1. Ensuring that the proposed project evaluate alternatives that ensure natural areas are protected and conserved and that biological diversity is maintained;
2. Identifying a project alternative that is most beneficial to fish and wildlife resources;
3. Obtaining basic biological data for the marine, estuarine, and terrestrial habitats to aid in the development of appropriate conservation measures;
4. Implementing mitigation measures to avoid and minimize potential direct and indirect project related impacts;
5. Incorporating habitat enhancement opportunities to benefit fish and wildlife resources in the Study Area;
6. Incorporating education and outreach activities in the project to inform the public about the uniqueness and fragility of the coastal ecosystem;
7. Developing and implementing monitoring and maintenance plans for habitats created or impacted by the project; and
8. Ensuring that the implementation of the reformulation plan does not conflict with other federal, state, and local projects within the project's Study Area.

VI. EVALUATION METHODOLOGY

Descriptions of natural resources are based on studies for similar projects, relevant grey and peer-reviewed literature, local, state, and federal fish and wildlife reports and plans, and personal communications with knowledgeable biologists, planners, coastal geologists, and engineers.

In this report, the Service provides a discussion of federal trust resources (*i.e.*, migratory birds, wetlands, endangered species, and anadromous fish), as well as other significant fish and wildlife resources, for the study area. As discussed in more detail in the following section, this report provides descriptions of fish and wildlife resources that use the three major ecological systems (marine, estuarine, and terrestrial) of the proposed Study Area.

VII. DESCRIPTION OF FISH AND WILDLIFE RESOURCES

A. PLANTS

1. Plant Communities

Below are descriptions of the plant communities, as described by Edinger *et al.* (2014), which are common within the FWCA analysis area:

a) Estuarine Communities

Salt Shrub – The common shrubs of the salt shrub community include the following: groundsel-tree (*Baccharis halimifolia*), saltmarsh-elder (*Iva frutescens*), and pasture rose (*Rosa Carolina*). The common herbaceous species are: salt-meadow grass (*Spartina patens*), black-grass (*Juncus gerardii*), and switchgrass (*Panicum virgatum*) (Edinger *et al.* 2014).

High Salt Marsh – Salt-meadow grass (*Spartina patens*) or a dwarf form of cordgrass (*S. alterniflora*) dominate large areas of this community. Spikegrass (*Distichlis spicata*), black-grass, and glassworts (*Salicornia* spp.) may also dominate large areas of this community. Common species of the upper slope of the high marsh include: black-grass, switchgrass, sea-lavender (*Limonium carolinianum*), seaside gerardia (*Agalinis marinta*), and slender saltmarsh aster (*Aster tenuifolius*) (Edinger *et al.* 2014).

Low Salt Marsh – Low marsh is comprised largely of a monospecific stand of cordgrass. Some species of marine algae can form dense mats on the surface sediments between the cordgrass stems, including knotted wrack (*Ascophyllum nodosum*) and rockweed (*Fucus vesiculosus*), sea lettuce (*Ulva* spp.), and hollow green weeds (*Enteromorpha* spp.). Other plants that may be present in the low marsh in low numbers include: glasswort (*Salicornia europaea*), saltmarsh sand-spur (*Spergularia marina*), and lesser sea blite (*Suaeda maritima*) (Edinger *et al.* 2014).

Brackish Interdunal Swales – This community is dominated by grasses, sedges, and rushes including salt-meadow grass, dwarf spikerush (*Eleocharis parvula*), three-square (*Schoenoplectus pungens*), flatsedge (*Cyperus polystachyos*), and jointed rush (*Juncus articulatus*). Other characteristic plants include: salt-meadow grass (*Leptochloa fusca* spp. *fascicularis*), seaside bulrush (*Bobloschoenus maritimus* spp. *paludosus*), toad-rush (*Juncus ambiguus*), sedge-rush (*Juncus scirpoides*), mock bishop's-weed (*Ptilimnium capillaceum*), golden dock (*Rumex maritimus*), eastern annual saltmarsh aster (*Symphyotrichum subulatum* var. *subulatum*), red pigweed (*Chenopodium rubrum*), saltmarsh fleabane (*Pluchea odorata*), rose-mallow (*Hibiscus moscheutos*), bushy knotweed (*Polygonum ramosissimum*), and saltmarsh-elder. Seabeach amaranth (*Amaranthus pumilus*) may also occur. Common reed can become invasive in this community (Edinger *et al.* 2014).

b) Terrestrial Communities

Maritime Beach – The characteristic species of the maritime beach include: American beach grass (*Ammophila breviligulata*), sea-rocket (*Cakile edentula* spp. *edentula*), seaside atriplex (*Atriplex patula*), seabeach atriplex (*A. arenaria*), seabeach sandwort (*Honkenya peploides*), salsola (*Salsola kali*), seaside spurge (*Chamaesyce polygonifolia*), and seabeach knotweed (*Polygonum glaucum*) (Edinger *et al.* 2014).

Maritime Dunes – As described earlier, the maritime dunes community is comprised of both active and stabilized dunes. The characteristic species of the active dunes include: American beach grass, dusty-miller (*Artemisia stelleriana*), beach pea (*Lathyrus japonicas*), sedge (*Carex silicea*), seaside goldenrod (*Solidago sempervirens*), and sand-rose (*Rosa rugosa*) (Edinger *et al.* 2014). The common species of stabilized dunes include: beach heather (*Hudsonia tomentosa*), bearberry (*Arctostaphylos uva-ursi*), beachgrass, cyperus (*Cyperus polystachyos* var. *macrostachyus*), seaside goldenrod, beach pinweed (*Lechea maritima*), jointweed (*Polygonella articulata*), sand-rose, bayberry (*Myrica pensylvanica*), beach-plum (*Prunus maritima*), poison ivy (*Toxicodendron radicans*), lichens (*Cladina submitis* and *Cetraria arenaria*), seabeach amaranth, and, in small numbers, stunted pitch pines (*Pinus rigida*) or post oaks (*Quercus stellata*) (Edinger *et al.* 2014).

Maritime Shrubland – Common shrubs and sapling trees of maritime shrubland include: shadbush (*Amelanchier canadensis*), bayberry, black cherry (*Prunus serotina*), arrowwood (*Viburnum dentatum*), and shining sumac (*Rhus copallinum*). Other shrubs and stunted trees that may be present include beach-plum, sand-rose, wild rose (*R. virginiana*), eastern red cedar (*Juniperus virginiana*), American holly (*Ilex opaca*), black oak (*Quercus velutina*), and sassafras (*Sassafras albidum*). Small amounts of the following that may also be found in this community include: highbush blueberry (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), red maple (*Acer rubrum*), and black chockeberry (*Aronia melanocarpa*) – these are often found in moister low areas (Edinger *et al*. 2014)

Characteristic vines include: poison ivy, Virginia creeper (*Parthenocissus quiquefolius*), greenbrier (*Smilax rotundofiloia*), oriental bittersweet, and Japanese honeysuckle. Herbaceous plants are very sparse in this community, but may include: flat-topped goldenrod (*Euthamia graminifolia*), wild indigo (*Baptisia tinctoria*), white-topped aster (*Aster paternus*), and little bluestem (*Schizachyrium scoparium*) (Edinger *et al.* 2014).

Maritime Grassland – The dominant grasses of the maritime grassland include: little bluestem, common hairgrass (*Deschampsia flexuosa*), and poverty-grass (*Danthonia spicata*). Other characteristic species include: Pennsylvania sedge (*Carex pensylvanica*), rush (*Juncus greenei*), Indian grass (*Sorghastrum nutans*), Atlantic golden aster (*Pityopsis falcate*), bushy rockrose (*Helianthemum dumosum*), hoary frostweed (*H. propinquum*), flat-topped goldenrod, white-topped aster, pussy's toes (*Antennaria plantaginifolia*), bitter milkwort (*Polygama polygama*), bayberry, shining sumac, and northern dewberry (*Rubus flagellaris*) (Edinger *et al.* 2014).

2. Rare Plants and Plants of Ecological Significance

Surveys conducted as part of an Environmental Impact Statement for the Arverne Urban Renewal Area Project (Wall and Associates, Inc. *et al.* 2003) identified five rare and/or ecologically significant plant species along the south shore of the eastern Rockaway Peninsula. The three rare plants that were located were the federally-listed seabeach amaranth (threatened), the NYS-listed seabeach knotweed (threatened), and the NYS-listed dune sandspur (*Cenchrus tribuloides*; rare). Surveyors also identified two ecologically-significant plants: milkweed (*Aesclepias syriaca*) and wild pepper grass (*Lepidium virginicum*). Milkweed is a host plant to the monarch butterfly (*Danaus plexippus*), which is being reviewed for federal listing status, and wild pepper grass is a host species for the checkered white (*Pontia protodice*), which is a species of special concern in New York.

Other rare plants that occur within Jamaica Bay and Breezy Point include: Houghton's umbrella-sedge (*Cyperus houghtonii*), blunt spikerush (*Elecharis obtuse* var. *ovata*), field-dodder (*Cuscuta pentagona*), smartweed-dodder (*Cuscuta polygonorum*), Schweinitz's flatsedge (*Cyperus schweinitzii*), Roland's sea-blite (*Suaeda rolandii*), willow oak (*Quercus phellos*), and retrorse flatsedge (*Cyperus retrorsus*) (U.S. Fish and Wildlife Service 1997).

B. WILDLIFE

1. AVIAN SPECIES

Migratory birds are a federal trust resource. Many species of migratory birds have experienced population declines in recent decades, largely due to direct and indirect destruction and fragmentation of their habitats (Dunne 1989).

The FWCA requires the Secretary of the Interior, through the Service, to identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the ESA. *Birds of Conservation Concern 2008* (U.S. Fish and Wildlife Service 2008) is the most recent effort to carry out this mandate. The overall goal of that report is to accurately identify the migratory and non-migratory bird species (beyond those already designated as federally threatened or endangered) that represent our highest conservation priorities. A resource assessment by the Service's IPaC (Information, Planning, and Conservation System) identified a total of 33 Birds of Conservation Concern that may occur seasonally or year-round within the Study Area (U.S. Fish and Wildlife Service 2018a). All the species below have been observed in the Study Area (Veit *et al.* 2002; eBIRD 2018); however, some of these species are rare occurrences in the area. These are listed in Table 1, below.

Table 1. Birds of Conservation Concern in the Study Area (U.S. Fish and Wildlife Service 2018a).

Species	**Scientific Name**	**Species**	**Scientific Name**
American Oystercatcher	*Haematopus palliates*	Nelson's Sparrow	*Ammodramus nelson*
Black Skimmer	*Rynchops niger*	Prairie Warbler	*Dendroica discolor*
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Prothonotary Warbler	*Protonotaria citrea*

Bobolink	*Dolichonyx oryzivorus*	Purple Sandpiper	*Calidris maritima*
Buff-breasted Sandpiper	*Calidris subruficollis*	Red-headed Woodpecker	*Melanerpes erythrocephalus*
Canada Warbler	*Cardellina Canadensis*	Red-throated Loon	*Gavia stellate*
Cerulean Warbler	*Dendroica cerulean*	Ruddy Turnstone	*Arenaria interpres morinella*
Clapper Rail	*Rallus crepitans*	Rusty Blackbird	*Euphagus carolinus*
Dunlin	*Calidris alpina arcticola*	Saltmarsh Sparrow	*Ammodramus caudacutus*
Evening Grosbeak	*Coccothraustes vespertinus*	Seaside Sparrow	*Ammodramus maritimus*
Golden-winged Warbler	*Vermivora chrysoptera*	Semipalmated Sandpiper	*Calidris pusilla*
Gull-billed Tern	*Gelochelidon nilotica*	Short-billed Dowitcher	*Limnodromus griseus*
Hudsonian Godwit	*Limosa haemastica*	Snowy Owl	*Bubo scandiacus*
Kentucky Warbler	*Oporornis formosus*	Whimbrel	*Numenius phaeopus*
Least Tern	*Sterna antillarum*	Willet	*Tringa semipalmata*
Lesser Yellowlegs	*Tringa flavipes*	Wood Thrush	*Hylocichla mustelina*
Long-eared Owl	*Asio otus*		

Jamaica Bay encompasses a large portion of the Study Area and supports numerous bird species. The NPS conducted bird surveys in Jamaica Bay from 1994 to 2014. Over the course of the NPS surveys, 325 species of birds were identified as using the Jamaica Bay Wildlife Refuge (National Park Service 2014). Many of these species are migratory species or rare occurrences, however, over 60 species are confirmed breeders (National Park Service 2014). Notable breeders within Jamaica Bay include wading bird colonies and obligate saltmarsh-breeding birds, such as saltmarsh sparrow (*Ammospiza caudacuta*) and clapper rail (*Rallus crepitans*). The habitats of the Rockaway Peninsula also support a number of breeding and migratory birds. In April 2000 and April 2001, the Jamaica Bay Ecosystem Research and Restoration Team (Veit *et al.* 2002) performed bird surveys at nine sites across Jamaica Bay, including three bayside locations on the Rockaway Peninsula: Dubos Point, Bayswater Point State Park, and Brant Point. During these surveys, they observed 142 species of birds across the three sites (full list in Appendix B). Of the nine sites surveyed throughout the bay, Dubos Point was one of three with the highest migrant shorebird diversity and Bayswater Point State Park was one of two with the highest in neotropical migrant landbird diversity.

Suites of birds that are found in the Study Area that are of particular conservation concern are discussed in more detail below.

a) Shorebirds and Seabirds

The Study Area provides essential nesting and foraging habitats for significant breeding colonies of shorebirds and seabirds, including the piping plover, roseate tern, least tern, common tern, black skimmer, and American oystercatcher. Roseate terns have historically nested within the Study Area, but have not been observed nesting recently, although some have been observed foraging in the area. It should also be noted that the black skimmer colony that nests within the Study Area is one of only three nesting skimmer colonies in New York.

Within the Study Area, the piping plover nests in the maritime beach and dune communities on the Rockaway Peninsula and forages on invertebrates primarily along the ocean and bay

shorelines. The least tern also nests on the maritime beaches, but forages for fish in ocean and bay open waters. The common tern and black skimmer breed on maritime beach/dune habitats and forage for fish in ocean and bay open waters. The American oystercatcher breeds and forages in the maritime beach and dune habitats of the Rockaway Peninsula, as well as in the estuarine habitats of Jamaica Bay.

Numerous migratory shorebirds can also be found during migratory periods in the estuarine communities of Jamaica Bay and the marine and maritime beaches of the Rockaway Peninsula. Most notably, NY's largest concentrations of migratory red knots are found in the marsh islands of Jamaica Bay. Significant flocks of semipalmated sandpiper (*Calidris pusilla*) and sanderling (*C. alba*) have also been documented (New York City Audubon, unpublished data). The red knot and other migratory shorebirds, such as sanderling and semipalmated sandpipers, also utilize the marine and maritime beaches within the Study Area during spring and fall migrations (eBird 2018).

Many species of shorebirds in the U.S. are suffering from declines in populations. The "*Atlantic Flyway Shorebird Business Strategy"* (Winn *et al.* 2013) identifies the following as some of the main threats to shorebirds: hunting, predation, human disturbance, and habitat loss and change. The following species are recognized by the "*Atlantic Flyway Shorebird Business Strategy"* as species of greatest conservation concern: American oystercatcher, semipalmated sandpiper, red knot, whimbrel (*Numenius phaeopus*), Wilson's plover (*Charadrius wilsonia*), marbled godwit (*Limosa fedoa*), piping plover, purple sandpiper (*Calidris maritima*), red-necked phalarope (*Phalaropus lobatus*), ruddy turnstone (*Arenaria interpres*), sanderling, snowy plover (*Charadrius nivosus*), American golden-plover (*Pluvialis dominica*), greater yellowlegs (*Tringa melanoleuca*), and lesser yellowlegs (*Tringa flavipes*). Except for the snowy and Wilson's plovers, all of these species have been recorded in the Study Area (eBird 2018).

b) Saltmarsh Birds

Many bird species rely on saltmarsh habitat for foraging and/or nesting. Certain species, such as saltmarsh sparrows and clapper rails, are obligate saltmarsh nesting species, meaning that they nest exclusively in saltmarsh habitat and are particularly vulnerable to marsh loss or degradation. Historic and current losses of saltmarsh habitat have led to a number of saltmarsh bird species being recognized as species of conservation concern (New York State Department of Environmental Conservation 2015; U.S. Fish and Wildlife Service 2008; and International Union for Conservation of Nature 2016). Sea-level rise continues to pose a threat to saltmarsh birds as it reduces available saltmarsh habitat and may lead to an increased frequency of nest flooding – a major cause of nest loss for marsh-nesting species (Gjerdrum *et al.* 2008; Shriver *et al.* 2007; Bayard and Elphick 2011).

The marsh islands and fringing marshes of Jamaica Bay provide nesting habitat for a number of marsh-nesting birds. The Jamaica Bay marsh islands provide habitat to a number of breeding colonies of wading birds each summer (Winston 2017). Obligate saltmarsh-nesting birds, including saltmarsh sparrow, seaside sparrow (*Ammodramus maritimus*), and clapper rail, nest on the marsh islands and in the fringing marshes along the bay (Kocek 2014; New York State Department of Environmental Protection 2005). These three species were also located in

habitats on the Rockaway Peninsula (Veit *et al.* 2002). Other marsh-dependent species that were located include, but are not limited to: American black duck (*Anas rubripes*), American bittern (*Botaurus lentiginosus*), great blue heron (*Ardea Herodias*), green heron (*Butorides virescens*), yellow-crowned night-heron (*Nyctanassa violacea*), black-crowned night-heron (*Nycticorax nycticorax*), great egret (*Ardea alba*), snowy egret (*Egretta thula*), and marsh wren (*Cistothorus palustris*) (Veit *et al.* 2002).

c) Waterfowl

Wintering waterfowl are found in both marine waters off the Rockaway Peninsula, as well as the estuarine waters in Jamaica Bay. Significant concentrations of wintering waterfowl can be found in Jamaica Bay. Large numbers of greater scaup, American black duck, brant, Canada goose (*Branta canadensis*), bufflehead (*Bucephala albeola*), canvasback (A*ythya valisneria*), mallard (*Anas platyrhynchos*), ruddy duck (*Oxyura jamaicensis*), red-breasted merganser (*Mergus serrator*), snow goose (*Chen caerulescens*), and American wigeon (*Anas americana*) have been documented since the late 1970s (New York State Department of State 1992; U.S. Fish and Wildlife Service 1997; Waldman 2008). Other waterfowl species documented within the bay include: horned grebe (*Podiceps auritus*), green-winged teal (*Anas crecca*), gadwall (*A. strepera*), northern shoveler (*A. clypeata*), and common goldeneye (*Bucephala clangula*) (U.S. Fish and Wildlife Service 1997). Jamaica Bay is recognized as a focal area by the Atlantic Coast Joint Venture (ACJV) *Waterfowl Implementation Plan* (Atlantic Coast Joint Venture 2005). The sheltered open water, fringing marshes, and mudflats provide habitat for wintering sea, bay, and dabbling ducks (Atlantic Coast Joint Venture 2005).

The waterfowl of the marine waters off the Rockaway Peninsula have not been as well described, however, the Atlantic Coast Wintering Sea Duck Survey (2008-2011) incorporated an aerial survey transect off of the coast of southwestern Long Island. White-winged scoter (*Melanitta fusca*), long-tailed duck (*Clangula hyemalis*), surf scoter (*M. perspicillata*), and black scoter (*M. americana*) were detected on this transect and others along the south shore of Long Island (Silverman *et al.* 2013). Because they were hard to distinguish down to species during the aerial surveys, bufflehead, goldeneye, and merganser species were reported as one consolidated group, which was also detected on the southwestern Long Island transect (Silverman *et al.* 2013, as cited in Michel *et al.* 2013).

Waterfowl are of conservation concern as mid-winter survey data from 1970-2003 indicated that various waterfowl species have suffered population declines (Atlantic Coast Joint Venture 2005). This includes species, such as the American black duck and the long-tailed duck, which are found in the Study Area. The status of many sea duck populations is largely unknown and, due to this concern, there are research and conservation initiatives for these species. Long-tailed duck, American common eider, black scoter, surf scoter, and white-winged scoter are designated as high priority species by the Sea Duck Joint Venture Management Board Management Board (SDJV); all of which have been located in the Study Area (Silverman *et al*. 2013; eBird 2018). Recent and ongoing efforts are being made to better understand these populations and the threats they may face (Sea Duck Joint Venture Management Board 2014). The main threats to

waterfowl are: habitat loss, fragmentation and degradation; contaminants; disease; invasive species; predation and harvest; human population and disturbance; and global climate change (Atlantic Coast Joint Venture 2005).

d) Neotropical Migratory Landbirds

Neotropical migrants are those bird species that breed in the U.S. and Canada, and migrate south to overwinter in the neotropics. Neotropical migratory landbirds (*e.g.*, migratory songbirds) make up a large proportion of neotropical migrants, as well as a large proportion of the avian community in the northeastern United States (Askins *et al.* 1990; Keller and Yahner 2006). Many neotropical migrants, including species of migratory songbirds, have suffered population declines in recent decades (Robbins *et al*. 1989; Askins *et al.* 1990; Sauer *et al.* 2014). Neotropical landbird migrants suffer mortality during all phases of their annual lifecycle; however, the greatest mortality for some species may occur during migratory periods (Holmes 2007). Numerous species of migratory neotropical migratory landbird species fulfill many of their life stages (*i.e.*, breeding and migration) within the Study Area.

The following neotropical bird species are recognized by the Service as species of concern (U.S. Fish and Wildlife Service 2008) and may be found within the Study Area: bobolink (*Dolichonyx oryzivorus*), Canada warbler (*Wilsonia canadensis*), cerulean warbler (*Dendroica cerulea*), golden-winged warbler (*Vermivora chrysoptera*), Kentucky warbler (*Oporornis formosus*), prairie warbler (*Dendroica discolor*), prothonotary warbler (*Protonotaria citrea*), and wood thrush (*Hylocichla mustelina*).

Additionally, a number of neotropical migratory landbird species are confirmed breeders within the Study Area including (but not limited to): American robin (*Turdus migratorius*), barn swallow (*Hirundo rustica*), cedar waxwing (Bombycilla cedrorum), common yellowthroat (*Geothlypis trichas*), gray catbird (*Dumetella carolinensis*), house wren (*Troglodytes aedon*), marsh wren, red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melospiza melodia*), tree swallow (*Tachycineta bicolor*), yellow warbler (*Dendroica petechia*), and willow flycatcher (*Empidonax traillii*) (National Park Service 2014; U.S. Fish and Wildlife Service 2018b).

2. Amphibians and Reptiles

Reptiles and amphibians that occur within the Study Area include: Fowler's toad (*Bufo woodhousii fowleri*), spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor*), green frog (*Rana clamitans*), spotted salamander (*Ambystoma maculatum*), redback salamander (*Plethodon cinereus*), northern brown snake (*Storeria d. dekayi*), smooth green snake (*Opheodrys vernalis*), eastern hognose snake (*Heterodon platirhinos*), eastern milk snake (*Lampropeltis triangulum triangulum*), northern black racer (*Coluber c. constrictor*), snapping turtle (*Chelydra serpentina*), eastern painted turtle (*Chrysemys p. picta*), and eastern box turtle (*Terrapene c. carolina*) (U.S. Fish and Wildlife Service 1997).

Diamondback Terrapins

Diamondback terrapins inhabit coastal marshes, tidal creeks, estuaries, bays, and coves where they forage and breed. Breeding and nesting typically occurs in May, June, and July. Nest locations are commonly found on uplands adjacent to estuarine habitats and include dunes, grasslands, shrublands, beaches, and sand/gravel trails (Feinberg and Burke 2004). Terrapin populations are declining across their range – Atlantic and Gulf Coasts of the United States. Major threats to terrapins include: road mortality, predators, mortality due to fishing gear, harvesting, and habitat destruction. Within Jamaica Bay, terrapins have been documented nesting at the GNRA – specifically, Rulers Bar Hassock and Little Egg Island (Feinberg and Burke 2003), JFK Airport, and Idlewild Park (Pehek *et al.* 2018). There have also been anecdotal reports of nesting adults and hatchling diamondback terrapins on the north side of the Rockaway Peninsula (Burke 2018).

3. Mammals

Resident mammals of the Jamaica Bay islands and shoreline include: opossum (*Didelphis virginiana*), eastern cottontail rabbit, eastern chipmunk (*Tamias striatus* – introduced), gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), muskrat (*Ondatra zibethicus*), and house mouse (*Mus musculus*). Migratory bats found at the Jamaica Bay Wildlife Refuge include: little brown bat (*Myotis lucifugus*), silver-haired bat (*Lasionycteris noctivagans*), red bat (*Lasiurus borealis*), and hoary bat (*Lasiurus cinereus*) (U.S. Fish and Wildlife Service 1997). Introduced nuisance mammal species include: Norway rat (*Rattus norvegicus*), feral cat (*Felis catus*), and feral dog (*Canis familiaris*) (U.S. Fish and Wildlife Service 1997).

Marine mammals that may occur within the vicinity of the Study Area include: harbor seal (*Phoca vitulina*), humpback whale (*Megaptera novaeangliae*), bottlenose dolphin (*Tursiops truncates*), and the federally-listed sperm whale (*Physeter microcephalus*; endangered) (U.S. Fish and Wildlife Service 1997). Other marine mammals that have been observed more widely in the New York Bight include: blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), North Atlantic right whale (*Eubalaena glacialis*), common dolphin (*Delphinus delphis*), Cuvier's beaked whale (*Ziphius cavirostris*), minke whale (*Balaenoptera acutorostrata*), pilot whale (*Globicephala melas*), and Risso's dolphin (*Grampus griseus*) (Tetra Tech and Smultea Sciences 2018).

C. FISH

1. ESSENTIAL FISH HABITAT (EFH)

The EFH provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) authorize the NOAA Fisheries to evaluate development projects proposed or licensed by federal agencies, including the Corps. If coastal development projects have the potential to adversely affect marine, estuarine, or anadromous species or their habitat, NOAA

Fisheries makes recommendations on how to avoid, minimize, or compensate these impacts (National Oceanic and Atmospheric Administration website, https://www.greateratlantic.fisheries.noaa.gov/habitat/efh/efhassessment.html).

The MSFCMA also establishes measures to protect Essential Fish Habitat (EFH). The NOAA Fisheries must coordinate with other federal agencies to conserve and enhance EFH, and federal agencies must consult with the NOAA Fisheries on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. In turn, the NOAA Fisheries must provide recommendations to federal and state agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH resulting from actions or proposed actions authorized, funded, or undertaken by that agency.

The EFH areas are depicted on the NOAA Fisheries' website: https://www.greateratlantic.fisheries.noaa.gov/habitat/efh/efhassessment.html). Several species designated as EFH species by the NOAA Fisheries are found in the Study Area. After reviewing the draft FWCA report, the NOAA Fisheries provided the following information about EFH species: "*The project area has been designated as EFH for a number of federally managed species, including Atlantic butterfish (Peprilus triacanthus), Atlantic mackerel (Scomber scombrus), Atlantic sea herring (Clupea harengus), black sea bass (Centropristis striata), bluefish (Pomatumus saltatrix), clearnose skate (Raja eglanteria), cobia (Rachycentron canadum), king mackerel (Scomberomorus cavalla), little skate (Leucoraja erinacea), long-finned inshore squid (Loligo pealei), monkfish (Lophius americanus), red hake (Urophycis chuss), scup (Stenotomus chrysops), Spanish mackerel (Scomberomorous maculates), summer flounder (Paralichthys dentatus), whiting (Merluccius bilinearis), windowpane flounder (Scophthalmus aquosus), winter flounder (Pseudopleuronectes americanus), winter skate (Leucoraja ocellata), and others.*

The project area is also EFH for several highly migratory species, including blue shark (Prionace glauca), dusky shark (Carcharinus obscurus), sanbar shark (Carcharinus plumbeus), and sand tiger shark (Odontaspis taurus). Sand tiger and dusky sharks have also been designated as Species of Concern by the NOAA. Species of Concern are those about which we have concerns regarding their status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act (ESA)." Note that the NOAA Fisheries defines the project area as the Atlantic coast of NYC between East Rockaway Inlet and Rockaway Inlet, areas within Jamaica Bay, and the offshore borrow area.

2. FINFISH

Jamaica Bay provides important spawning, foraging, and nursery habitat for many finfish species. Species documented in the bay include: winter flounder, summer flounder, windowpane flounder, weakfish (*Cynoscion regalis*), bluefish, scup, blueback herring (*Alosa aestivalis*), Atlantic cod (*Gadus morhua*), black sea bass, northern kingfish (*Menticirrhus saxatilis*), tautog (*Tautoga onitis*), Atlantic silversides, mummichog (*Fundulus heteroclitus*), striped killifish (*Fundulus majalis*), Atlantic menhaden (*Brevoortia tyrannus*), bay anchovy, northern pipefish, American shad (*Alosa sapidissima*), Atlantic sturgeon (*Acipenser*

oxyrhynchus), sea robin (*Prionotus carolinus*), striped bass (*Morone saxatilis*), banded killifish (*Fundulus diaphanus*), cunner (*Tautogolabrus adspersus*), inland silversides (*Menidia berylinna*), striped sea robin (*Prionotus evolans*), white mullet (*Mugil curema*), and white perch (*Morone americana*) (National Park Service 2007; U.S. Fish and Wildlife Service 1997; New York State Department of State 1992). American eel (*Anguilla rostrata*), once common in Jamaica Bay, have experienced range-wide declines (Haro *et al.* 2000 *in* Waldman 2008). A summary table of species found within Jamaica Bay can be found in Appendix C.

Many common species found in the nearshore and offshore habitats are the same as the species found in Jamaica Bay and a summary of nearshore and offshore species is provided in Appendix D. Many of the species present are EFH-designated species. As discussed above, EFHs are those aquatic habitats where fish spawn, breed, feed or grow to maturity and include wetlands, coral reefs, sea grasses, and rivers. The EFH provisions of the MSFCMA authorize the NOAA Fisheries to evaluate development projects proposed or licensed by federal agencies, including the Corps. If coastal development projects have the potential to adversely affect marine, estuarine, or anadromous species or their habitat, the NOAA Fisheries makes recommendations on how to avoid, minimize, or compensate these impacts (NOAA website: https://www.greateratlantic.fisheries.noaa.gov/habitat/efh/efhassessment.html).

In addition to Jamaica Bay and the nearshore and offshore waters, the inlets in the Study Area are also important to numerous species of fish. In their response to the Draft FWCA report, the NOAA Fisheries identified a number of fish that transit the inlets in the Study Area to move between nearshore and offshore waters and estuarine waters. These species include, but are not limited to, commercially or recreationally important species such as winter flounder, as well as anadromous fishes, such as river herring (alewife [*Alosa pseudoharengus*] and blue back herring [*Alosa aestivalis*]). Winter flounder (as well as other species) may use the inlets to access estuarine habitats in which they spawn. Anadromous species use the inlets as migratory pathways to nursery and forage habitat within the estuary beyond the inlet. Alewife and blueback herring spend most of their adult life at sea, but return to freshwater areas to spawn in the spring.

D. INVERTEBRATES

1. Marine Invertebrates

This section only contains a brief description of these ecological resources. The Service recommends that the Corps coordinate with the NOAA Fisheries for a more in-depth discussion of marine invertebrate resources in the Study Area and potential impacts resulting from implementation of the proposed action. The offshore marine habitat supports shellfish and crustaceans, such as mud clam (*Mulinia lateralis*), razor clam (*Ensis directus*), surf clam (*Spisula solidissima*), blue mussel (*Mytilus edulis*), soft shell clam (*Mya arenaria*), blue crab (*Callinectes sapidus*), and American lobster (*Homarus americanus*) (U.S. Fish and Wildlife Service 1997). Other marine subtidal benthic macrofauna that may be found in the Study Area include: tellin clam (*Tellinidae* spp.), sand dollar (*Echinarachnius parma*), amphipod species (*e.g.*,

Protohaustarius deichmaae, Unicola irrorata), and polychaete species (*e.g., Sthenelais limicola, Lumbrineris fragilis, Spiophanes bombyx*), all of which are found in habitats described as a medium, coarse-grain sand community (Steimle and Stone 1973).

Surf clam populations were previously known to occur from the shoreline to approximately 2 mi. offshore (New York State Department of Environmental Conservation 2002). Overall, the NYS waters of the Atlantic Ocean were noted as a major surf clam fishery. In 2001, 444,053 bushels of surf clams, with a value of $4.5 million were harvested (New York State Department of Environmental Conservation 2002). Historically, surf clam surveys conducted along the Rockaway Beach Peninsula have been shown to produce a harvest valued at approximately $100,000 per 100 ac or more (New York State Department of Environmental Conservation 1994).

The bay supports shellfish populations of hard clams (*Mercenaria mercenaria*), soft clams (*Mya arenaria*), mussels, and rock crabs (*Cancer irroratus*) (New York State Department of State 1992). At one time, Jamaica Bay supported a large fishery for oyster (*Crassostrea virginica*), hard clam, softshell clam, and blue crab (Waldman 2008). However, due to threats of disease, the fisheries were closed in 1921 (Waldman 2008). A list of the aquatic species is provided in Appendix E.

Oysters were once an abundant fishery producing upwards of 700,000 bushels of oysters per year at its peak (Grambo and Vega 1984, *in* Waldman 2008; Franz 1982, *in* Zarnoch and Schreibman 2012). However, overfishing, habitat loss from dredging and filling, and pollution led to a collapse of the fishery (Zarnoch and Schreibman 2012).

Recent efforts by Zarnoch and Schreibman (2012) and the NYCDEP, in conjunction with the Suffolk Cornell Cooperative Extension (SCEE), have carried out studies to determine whether oysters could be able to survive under the current conditions of the Bay. Zarnoch and Schreibman (2012) concluded that juvenile oysters transplanted into Jamaica Bay are likely to survive and grow. In 2010, an oyster bed pilot study using spat-on-shell and spat-covered reef balls was undertaken within Jamaica Bay by the NYCDEP, the SCEE and the NYSDEC. A follow-up assessment in 2016 determined that the oysters were alive and appeared to be healthy (New York City Department of Environmental Protection 2016).

Horseshoe Crabs

Horseshoe crabs can be found in the waters of the Study Area. Their eggs provide an important food source for migrating shorebirds. Horseshoe crabs are also important to medical research and pharmaceutical companies and are harvested by commercial fishermen to be used as bait in eel and conch fisheries. Coast-wide management of horseshoe crabs is essential to maintain healthy populations. The status of horseshoe crab populations along the Atlantic coast is poorly understood, but horseshoe crabs continue to be harvested while their populations decline. A decline in the horseshoe crab population could severely affect migrating shorebird populations that depend on the eggs for survival. The survival of this species is linked to the survival of the red knot, as horseshoe crab eggs are an important food source for this species.

Horseshoe crabs are known to spawn within Jamaica Bay. Documented spawning sites include: Plumb Beach, Dead Horse Bay, Big Egg Island, Spring Creek, Bayswater Point State Park, Brant Point, and Dubos Point (Sclafani *et al.* 2014; Botton *et al.* 2006).

2. Insects, Moths, and Butterflies

The Bay is located along the migration route of the monarch butterfly (Brower 2004, *in* Waldman 2008) and provides habitat for a number of insects, skippers, and butterflies (including several regionally- and state-rare species), including the checkered white, which has been observed on the Rockaway Peninsula (Wall and Associates, Inc. *et al.* 2003). A summary table of the insects, moths, and butterflies is provided in Appendix F.

E. THREATENED AND ENDANGERED SPECIES AND SPECIES UNDER REVIEW

Pursuant to section 7 of the ESA, the Corps is required to make a determination as to whether the proposed project "may affect" listed species and seek the concurrence from both the Service and the NOAA Fisheries. The Service's IPaC system (https://ecos.fws.gov/ipac/) contains information on listed species and should be used in the Corps' determination process along with consultation with the Service. In correspondence dated September 27, 2018, the Corps requested formal consultation for piping plover and seabeach amaranth populations found in the proposed project area. The Corps also determined that the proposed project would not be likely to adversely affect the red knot.

Should the project also necessitate consultation with the NOAA Fisheries, in accordance with the ESA, the appropriate contact is provided below:

Mr. Mark Murray Brown
Section 7 Coordinator
NOAA Fisheries
Greater Atlantic Regional Fisheries Office
55 Great Republic Drive
Gloucester, MA 01930
(978) 281-9328

1. FEDERALLY-LISTED THREATENED AND ENDANGERED SPECIES

Below is a brief discussion of the federally-listed threatened and endangered species that are likely to occur in the Study Area. Their status has been previously noted in this report, but more detailed information is provided below. They will all be addressed in the Service's Biological Opinion for the current Project.

a) <u>Piping Plover</u>

The piping plover was listed as threatened and endangered pursuant to the ESA on January 10, 1986. Protection of the species under the ESA reflects the species precarious status rangewide.

Three separate breeding populations, each with its own recovery plan and recovery criteria, were affirmed in the 2009 Five-Year Review (U.S. Fish and Wildlife Service 2009). Piping plovers that breed on the Atlantic Coast of the U.S. and Canada are listed as threatened under the ESA. Piping plovers that breed in the Great Lakes watershed are listed as endangered, while the population breeding on Northern Great Plains of the U.S. and Canada is listed as threatened (U.S. Fish and Wildlife Service 1985, 2009). All piping plovers are listed as threatened on their shared migration and wintering range, which extends along the U.S. Atlantic and Gulf Coasts from North Carolina to Texas, and into Mexico, the Bahamas, and West Indies (Elliott-Smith and Haig 2004; Elliott-Smith *et al.* 2009). Threats to Atlantic Coast piping plovers in the breeding portion of their range identified in the 1996 Recovery Plan include: habitat loss and degradation, disturbance by humans and pets, increased predation, and oil spills (U.S. Fish and Wildlife Service 1996a).

The Atlantic Coast piping plover breeds on sandy, coastal beaches from Newfoundland to North Carolina. On Long Island, including the Study Area, piping plovers are found on ocean and bay beaches from the time they arrive to breed in March and April until their departure to wintering grounds in September. Piping plovers nest above the high tide line on coastal beaches, sandflats at the ends of sandspits and barrier islands, gently-sloping fore dunes, blowout areas behind primary dunes, sparsely-vegetated dunes, and washover areas cut into or between dunes. Feeding areas include: intertidal portions of ocean beaches, washover areas, mudflats, sandflats, wracklines, and shorelines of coastal ponds, lagoons, or saltmarshes (U.S. Fish and Wildlife Service 1996a).

The ocean beaches within the Study Area support nesting piping plovers and are monitored and managed each nesting season. The New York City Department of Parks and Recreation (NYCDPR) monitor and manage the beaches in Far Rockaway and Arverne; the NPS manages and monitors the GNRA parcels (Jacob Riis, Fort Tilden, and Breezy Point); and the Breezy Point Cooperative manages cooperatively with the Service (private beach community from B201-B222 Streets).

b) Red Knot

The red knot is a medium-sized migratory shorebird. The rufa red knot subspecies was listed as threatened under the ESA on January 12, 2015. The rufa red knot was listed as a threatened species due to loss of both breeding and nonbreeding habitat; likely effects related to disruption of natural predator cycles on the breeding grounds; reduced prey availability throughout the nonbreeding range; and increasing frequency and severity of asynchronies (mismatches) in the timing of the birds' annual migratory cycle relative to favorable food and weather conditions.

Red knots breed in the Canadian arctic and winter mainly in Tierra del Fuego, northern Brazil, or Florida, and migrate through NY (as well as other places along the Atlantic Coast), to and from breeding sites in the spring and fall (U.S. Fish and Wildlife Service 2014). In North America, red knots are found along sandy, gravel or cobble beaches, tidal mudflats, saltmarshes, shallow coastal impoundments, and lagoons and peat banks. Red knots use sandy beaches during both the spring and fall migration (U.S. Fish and Wildlife Service 2014).

Within the Study Area, red knots utilize low-energy bay and ocean intertidal areas (*e.g.*, tidal flats and tidal marshes) as stopover/foraging habitat during spring and fall migrations.

c) Roseate Tern

The roseate tern is a medium-sized, gull-like tern. The northeastern and Caribbean breeding populations of the roseate tern were designated, respectively, as endangered and threatened, on November 2, 1987. The northeastern population includes birds that breed (or formerly bred) along the Atlantic coast of the U.S. from North Carolina to Maine. The primary reasons for listing the northeastern population of the roseate tern as endangered were the concentration of the population into a small number of breeding sites and, to a lesser extent, a decline in total numbers (U.S. Fish and Wildlife Service 1998a).

Roseate terns are an exclusively marine bird, usually breeding on small islands and occasionally on sand dunes of barrier beaches (U.S. Fish and Wildlife Service 2011). During the breeding season, birds typically forage over shallow coastal waters around the breeding colony. Roseate terns have historically nested in the Study Area on the beaches of the Rockaway Peninsula; however, they have not been documented nesting in the area in over five years.

d) Seabeach Amaranth

Seabeach amaranth is an annual plant that grows on sandy ocean beaches. On April 7, 1993, it was added to the List of Endangered and Threatened Wildlife and Plants as a threatened species. The listing was based upon the elimination of seabeach amaranth from two-thirds of its historic range, and continuing threats to the 55 populations that remained at the time (U.S. Fish and Wildlife Service 1993). Threats to seabeach amaranth include: trampling from off-road vehicles (ORV) and/or pedestrians; loss of habitat from development; beach stabilization practices that promote dense beachgrass growth, burial of seed banks, and competition with perennial plants as beach habitat is stabilized (U.S. Fish and Wildlife Service 1996b).

Seabeach amaranth grows within the Study Area within the maritime beach and dune communities of the Rockaway Peninsula. Within the Study Area, seabeach amaranth is monitored and managed by the NPS, the NYCDPR, and the Breezy Point Cooperative, in cooperation with the Service, on their respective properties.

e) Sea Turtles

The Service and the NOAA Fisheries share jurisdiction for sea turtles. The NOAA Fisheries has responsibility for federally-listed sea turtles in the marine environment and the Service has responsibility while they are on land. There are four threatened or endangered sea turtle species that may occur within the Study Area: loggerhead sea turtle (*Caretta caretta*; threatened), Kemp's ridley sea turtle (*Lepidochelys kempii*; endangered), green sea turtle (*Chelonia mydas*; threatened), and leatherback sea turtle (*Dermochelys coriacea*; endangered). Sea turtles typically occur along the Long Island coast from May to mid-November, with the highest concentrations present from June through October. In the Study Area, these species are usually limited to the marine environment and are typically the sole responsibility of the NOAA Fisheries. However,

there is a recent documented case of a nesting Kemp's Ridley sea turtle on the Rockaway Peninsula. The following have been identified as threats to sea turtles in the marine environment: bycatch in commercial and recreational fisheries, capture during channel dredging, vessel collisions, marine pollution, and impingement on power plant intakes, among others (National Oceanic and Atmospheric Administration 2017). Threats to nesting sea turtles, eggs, and hatchlings include, but are not limited to: beach erosion, beach armoring, beach nourishment, artificial lighting, predators, invasive plants, beach driving, beach cleaning, human presence, inundation by tides, and poaching (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991; National Marine Fisheries Service, U.S. Fish and Wildlife Service, and SEMARNAT 2011).

f) Sturgeon

The federally-listed Atlantic sturgeon (endangered, threatened) may occur in the Study Area and is under the jurisdiction of the NOAA Fisheries. Sturgeon are an anadromous species found in rivers, estuaries, and coastal waters along the Atlantic Coast, and could occur in the Rockaway Inlets and Jamaica Bay. Atlantic sturgeons that are spawned in rivers of the U.S. or are captive progeny of Atlantic sturgeon that spawned in the U.S. are listed under the ESA as five Distinct Population Segments (DPS). As of February 6, 2012, the NY Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered. The Gulf of Maine DPS is listed as threatened.

g) Atlantic Large Whales

After reviewing the draft FWCA report, the NOAA Fisheries provided the following additional information as it pertains to endangered marine mammals: "*Federally endangered North Atlantic right and fin whales occur year-round off the New York coast in the Atlantic Ocean. Right whales are most likely to occur in the offshore borrow areas between November and April and fin whales are most likely to occur between October and January. Right whales feed on copepods and could be foraging in the Study Area if suitable forage in present; right whales are also likely to occur in the Study Area while migrating along the Atlantic coast. Fin whale sightings off the eastern United States are centered along the 100m isobaths, but fin whales are well spread out over shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1987; Hain et al. 1992). Fin whales feed on small schooling fish, squid, and crustaceans, including krill. Sperm and sei whales* [*Balaenoptera borealis*] *are limited to the offshore area beyond the continental shelf.*"

2. Species under Review for Federal Listing

The Service is evaluating the little brown bat, the tri-colored bat (*Perimyotis subflavus*; NYSDEC species of concern), the monarch butterfly, and the yellow-banded bumblebee (*Bombus terricola*) to determine if listing under the ESA is warranted. These four species may be present in the Study Area. Species being evaluated for listing do not receive any substantive or procedural protection under the ESA, and the Service has not yet determined if listing of any of these three species is warranted. However, the Corps should be aware that these species are being evaluated for possible listing and may wish to include them in field surveys and/or impact

assessments, particularly for projects with long-term planning horizons and/or long operational lives. Despite the current status of these species regarding listing decisions, each of these species is in decline range-wide for the East Coast.

F. SPECIES OF GREATEST CONSERVATION NEED

Since 2001, the Service has awarded State Wildlife Grants (SWG) for "the development and implementation of programs for the benefit of wildlife and their habitat, including species that are not hunted or fished…" To participate in the SWG program, as directed by Congress, the fish and wildlife resource agencies of each state, commonwealth, territory, and the District of Columbia developed a Comprehensive Wildlife Conservation Plan (later referred to as a State Wildlife Action Plan or SWAP) for review and approval by the Service. All the SWAPs were submitted to the Service and approved by early 2006. These plans identify and describe species of greatest conservation need and include many species that have experienced significant population declines.

The Service recognizes that the State of New York has identified species of greatest conservation need as part of their SWAP. Many of those identified species overlap with species that are discussed in this report. We seek recommendations from the NYSDEC on the particular species of greatest conservation need that they prefer addressed in the Final FWCA Report.

G. WETLANDS

Saltwater and freshwater marshes can be found throughout Jamaica Bay, along the south shore of Rockaway Peninsula, and scattered along the Jamaica Bay shoreline. The majority of the wetlands present in the Study Area are categorized as estuarine and marine deepwater, and estuarine and marine wetland. There are some limited freshwater marshes located on the barrier island and mainland.

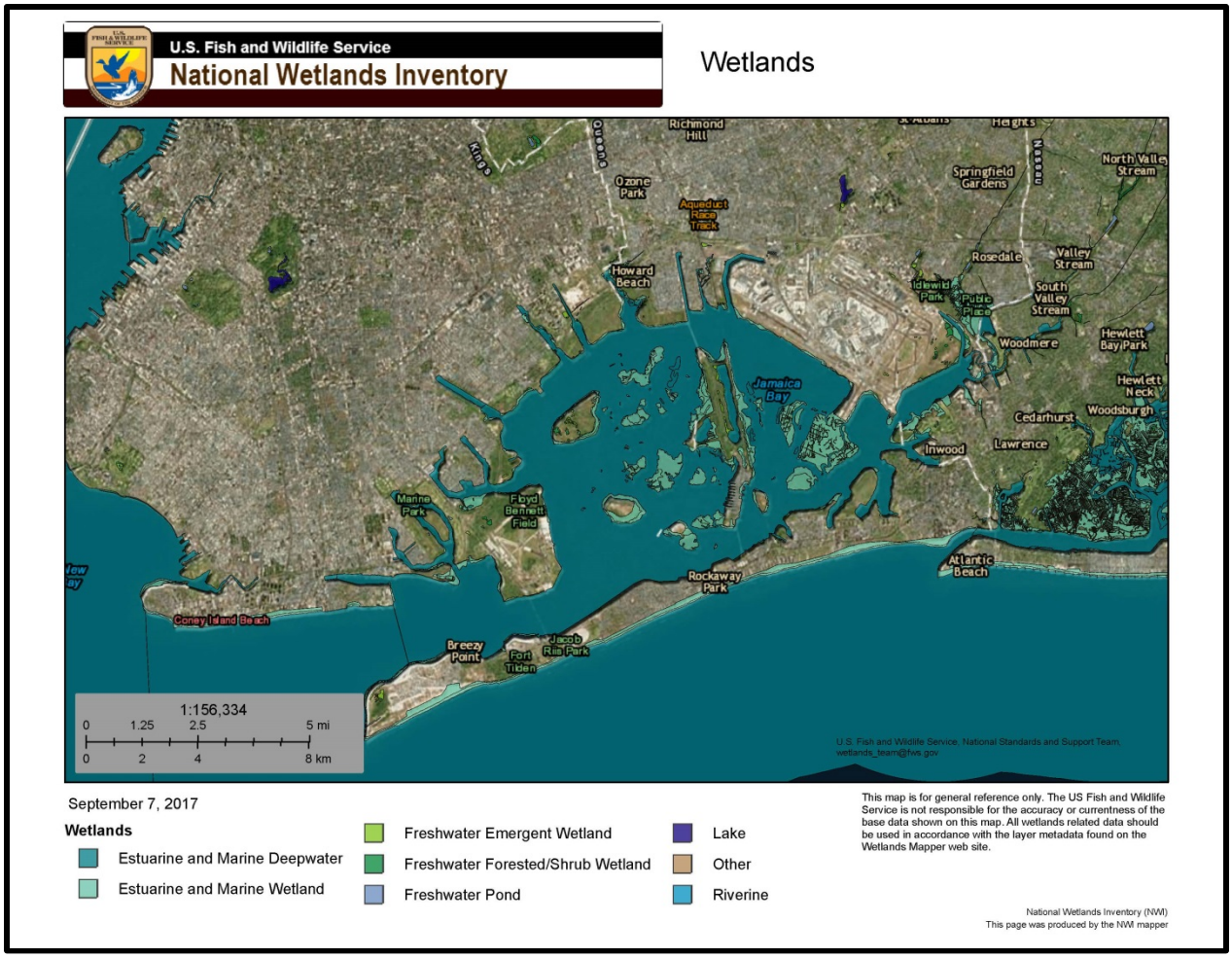


Figure 3. National Wetlands Inventory Map of the Study Area. (https://www.fws.gov/wetlands/data/mapper.html).

1. Saltwater Marshes

Saltwater marshes are considered by the Service to be aquatic resources of national importance due to their increasing scarcity and high habitat value for fish and wildlife within federal trusteeship (*i.e.*, migratory waterfowl, wading birds, other migratory birds, threatened and endangered species, and interjurisdictional fisheries). Marshes are among the most productive communities known, providing important ecological services including wildlife habitat, shoreline erosion control, and water column filtration (Waldman 2008). They perform a variety of important functions that benefit both fish and wildlife resources such as spawning and nesting habitat for fish and wildlife. Saltmarshes also provide storm protection for human infrastructure.

The loss of wetlands in Jamaica Bay is significant. Since the European colonization, it is estimated that approximately 12,000 ac of 16,000 ac of saltmarsh has been lost (New York City Department of Environmental Protection 2007; U.S. Fish and Wildlife Service 1997; Waldman 2008). Rates of saltmarsh loss have been estimated based on the analysis of aerial photographs. Between 1924 and 1974, the rate of loss was approximately 0.4 percent annually. Since 1974, the rate has increased to 1.4 percent annually (Hartig *et al*. 2002, *in* Waldman 2008).

There are various factors that may have contributed to this decline, including: sediment deprivation, channel deepening, eutrophication, stabilization of the Rockaway Inlet, growth of the Rockaway peninsula, and sea-level rise. Water quality issues, particularly increased nitrogen levels and eutrophication, make saltmarshes more vulnerable to sea-level rise by weakening root systems and through loss of organic biomass (due to increased microbial decomposition) resulting in marsh elevation loss (Turner *et al.* 2009; New York State Department of Environmental Conservation 2014b).

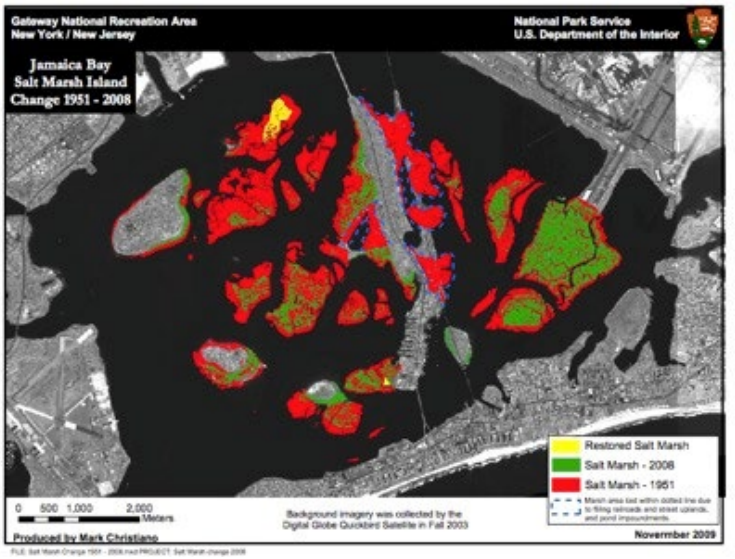


Figure 4. Historic Wetland Losses in Jamaica Bay from 1951 – 2008. (Yellow: Restored saltmarsh; Green: Saltmarsh 2008; Red: Saltmarsh 1951).

2. Freshwater Wetlands

Like tidal marshes, freshwater wetlands provide habitat for a variety of fish and wildlife resources while also providing ecological services for people. Historically, the Study Area contained more freshwater wetland habitat. However, due to conversion of wetlands to agricultural, industrial, or residential uses, many wetlands were lost. Only one percent of those freshwater wetlands that existed in the NYC pre-colonial era remain (New York City 2009). Within the Study Area, freshwater wetlands are restricted to the western point of Rockaway Peninsula, and Canarsie Pol, Rulers Bar Hassock in the Jamaica Bay Wildlife Refuge, as well as east and west of Hendrix Creek, and along the southeast corner of JFK airport.

VIII. FUTURE WITHOUT PROJECT CONDITIONS

This report assumes that several ongoing and future projects are likely to occur within the Study Area even if this project is not implemented. These projects include maintenance dredging of the Rockaway Inlet Federal Navigation Channel and East Rockaway Inlet Navigation Channel. In the absence of the Recommended Plan, it is also likely that state and local governments would

seek permits from the Corps' Regulatory Branch to undertake smaller-scale beach nourishment projects or that the Corps will explore alternative studies, such as the NY and NJ Harbor Area and Tributaries Feasibility Study to develop coastal storm risk reduction measures. Various beach management activities, such as beach scraping, are being carried out within the Study Area and will likely continue to occur.

In the without-project condition, erosional events and future storms are likely to occur. Natural features, such as dunes and beaches, would likely be shaped by these events and natural processes would occur to the extent possible along the developed shoreline. Erosion and storms may directly threaten human structures such as the reconstructed boardwalk and other infrastructure along the oceanfront, bay shorelines, and upland interior. If the elevation of the beach and dunes is lowered due to storms and erosion, their capability to provide storm protection may be reduced, which may expose the coastal communities to extensive property damage and loss. However, sand accretion due to storms may also occur.

Natural processes and human activities would continue to greatly influence the ecological communities on Rockaway peninsula, Jamaica Bay, and the offshore marine habitats. The maritime beach and dunes along the beaches, which are heavily developed, could continue to erode or accrete due to natural processes. In spite of the extensive development on the Rockaway Peninsula, shorebird habitat is present and significant erosional loss of these beaches would adversely affect local shorebird populations by reducing their nesting areas.

As discussed above, there is relatively less opportunity for natural processes to create and maintain habitat features, such as lower lying beaches, variable dune fields, and ephemeral pools. Relatively larger-scale habitat-forming natural processes are only likely to occur in the undeveloped, western area of the Rockaway peninsula. Further, in the without-project condition, the maritime beach in these areas that do not have the ability to migrate or roll over, will likely result in the loss of shorebird habitat. The marine intertidal system would naturally fluctuate in response to patterns and rates of shoreline accretion and erosion in the without project condition.

The future of the proposed offshore dredging area in the without-project scenario would likely be the continued existence of a benthic-pelagic sandy bottom community in its present condition. The offshore borrow would not be characterized by unnatural depressions created by dredging and existing populations of marine invertebrates and benthic/pelagic finfish species would not be disturbed or destroyed by mechanical dredging operations over the next 50 years.

There are a number of projects and studies being carried out that will affect Jamaica Bay. The Corps has carried out a number of projects related to restoration efforts and storm damage protection. A number of state and local efforts have been undertaken to improve habitats along the shoreline of the bay and to restore water quality. If this general trend in habitat restoration and water quality improvement continue then the general condition of the bay will improve. It is likely that in light of the urbanized nature of the Study Area, local, state, and federal efforts will continue to be studied in order to protect the study area from future storm damage.

IX. OTHER ENVIRONMENTAL CONDITIONS: CLIMATE CHANGE AND SEA-LEVEL RISE

The term "climate change" refers to a change in the mean or variability of one or more measures of climate (*e.g*., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (Intergovernmental Panel on Climate Change 2007). Extensive analyses of global average surface air temperature, the most widely-used measure of change, clearly indicate that warming of the global climate system has occurred over the past several decades (Intergovernmental Panel on Climate Change 2013). One very likely outcome of climate change is an accelerated rise in sea level. Measurements of global mean sea level indicate sea level has risen at an average rate of 1.7 millimeters (mm) per year from 1901 to 2010; at a faster rate of 3.2 mm per year from 1993 to 2010; and will exceed that rate during the 21st Century (International Panel on Climate Change 2013). Sea-level rise will likely have implications for restoration activities planned or underway in the HRE Feasibility Study Area. Sea-level rise will affect the types of natural communities found in the HRE Feasibility Study Area. Additional tidal flow from modest sea-level rise may have both beneficial and adverse impacts on restoration that are difficult to predict without additional information (*e.g.*, precise elevations of restoration sites, site-specific sedimentation/erosion rates, and predicted future current velocities) (U.S. Fish and Wildlife Service 2007b). Recently, sea-level rise in a 1,000 kilometers (km) reach of the Atlantic Coast from Cape Hatteras, North Carolina, to Cape Cod, Massachusetts (which includes the HRE Feasibility Study Area), experienced three to four times higher sea-level rates than the global average (Sallenger *et al.* 2012). Many models of climate change project a shift to more intense individual storms and fewer weak storms in the North Atlantic Basin. Long-term effects of climate change may impact coastal communities such as the communities on Rockaway Peninsula and contribute to continued loss of saltmarsh in Jamaica Bay.

Climate change is expected to have impacts on oceans and estuaries beyond sea-level rise. The Intergovernmental Panel on Climate Change identified changes in water temperature and acidification of ocean water as other wide-reaching concerns resulting from climate change (Wong *et al*. 2014). Changes in water temperature may impact the distribution, abundance, and production of aquatic life (Wong *et al.* 2014; Scavia *et al*. 2002). As a result of warmer temperatures, some species may be pushed pole-ward, some may suffer from living in sub-optimal temperatures, while others may be lost entirely (Wong *et al.* 2014; Scavia *et al.* 2002). Acidification due to the absorption of increased atmospheric carbon dioxide could have impacts on the ocean's "calcifiers," such as shellfish, which may not be able to survive at higher acidity levels (Wong *et al.* 2014). The effects of climate change will likely result in more localized impacts, as well. A concern for estuaries is the exacerbation of existing human pressures, such as eutrophication. For example, changes in climate may result in alterations of freshwater inputs, water temperature, sea level, and ocean exchange, which can make estuaries more vulnerable to eutrophication (Scavia *et al.* 2002). Other climate-related impacts to estuaries may include: changes in water residence time, nutrient delivery, dilution, vertical stratification, phytoplankton growth rates, and sediment deposition/erosion balances as a result of changes in freshwater inflow, air temperatures, and precipitation patterns (Wong *et al*. 2014; Scavia *et al*. 2002).

X. DESCRIPTION OF THE RECOMMENDED PLAN

The Recommended Plan is comprised of an Atlantic shorefront component and three separate HFFRRF projects on Jamaica Bay: 1) Mid-Rockaway, 2) Cedarhurst Lawrence, and 3) Motts Basin North.

The Atlantic shorefront component consists of beach restoration with renourishment, groin extension, construction of new groins, and a composite seawall. The Jamaica Bay component consists of three separate high frequency flooding risk reduction features HFFRRFs along the bay shoreline. The HFFRRFs are small-scale coastal storm risk management (CSRM) features to reduce risks for communities vulnerable to high frequency events and to provide CSRM in the short-term prior to construction of a comprehensive solution developed as part of upcoming NY NJ Harbor and Tributaries feasibility study.

A. ATLANTIC SHOREFRONT

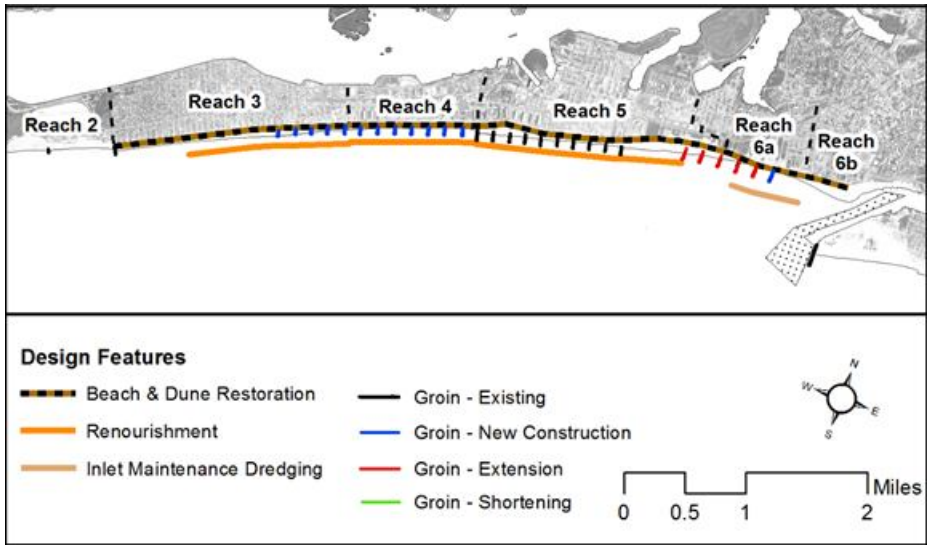


Figure 5. Atlantic Shorefront Project Elements.

The Atlantic shorefront project elements (including tapers) span from Beach 9th Street to Beach 169th Street. The recommended plan in this area combines beach restoration and erosion control and two tapered beach sections at both the east and west end of the project. In summary, the recommended plan on the Atlantic Ocean shorefront consists of the following features:

- A reinforced dune (composite seawall) with a structure crest elevation of +17 ft NAVD88 and dune elevation of +18 ft NAVD88, and a design berm width of 60 ft extending approximately 35,000 linear ft from Beach 9th Street to Beach 149th Street. The bottom of dune reinforcement extends up to 15 ft below the dune crest.
- A beach berm elevation of +8 ft NAVD88 and a depth of closure of -25 ft NAVD88.
- A total beachfill quantity of approximately 1.6 million cy for the initial placement, including tolerance, overfill, and advanced nourishment with a 4-year

renourishment cycle of approximately 1,021,000 cy, resulting in an advance berm width of 60 ft;

- Obtaining sand from a borrow area located approximately 2 mi south of the Rockaway Peninsula and about 6 mi east of the Rockaway Inlet. It is about 2.6 mi long, and 1.1 mi wide, with depths of 36 to 58 ft and contains approximately 17 million cy of suitable beachfill material, which exceeds the required initial fill and all periodic renourishment fill operations.
- Extension of five existing groins; and new construction of 13 new groins.

1. Composite Seawall and Berm Description

The structure crest elevation is +17 ft NAVD88, the dune elevation is +18 ft NAVD88, and the design berm width is 60 feet. The composite seawall will be constructed of armor stone and sheet pile walls. The composite seawall may be adapted in the future to rising sea levels by adding a layer of armor stone and extending the concrete cap up to the elevation of the armor stone.

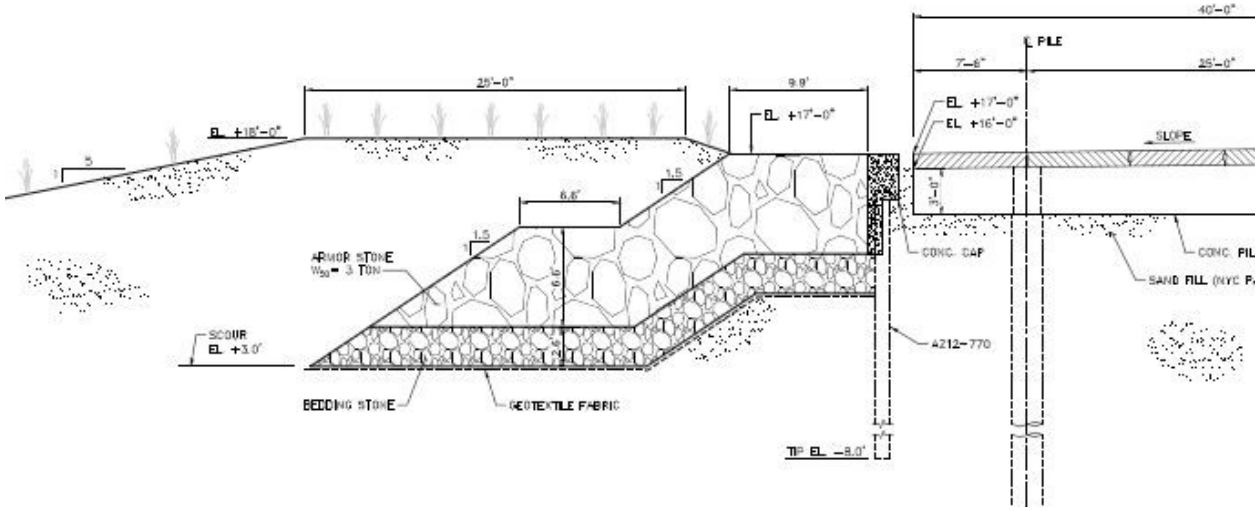


Figure 6. Composite Seawall Beach 19th Street to Beach 126th Street.

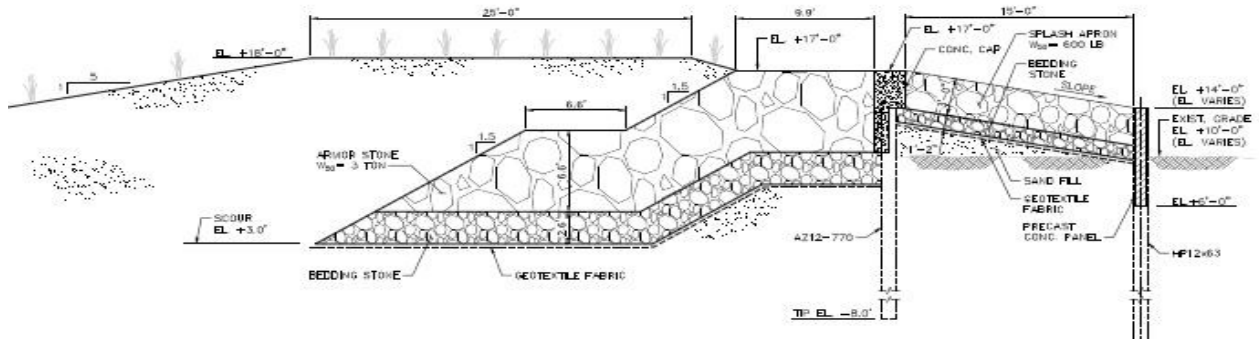


Figure 7. Composite Seawall Beach 126th Street to Beach 149th Street.

2. Beachfill Description

The recommended plan includes dune and beachfill, as well as beachfill tapers on either side. The dune and beachfill (including tapers) extends from the eastern end of the barrier island at Beach 9th Street west to Beach 169th Street. The dune will have a top elevation of +18 ft above NAVD88, a top width of 25 ft, and landward and seaward slopes of 1V:5H that will extend along the entire footprint (1V:3H on landward slope fronting the boardwalk). The berm will have a minimum width of 60 ft at an elevation of +8 ft NAVD88. The width of the design berm is controlled by the alignment of the baseline. The baseline is aligned with the natural shoreline and the distance from the baseline to the design shoreline is always 243 feet. The alignment of the dune follows the unnatural alignment of the boardwalk and, as a result, the distance between the toe of the dune and the seaward crest of the berm varies. Initial beachfill and renourishment quantities are provided in Table 2 below:

Table 2. Initial Construction Beachfill Quantities.

Sub-reach	Beachfill	Renourishment per
West Taper	306,000	
Sub-reach 3	356,000	444,000
Sub-reach 4	294,000	133,000
Sub-reach 5	321,000	444,000
Sub-reach 6a	250,000	0
Sub-reach 6b	20,000	0
East Taper	49,000	0
Total	**1,596,000**	**1,021,000**

Note: Renourishment would occur on a four-year cycle.

3. New Groins and Groin Extension Description

Three types of groin measures are considered in the alternative analysis: new groin construction, groin extension, and groin shortening. The Project involves construction of twelve new groins in Reaches 3 and 4 (between 92nd Street – 121st Street) and an additional groin in reach 6a (34th Street). The five groin extensions are located in Reach 6a (between 37th Street – 49th Street). The spacing between groins is based on the existing spacing in Reach 5 (720 ft) and Reach 6a (780 ft). The required lengths of the new groins are based on the GENESIS-T model simulations. The extension of the groin lengths vary and range from 75 ft to 200 feet. Groin widths will be 13 feet. A summary of groin dimensions can be found in Table 3 below:

Table 3. Summary of Groin Lengths.

Alternative	Reach	Number	Street	HSS (ft)	ISS (ft)	OS (ft)	Total (ft)	Notes:
Alt 3	6a	1	34th St	90	108	328	526	new 526'
Alt 3	6a	2	37th St	90	108	328	526	extension 175'
Alt 3	6a	3	40th St	90	108	328	526	extension 200'
Alt 3	6a	4	43rd St	90	108	228	426	extension 75'
Alt 3	6a	5	46th St	90	108	228	426	extension 150'
Alt 3	6a	6	49th St	90	108	228	426	extension 200'
Alt 3	4	1	92nd St	90	108	128	326	new 326
Alt 3	4	2	95th St	90	108	128	326	new 326
Alt 3	4	3	98th St	90	108	128	326	new 326
Alt 3	4	4	101st St	90	108	128	326	new 326
Alt 3	4	5	104th St	90	108	128	326	new 326

Alt 3	4	6	106th St	90	108	128	326	new 326
Alt 3	4	7	108th St	90	108	128	326	new 326
Alt 3	3	8	110th St	90	108	153	351	new 351
Alt 3	3	9	113th St	90	108	178	376	new 376
Alt 3	3	10	115th St	90	108	178	376	new 376
Alt 3	3	11	118th St	90	108	178	376	new 376
Alt 3	3	12	121st St	90	108	128	326	new 326

* HSS = horizontal shore section extending along the design berm; ISS = an intermediate sloping section extending from the berm to the design shoreline; OS = outer sloping section that extends from the shoreline to offshore; HD = head section is part of the OS and is typically constructed at a flatter slope than the trunk of the groin and may require larger stone due to the exposure to breaking waves.

4. Beachfill Tapers

The east beachfill taper is approximately 3,000 ft in shorefront length from Beach 19th Street east to Beach 9th Street. It will consist of 1,000 ft of dune and beach taper, including reinforced dune feature, and approximately 2,000 ft of dune and beachfill without reinforced dune feature. In addition to the tapering of berm width, the dune elevation also tapers from an elevation of +18 ft NAVD88 at 19th Street down to approximately +12 ft NAVD88 at Beach 9th Street, which will be tied into the existing grade.

The west beachfill taper is approximately 5,000 ft in shorefront length from Beach 149th Street west to Beach 169th Street fronting Riis Park. The beachfill taper will be beachfill only with a berm width tapered from the design width at 149th Street to the existing width and height at 169th Street. In addition to the beachfill taper, a tapered groin system comprised of three (3) rock groins is included for this section.

B. JAMAICA BAY HIGH FREQUENCY FLOODING RISK REDUCTION FEATURES

1. Cedarhurst-Lawrence

The project is located in Nassau County and crosses the border between the Village of Cedarhurst and the town of Hempstead. The project site is on a channel that is located west of the Lawrence High School. The project begins on the east side of the channel and consists of approximately 1000 ft of deep bulkhead that follows the existing bulkhead line around the southern and western shores of the channel. The project will also modify three existing outfalls in the area where the bulkhead will be raised. Each outfall will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch or drainage collection pipe, with inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide, the ditch or pipes will direct runoff towards a pump station.

2. Motts Basin North

This project consists of construction of 540 ft of medium floodwall beginning just north of the corner Alameda Avenue and Waterfront Boulevard and running parallel to Waterfront Boulevard on its south side. The line of protection then shifts to a section of medium floodwall above an existing outfall, continuing east for 47 ft before transitioning back into a low floodwall for an additional 105 feet. Project design elevations vary have preliminarily been established based on the expected wave exposure and are +8.0 feet.

The existing outlet will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch. Inlets will connect to the existing and one proposed additional drainage outlets.

3. Mid-Rockaway

a) Edgemere Area

This project alignment follows the coastal edge of Edgemere where a series of HFFRR-Features are interlinked to form the perimeter line of risk reduction. The alignment consists of approximately 480 ft of medium floodwall, 660 ft of high floodwall, 1,510 ft of low berm, 2,060 ft of medium berm, 80 ft of high berm, 2,260 ft of hybrid berm, and 250 ft of bulkhead. One road ramp is included to maintain access to the waterfront. Three existing outlets will be modified to prevent high tides or storm surge to result in flow reversal and cause flooding through the drainage system. Twelve new outfalls (5 ft x 3 ft) are included within the project and three new pump stations are included within the design. This area also includes two areas where the NNBFs are implemented, one on the east and one on the west side of the peninsula.

NNBF Descriptions:

Edgemere 1: On the west side of the Edgemere neighborhood, the proposed NNBF design with the establishment of the rock sill, will protect some of the existing eroding wetlands habitats, both subtidal and intertidal, and will provide for some areas where high marsh – scrub/shrub habitat can be established. The rock sills are also intended to provide and habitat for attached fauna such as ribbed mussels and oysters.

Edgemere 2: On the east side of the Edgemere neighborhood, a large area of wetland habitat is proposed to be restored and created between the constructed berm on the land and the newly constructed rock sill, just off of the existing coastline. The proposed NNBF includes the removal of the *Phragmites* where appropriate, and restoration of the intertidal habitats including planting of smooth cordgrass and high marsh at appropriate elevations, as well as ribbed mussel and oyster reef restoration, which will aid in attenuating wave action.

b) Arverne Area

This alignment consists of the construction of approximately 3,170 ft of low floodwall, 480 ft of medium floodwall, 440 ft of high floodwall, 2,630 ft of low berm, 580 ft of hybrid berm, 890 ft of bulkhead, and 990 ft of revetment, as well as three areas where NNBFs (discussed below separately). Three road ramps and one vehicular gate are included to maintain access to the waterfront. Eight existing outlets will be modified to add a valve chambers that will include a sluice gate and flap valve to prevent high tides or storm surge to result in flow reversal and cause flooding through the drainage system. Eight new outfalls (5 ft x 3 ft) are included within the project. In addition, three new pump stations are included within the design.

NNBF Descriptions:

Arverne 1: The north-west corner of the Arverne peninsula (Brant Point). This NNBF will include installation of rock sills off the existing, eroding shoreline to protect the toe of the slope and dampen incoming waves so the existing shoreline could be regraded and potentially extended seaward. This NNBF will also include the removal of the *Phragmites* and creation/restoration of the intertidal wetland habitat and high marsh. Some existing uplands features are to be regraded to high marsh. A portion of the existing upland maritime forest between the berm feature and the wetlands are to remain undisturbed and expanded where practical.

Arverne 2: At the north-east corner of the peninsula where there is currently a narrow beach (Dubos Point), in between Beach 69th Street and just east of Beach 65th Street, a NNBF is proposed that includes the construction of rock sills to create an intertidal flat and replanting with smooth cordgrass (low marsh). Further upslope and to the east intertidal marsh can be regraded to provide high marsh habitat adjacent to the existing upland habitats providing a buffer in anticipation of rising sea level. Additional materials or techniques for oyster and ribbed mussel restoration may be included in the final design.

Arverne 3: To the east of Marina 59, the proposed NNBF includes restoration of an intertidal flat, protected by rock sills, and regrading of the higher elevations areas to accommodate the establishment of intertidal marsh similar to the adjacent natural marsh areas.

c) Hammels Area

This project alignment consists of approximately 2,550 ft of low floodwall and a total of six road ramps that provide risk reduction to the Hammels area. Three new outfalls (5 ft x 3 ft) are included within the project. The three existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge to result in flow reversal and cause flooding through the drainage system. In addition, two new pump stations are included within the design.

XI. DESCRIPTION OF PROJECT IMPACTS ON FISH AND WILDLIFE RESOURCES

The proposed action has the potential to directly and indirectly impact fish and wildlife resources within the Study Area and the condition of Jamaica Bay and Rockaway Peninsula resulting from the proposed project.

As described above, the Corps has identified an alternative that includes a composite seawall and dune with beach renourishment, and the construction and extension of groins on the Atlantic shoreline, and construction of bulkheads, floodwalls, revetments, and rock sills on the bay shoreline.

A. IMPACTS

1. Habitat Loss and Modification

The Recommended Plan will result in habitat modifications that will likely adversely impact fish and wildlife species. As noted above, the Recommended Plan includes: the placement of beachfill; construction of a composite seawall; the construction of new groins and the modification of existing groins; the construction of bulkheads, floodwalls, and berms (with associated outfalls); and the construction of rock sills with associated wetlands.

a) Beachfill/Berm

Increasing beach width through beachfill and berm creation may have some positive impacts, such as creating habitat area for beach-nesting birds and seabeach amaranth. Potentially beneficial impacts of beach nourishment have been observed at other Corps sites existing on Long Island (wider beaches provide more shorebird breeding areas/growing areas for coastal plants); however, these are not well studied and remain anecdotal as to their long-term contribution to resource conservation.

Habitat modifications, even when intended to be beneficial can sometimes have negative consequences through loss or reduction of forage resources, habitat alteration, habitat succession, or habitat fragmentation . For example, though black skimmers and terns frequently nest on dredge spoil islands, they abandoned Meadow Island on Long Island after the deposition of dredge spoil altered the vegetation on the island (Burger and Gochfeld 1990a). While this is a bay island site that differs from the beaches in the Study Area, it still serves as an example of habitat modification leading to negative impacts.

Depending on the species under evaluation, beach nourishment activities may also have relatively shorter-term impacts resulting from increased turbidity in the nearshore zone and burial of benthic invertebrates. These impacts will be discussed later in the report.

b) Composite Seawall

The construction of a composite seawall in the Study Area may negatively impact the wildlife and plants within the maritime beach and dune communities by permanently altering the ocean beach, and affecting microhabitats within the dune systems on the island. It is also not known whether a revetment capped with sand would provide suitable nesting habitat, or support natural vegetation densities. Additionally, the landward edge of the composite seawall would be exposed on the top, thereby eliminating sandy dune habitat that currently exists, and preventing use of this area by beach-nesting birds. There is also the potential for storm events or sea-level rise to expose the composite seawall completely, potentially leading to negative impacts on beach habitat and fish and wildlife resources due to erosion in front of the structure and at its flanks. Beach renourishment will occur in the Study Area every four years throughout the 50-year life of the project and may help to prevent the exposure of the seawall and resulting impacts, but it is unknown if this is cycle would adequately address exposure should it occur. Additionally, the project description does not discuss proposed renourishment in the area of the 5000-ft western taper between Beach 149th Street and Beach 169th Street. Furthermore, the exposure of the composite seawall is a concern beyond the life of the project due to its permanent nature.

As noted above, one of the potential concerns regarding seawalls is the potential loss or narrowing of beach habitat. Dugan *et al.* (2011) describe this loss as occurring through three processes: placement loss, passive erosion, and active erosion. Placement loss is described as the resulting loss of beach width due to the footprint of the armoring structure (Dugan *et al.* 2011). Passive erosion occurs as sea-level rises and the seawall acts as a fixed structure, which does not allow for landward migration and causes the beach fronting the wall to drown (Dugan *et al.* 2011; Tait and Griggs 1990). Lastly, active erosion occurs as waves reflect off the surface of the wall and cause erosion in front or flanking the wall (Dugan *et al.* 2011; Tait and Griggs 1990).

Tait and Griggs (1990) reviewed a number of studies regarding the impacts of seawalls on Pacific, Gulf, and Atlantic coast beaches. Based on their review they found that beach response to seawalls occurred both in front of and adjacent to seawalls and was highly variable across sites. The following beach responses were seen in the field and summarized by Tait and Griggs (1990):

> "Scour Trough – a linear trough or depression fronting a seawall.
>
> Deflated Profile – the lowering or erosion of the beach face.
>
> Beach Cusps – crescentic or semi-circular embayments on the beach face.
>
> Rip Current Trough – a trough or embayment crossing through the surf zone.
>
> End Scour – erosion of the unprotected beach adjacent to the end of a seawall.

Upcoast Sand Accretion – the impoundment of sand on the upcoast or updrift end of a structure."

Tait and Griggs (1990) found that any of the above-described responses may occur at a seawall, but recognized that beach response may also be indistinguishable from adjacent beaches lacking seawalls. While responses might vary among sites, Tait and Griggs (1990) concluded that long-term shoreline retreat is the most important factor affecting the impact of a seawall and that in areas that experience long-term retreat, the beaches fronting seawalls would eventually be lost.

Hall and Pilkey (1991) evaluated beaches with seawalls in New Jersey. They found that dry beach width was narrowest at beaches with seawalls, and widest at beaches that lacked structures. Even when compared to adjacent beaches, that are likely to be affected by similar wave and storm conditions, they found that sections of beach with seawalls and groins were narrower than immediately adjacent beaches that were unstructured. The density of hard structures also seemed to influence dry beach width as beaches with greater densities of stabilizing structures had narrower beaches. Similarly, Dugan *et al.* (2008) found that some beach zones on California beaches were narrower where there were seawalls. They found that certain upper intertidal beach zones were narrower or completely lacking in front of seawalls than at unarmored beaches. Mid-intertidal zones were also found to be narrower at armored vs. unarmored beaches.

The narrowing or loss of beach within the Study Area is a concern as these beaches provide nesting habitat for a variety of beach-nesting bird species and migratory shorebirds, including the piping plover and red knot. Use of these beaches as breeding or migratory areas would be eliminated should these beaches become too narrow or be lost completely. Dugan *et al.* (2008) noted impacts of seawalls on southern California beaches on shorebirds, seabirds, and their prey resources. They found that abundance, biomass, and individual size of beach macroinvertebrates were less on armored than unarmored beach segments. Birds were also more abundant and diverse on the unarmored sections of beach. Shorebirds, which were primarily using the beach for foraging, and gulls and seabirds, which were using the beach mostly for roosting, were both more abundant and diverse in unarmored sections. The negative response of the roosting birds suggests that prey base alone does not drive the use of these beaches by the birds, and that seawalls may have broader ecological impacts on birds.

Loss or severe narrowing of beaches in the Study Area would also impact other rare or federally-listed species including seabeach knotweed and seabeach amaranth – both of which occur in maritime beach and dune communities.

c) Artificial Dunes and Dune Plantings

The construction and planting of artificial dunes may impact beach dwelling animals and plants. The construction of the dune is proposed for areas that are currently used for nesting by beach-nesting birds. Modifying the habitat has potential to impact the nesting birds as it is not known if they will use the constructed dune in the same way as existing habitat. Piping plovers will nest on dunes, but the dunes they choose are generally low and gently sloping (Maslo *et al.* 2011). Dunes greater than 2.0 m in height and with slope greater than 20 percent are considered

undesirable for piping plovers and even lower and gentler profiles are recommended as targets for restoration projects (target values: 1.1 m dune height and 14 percent dune slope) (Maslo *et al.* 2011). Least terns are also not generally described as nesting on dunes. Atlantic Coast least terns are known to nest on flat, open beaches; beach berms; dredge spoil islands; dredge knobs; and large flats (Gochfeld 1983; Burger and Gochfeld 1990b). They are described as nesting on the beach berm at the base of the outer dune (Gochfeld 1983) and, within a colony, prefer to nest in the center of the beach rather than towards the dune or the ocean (Burger and Gochfeld 1990b). While nesting sites are generally flat, least terns showed some preference for nesting on small mounds and ridges within those sites, and nest elevations were higher than random points, however, the ridges were described as being only 10-20 centimeters (cm) higher than surrounding areas, and elevation differences were slight (Burger and Gochfeld 1990b).

Dune construction may also influence vegetation growth in and around the nesting areas. As the dunes would not be frequently overwashed, vegetation may become thick over time. Thick vegetation may preclude nesting as beach-nesting birds often prefer nesting locations that are bare or lightly-vegetated (Maslo *et al.* 2011; Cohen *et al.* 2008; Burger and Gochfeld 1990b; Kotliar and Burger 1986; Gochfeld 1983; Thompson and Slack 1982). The beach-nesting bird species present within the Study Area typically prefer to nest in areas with less than 30 percent vegetation cover. Studies have shown that least terns prefer 5-10 percent cover and colonies often do not use sites with greater than 20 percent cover (Gochfeld 1983), black skimmers generally use areas with up to 10 percent vegetation cover and do not use areas with greater than 30 percent cover (Burger and Gochfeld 1990a), and common terns nest on beaches with 10-25 percent vegetation cover (Birds of North America 2018). Maslo *et al.* (2011) found that the majority of the piping plovers in their study nested in vegetation cover that was less than 20 percent. They recommended 13 percent vegetation cover as a restoration target, and suggested that anything greater than 33.5 percent cover was unsuitable for nesting plovers.

It is believed that beach-nesting birds avoid nesting in or near thick vegetation as doing so may make birds and nests more vulnerable to predators as birds may not detect them as well (Burger 1987; Prindiville-Gaines and Ryan 1988). Studies of piping plover have shown that nests closer to vegetation or in areas of greater vegetation cover have less success than those further from vegetation or in less densely vegetated areas (Espie *et al.* 1996; Prindiville-Gaines and Ryan 1988). A study of Kentish plovers (*Charadrius alexandrinus*) also demonstrated experimentally that plovers were able to detect predators at greater distances and suffered less mortality at the nests with no or little vegetative cover (Amat and Masero 2004).

Construction of a dune may also impact seabeach amaranth. The "*Seabeach Amaranth Recovery Plan"* (U.S. Fish and Wildlife Service 1996b) states that *"any stabilization of shoreline is detrimental for a pioneer, upper beach annual whose niche or 'life strategy' is the colonization of unstable, unvegetated, or new land, and which is unable to compete with perennial grasses."* On North Carolina's barrier islands, the zone where seabeach amaranth is absent corresponds almost exactly with the presence of an artificial barrier dune built and maintained by various federal agencies from the 1930s to 1950s (U.S. Fish and Wildlife Service 1996b).

d) Construction and Modification of Groins

Construction of the groins involves the direct removal of sandy habitat in the intertidal and nearshore areas. Intertidal and nearshore habitat will be permanently altered from sandy habitat to rocky subtidal/intertidal habitat by the construction of the groins. While these structures may function as habitat after the completion of the project, the habitat structure and biotic community will be altered from the before-project condition. Additionally, the construction of the project may change habitat formation patterns along the beach, as well as areas downdrift of the project (U.S. Fish and Wildlife Service 2000). The construction of the groins will permanently alter the feeding, sheltering, and breeding areas for fish and wildlife. The permanence of these features will reduce the effective areas available to species that utilize sandy habitat for feeding sheltering and breeding. For example, surf clams burrow in medium to course sand and gravel substrates, habitat that would no longer exist in areas where groins are proposed (U.S. Fish and Wildlife Service 1983).

The Service believes that construction of large hard structures on the beach will change habitat formation patterns. The shoreline would not exist in a continuous line after construction of the groins. Instead, it will consist of several "cells" created by the groins and result in the fragmentation of the shoreline. Erosion from increased wave energy could create vertical scarps or concave formation along the shoreline. These formations, combined with the structures themselves, may disrupt foraging by shorebirds, such as black skimmers, who skim along the surface of the shallow water to capture food. Foraging piping plover broods, which also move along the shoreline searching for prey in the intertidal zone and wrackline, will have to move up the beach and around the groins, consuming valuable energy needed for survival (U.S. Fish and Wildlife Service 2000).

Impacts to beach habitat and fish and wildlife resources may occur beyond the immediate area of the groin field as groins can have impacts on downdrift beaches. Structures such as groins that act as littoral drift barriers may cause erosion on downdrift beaches (Bruun 1995). Erosion and narrowing of beaches downdrift could reduce available habitat for breeding or foraging shorebirds and seabirds, and can reduce habitat for plants such as seabeach amaranth.

e) HFFRRFs: Shoreline Armoring

Bulkheads and other alongshore structures (*e.g.*, revetments, seawalls) can have a number of negative impacts on coastal habitats. These hard shore-parallel structures reflect wave energy and can cause erosion, sometimes resulting in loss of intertidal habitat and creation of deeper waters (Prosser *et al.* 2017; Dugan *et al.* 2011). This can be detrimental as shallow nearshore habitats often serve as foraging, refuge, and nursery areas for fish and aquatic invertebrates (Dugan *et al.* 2011; Ruiz *et al.* 1993; Beck *et al.* 2001) and studies have shown that diversity, abundance, and community structure of aquatic organisms can be adversely impacted by these structures (Bilkovic and Roggero 2008; Seitz *et al.* 2006; Kornis *et al.* 2017). Bulkheads and other shore-parallel structures, such as floodwalls, can also reduce terrestrial-aquatic connectivity. Exchange of sediment, nutrients, and organic material between terrestrial and aquatic habitats can be disrupted by these structures (Dugan *et al.* 2011; Bilkovic and Roggero 2008).

Different types of hardened shorelines may have different value to fish and wildlife resources. For example, Bilkovic and Roggero (2008) found that fish community integrity was lower at shorelines with bulkheads than at natural or riprap revetment shorelines. Similarly, Seitz *et al.* (2006) found that the abundance and diversity of bivalves and infauna (polychaetes, amphipods, etc.) was lower adjacent to bulkheads than adjacent to natural marsh or riprap. Rock sills associated with hybrid living shorelines, supported more fish and aquatic invertebrates than bulkheads or traditional rock revetments (Gittman *et al.* 2016; Bilkovic and Mitchell 2013).

Much of the shoreline in the Study Area has already been hardened; however, if the project introduces hardened structures to areas that have little existing structure or converts one shoreline type to another (*e.g.*, converting a concrete rubble shoreline to a bulkhead), this may cause impacts to fish and aquatic organisms. Furthermore, construction of bulkheads, berms, and revetments are proposed in areas that have fringing saltmarsh. The Service is concerned that these structures may result in the loss of saltmarsh due to direct conversion of habitat or as the result of construction activities related to the shoreline protection structures. The construction of shoreline structures may also have other less direct impacts, such as increased runoff into Jamaica Bay. New storm water outfalls that would divert water into Jamaica Bay are proposed in association with the floodwalls and berms. These outfalls could be a conduit for pollutants and may impact water quality.

f) HFFRRFs: Natural and Nature Based Features

The use of nature-based features such as rock sill or marsh toe revetments in association with marshes may provide benefits to fish and wildlife resources over using traditional shoreline hardening approaches. Balouskus and Targett (2016) found that densities of some fish species were greater along a hybrid shoreline (comprised of a saltmarsh and riprap sill), than along shoreline with only a traditional riprap structure. Similarly, Gittman *et al.* (2016) found higher abundances of fishes at marsh sill sites than at sites with bulkheads, and found that marshes with sills may act as nursery habitat for fish. These nature-based approaches may provide more diverse habitat than traditional shoreline stabilization structures as they allow for colonization of a greater diversity of organisms, by allowing for the colonization of both infauna and epifauna. Both marsh sills and traditional riprap revetments provide structure for epifauna; however, traditional riprap revetments preclude the colonization of infauna due to loss of the intertidal zone. Marsh sills are often placed slightly offshore and preserve some amount of intertidal habitat, thereby allowing recruitment of both infauna and epifauna (Bilkovic and Mitchell 2013).

In some studies, marshes with sills have also performed as well as, or better than, natural marshes in providing habitat for marine organisms. Gittman *et al.* (2016) found that, at three years post-construction, the abundance and diversity of fishes and crustaceans was higher at marshes with sills than at natural fringing marshes without sills. Currin *et al*. (2007) also found that fish and invertebrates used marsh with stone sills in similar numbers to natural marshes. However, these results are not consistent across all studies. Balouskus and Target (2016) saw greater fish densities at riprap sills than at a traditional riprap revetment shoreline; however, fish densities were still lower than at natural marshes. Subramanian *et al.* (2008) also noted that sills can have detrimental impacts on wildlife as fish and crabs may get caught behind sills when tides recede and they are unable to escape.

The construction of marsh sills also involves trade-offs as they result in the conversion of existing habitat into an intertidal-sill; existing habitats that may be lost to conversion include relict fringe marshes, unvegetated tidal flats, and shallow subtidal bottom (Bilkovic *et al.* 2016; Bilovich and Mitchell 2013). The conversion of habitat to rock sills may also lead to subsequent changes in benthic communities. In one study, the construction of marsh sills was shown to benefit epifauna, but resulted in a reduction of the abundance, biomass, and diversity of infauna (Bilkovic and Mitchell 2013). Changes in community structure measured after the construction of sills showed increases in density and biomass of large bivalves, but decreases in density and biomass of polychaetes (Davenport *et al.* 2017).

Sediment characteristics (*e.g.*, grain size, relative amounts of organic matter) and sediment accretion rates have also been shown to vary among marsh sill sites and differ from natural marshes. Marshes with sills had greater organic matter content, and higher sediment accretion rates than natural marshes (Currin *et al.* 2008). Greater accretion rates in marshes with sills may result in the conversion of low marsh to high marsh, and may reduce the fishery habitat value of that marsh (Currin *et al.* 2007). Sediment characteristics at marsh sills, however, were not consistent across studies. Other studies have found that marshes with sills had coarser sediment and lower organic matter than natural marshes (Bilkovic and Mitchell 2013). Low soil organic matter content may limit infauna colonization (Bilkovic *et al.* 2016; Sacco *et al.* 1994).

The design of a sill can influence its relative impact on habitats and fish and wildlife. Sill height, placement relative to the shore, sill porosity, and presence or absence of gaps/openings can influence the health of the saltmarsh behind the sill, tidal flushing, and the ability of aquatic organisms to access the marsh. Marsh sills placed too close to the marsh, that are designed too high, that don't incorporate any gaps or openings, and/or that have rock that is packed too tightly may limit tidal exchange, cause marsh to die off behind the sill, and restrict access of aquatic organisms (Bilkovic *et al.* 2016; Subramanian *et al.* 2008; Duhring 2008; Bosch *et al.* 2006). The proper design of gaps or openings is also important as they can cause marsh erosion or accretion in the gap if they are not designed correctly (Bosch *et al.* 2006; Hardaway *et al.* 2007; O'Donnell 2017).

The current shoreline and fringing marshes along the bay shoreline of the Rockaway Peninsula are known to support saltmarsh birds and horseshoe crabs. Should the installation of rock sills negatively impact the saltmarsh or prevent access to the shoreline these species may be negatively impacted.

g) Borrow Area Dredging

This section addresses the impacts to the marine subtidal habitats in the offshore dredging area. A description of the potential physical and biological changes and their associated impacts is given in Minerals Management Service (MMS) (2001). Some notable potential biological effects to fish and invertebrates include, but are not limited to: (1) removal or loss of infauna and epifauna at the borrow site for one to five years to a community with comparable pre-disturbance abundance and diversity and biomass but different species composition and structure; (2) altered energy transfer on the food chain and altered composition of fish prey base; (3) loss of spawning habitat; (4) loss of overwintering habitat; and (5) changes in community

structure (species present, diversity, abundance, and biomass in surrounding areas) (Minerals Management Service 2001).

The primary adverse impact on the environment due to dredging operations at a borrow area involves the direct disturbance and destruction of benthic resources and their habitats from the dredge, which results in a loss of benthic organisms from the immediate area. Dredging may lower the productivity of a borrow area, and thus, the usefulness of the site for the production of fish and shellfish may decrease until a typical community is re-established in the borrow area (Woodward-Clyde Consultants 1975).

In addition to direct loss of benthic organisms to dredging, dredging can result in a number of different alterations to the seabed, which may affect its suitability as habitat for benthic organisms. Deep borrow pits are a possible result of seabed alteration from dredging. Small deep pits may become poor habitat due to reduced water circulation and high sedimentation rates can lead to anoxic conditions lethal to species using the pits. These adverse impacts have been found to be minimal in areas with strong currents where oxygen can be quickly replenished (Turbeville and Marsh 1982). Some borrow pits have also been shown to attract numerous fish and serve as resting places for sea turtles. Dredging can also lead to changes in sediment composition by exposing underlying sediments that are different from the existing sediments. Changes in sediment may impact the assemblage of benthic species, the ability of benthic organisms to burrow or feed, and/or the rate of recovery at a borrow site (Byrnes *et al.* 2004).

Recovery times for benthic communities at dredge sites vary. Many studies concluded that the benthic community within the borrow area of a dredge operation is fully recovered within one-year, while other studies found that recovery took more than one year and that species composition was still changing because sediment composition had not returned to pre-dredging conditions (Greene 2002; U.S. Army Corps of Engineers 2016c). Other studies suggest that recovery time may take one to five years to return to original levels of biomass and abundance (Greene 2002). Greene (2002) provided the following summary of factors that influence recovery time and degree of diversity of benthic organisms:

> "1) Duration and timing of dredging; 2) the type of dredging equipment used to extract the sediment; 3) sediment composition of the mine site; 4) amount of sand removed from the site; 5) the fauna present in the mine pit and surrounding area prior to dredging and their ability to adapt to change; 6) characteristics of the new sediment interface; 7) life history characteristics of fauna that recolonize; 8) water quality at the site; 9) hydro-dynamics of the mine pit and surrounding area; and 10) degree of sedimentation that occurs following dredging."

The impacts of dredging on benthic organisms may have further impacts on organisms that forage on benthic resources. For example, seabirds also use these open ocean habitats and can experience loss of foraging resources due to dredging, which can result in shifts in foraging patterns (U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, *pers. comm*. 2004). The Bureau of Ocean Energy Management (BOEM; formerly MMS) which oversees exploration of

offshore areas for mining, and oil and gas reserves, has recognized the potential impacts of their programs to seabirds and has undertaken, in certain areas of the country, surveys to understand seabird distribution and abundance in their project areas.

2. Disturbance and Mortality

Disturbance to fish and wildlife resources will likely occur during construction and as a result of the Project's modification of habitats. The following is a discussion of the likely impacts resulting from the implementation of this project.

a) Shorebirds and Seabirds

The timing of beach nourishment activities, construction of the composite seawall, and construction of groins will be a major factor regarding short- and long-term impacts for breeding and migrating shorebird and seabird species. The direct effects of these construction activities include disruption of breeding, foraging, and roosting activities. Beach construction activities are usually very intensive environmentally disruptive operations, which involve the mobilization and use of heavy equipment and vehicles on the ocean beaches. The operation of dredging equipment immediately adjacent to a shoreline that is used as a courtship, nesting, and brood-rearing area has the potential to disturb shorebirds to the point where they may not successfully nest and fledge young. Dredging equipment that is operated immediately adjacent to shorebird breeding habitat may preclude shorebirds from using the habitat entirely, forcing them to seek appropriate habitat elsewhere. Operation of machinery used to move dredge pipeline and to grade the nourished beach can greatly disturb shorebirds and their nests, and can endanger the lives of chicks (U.S. Fish and Wildlife Service 1995). However, even low levels of human activity have been shown to result in disturbance and displacement of shorebirds at migration staging and roosting areas (Pfister *et al.* 1992). Migratory shorebirds are particularly vulnerable to disturbance at roosting sites at high tides where the habitat available for roosting is diminished (U.S. Fish and Wildlife Service 1998b).

Long-term indirect impacts as a result of the project are also likely, as recreational activities on beaches within the Study Area may increase as a result of the proposed project and the resulting wider beaches. Recreational activities that may potentially adversely affect these species include: an increase in beach patrons and associated activities (sunbathing, sports, playing loud music, etc.), unleashed pets, fireworks, kite-flying, and increase in garbage and refuse concomitant with increased recreational activities. Unleashed pets, such as dogs and cats, can prey on shorebirds. Kite-flying may disturb these species as it is believed that the ground-nesting shorebirds perceive kites as avian predators.

Consequently, human activities may adversely affect productivity of shorebirds (Ruhlen *et al.* 2002) and influence foraging activity of some shorebird species (Burger and Gochfeld 1991). Wide beaches with little human disturbance at the time these species initiate nesting (March to May) often experience heavy recreational pressure later in the nesting season (June through August), potentially creating sufficient disturbance to cause abandonment of nests, interfere with foraging, cause broods to be separated from adults, or attract predators.

b) Saltmarsh Birds and Neotropical Migrants

Nesting birds, including saltmarsh nesting birds and neotropical migrant songbirds, typically occupy the Study Area between April and September. Migrants are typically present from March through late May and early September through mid-October. Resident species are present year-round. Conducting construction activities during important biological windows can lead to disruption of breeding, feeding, and resting/staging behavior. As a result, construction will likely temporarily disrupt resident birds and breeding migrants. Prolonged absences of adults from their nests can jeopardize eggs or young. Depending on weather conditions, eggs may overheat or cool and fail to hatch. Young nestlings rely on their parents to provide warmth or shade, and may die from hypothermia or heat stress if adults are forced away from the nest for an extended period of time. Eggs and juveniles are subject to greater predation risk while they are unattended. Some species could be displaced if construction activities are planned during breeding or migration periods. Other species that overwinter in wetlands may be disturbed and displaced should construction occur during the winter season.

c) Diamondback Terrapins

Habitat for diamondback terrapins along the bay shoreline of the Rockaway Peninsula is limited, however, there are anecdotal reports of nesting terrapins. If they are present along the shoreline in the areas proposed for HFFRRFs, nesting turtles, their nests, and/or overwintering turtles could be killed or otherwise disturbed by construction activities associated with these features.

d) Fish and Aquatic Invertebrates

In-water work associated with dredging, groin construction, and the construction of HFFRRFs and NNBFs will cause disturbance and potentially direct mortality to fish and aquatic invertebrates. Offshore dredging directly effects fish by displacing mobile fish populations from the dredging operation site (Woodhead 1992) and results in direct mortality of immotile organisms. Similarly, the construction of groins, rocks sills, or other in-water structures would result in the burying of existing benthic organisms, and use of the shoreline area by fish and other mobile aquatic organisms would be temporarily disrupted by construction activities. Direct burial of most benthic organisms would generally be lethal, although some burrowing clams and crustaceans may be able to migrate upwards (U.S. Army Corps of Engineers 1992). Motile organisms, such as fish, appear to be the least affected by construction activities as they are able to move to avoid disturbances (Hurme and Pullen 1988).

Spawning horseshoe crabs could also be disturbed or disrupted by construction activities. Construction activities or vessels that create a wake could also disrupt horseshoe crab eggs.

e) Federally-Listed Species

Impacts to federally-listed species under the jurisdiction of the Service will be addressed in detail in the Biological Opinion for this project. Provided below is a brief discussion of impacts to listed species.

The proposed project has the potential to exert both direct and indirect adverse effects on the piping plover, red knots, and seabeach amaranth. Dredging and beach disposal activities during the plover breeding season have the potential to exert direct adverse effects on the piping plover as a result of disruption of courtship, nesting, and feeding activities, and alteration of their habitat. Likewise, if these activities occur during red knot migratory periods they may disrupt foraging and roosting activities of this species. Seabeach amaranth may also be directly impacted by beach nourishment through burial of adult plants and seeds, or crushing of adult plants construction vehicles.

Disturbance to federally-listed species may also come from indirect effects of the project. Increased beach width due to the project can lead to an increase in human recreation on beaches. This may have negative impacts on piping plovers that use the beaches to nest and rear chicks and red knots using the beaches to forage and roost. Increased numbers of people on the beach can disrupt breeding or foraging activities of these species. Other recreation-related activities that may potentially disturb piping plovers and red knots include: off-road vehicle (ORV) use, unleashing of pets, fireworks, kite-flying, and removal of wrack near plover nesting and feeding areas. Increased recreation could also lead trampling of seabeach amaranth plants and seeds.

3. Turbidity and Suspended Sediment

The project contains a number of activities that can result in sediment suspension and turbidity. Beach nourishment, in-water activities (such as construction of groins, bulkheads, and rock sills), and borrow area dredging may lead to suspended sediment and turbidity which may impact fish and other aquatic organisms.

Localized turbidity plumes can have lethal and sublethal effects on benthos and fish. Suspended sediments can have direct impacts on fish, including hematological compensation for reduced gas exchange across gill surfaces; abrasion of epithelial tissue; packing of the gut with large quantities of ingested solids, which may have little nutritive value; disruption of gill tissues (abrasion, clogging, increased activity of mucosa); and increased activity with a reduction of stored metabolic reserves (Profiles Research and Consulting Groups, Inc. 1980). Some of these impacts, such as the coating of gills, can cause mortality (O'Connor *et al.* 1976). Impacts may vary across species.

Other direct impacts of sediments include the smothering of immobile benthic organisms, fish eggs, and non-motile fish larvae or adults (Stern and Stickle 1978). Sediment burial can delay hatching time or lower hatching success of the eggs of some species (Schubel and Wang 1973; Auld and Schubel 1978; Nelson and Wheeler 1997; Berry *et al.* 2011). The impacts of suspended sediment and sediment burial on benthic invertebrates includes mortality, decreased body condition, and changes in growth or development (Wilber and Clarke 2001; Greene 2002; Colden and Lipcius 2015). However, the impacts of sediment on fish and benthic invertebrates is varied across species and life stages, and some species such as bivalves can be somewhat silt-tolerant (Wilber and Clarke 2001; Sherk *et al.* 1974).

In addition to direct effects, turbidity and suspended sediments may also impact fish and benthos in indirect ways. For example, suspended sediment can mask pheromones used by migratory

fishes to reach their spawning grounds and impede their migration (Newcombe and MacDonald 1991). Suspended sediments may also impact aquatic organisms by creating anoxic water conditions (O'Connor *et al.* 1976) and/or decreasing light penetration (Stern and Stickle 1978). Studies have shown that turbidity and resulting shading and light scattering can have negative impacts on the ability of fish to detect prey and may hinder foraging efforts (Breitburg 1988; Benfield and Minello 1996). However, the influence of turbidity and light on foraging ability may vary among different sizes and types of fish; some groups of fish such as planktivores and fish larvae may benefit from turbid conditions (Utne-Palm 2002; Wilber and Clarke 2001).

4. Burial of Marine Intertidal and Marine Beach Invertebrate Species

The Corps estimates that 804,000 cy of sediment will be required for initial construction and approximately 1,021,000 cy of sediment for renourishment events. Placement of sand will lead to the burial and subsequent mortality of marine invertebrates. Beach resources affected by the placement of sand include flora and fauna found on the upland (vascular plants, terrestrial arthropods, and avifauna, etc.) and microphytobenthos (benthic micro-algae) and marine zoobenthos (Speybroeck *et al.* 2006). Speybroeck *et al.* (2006) states that the speed and degree of ecological recovery is largely dependent on four factors: the quality and quantity of the sediment; the nourishment technique and strategy applied; the place and size of nourishment; and the physical environment prior to nourishment. Model simulations conducted by Vanden Eede *et al.* (2014) found that species richness is not affected by beach nourishment because ecological niches remain available; however, because of steeper slopes, the niches are smaller. The model indicated that sediment grain size is important to the recolonization of macrobenthos, as well as nourishment specific and ecosystem dependent factors such as nourishment period, method and technique, erosion susceptibility, and the recolonizing capabilities of the species as discussed in Speybroeck *et al.* (2006).

Speybroeck *et al.* (2006) recognizes that the majority of studies have focused on macrobenthic infauna (*e.g.*, Reilly and Bellis 1978; Parr *et al.* 1978; Gorzelany and Nelson 1987; Peterson *et al.* 2000; Peterson and Manning 2001; Lindquist and Manning 2001), were not standardized and that these studies are primarily short-term studies, and that little is known about the cumulative effects of repeated renourishments. Few studies have focused on the impacts to primary producers (Cahoon *et al.* 2012). Studies report that recovery of benthic infauna can occur within a matter of months or may take several years to recover. This variation is likely due to variations in the factors listed above.

Recovery time of benthic invertebrates appears to show variability. Some studies have observed that when nourishment ceases, the recovery of the community is rapid and complete recovery may occur within one or two seasons (Reilly and Bellis 1978; Parr *et al.* 1978). No significant long-term negative effects of beach nourishment on nearshore benthic fauna were found during monitoring of a beach replenishment project on a central Florida east coast sand beach community (Gorzelany and Nelson 1987), but long-term adverse impacts to benthic fauna at North Topsail Beach, North Carolina, resulted following beach nourishment (Peterson and Manning (2001). However, Lindquist and Manning (2001) reported that periodic nourishment of beaches appeared to prevent the full recovery of benthic species. The ability of macrofauna to recover is due to: (a) their short life cycles, (b) their fast reproductive potential, and (c) the

recruitment of plankton larvae and motile macrofauna from nearby unaffected areas (Naqvi and Pullen 1982).

The time of year that nourishment occurs may impact recovery times of invertebrates. When nourishment is completed between early August and early October, the community may recover within two months prior to the winter decline. Recovery time following nourishment in mid to late October is expected to occur within the range of two to six months. If nourishment occurs between the months of late October and January, the compounding effects of nourishment and seasonal population decline will result in a minimum of six months recovery time for the community (Burlas *et al.* 2001). In 2003, the time period for benthic recolonization was approximately 12 to 18 months for the Fire Island Community project area (Land Use Ecological Services, Inc. 2005). Terwilliger Consulting Inc. (2009) states that beachfill should be of the thinnest depth possible to facilitate the repopulation of the fill areas based on Defeo *et al. (*2009) who recommend repeated application of layers no thicker than 30 centimeters.

Impacts of beach nourishment on benthic invertebrates may have impacts on organisms that feed on them. For example, at Bogue Banks, North Carolina, a cold-season renourishment project that deposited sediment coarser than the existing sediment caused a decline in biomass of a number of benthic invertebrate species (Peterson *et al.* 2006). As a result of the decreased prey availability and, possibly, also as a result of the coarser sediment, the number of foraging shorebirds at the beach was also greatly reduced (Peterson *et al.* 2006). This suggests the importance of matching sediment characteristics to the original sediments, as well as the potential impacts of decreased benthic resources on shorebirds. As previously discussed, timing of placement also influences the length of recovery time of benthic invertebrates. Should the timing of a project prevent the recovery of benthic invertebrates prior to critical shorebird migration or nesting seasons, it may be reasonable to conclude that this too may impact shorebirds for at least one season after nourishment occurs.

B. CUMULATIVE IMPACTS

There are a number of other federal and local projects within or adjacent to the Study Area (see Appendix A) that have recently occurred, are ongoing, or that are proposed for the future that have had or will likely have impacts on habitats and fish and wildlife resources. Taken together, these projects will likely have cumulative impacts on fish and wildlife resources within and beyond the Study Area. The Service did not undertake a cumulative impacts analysis for the Recommended Plan, however, the abundance of projects within or adjacent to the Study Area that impact fish and wildlife resources underscores the importance of implementing mitigation measures for the current project. We request that the Corps provide an assessment of the effectiveness of implemented mitigation measures to date for completed and/or ongoing projects within or adjacent to the Study Area as part of the cumulative impacts analysis in their final report. If this information has already been developed, we request that the Corps share it with us so that we can review it and include it in our final FWCA report.

The following upcoming or ongoing federal projects occur within or immediately adjacent to the Analysis Area of the current project:

- Atlantic Coast of NYC-Rockaway Inlet to Norton Point, Shore Protection Project
- Rockaway Inlet Federal Navigation Channel Project
- East Rockaway Inlet Federal Navigation Channel Project
- Atlantic Coast of Long Island, Jones Inlet to East Rockaway Inlet, Long Beach, NY, Storm Damage Reduction Project
- NY NJ Harbor and Tributaries Coastal Storm Risk Management Feasibility Study.
- Hudson River Estuary Restoration Feasibility Study

More information about these and other projects within or adjacent to the Study Area can be found in Appendix A.

XII. SERVICE PLANNING AND MITIGATION RECOMMENDATIONS

The Service provides the following planning and mitigation recommendations to facilitate the Corps in developing avoidance and minimization measures to avoid or limit project related impacts to trust resources.

The planning recommendations given below are provided as measures related to the formulation and design of the proposed project. As the project advances, through the Corps' planning process, the Service considers the consultation under the FWCA as an opportunity to integrate fish and wildlife conservation into the planning process.

The Service's Mitigation Policy (Policy) (U.S. Fish and Wildlife Service 1981) was developed to guide our preparation of recommendations on mitigating the adverse impacts of land and water developments on fish, wildlife, their habitats, and uses thereof. It helps both the Service and the federal action agency, in this case, the Corps, by assuring consistent and effective recommendations, by outlining policy for the levels of habitat mitigation needed, and the various methods for accomplishing mitigation for habitat losses associated with such projects. It allows federal action agencies to anticipate Service recommendations and to assist in the preparation of mitigation measures early, thus avoiding delays and assuring equal consideration of fish and wildlife resources with other project features and purposes.

The term "mitigation" is defined in the Service's Policy (U.S. Fish and Wildlife Service 1981) as: (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating impacts over time; and (e) compensating for impacts by replacing or providing substitute resources or habitats.

The Service has jurisdiction over a broad range of fish and wildlife resources. Service authorities are codified under multiple statutes that address management and conservation of natural resources from many perspectives, including, but not limited to, the effects of land, water, and energy development on fish, wildlife, plants, and their habitats. The types of resources for which the Service is authorized to recommend mitigation also include those that

contribute broadly to ecological functions that sustain species. Section 404 of the Clean Water Act (CWA; 33 CFR 320.4) codifies the significance of wetlands and other waters of the U.S. as important public resources for their habitat value, among other functions.

Mitigation planning often presents practicable opportunities to implement mitigation measures in a manner that outweighs impacts to affected resources. When resource enhancement is also consistent with the mission, authorities, and/or responsibilities of action proponents, the Service will encourage proponents to develop measures that result in no net loss toward achieving conservation objectives for the resources affected by their actions.

Objectives identified by the Service in providing recommendations on this feasibility study are to protect and conserve fish and wildlife resources in the Study Area. This includes developing recommendations to make the project more environmentally compatible and to further conserve and enhance the diversity and abundance of fish and wildlife resources and their habitats.

The outcome of consultation under section 7 of the ESA or future consultations under the FWCA, could affect the recommendations herein. In addition, the Service provides conservation measures intended to facilitate the recovery of listed species, sensitive habitats, and other fish and wildlife resources.

A. CORPS PROPOSED MITIGATION MEASURES/BEST MANAGEMENT PRACTICES

In the revised General Re-evaluation Report/Environmental Impact Statement (GRR/EIS), the Corps describes conservation measures that they plan to implement or have already incorporated into the project for the benefit of fish of wildlife resources. These measures are summarized below:

- Best management practices (BMPs) (*e.g.*, silt fencing) to control erosion and sedimentation during construction will be implemented.
- Time-of-year restrictions will be observed to avoid impacts to fish and wildlife resources, including a time-of-year restriction for piping plovers (no work April 1 through September 1).
- NNBFs have been incorporated into the Mid-Rockaway Edgemere Area and the Mid-Rockaway Arverne Area HFFRRF projects where possible to reduce shoreline hardening and to promote restoration of native habitats.

There will be 7.65 ac of wetlands restored and/or created as part of the NNBFs, which will serve as mitigation for the estimated 3.74 ac of federal and state regulated waters and wetlands under the CWA that will be impacted by the project. The Corps will also restore 1.35 ac of maritime forest habitat at the Mid-Rockaway Arverne Area HFFRRF to mitigate for the loss of 1.81 ac of maritime forest resulting from the project.

The Corps also states that it will continue to work with the Service to avoid, minimize, and mitigate impacts to wildlife, and will continue to work with the Service and the NOAA Fisheries to ensure that reasonable and prudent measures and standard BMPs are incorporated into project plans to minimize adverse impacts to federally-protected species. Likewise, they stated that it is

also assumed that the latest protective BMPs and conservation measures will be incorporated into the project plans to minimize potential adverse impacts to protected state listed species.

B. PLANNING RECOMMENDATIONS

1. Habitat Loss, Degradation, and Fragmentation

As habitats in the Study Area have been lost and modified due to human development, we recommend that the Corps evaluate if there are any additional areas within the HFFRRF projects where shoreline hardening can be further reduced. We also recommend that the Corps create and enhance fish and wildlife habitat where appropriate throughout the Study Area, and incorporate adequate monitoring and maintenance of habitats to ensure that they remain useable by fish and wildlife resources for the life of the project (additional recommendations regarding monitoring and maintenance are included under *Mitigation Recommendations*). An adaptive management plan for mitigation measures should be developed to ensure implementation and success. Further coordination with the Service under a separate scope of work will be necessary to achieve this goal. As some aspects of the project are designed only to a feasibility level, the amount of habitat required for mitigation is not established at this time (*e.g.,* wetland losses are not fully known, as a formal wetland delineation has not been undertaken). Mitigation planning should address mitigation ratios for the different habitat types affected by this project. In general, we recommend at least 1:1 to avoid net loss of any given habitat; however, some habitats may require larger ratios. For example, wetland mitigation may necessitate higher ratios as restored or created wetlands might not provide the same functions as existing wetlands, or they may lose function for a period of time as they become established. A mitigation ratio greater than 1:1 may be needed to offset these losses. Overall, the Service will continue to work with the Corps as final designs are developed to provide more accurate measures of mitigation and to determine appropriate mitigation ratios.

In their response to the Draft FWCA report (full response in Appendix G), the Corps indicated that habitat mitigation is not associated with the proposed project, but in order to minimize erosion, maximize stability and longevity, and to attenuate wave energy, the plan was designed to minimize and, in some areas, preserve functional effectiveness of the bayside habitat. The Corps will also further evaluate ways to minimize project impacts during the pre-construction engineering and design (PED) phase. We acknowledge the Corps' response, however, we continue to recommend habitat mitigation measures to offset impacts to fish and wildlife resources.

2. Invasive Species

The Corps and its project stakeholders should commit to a long-term effort at managing habitat created or restored as a result of the Project to prevent the colonization or recolonization of invasive species. This effort should incorporate post-project monitoring and maintenance to ensure that the intended plants are successful and that invasive species such as common reed do not become problematic.

3. Wildlife Management

In the Draft FWCA report, we recommended, in accordance with the 2003 MOA entitled, "*Aircraft-Wildlife Strikes,"* and the subsequent 2007 circular entitled, *"Hazardous Wildlife Attractants on or Near Airports,"* the Corps should commence coordination with the Service and the FAA for activities in close proximity to JFK Airport so that the NNBFs can be sited and designed without creating hazardous conditions for aircraft.

The Corps provided the following response in their comments on the Draft FWCA report:

"*In accordance with the FAA Advisory Circular 150/5200-33B and the Memorandum of Agreement with FAA to address aircraft-wildlife strikes, when considering proposed flood risk management measures and mitigation areas, USACE must take into account whether the proposed action could increase wildlife hazards. The FAA recommends minimum separation criteria for land-use practices that attract hazardous wildlife to the vicinity of airports. These criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure airspace or air operations area (AOA).*

These separation criteria include:

- *Perimeter A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000 feet from the nearest AOA;*
- *Perimeter B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000 feet from the nearest AOA; and*
- *Perimeter C: Five-mile range to protect approach, departure, and circling airspace.*

As stated, the closest airport the study area that must comply with these standards is the John F. Kennedy International Airport, Queens County, New York. The natural features in the recommended alternative are within the limits of the 5-mile perimeter of the airport, and as designed are not expected to introduce hazardous wildlife attractants. In addition, the habitat acreage created is not large enough to provide nesting habitat for the potential species that cause hazards. The District will confirm these designs with the FAA and PANYNJ."

4. Environmental Contaminants

In the Draft FWCA report, we recommended pre-construction monitoring for sediment contaminants at the locations of the NNBFs, and urged that construction should not proceed without prior screening for contaminants. If concentrations of contaminants in sediment exceed acceptable thresholds, we noted that biological testing and/or remediation may be necessary.

In response to the Draft FWCA report (full response in Appendix G), the Corps indicated that a scope of work will be prepared during the PED phase to conduct specific testing for hazardous, toxic, and radioactive waste (HTRW) in the HFFRRF areas. If HTRW is located, the Corps will assess if the project can be realigned to avoid the contaminated site. In accordance with ER 1165-2-132, if the project alignment cannot be revised, the project's non-federal sponsor would be responsible for the removal of any contaminants to allow the construction of the alignment.

The non-federal sponsor will conduct, at 100 percent their expense, those remedial activities necessary to remove contaminated materials in accordance with ER 1165-2-132. The Corps will continue to coordinate with all parties, including the State of NY, City of NY, and the NPS.

5. Supply of Genetic Stock of Native Plantings

The Corps should use locally-sourced and genetically-diverse plants in any plantings associated with the Project. As there are a number of other proposed projects in the region that will also incorporate native plantings, some large in scale (*e.g.*, HRE Restoration Feasibility Study), the Corps should develop a plan for the acquisition of locally sourced plants that accounts for a shortage of these plants in the NYC region. The Corps may consider undertaking a seed collection effort (as the BLM has begun) to begin fulfilling their planting needs for the HRE Feasibility Study Area (Bureau of Land Management 2015). This collection effort will comply with Title 18 Chapter 1 of the Administrative Code of the City of New York (Native biodiversity planting practices) which requires "…greater native biodiversity … in public landscapes." (many of the HRE restoration projects are located on NYC-owned public lands).

C. MITIGATION RECOMMENDATIONS

1. Habitat Loss and Modification

a) Beachfill/Berm Creation

- The Corps should ensure that the dredged sand for beach nourishment is compatible with the sand that is now on the beach with respect to grain size, clay content, and organic matter.
- Sand grain size distribution should be monitored at the beach nourishment site before the project and immediately after project completion.
- The beach fill area should be finished to the same slope as the surrounding beach and the area should be graded at a gentle uniform slope with no piles, ridges, or holes left in the final graded beach placement materials.
- If the project creates additional nesting habitat within the Study Area through the extension of the berm habitat, the Corps should ensure that these areas are properly monitored and managed, recognizing that existing monitoring programs may not have the staff or resources to take on additional monitoring or management responsibilities.

b) Composite Seawall

- As it is designed, the landward side of the composite seawall is exposed at the crest of the dune. Based on the current project description, it appears this would result in the loss of approximately 9 ac of sandy maritime dune habitat that may serve as has habitat for beach-nesting birds. In response to the Draft FWCA report (full response in Appendix G), the Corps indicated that, during the PED phase, they will evaluate potential options of covering the exposed portion of the composite seawall. The Service supports this, and continues to recommend that the Corps should

mitigate for any loss of habitat if the final design not incorporate full burial of the composite seawall.

- The Service requests more information about how the Corps will monitor, prevent, and/or mitigate for any additional loss of sand at the crest of the dune and exposure of the composite seawall due to settling of sand through the composite sea wall or from wind or water erosion.
- We recommend developing a management plan for the composite seawall and dune to ensure that action is taken if the sand dune is eroded and the seawall becomes exposed. Should the seawall become exposed, a plan should be in place to re-bury the wall. Plans should be developed for both the breeding season (April 1 through September 1) and the non-breeding season, as different courses of action will be necessary. For any exposure that may occur during the non-breeding season, we recommend that the wall is buried prior to the next shorebird nesting season (April 1 through September 1). We recommend that the Corps work with the Service to develop a protocol for dealing with exposure that happens within the nesting season.
- If the project results in loss of nesting habitat through erosion or construction of the composite seawall, the area of habitat impacted should be determined and mitigated using an appropriate mitigation ratio determined through further consultation with the Service under the FWCA.

c) Artificial Dunes and Dune Planting

- We recommend that the Corps evaluate if the dune can be designed so that it is less than a 20 percent slope on the seaward side to better accommodate breeding piping plovers and other beach-nesting birds.
- The Corps has expressed that American beachgrass will be planted on 18-inch (in.) centers within a row and can be modified to 24 in. on center where piping plover nesting is present or has the potential for nesting (Mazey 2018). We request more information from the Corps about what percent cover this planting scheme would achieve and how it would be maintained.
- The Corps should maintain vegetation on the dune and the berm so that it continues to support nesting terns, skimmers, oystercatchers. An assessment of existing conditions relative to habitat suitability should be performed to assist in determining appropriate vegetation density for these species. Recommendations for vegetation densities for piping plover will be considered in the Biological Opinion. Any vegetation maintenance or maintenance in nesting areas should occur outside of the breeding season (April 1 through September 1).
- A vegetation management plan should be developed to achieve and maintain target densities once they are established.

d) Construction and Modification of Groins

- The construction of new groins and extension of existing groins at the eastern end of the Rockaway Peninsula should avoid adversely affecting sand accretion on downdrift beaches west of the new and extended groins.

- Monitoring should occur to determine the effects of new and extended groins on the beaches west of the groins.
- The Corps should develop remedial action plans should the new or extended groins be proven to negatively impact the beaches west of the groin fields.
- It is unclear from the project description whether the new groins would be buried. To reduce potential impediments to foraging shorebirds we recommend that the groins are buried to the greatest extent practicable.

e) HFFRRFs: Shoreline Armoring

- The Service requests that further consideration is given to the proposed construction of bulkhead along the shoreline of Thursby Basin Park on the western shore of Sommerville Basin. We recommend evaluating the feasibility of a structure further landward around the perimeter of the undeveloped lot, instead of hardening the shoreline at this location. In response to the Draft FWCA report, the Corps stated that, during the PED phase, the alignment of hard structures will be located to minimize impacts to sensitive to areas.
- The Service recommends that the Corps continue to evaluate and modify HFFRRF and NNBF project designs to minimize loss of, or impacts to, wetlands. If losses cannot be avoided, the Corps should mitigate in accordance with section 404 of the CWA and continue to coordinate with the Service to develop appropriate mitigation ratios.
- The Corps has provided estimated acres of wetland loss, restoration/creation, and enhancement. We request that Corps complete a formal wetland delineation and provide an updated summary of the acres of existing wetlands and the acres of wetland that will be lost, restored, created, and enhanced due to the project, with each category broken out separately (*i.e.,* restoration and creation would not be grouped).
- The Corps indicated that 1.81 ac of maritime forest would be impacted by the project and that they would offset this loss by restoring 1.35 ac of maritime forest. We recommend that the Corps mitigate this habitat with at least a 1:1 to ratio.
- We recommend that the Corps develop measures to filter storm water that will be diverted to the Bay via new outfalls such that floatables and other pollutants are removed or reduced.
- The Corps should work with local communities and the NYCDEP in establishing green infrastructure practices (*e.g*., rain gardens, bio-retention swales, etc.) to reduce stormwater runoff within the drainage basins impacted by the Project.

f) HFFRRFs: Natural and Nature Based Features

- Rock sills should be designed such that they allow for sufficient tidal exchange and access by fish and aquatic organisms. To do this, sills should be designed to incorporate openings or drop-downs, should range from 0 to +1 ft above mean high water, and should be placed channel-ward of the mean low water line – not directly

on the marsh (Bosch *et al.* 2006). Additional recommendations regarding sill design, design of openings, and marsh establishment can be found in "*Shore Erosion Control Guidelines*" (Bosch *et al.* 2006).

- We recommend that the Corps follow all relevant guidance as described in the NYSDEC's "*Tidal Wetlands Guidance Document, Living Shoreline Techniques in the Marine District of New York State*" (New York State Department of Environmental Conservation 2017).
- Horseshoe crabs were documented at Brant Point and Dubos Point during surveys performed in 2000. As habitats may have changed since that time, the Corps should survey for spawning horseshoe crabs at all locations with suitable habitat within the HFFRRF project areas. Should horseshoe crabs be located, the Corps should give specific consideration to the design of the rock sill at or around horseshoe crab locations to ensure that horseshoe crabs are not impeded by the structure, and to enhance spawning habitat.
- The Corps should develop a monitoring plan to monitor the establishment and survival of marsh vegetation, use of the marsh by fish and other aquatic organisms, and tidal flushing. Development of an adaptive management plan to address any problems is also recommended.
- For establishment of low marsh we make the following recommendations: saltmarsh cordgrass can be propagated by bareroot seedlings, plugs, or seedlings in peat pots (Broome 1990). Direct seeding is generally less reliable and there have been incidences when low seed viability reduced successful establishment of this species. Bareroot seedlings or plugs are generally less expensive than potted seedlings. Most low saltmarsh planting plans involve planting plugs on 24-in. or 36-in. centers. We recommend that saltmarsh cordgrass plugs be planted on 18-in. centers along the newly created creek banks and areas subject to wave action. The closer spacing will reduce the time to establish dense cover and will reduce opportunities for erosion. If Canada geese or brant are abundant in the Study Area following planting, they may pose a risk to the successful establishment of dense stands of vegetation. Techniques to prevent over browsing of the freshly-planted marsh areas may need to be implemented.
- We recommend the following for the establishment of high marsh: Like saltmarsh cordgrass, saltmeadow hay, and spike grass can be propagated by bareroot seedlings and plugs. Seeding is not as effective for this species and would require the collection of mature seed and cold stratification of the seed over the winter and spring months. Fertilization may also be necessary, but the greater interval between tidal flushes allows the use of standard (as opposed to slow-release) fertilizers (Broome 1990). We recommend planting at 24-in. centers to quickly establish a dense cover of vegetation to reduce the opportunity for common reed to become established. Geese and brant may need to be discouraged from using the site until the vegetation becomes established.
- We recommend the following for the establishment of transition zones: Marsh elder and groundsel-tree are two species well adapted to transition zones between low marsh and adjacent uplands. These species are tolerant of saline conditions and infrequent tidal inundation. Peat pots or bareroot seedlings should be planted on 3-ft (90 cm) centers. To stabilize slopes, the Service recommends a conservation mix

containing annual rye (*Lolium* spp.) for quick cover and slope stabilization, and a native grass such as switchgrass that will increase habitat diversity and help prevent common reed colonization.

g) Borrow Area Dredging

- All offshore dredging activities should be coordinated with the NYSDEC – Region 2 in regard to the protection of resources under their jurisdiction.
- Exposing and impacting various sediment types during dredging should be avoided. Maintaining the same sediment type at the borrow area will increase the probability that the same pre-dredging benthic assemblage will re-establish after dredging.
- Producing deep, steep-sided pits with little to no water circulation that may lead to silt and organic matter accumulation and hypoxic or anoxic conditions, should be avoided. Broad, shallow pits with gently sloping sides are less likely to exhibit these effects.
- In recognition of the seabird monitoring activities being undertaken by BOEM (previously the MMS) on potential offshore sand reserves in other parts of the country, the Corps should adopt a similar sampling program for this federal trust resource. These surveys will be necessary to develop appropriate mitigation measures. Until these surveys are completed, the Service is unable to provide adequate mitigation measures to protect these species.
- The Service recommends that the Corps develop a pre- and post-monitoring program based on the guidance protocols developed by the MMS (see Minerals Management Service 2001) for finfish and benthic assemblages within the offshore dredging areas. The justification for their approach is the observation that while benthic species abundance has been shown to return to pre-dredging levels, in some cases from 1 to 2 years after dredging, species composition may be different and the ability of fishes to use such altered assemblages for prey is uncertain. Therefore, the purpose is centered more towards trophic transfer relationships under modified conditions, as opposed to changes in the resident fish community (Minerals Management Service 2001).
- The Corps should consult with the NYSDEC as to whether additional quantitative baseline surveys on the density and age distribution of surf clams should be collected to determine the surf clam resources within the offshore dredging area. This information can be used to determine areas, within the dredging zone, that should be excluded from dredging operations, and will also enable the Corps to better determine the value of surf clam resources that may be impacted by dredging.

2. Disturbance and Mortality

a) Shorebirds and Seabirds

- Activities associated with beach nourishment; berm, composite seawall, and dune construction; and groin rehabilitation should be accomplished outside of the

breeding season for federally- and state-listed species (April 1 through September 1).

- To avoid or minimize recreational impacts, the protection of these species should be demonstrated prior to project implementation. This should occur by developing and completing plans for educating residents, landowners, or beach managers of the management requirements discussed below, and, prior to project commencement, by obtaining a written agreement from residents, landowners, or beach managers for full cooperation with the Corps and the Service, or mutually agreed-upon designated representatives (*e.g.*, the NYSDEC).
- Access to the project beaches should be provided to the Service, the Corps, or their mutually agreed upon designated representatives, to survey and monitor waterbird and shorebird use areas. Access should be given during daylight hours on any day(s) of any given year at the required frequency to accomplish the purposes stated above.
- Protection measures should be provided for that include the placement of symbolic fencing around breeding areas to avoid or minimize the impacts associated with recreational users.
- Fireworks should be prohibited on beaches used by shorebirds or colonial waterbirds as breeding, foraging, loafing, or roosting areas.
- The Corps should work with the landowners to implement leash laws and develop laws and regulations to control cats during the migratory bird use periods.
- Feeding of raccoons, gulls, or other wildlife should be prohibited to minimize mortality of migratory birds.
- Public access on dunes should be limited to wooden walkways over the dune in order to maintain beach grass beneath the walkway, and on the dunes.

b) Saltmarsh Birds and Neotropical Songbirds

- To the greatest extent practicable, the Corps should avoid construction activities, particularly any vegetation removal, within saltmarsh, salt shrub, maritime dune, maritime grassland, and maritime shrubland habitats from March 15 to July 31.

c) Diamondback Terrapins

- We recommend that the Corps survey for diamondback terrapins in all suitable habitat that will be impacted by the Project.
- Should terrapins be located, the Corps should coordinate with the Service and other relevant agencies to develop a plan to avoid impacts to and/or enhance habitat for this species.

d) Fish and Aquatic Invertebrates

- The Service recommends that the Corps consult with the NOAA Fisheries and the NYSDEC to determine if time-of-year construction windows are warranted for any aspect of the proposed project, including in-water work, to protect migrating, overwintering, and/or spawning fish species.

- We recommend that the Corps survey for spawning horseshoe crabs in all suitable habitat that will be impacted by the Project.
- In-water construction activities should not occur between May 1 and July 1 in any location that spawning horseshoe crabs are identified.

3. Turbidity and Suspended Sediment

- To minimize short-term increases in turbidity, work should begin from the landward side before "breaking out" into open water areas.
- Silt fence should be properly installed between disturbed areas and adjacent wetlands. At least 6 in. (15 cm) of the toe of the silt fence should be buried parallel to the ground surface on the upslope side of the fence. The silt fence should be inspected following installation and after significant storm events to ensure that it is functioning properly. Silt fence is preferable to hay or straw bales as the bales represent a potential undesirable seed source in maritime shrubland or grassland habitats.
- The use of soil erosion control measures, as approved by the local Soil Erosion Control District, should be installed prior to the grading of any projects. The use of jute matting or other biodegradable natural material is recommended for stabilizing all project construction areas. The matting should be maintained until the site has recovered sufficiently to avoid any soil movement within or off the proposed project site(s). The matting will also aid in improved stabilization of any planted materials.
- The Service recommends that the temporary access routes and staging areas for all construction activities be restricted from sensitive habitat areas, including wetlands and riparian zones. The use of low ground pressure vehicles for all work proposed in marshes and open waters, when necessary, should be implemented.

4. Burial of Invertebrates

- Recognizing the impacts of nourishment on beach invertebrates and shorebird foraging, and that renourishment is scheduled to occur every four years for the life of the project, we recommended in the Draft FWCA report, that the Corps mitigate by creating potential shorebird foraging habitat elsewhere within the Study Area. In their response to this recommendation in the Draft FWCA report, the Corps provided the following comment:

  " *It is acknowledged that beach nourishment results in short-term declines in abundance, biomass, and taxa richness. However, studies within the NY/NJ Bight have shown recovery of intertidal assemblages are complete within 2- 6.5 months of the conclusion of filling. Differences in the rate of recovery were most likely due to differences in when nourishment was complete. Recovery was the quickest when filling was completed before the low point in the seasonal cycle of infaunal abundance. It is important that the grain size of the fill material matched that of the beaches to be nourished.*"

The Service recognizes that recovery times after nourishment are variable, and that recovery may occur within 2 to 6.5 months of placement under certain conditions. However, a recovery time that lasts 2 to 6.5 months is long enough to encompass one or more migratory periods for shorebirds and/or an entire nesting season, thereby impacting foraging quality during these critical life stages. These impacts would occur during initial placement, as well as every four years when the beach is renourished, potentially impacting multiple migratory and/or breeding seasons. As such, the Service continues to recommend that the Corps mitigate the impacts on foraging habitat through the creation of foraging habitat elsewhere within the Study Area.

D. ENHANCEMENT OPPORTUNITIES

- We recommend continued coordination with the Service and other relevant partners to develop plans prior to project construction to create habitat to benefit species, such as horseshoe crabs, saltmarsh birds, and/or diamondback terrapins where appropriate within the HFFRRF locations.
- The Corps may consider working with local partners to restore additional habitat at Dubos Point. Upon a site visit, the Service noted the presence of invasive species within the park (*e.g.*, common reed). The area would benefit from efforts to control invasive species.
- The Corps may also consider enhancing spawning habitat for horseshoe crabs at Dubos Point outside of the project footprint.
- To provide better habitat for beach-nesting birds, the Corps may consider working with local partners to eradicate Asiatic sand sedge from the beaches within the Study Area. This exotic plant can outcompete native plant species and form thick patches, which can be degrade habitat for beach-nesting birds.
- A number of areas of saltmarsh habitat along the north shore of the Rockaway Peninsula were identified as potential restoration areas in the Corps' *Jamaica Bay Navigational Channels and Shoreline Environmental Surveys Final Report* (U.S Army Corps of Engineers 1997). Some of these areas are within or adjacent to the proposed HFFRRFs. In the Draft FWCA report, we suggested that the Corps may consider restoring saltmarsh and other coastal communities in these areas in order to provide added habitat for fish and wildlife. In response to this recommendation in the Draft FWCA report (full response in Appendix G), the Corps stated the purpose of the current Study is to provide coastal storm risk management measures to the Study Area, and that the Hudson Raritan Estuary Ecosystem Restoration Study will be focusing and recommending restoration opportunities within the Jamaica Bay Planning Region. The Service notes the purpose and limitations of the current Study, but maintains this as a recommendation.

E. THREATENED AND ENDANGERED SPECIES RECOMMENDATIONS

Section 7(a)(2) of the ESA, requires all federal agencies, in consultation with the Secretary of the Interior, to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any listed species. In consultation with the Service, the

Corps shall utilize its authority to further the purposes of the ESA in the conservation and recovery of listed species and the ecosystems on which they depend. Further, 50 CFR 402.02 states that the "effects of an action" to be considered during consultation include "direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action...."

The Service will continue to coordinate with the Corps in their section 7(a)(2) ESA consultation process for this project, and recommendations for endangered and threatened species under the jurisdiction of the Service will be described in the Biological Opinion.

XIII. SERVICE CONCLUSIONS

Section 2(b) of the FWCA requires that the final report of the Secretary of the Interior: 1) determine the magnitude of the impacts of the proposed projects on fish and wildlife resources; and 2) make specific recommendations as to measures that should be taken to conserve those resources. The Service has reviewed the current literature on the biological and physical processes influencing the marine, estuarine, and terrestrial communities of the Study Area. When the project is considered within the context of the existing and foreseeable coastal projects, this project has the potential to have significant adverse ecological impacts to fish and wildlife resources of national significance. However, the implementation of the conservation/mitigation measures proposed by the Corps and the Service, as described in this report, will assist the Corps in offsetting many of the potential adverse impacts presented in this report. As the Corps moves from feasibility level designs to final designs, they should continue to the coordinate with the Service as project designs are further developed so that the Service can provide revisions or supplements to this 2(b) report, as necessary.

XIV. REFERENCES

Amat, J.A., and J.A. Masero. 2004. Predation Risk on Incubating Adults Constrains the Choice of Thermally Favourable Nest Sites in a Plover. *Animal Behaviour*, 67(2): 293-300.

Askins, R.A., J.F. Lynch, and R. Greenberg. 1990. Population Declines in Migratory Birds in Eastern North America. *Current Ornithology*, 7: 1-57.

Atlantic Coast Joint Venture. 2005. *North American Waterfowl Management Plan: Atlantic Coast Joint Venture Waterfowl Implementation Plan*. Available online at: http://acjv.org/planning/waterfowl-implementation-plan/.

Auld, A.H., J.R. Schubel. 1978. Effects of Suspended Sediment on Fish Eggs and Larvae: A Laboratory Assessment. *Estuarine and Coastal Marine Science*, 6(2): 153-164. February

Balouskus, R.G., and T.E. Targett. 2016. Fish and Blue Crab Density Along a Riprap-Sill-Hardened Shoreline: Comparisons with Spartina Marsh and Riprap. *Transactions of the American Fisheries Society*, 145: 766-73

Bayard, T.S., and C.S. Elphick. 2011. Planning for Sea-Level Rise: Quantifying Patterns of Saltmarsh Sparrow (*Ammodramus caudacutus*) Nest Flooding Under Current Sea-Level Conditions. *The Auk*, 128(2): 393-403.

Beck, M.W., K.L. Heck, K.W. Able, D.L. Childers, D.B. Eggleston, B.M. Gillanders, B. Halpern, C.G. Hays, K. Hoshino, T.J. Minello, R.J. Orth, P.F. Sheridan, M.P. Weinstein. 2001. The Identification, Conservation, and Management of Estuarine and Marine Nurseries for Fish and Invertebrates. *BioScience*, 51(8): 633-641.

Benfield, M.C., and T.J. Miniello. 1996. Relative Effects of Turbidity and Light Intensity on Reactive Distance and Feeding of an Estuarine Fish. *Environmental Biology of Fishes*, 46(2): 211-216. June 1996.

Benotti, M.J., and B.J. Brownawell. 2007. Distributions of Pharmaceuticals in an Urban Estuary During Both Dry- and Wet- Weather Conditions. *Environmental Science Technology*, 41: 5795-5802.

Benoit, L.K., and R.A. Askins. 1999. Impact of the Spread of *Phragmites* on the Distribution of Birds in Connecticut Tidal Marshes. *Wetlands*, 19: 194-208.

Berry, W.J., N.I. Rubinstein, E.K. Hinchey, G. Klein-MacPhee, and D.G. Clarke. 2011. *In*: Western Dredging Association (WEDA) 31st Annual Western Hemisphere Dredging Technical Conference and Texas A&M (TAMU) 42nd Annual Dredging Seminar, Nashville, TN. June 5-8, 2011. Texas A&M University, College Station, TX. pp 47-57.

Bilkovic, D.M., and M.M. Mitchell. 2013. Ecological Tradeoffs of Stabilized Salt Marshes as a Shoreline Protection Strategy: Effects of Artificial Structures on Macrobenthic Assemblages. *Ecological Engineering*, 61: 469-481.

Bilkovic, D.M., M. Mitchell, P.M. Mason, and K. Duhring. 2016. The Role of Living Shorelines as Estuarine Habitat Conservation Strategies. *Coastal Management*, 44: 3.

Bilkovic, D.M., and M.M. Roggero. 2008. Effects of Coastal Development on Nearshore Estuarine Nekton Communities. *Marine Ecology Progress Series*, 358: 27-39.

Birds of North America Online. 2018. Birds of North America Online: Common Tern. The Cornell Lab of Ornithology. Available online at: http://birdsna.org/ . Accessed on: August 28, 2018.

Bosch, J., C. Foley, L. Lipinski, C. McCarthy, J. McNamara, A. Naimaster, A. Raphael, A. Yang, and A. Baldwin. 2006. Shore Erosion Control Guidelines Marsh Creation. Maryland Department of the Environment, Wetland and Waterways Program. Funded by U.S. Protection Agency State Wetland Program Development Grant CD 982279-01-0.

Botton, M.I., R.E. Loveland, J.T. Tanacredi, and T. Itow. 2006. Horseshoe Crabs (*Limulus polyphemus*) in an Urban Estuary (Jamaica Bay, New York) and the Potential for Ecological Restoration. *Estuaries and Coasts*, 29(5): 820-830. October 2006.

Breitburg, D.L. 1988. Effects of Turbidity on Prey Consumption by Striped Bass Larvae. *Transactions of the American Fisheries Society*, 117: 72-77.

Broome, S.W. 1990. Creation and Restoration of Tidal Wetlands of the Southeastern United States. *In* J.A. Kusler and M.E. Kentula (*Eds.*), *Wetland Creation and Restoration: The Status of the Science*, pp. 37-72. Island Press, Washington, D.C.

Brower, L.P. 2004. Understanding and Misunderstanding the Migration of the Monarch Butterfly (*Nymphalidae*) in North America: 1857-1995. *Journal of the Lepidopterists Society*, 49: 304- 385.

Bruun, P. 1995. The Development of Downdrift Erosion. *Journal of Coastal Research*, 11(4): 1242-1257.

Bureau of Land Management. 2015. *National Seed Strategy for Rehabilitation and Restoration 2015 - 2020*. Bureau of Land Management. U.S. Department of the Interior. Technical Bulletin BLM/WO/GI-15/012+7400. 51 pp. Available online at: www.blm.gov/seedstrategy.

Burke, R. 2018. Email to the Service dated July 17, 2018, transmitting requested information regarding the presence of nesting diamondback terrapins on the Rockaway Peninsula.

Burger, J. 1987. Physical and Social Determinants of Nest-Site Selection in Piping Plover in New Jersey. *The Condor*, 89: 811-818.

Burger, J., and M. Gochfeld. 1990a. The Black Skimmer: Social Dynamics of a Colonial Species. Columbia University Press, New York, NY.

Burger, J., and M. Gochfeld. 1990b. Nest-Site Selection in Least Terns (*Sterna antillarum*) in New Jersey and New York. *Colonial Waterbirds*, 13(1): 31-40. January 1990.

Burger, J., and M. Gochfeld. 1991. Human Activity Influence and Diurnal and Nocturnal Foraging of Sanderlings (*Calidris alba*). *The Condor* 93: 259-265.

Burger, M.F., and J.M. Liner. 2005. *Important Bird Areas of New York: Habitats Worth Protecting*. Audubon New York, Second Edition. 352 pp.

Burghardt, K.T., D.W. Tallamy, and W.G. Shriver. 2009. Impact of Native Plants on Bird and Butterfly Biodiversity in Suburban Landscapes. *Conservation Biology*, 23(1): 219-224.

Burlas, M. G.L. Ray, and D. Clarke. 2001. The New York Districts Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury Park to Manasquan Section Beach

Erosion Control Project. Final Report. U.S. Army Engineer District, New York and U.S. Army Engineer Research and Development Center, Waterways Experiment Station.

Byrnes, M.R., R.M. Hammer, S.W. Kelley, J.L. Baker, D.B. Snyder, T.D. Thybaut, S.A. Zichichi, L.M. Lagera, S.T. Viada, B.A. Vittor, J.S. Ramsey, and J.D. Germano. 2004. Environmental Surveys of Potential Borrow Areas Offshore Northern New Jersey and Southern New York and the Environmental Implications of Sand Removal for Coastal and Beach Restoration. U.S. Department of the Interior, Minerals Management Service, Leasing Division, Marine Minerals Branch. Herndon, VA. OCS Report MMS 2004-044, Volume 1 (Main Text, 264 pp.) + Volume II (Appendices, 194 pp.).

Cahoon, L., Carey, E.S., and I.E. Blum. 2012. Benthic Microalgal Biomass on Ocean Beaches: Effects of Sediment Grain Size and Beach Renourishment. *Journal of Coastal Research*, 28(4): 853-859.

Charles, H., and J.S. Dukes. 2007. Impacts of Invasive Species on Ecosystem Services. *In* Dr. Wolfgang Nentwig (*Ed.*), *Biological Invasions* (pp. 217-237). Berlin Heidelberg: Springer.

Cohen, J.B., E.H. Wunker, and J.D. Fraser. 2008. Substrate and Vegetation Selection by Nesting Piping Plovers. *The Wilson Journal of Ornithology*, 120(2): 404-407. [GTW1]

Colden, A., and R.N. Lipcius. 2015. Lethal and Sublethal Effects of Sediment Burial on the Eastern Oyster, *Crassostrea virginica*. *Marine Ecology Progress Series*, 527: 105-117.

Corcoran, J., M.J. Winter, and C.R. Tyler. 2010. *Pharmaceuticals in the Aquatic Environment: A Critical Review of the Evidence for Health Effects in Fish*. *Critical Reviews in Toxicology*, 40(4): 287-304.

Currin, C.A., P.C. Delano, L.M. Valdes-Weaver. 2007. Utilization of a Citizen Monitoring Protocol to Assess the Structure and Function of Natural and Stabilized Fringing Salt Marshes in North Carolina. *Wetlands Ecology and Management*, 16: 97-118.

Davenport, T.M., R.D. Seitz, K.E. Knick, and N. Jackson. 2017. Living Shorelines Support Near-Shore Benthic Communities in Upper and Lower Chesapeake Bay. Coastal and Estuarine Research Federation. December 2017. Available online at: https://doi.org/10.1007/s12237-017-0361-8.

Defeo, O., A. McLachlan, D.S. Schoeman, T. Schlacher, J.E. Dugan, A. Jones, M. Lastra, and F. Scapini. 2009. Threats to Sandy Beach Ecosystems: A Review. *Estuarine, Coasta,l and Shelf Science*, 81(1): 1-12.

Dugan, J.E., L. Airoldi, M.G. Chapman, S.J. Walker, and T. Schlacher. 2011. Estuarine and Coastal Structures: Environmental Effects, a Focus on Shore and Nearshore Structures. *Treatise on Estuarine and Coastal Science*, 8: 17–41.

Dugan, J.E., D.M. Hubbard, I.F. Rodil, D.L. Revell, and S. Schroeter. 2008. Ecological Effects of Coastal Armoring on Sandy Beaches. *Marine Ecology*, 29(Suppl. 1): 160-170.

Duhring, K.A. 2008. A Comparison of Structural and Nonstructural Methods for Erosion Control and Providing Habitat in Virginia Salt Marshes. pp 41-47. *In*: Erdle, S.Y., J.L.D. Davis, and K.G. Sellner (*Eds*.). Management, Policy, Science, and Engineering of Nonstructural Erosion Control in the Chesapeake Bay: Proceedings of the 2006 Living Shoreline Summit. CRC Publ. No. 08-164, Gloucester Point, VA. 136 pp.

Dunne, P. (*Ed*.). 1989. *New Jersey at the Crossroads of Migration*. New Jersey Audubon Society, Franklin Lakes, NJ. 74 pp.

eBird. 2018. eBird: An Online Database of Bird Distribution and Abundance [web application]. eBird, Ithaca, NY. Available online at: http://www.ebird.org.

Edinger, G.J., D.J. Evans, S. Gebauer, T.G. Howard, D.M. Hunt, and A.M. Olivero (*Eds*.). 2014. *Ecological Communities of New York State.* Second Edition. A revised and expanded edition of Carol Reschke's Ecological Communities of New York State. New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY.

Eggleton, J., and K.V. Thomas. 2004. A Review of Factors Affecting the Release and Bioavailability of Contaminants During Sediment Disturbance Events. *Environment International*, 30: 973-980.

Elliott-Smith, E., and S. M. Haig. 2004. Piping Plover (*Charadrius melodus*), *In* The Birds of North America Online (A. Poole, *Ed*.). Ithaca: Cornell Lab of Ornithology. Available online at: http://bna.birds.cornell.edu/bna/species/002/articles/introduction. Accessed: August 2011.

Elliott-Smith, E., S.M. Haig, and B.M. Powers. 2009. Data from the 2006 International Piping Plover Census: U.S. Geological Survey Data Series 426. 332 pp.

Espie, R.H.M., R.M. Brigham, and P.C. James. 1996. Habitat Selection and Clutch Fate of Piping Plovers (Charadrius melodus) breeding at Lake Diefenbaker, Saskatchewan. *Canadian Journal of Zoology*, 74: 1069-1075.

Fabbri, E., and S. Franzellitti. 2016. *Human Pharmaceuticals in the Marine Environment: Focus on Exposure and Biological Effects in Animal Species*. *Environmental Toxicology and Chemistry*, 35(4): 799-812.

Feinberg, J.A., and R.L. Burke. 2003. Nesting Ecology and Predation of Diamondback Terrapins, *Malaclemys terrapin*, at Gateway National Recreation Area, New York. *Journal of Herpetology*, 37(3): 517-526.

Feinberg, J., and R. Burke. 2004. *The Diamondback Terrapin: Gateway's Salt Marsh Turtle*. Available online at: http://www.dtwg.org/Bibliography/Brochures/Gateway's%20salt%20marsh%20turtle.pdf Accessed on: February 14, 2017.

Franz, D.R. 1982. An Historical Perspective on Mollusks in Lower New York Harbor, with Emphasis on Oysters. *In* G.F. Meyer (Ed.), Ecological Stress and the New York Bight: Science and Management. Columbia, SC: Estuarine Research Federation. pp. 181-197.

Gaw, S., K.V. Thomas, and T.H. Hutchison. 2014. *Sources, Impacts and Trends of Pharmaceuticals in the Marine and Coastal Environment*. *Philosophical Transactions of the Royal Society*, B 369: 20130572. Available online at: http://dx.doi.org/10.1098/rstb.2013.0572.

Gittman, R.K., C.H. Peterson, C.A. Currin, F.J. Fodrie, M.F. Piehler, and J.F. Bruno. 2016. Living Shorelines Can Enhance the Nursery Role of Threatened Estuarine Habitats. *Ecological Applications*, 26(1): 249-263.

Gjerdrum, C., K. Sullivan-Wiley, E. King, M.A. Rubega, and C.S. Elphick. 2008. Egg and Chick Fates During Tidal Flooding of Saltmarsh Sharp-Tailed Sparrow Nests. *The Condor*, 110(3): 579-584.

Gochfield, M. 1983. Colony Site Selection by Least Terns: Physical Attributes of Sites. *Colonial Waterbirds*, 6: 205-213.

Gorzelany, I.F., and W. Nelson. 1987. The Effects of Beach Replenishment on the Benthos of a Sub-Tropical Florida Beach. Department of Oceanography and Ocean Engineering, Florida Institute of Technology, Melbourne, FL.

Grambo, G., and C. Vega. 1984. Jamaica Bay: A Site Study. U.S. Geological Survey, Long Island Division, Coram, NY.

Greene, K. 2002. Beach Nourishment: A Review of the Biological and Physical Impacts. ASMFC Habitat Management Series No. 7. Atlantic States Marine Fisheries Commission, Washington, D.C.

Hall, M.J., and O.H. Pilkey. 1991. Effects of Hard Stabilization on Dry Beach Width for New Jersey. *Journal of Coastal Research*, 7(3): 771-785.

Hardaway, C.S., J. Shen, D.A. Milligan, C.A. Wilcox, K.P. O'Brien, W.G. Reay, and S. Lerberg. 2007. Performance of Sills: St. Mary's City, St. Mary's River, Maryland. Virginia Institute of Marine Science, College of William and Mary. Funded in part by the Department of Environmental Quality's Coastal Resources Management Program through grant No. NA06NOS4190241.

Haro, A., W. Richkus, K. Whalen, A. Hoar, W.D. Busch, S. Lary, T. Brush, and D. Dixon. 2000. Population Decline of the American Eel: Implications for Research and Management. *Fisheries*, 25(9):7-16.

Hartig, E.K., V. Gornitz, A. Kolker, F. Mushacke, and D. Fallon. 2002. Anthropogenic and Climate-change Impacts on Salt Marshes of Jamaica Bay, New York City. *Wetlands*, 22: 77-89.

Hejda, M., P. Pyšek and V. Jarošík. 2009. Impact of Invasive Plants on the Species Richness, Diversity, and Composition of Invaded Communities. *Journal of Ecology*, 97: 393-403.

Herrera, A.M., and T.L. Dudley. 2003. Reduction of Riparian Arthropod Abundance and Diversity as a Consequence of Giant Reed (*Arundo donax*) Invasion. *Biological Invasions*, 5: 167-177.

Holmes, R.T. 2007. Understanding Population Change in Migratory Songbirds: Long-Term and Experimental Studies of Neotropical Migrants in Breeding and Wintering Areas. *Ibis*, 149(Suppl. 2): 2-13.

Hufford, K.M., and S.J. Mazer. 2003. Plant Ecotypes: Genetic Differentiation in the Age of Ecological Restoration. *Trends in Ecology and Evolution*, 18: 147-155.

Hurme, A.K., and E.J. Pullen. 1988. Biological Effects of Marine Sand Mining and Fill Placement for Beach Replenishment. *Marine Mining*, 7: 123-136.

Intergovernmental Panel on Climate Change. 2013. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the IPCC*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 1535 pp.

_____. 2007. *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II, and III to the Fourth Assessment*. IPCC, Geneva, Switzerland.

International Union for Conservation of Nature. 2016. *The IUCN Red List of Threatened Species. Version 2016-3*. Available online at: www.iucnredlist.org. Accessed on: January 12, 2017.

Keller, G.S., and R.H. Yahner, R. 2006. Declines of Migratory Songbirds: Evidence for Wintering-Ground Causes. *Northeastern Naturalist*, 13(1): 83-92.

Knott N.A., J.P Aulbury, T.H. Brown, and E.L. Johnston. 2009. Contemporary Ecological Threats from Historical Pollution Sources: Impacts of Large-Scale Resuspension of Contaminated Sediments on Sessile Invertebrate Recruitment. *Journal of Applied Ecology*, 46: 770–781.

Kocek, A. 2014. Secretive Marshbird Occurrence and Abundance in Urban Salt Marshes of New York City, NY. Final Report to the Edna Bailey Sussman Foundation.

Kornis, M.S., D.M. Bilkovic, L.A. Davias, and S. Giordano. 2017. Shoreline Hardening Affects Nekton Biomass, Size Structure, and Taxonomic Diversity in Nearshore Waters, with Responses Mediated by Functional Species Groups. *Estuaries and Coasts*, 41(Suppl. 1): S159-S179.

Kotliar, N.B., and J. Burger. 1986. Colony Site Selection and Abandonment by Least Terns *Sterna antillarum* in New Jersey, USA. *Biological Conservation*, 37(1): 1-21.

Kubiak, T., C. Stern, and M. Foster. 2007. *Development of a Preliminary Remediation Goal (PRG) for Dioxin in Sediment for the Passaic River / Newark Bay and Raritan Bay Complex, New Jersey, Using a Reproductive End-Point in the Eastern Oyster*. Presented at the 28th Annual Meeting of the Society for Environmental Toxicology and Chemistry, Milwaukee. U.S. Fish and Wildlife Service, New Jersey Field Office.

Land Use Ecological Services, Inc. 2005. Western Fire Island and Fire Island Pines Beach Nourishment Report – 2005 Environmental Monitoring Report. 14 pp. + Appendices.

Latimer, J.S., W.R. Davis, and D.J. Keith. 1999. Mobilization of PAHs and PCBs from In-Place Contaminated Marine Sediments During Simulated Resuspension Events. *Estuarine Coastal and Shelf Science*, 49: 577- 595.

Lindquist, N., and L. Manning. 2001. Impacts of Beach Nourishment and Beach Scraping on Critical Habitat and Productivity of Surf Fishes. Final Report to the North Carolina Fisheries Resource Grant Program. 41 pp. + Appendices.

Long, E.R., D.D. Mac Donald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects of Chemical Concentrations in Marine and Estuarine Sediments. *Environmental Management*, 19(1): 81-97.

Luoma, S.N. 1983. Bioavailability of Trace Metals to Aquatic Organisms - A Review. *Science of the Total Environment*, 28: 1-22.

Maslo, B., S.N. Handel, and T. Pover. 2011. Restoring Beaches for Atlantic Coast Piping Plovers (*Charadrius melodus*): A Classification and Regression Tree Analysis of Nest-Site Selection. *Restoration Ecology*, 19(201): 194-203.

Mazey, D. 2018. Email to the Service dated August 22, 2018, transmitting requested information regarding project designs for the *Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study.*

Michel, J., A.C. Bejarano, C.H. Peterson, and C. Voss. 2013. Review of Biological and Biophysical Impacts from Dredging and Handling of Offshore Sand. U.S. Department of the Interior. Bureau of Ocean Energy Management. Herndon, VA.

Minerals Management Service. 2001. Final Report Development and Design if Biological and Physical Monitoring Protocols to Evaluate the Long-Term Impacts of Offshore Dredging Operations on the Marine Environment. Prepared for the U.S. Department of the Interior, Minerals Management Service, International Activities and Marine Minerals Division Under Contract No. 14-35-0001-31051. 166 pp. + Appendix.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery Plan for U.S. Population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C.

National Marine Fisheries Service, U.S. Fish and Wildlife Service, and SEMARNAT. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland. 156 pp. + Appendices.

National Oceanic and Atmospheric Administration. 2017. NOAA Fisheries. Greater Atlantic Region. Sea Turtle Program. Managing, Conserving, and Rebuilding Populations of Sea Turtles in the Greater Atlantic Waters. Available online at: https://www.greateratlantic.fisheries.noaa.gov/Protected/seaturtles/. Accessed: August 2, 2017.

National Park Service. 2007. *Data from the 2007 Jamaica Bay Bioblitz*. Available online at: http://www.ciesin.org/jamaicabay/stakeholder/fed_nps.jsp.

_____. 2014. *Birds of Jamaica Bay*. U.S. Department of Interior. Gateway National Recreation Area. Jamaica Bay Wildlife Refuge. 4 pp.

Naqvi, S.M., and E.J. Pullen. 1982. Effects of Beach Nourishment and Borrowing on Marine Organisms. Fort Belvior: U.S. Army Corps of Engineers, Coastal Engineering Research Center. MR 82-14.

Nayer, S., B.P. Goh, and L.M. Chou. 2004. Environmental Impact of Heavy Metals from Dredged and Resuspended Sediments on Phytoplankton and Bacteria Assessed in *in situ* Mesocosms. *Ecotoxicology and Environmental Safety*, 59(3): 349-369.

Nelson, D.A., and J.L. Wheeler. 1997. The Influence of Dredging-Induced Turbidity and Associated Contaminants Upon Hatching Success and Larval Survival of Winter Flounder, *Pleuronectes americanus*, a Laboratory Study. Final Report, Grant CWF No. 321-R, to Connecticut Department of Environmental Protection, by National Marine Fisheries Service, Milford, CT.

Newcombe, C.P., and D.D. Macdonald. 1991. Effects of Suspended Sediments on Aquatic Ecosystems. *North American Journal of Fisheries Management*, 11(1): 72-82.

New York City. 2009. *New York City Wetlands Policy Paper*. Mayor's Office of Long-Term Planning and Sustainability. New York City Hall, New York, NY. 44 pp. Available online at: http://www.nyc.gov/html/om/pdf/2009/pr050-09.pdf.

New York City Department of Environmental Protection. 2007. Jamaica Bay Watershed Protection Plan. Available online at: <http://www.nyc.gov/html/dep/html/dep_projects/jamaica_bay.shtml#plan>

New York City Department of Environmental Protection. 2016. Jamaica Bay Watershed Protection Plan 2016 Update. Prepared by the Bureau of Environmental Planning and Analysis, New York City Department of Environmental Protection.

New York State Department of Environmental Conservation. 2018. Draft 2018 New York State Section 303(d) List. Available online at: https://www.dec.ny.gov/docs/water_pdf/303dlistdraft18.pdf.

_____. 2017. Tidal Wetlands Guidance Document: Living Shoreline Techniques in the Marine District of New York State. Bureau of Marine Resources. Available online at: http://www.dec.ny.gov/docs/fish_marine_pdf/dmrlivingshoreguide.pdf.

_____. 2016. Proposed Final 2016 New York State Section 303(d) List. Available online at: http://www.dec.ny.gov/docs/water_pdf/303dproplist2016.pdf.

_____. 2015. *New York State Species of Greatest Conservation Need*. Available online at: http://www.dec.ny.gov/animals/9406.html.

_____. 2014a. *Screening and Assessment of Contaminated Sediment.* New York State Department of Environmental Conservation, Division of Fish, Wildlife, and Marine Resources, Bureau of Habitat, June 24, 2014. 99pp.

_____. 2014b. *Nitrogen Pollution and Adverse Impacts on Resilient Tidal Marshlands*. NYSDEC Technical Briefing Summary. Available online at: http://www.dec.ny.gov/docs/water_pdf/impairmarshland.pdf.

_____. 2005. The Second Atlas of Breeding Birds in New York State. New York State Department of Environmental Conservation, Fish, Wildlife and Marine Resources, Albany, NY. Available online at: http://www.dec.ny.gov/animals/7312.html.

_____. 2002 Atlantic Ocean Surf clam Population Assessment. Prepared by Bureau of Marine Fisheries – Division of Fish, Wildlife, and Marine Resources, East Setauket, NY. 29 pp.

_____. 1994. Concerns Regarding the Long Beach Storm Damage Project. Stony Brook: New York State Department of Environmental Conservation letter to U.S. Fish and Wildlife Service.

New York State Department of State. 1992. *Jamaica Bay Significant Coastal Fish and Wildlife Habitats*. NYS Department State Office of Planning and Development. Available online at: https://www.dos.ny.gov/opd/programs/consistency/Habitats/nyc/Jamaica_Bay.pdf.

O'Connor, J.M., Neumann, and J.A. Sherk, Jr. 1976. *Lethal Effects of Suspended Sediments on Estuarine Fish*. TP 76-20. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, VA.

O'Donnell, J.E.D. 2017. Living Shorelines: A Review of Literature Relevant to New England Coasts. *Journal of Coastal Research*, 33(2): 435-451.

O'Neil, J.M., D. Taillie, B. Walsh, W.C. Dennison, E.K. Bone, D.J. Reid, R. Newton, D.L. Strayer, K. Boicourt, L.B. Birney, S. Janis, P. Malinowski, and M. Fisher. 2016. New York Harbor: Resilience in the Face of Four Centuries of Development. *Regional Studies in Marine Science*, 8(2): 274-286.

Overturf, M.D., J.C. Anderson, Z. Pandelides, L. Beyger, and D.A. Holdway. 2015. *Pharmaceuticals and Personal Care Products: A Critical Review of the Impacts on Fish Reproduction*. *Critical Reviews in Toxicology*, 45(6): 469-491

Parr, T., E. Diener, and S. Lacy. 1978. Effects of Beach Replenishment on Nearshore Sand Fauna at Imperial Beach, California. Fort Belvior: U.S. Army Corps of Engineers, Coastal Engineering Research Center. MR-74.

Pehek, E., K. McCarthy, B. Simmons, C. Garcia, P. Bartoszewski, G. Cullman, and N. Auyeung. 2018. Diamondback Terrapin Pilot Study, Idlewild Park, Queen, NY. Monitoring and Assessment Report. Natural Resources Group, City of New York Parks and Recreation.

Peterson, C.H., D.H.M. Hickerson, and G.G. Johnson. 2000. Short-term Consequences of Nourishment and Bulldozing on the Dominant Large Invertebrates of a Sandy Beach. *Journal of Coastal Research*, 16(2): 368-378.

Peterson, C.H., and L. Manning. 2001. How Beach Nourishment Affects the Habitat Value of Intertidal Beach Prey for Surf Fish and Shorebirds and Why Uncertainty Still Exists. *Proceedings of the Coastal Ecosystems and Federal Activities Technical Training Symposium*, August 20-22, 2001. 2 pp.

Peterson, C.H., M.J. Bishop, G.A. Johnson, L.M. D'Anna, and L.M. Manning. 2006. Exploiting beach filling as an unaffordable experiment: Benthic intertidal impacts propagating upwards to shorebirds. *Journal of Experimental Marine Biology and Ecology*, 338(2): 205-221.

Pfister, C., B.A. Harrington, and M. Lavine. 1992. The Impact of Human Disturbance on Shorebirds at a Migration Staging Area. *Biological Conservation*, 60: 115-126.

Prindiville-Gaines, E., and M.R. Ryan. 1988. Piping Plover Habitat Use and Reproductive Success in North Dakota. *Journal of Wildlife Management*, 52(2): 266-273.

Profiles and Research Consulting Groups, Inc. 1980. Seasonal Restrictions on Dredging Projects by NMFS in the Northeast. Volume 1. Prepared for the National Marine Fisheries Service under Contract SB 1408(a) -79-C-169.

Prosser, D.J., T.E. Jordan, J.L. Nagel, R.D. Seitz, D.E. Weiler, and D.F. Whigham. 2017. Impacts of Coastal Land Use and Shoreline Armoring on Estuarine Ecosystems: An Introduction to a Special Issue. *Estuaries and Coasts*, 41(Suppl. 1): 2-18. September 2017.

Reilly, F., and V.J. Bellis. 1978. A Study of the Ecological Impact of Beach Nourishment with Dredged Materials on the Intertidal Zone. Inst. For Coastal and Marine Resources, East Carolina University Technical Report No. 4. East Carolina University, Greenville, NC.

Robbins, C.S., J.R. Sauer, R.S. Greenberg and S. Droege. 1989. Population Declines in North American Birds that Migrate to the Neotropics. *Proceedings of the National Academy of Sciences*, 86: 7658-7662.

Ruhlen, T.D., S. Abbott, L.E. Stenzel, and G.W. Page. 2002. Evidence that Human Disturbance Reduces Snowy Plover Chick Survival. *Journal of Field Ornithology*, 74(3): 300-304.

Ruiz, G.M., A.H. Anson, and M.H. Posey. 1993. Shallow Water as a Refuge Habitat for Fish and Crustaceans in Non-Vegetated Estuaries: An Example from Chesapeake Bay. *Marine Ecology Progress Series*, 99: 1-99.

Sacco, J.N., E.D. Seneca, and T.R. Wentworth. 1994. Infaunal Community Development of Artificially Established Salt Marshes in North Carolina. *Estuaries*, 17(2): 489-500.

Sallenger A.H., K.S. Doran, and P.A. Howd. 2012. Hotspot of Accelerated Sea-Level Rise on the Atlantic Coast of North America. Nature Climate Change, Volume 2. December 2012. 5 pp. Available online at: http://www.nature.com/nclimate/journal/v2/n12/full/nclimate1597.html. Accessed on: February 1, 2017.

Sauer, J.R., J.E. Hines, J.E. Fallon, K.L. Pardieck, D.J. Ziolkowski, Jr., and W.A. Link. 2014. *The North American Breeding Bird Survey, Results and Analysis 1966 – 2013, Version 01.30*. 2015 USGS Patuxent Wildlife Research Center, Laurel, MD. Most Recent Update: January 30, 2015.

Scavia, D., J.C. Field, D.F. Boesch, R.W. Buddemeier, V. Burkett, D.R. Cayan, M. Fogarty, M.A. Harwell, R.W. Howarth, C. Mason, D.J. Reed, T.C. Royer, A.H. Sallenger, and J.G. Titus. 2002. Climate Change Impacts on U.S. Coastal and Marine Ecosystems. *Estuaries*, 25(2): 149-164.

Schubel, J.R., and D.P. Wang. 1973. The Effects of Suspended Sediment in Northern Chesapeake Bay. *Powder Technology*, 6: 9-16.

Sclafani, M., L. Brousseau, K. McKown, C. Sukowski, M. Sautkulis, R. Sysak, and C. Humphrey. 2014. Migratory Shorebird Foraging and Horseshoe Crab Spawning Surveys for the New York State Marine District: A Look at Species Interactions. Cornell Cooperative Extension of Suffolk County, Marine Program and New York State Department of Environmental Conservation.

Sea Duck Joint Venture Management Board. 2014. *Sea Duck Joint Venture Strategic Plan 2014- 2018*. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA; Canadian Wildlife Service, Sackville, New Brunswick, Canada. 16 pp.

Seitz, R.D., R.N. Lipcius, N.H. Olmstead, M.S. Seebo, and D.M. Lambert. 2006. Influence of Shallow-Water Habitats and Shoreline Development on Abundance, Biomass, and Diversity of Benthic Prey and Predators in Chesapeake Bay. *Marine Ecology Progress Series*, 326: 11-27.

Sherk, J.A., J.M. O'Conner, and D.A. Neumann. 1974. *Effects of Suspended and Deposited Sediments on Estuarine Organisms, Phase II*. Reference No. 74-02, National Research Institute, Solomons, MD.

Shriver, G.W., P.D. Vickery, T.P. Hodgman, and J.P. Gibbs. 2007. Flood Tides Affect Breeding Ecology of Two Sympatric Sharp-Tailed Sparrows. *The Auk*, 124(2): 552-560.

Silverman, E.D., D.T. Saalfeld, J.B. Leirness, and M.D. Koneff. 2013. Wintering Sea Duck Distribution Along the Atlantic Coast of the Unites States. *Journal of Wildlife Management*, 4(1): 178-198. June 2013.

Speybroeck, J., D. Bonte, W. Courtens, T. Gheskiere, P. Grootaert, J.P. Maelfait, M. Mathys, S. Provoost, K. Sabbe, E.W.M. Stienen, V. Van Lancker, M. Vincx, and S. Degraer. 2006. Beach Nourishment: An Ecologically Sound Coastal Defense Alternative? A Review. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 16: 419-435.

Stalter, R., D. Kincaid, and M. Byer. 2009. Control of Nonnative Invasive Woody Plant Species at Jamaica Bay Wildlife Refuge, New York City. *Arboriculture and Urban Forestry*, 35(3): 152-156.

Steimle, F., and R. Stone. 1973. Abundance and Distribution of Inshore Benthic Fauna of Southwestern Long Island. NOAA Technical Report, NMFS SSRF-673.

Steinberg, N., D.J. Suszkowski, L. Clark and J. Way. 2004. *Health of the Harbor: The First Comprehensive Look at the State of the NY/NJ Harbor Estuary*. A Report to the NY/NH Harbor Estuary Program. Hudson River Foundation, New York, NY. 82 pp.

Stern. E.M., and W.B. Stickle. 1978. Effects of Turbidity and Suspended Material in Aquatic Environments. Vicksburg: U.S. Army Corps of Engineers, Waterways Experiment Station. Technical Report D-78-21.

Subramanian, B., G. Slear, K.M. Smith, and K. A. Duhring. 2008. Current Understanding of the Effectiveness of Nonstructural and Marsh Sill Approaches. *In*: Erdle, S.Y., J.L.D. Davis, and K.G. Sellner (*Eds*.). 2008. Management, Policy, Science, and Engineering of Nonstructural Erosion Control in the Chesapeake Bay: Proceedings of the 2006 Living Shoreline Summit. CRC Publ. No. 08-164, Gloucester Point, VA. 136 pp.

Taedoki B.V. and The Rockefeller Foundation. 2016. *Challenges in Supplying Native Plants for Resilience Projects*. Amsterdam, Netherlands. 32 pp.

Tait, J.F., and G.B. Griggs. 1990. Beach Response to the Presence of a Seawall: A Comparison of Field Observations. *Shore and Beach*, 58: 11-28.

Terwilliger Consulting, Inc. 2009. Best Management Practices for Shoreline Stabilization to Avoid and Minimize Adverse Environmental Impacts.

Tetra Tech and Smultea Sciences. 2018. Year 1 Annual Survey Report for New York Bight Whale Monitoring Aerial Surveys March 2017-February 2018. New York State Department of Environmental Conservation. East Setauket, NY. Tetra Tech Contract C009926. 115 pp. + Appendices.

Thompson, B.C., and R.D. Slack. 1982. Physical Aspects of Colony Selection by Least Terns on the Texas Coast. *Colonial Waterbirds*, 5: 161-168.

Turbeville, D.B., and G.A. Marsh. 1982. Benthic Fauna of an Offshore Borrow Area in Broward County, Florida. MR 82-1, U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvior, VA. 26 pp.

Turner, R., B.L. Eugene, J.M. Teal, C.S. Milan, E.M. Swenson, and D.D. Goehringer-Toner. 2009. Saltmarshes and Eutrophication: An Unsustainable Outcome. *Limnology and Oceanography*, 54(5): 1634-1642.

U.S. Army Corps of Engineers. 2018. Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay. Revised Draft Hurricane Sandy General Reevaluation Report and Environmental Impact Statement. Dated August 2018. U.S. Army Corps of Engineers, New York District, New York, NY.

_____. 2016a. Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay: Draft Hurricane Sandy General Reevaluation Report and Environmental Impact Statement. Dated June 2016. U.S. Army Corps of Engineers, New York District, New York, NY.

_____. 2016b. Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay: Draft Hurricane Sandy General Reevaluation Report and Environmental Impact Statement: Volume III: Environmental Appendix. Dated August 2016. U.S. U.S. Army Corps of Engineers, New York District, New York, NY.

_____. 2016c. Fire Island Inlet to Montauk Point Reformulation Study Draft Environmental Impact Statement. U.S. Army Corps of Engineers, New York District, New York, NY.

_____. 2009. Hudson-Raritan Estuary Comprehensive Restoration Plan. Volume I. Draft. March 2009. U.S. Army Corps of Engineers, New York District, New York, NY.

_____. 1997. Jamaica Bay Navigational Channels and Shoreline Environmental Surveys: Final Report. Dated December 1997. U.S. Army Corps of Engineers, New York District, New York, NY.

_____. 1992. Atlantic Coast of New York City- Rockaway Inlet to Norton Point Coney Island Area Shore Protection Project. Final General Design Memorandum. U.S. Army Corps of Engineers, New York District, New York, NY.

U.S. Army Corps of Engineers, Port Authority of New York and New Jersey (Corps and PANYNJ). 2016. *Hudson –Raritan Estuary Comprehensive Restoration Plan, Version 1.0*. U.S. Army Corps of Engineers, New York District, New York, NY.

U.S. Fish and Wildlife Service. 2018a. *Information, Planning, and Conservation System. Environmental Conservation Online System*. U.S. Fish and Wildlife Service, Geospatial Services. Denver, CO. Retrieved from: http://ecos.fws.gov/ipac/.

_____. 2018b. Neotropical Migratory Bird Conservation Act. Available online at: https://www.fws.gov/bird habitat/Grants/NMVCA/Birdlist.shtm. Accessed on: September 7, 2018.

_____. 2018c. Hudson Raritan Estuary Comprehensive Restoration Plan HRE Ecosystem Restoration Feasibility Study Final Fish and Wildlife Coordination Act Section 2(B) Report. Dated April 2018. U.S. Fish and Wildlife Service (Long Island Field Office, Shirley, NY; New York Field Office, Cortland, NY; and New Jersey Field Office, Pleasantville, NJ).

_____. 2014. Rufa Red Knot Background Information and Threats Assessment Supplement to Endangered and Threatened Wildlife and Plants; Final Threatened Status for the Rufa Red Knot (*Calidris canutus rufa*). Federal Register No l. 79 No. 238, 50 CFR Part 17 [Docket No. FWS-R5-ES-2013-0097;4500030113].

_____. 2011. Roseate Tern: North American Subspecies Fact Sheet. U.S. Fish and Wildlife Service, Hadley, MA. Available online at: https://www.fws.gov/northeast/pdf/roseatetern051 l .pdf.

_____. 2008. *Birds of Conservation Concern 2008*. Division of Migratory Bird Management. Arlington, Virginia. 85 pp. Available online at: http://www.fws.gov/migratorybirds.

_____. 2009. Piping Plover (*Charadrius melodus*) 5-year Review: Summary and Evaluation. U.S. Fish and Wildlife Service , Northeast Regional Office, Hadley, MA. Available online at: http://www.fws.gov/northeast/endangered/pdf/piping_plover_five_year_review_and_summary.pdf.

_____. 2007a. Phragmites: Questions and Answers. Fact Sheet. U.S. Fish and Wildlife Service, Gulf of Main Program, Falmouth, ME. Available online at: http://www.fws.gov/northeast/gulfofmaine.

_____. 2007b. Planning Aid Letter for the CRP on Corps' Draft Target Ecosystem Characteristics. U.S. Fish and Wildlife Service, New Jersey Field Office, Pleasantville, NJ. September 14, 2007.

_____. 2000. Atlantic Coast of New York City – East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York Storm Damage Reduction Project Fish and Wildlife Coordination Act Section 2(b) Report. Dated November 2000. U.S. Fish and Wildlife Service , Long Island Field Office, Shirley, NY.

_____. 1998a. Roseate Tern Recovery Plan, Northeastern Population. First Update. U.S. Fish and Wildlife Service, Northeast Region, Hadley, MA.

_____. 1998b. Fire Island Inlet to Montauk Point Beach Erosion Control and Hurricane Protection Project Reach I – Fire Island Inlet to Moriches Inlet Interim Storm Damage Protection Plan Draft Fish and Wildlife Coordination Act Section 2(b) Report. U.S. Fish and Wildlife Service, Long Island Field Office, Islip, NY. 59 pp.

_____. 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. U.S. Fish and Wildlife Service, Southern New England, New York Bight Coastal Ecosystems Program, Charlestown, RI.

_____. 1996a. Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. U.S. Fish and Wildlife Service, Hadley, MA. 258 pp.

_____. 1996b. Recovery Plan for Seabeach Amaranth (*Amaranthus pumilus*) Rafinesque. U.S. Fish and Wildlife Service, Southeast Region, Atlanta, GA.

_____. 1995. Fish and Wildlife Coordination Act Report, Section 2(b): Atlantic Coast of Long Island, Jones Inlet to East Rockaway Inlet, Long Beach Island, New York. Storm Damage Reduction Project. U.S. Fish and Wildlife Service, Islip, NY. 31 pp.

_____. 1993. Endangered and Threatened Wildlife and Plants: Determination of Seabeach Amaranth (*Amaranthus pumilus*) to a Threatened Species. 58FR: 18035-18042.

_____. 1985. Determination of Endangered and Threatened Status for the Piping Plover. 50FR: 50726-50734.

_____. 1983. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic): Surf Clam. U.S. Fish and Wildlife Service, Slidell, LA. FWS/OBS-82/11.13, TREL-82-4.

_____. 1981. U.S. Fish and Wildlife Service Mitigation Policy. Federal Register, Friday, January 23, 1981. 46: 7644-7663.

Utne-Palm, A.C. 2002. Visual Feeding of Fish in a Turbid Environment: Physical and Behavioural Aspects. *Marine and Freshwater Behaviour and Physiology*, 35(1-2): 111-128.

Vanden Eede, S., J. Van Tomme, C. De Busschere, M.L. Vandegehuchte, K. Sabbe, E.W.M. Stienen, S. Degraer, M. Vincx, and D. Bonte. 2014. Assessing the Impact of Beach Nourishment on the Intertidal Food Web through the Development of a Mechanistic-Envelope Model. *Journal of Applied Ecology*, 51: 1304-1313.

Veit, R.R., A. Bernick, and J. Santora. 2002. Birds of the Jamaica Bay Ecosystem. *In*: Jamaica Bay Ecosystem Research and Restoration Team Final Report. National Park Service, Division of Natural Resources, Gateway National Recreation Area, Staten Island, NY.

Waldman, J. 2008. *Research Opportunities in the Natural and Social Sciences at the Jamaica Bay Unit of Gateway National Recreation Area*. Prepared for the National Park Service, Jamaica Bay Institute. Queens College, Biology Department, Flushing, NY.

Wall and Associates, Inc., International Engineering and Development Corporation, STV Incorporated, P.W. Grosser Consulting, Inc., Long Island Analytical Laboratories, Inc. 2003. Final Environmental Impact Statement for the Arverne Urban Renewal Area (CEQR No. 02HPD004Q). Prepared for New York City Department of Housing Preservation and Development, New York, NY.

Wilber, D.H., and D.G. Clarke. 2001. Biological Effects of Suspended Sediments: A Review of Suspended Sediment Impacts on Fish and Shellfish with Relation to Dredging Activities in Estuaries. *North American Journal of Fisheries Management*, 21: 855-875.

Winn, B., S. Brown, C. Spiegel, D. Reynolds, and S. Johnston. 2013. *Atlantic Flyway Shorebird Business Strategy: A Call to Action: Phase 1.* Available online at: http://www.acjv.org/temp_ftp/shorebird_bus_strat_phase_1.pdf.

Winston, T. 2017. New York City Audubon's Harbor Herons Project: 2017 Nesting Survey Report. New York City Audubon, New York, NY.

Wintermyer, M.L., and K.R. Cooper. 2003. Dioxin/furan and Polychlorinated Biphenyl Concentrations in Eastern Oyster (*Crassotrea virginica*) Tissues and the Effects on Egg Fertilization and Development. *Journal of Shellfish Research*, 22(3): 737-746.

Wong, P.P., I.J. Losada, J.P. Gattuso, J. Hinkel, A. Khattabi, K.L. McInnes, Y. Saito, and A. Sallenger. 2014. Coastal Systems and Low-Lying Areas. *In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White [*Eds.*]). Cambridge University Press, Cambridge, UK, and New York, NY, USA. pp. 361-409.

Woodhead, P.M.J. 1992. *Assessments of the Fish Community and Fishery Resources of the Lower New York Bay Area in relation to a Program of Sand Mining Proposed by New York State*. Stony Brook: Marine Sciences Research Center, SUNY at Stony Brook.

Woodward-Clyde Consultants. 1975. Rockaway Beach Erosion Control Project Dredge Material Research Program Offshore Borrow Area. San Francisco: Woodward-Clyde Consulting Engineers, Geologists, and Environmental Scientists.

Zarnoch, C.B., and M.P. Schreibman. 2012. Reproduction of Eastern Oysters, *Crassostrea Virginica. In* a New York City Estuary: Implications for Restoration. Urban Habitats. ISSN 1541-7115.

Zarull, M.A., J.H. Hartig, and L. Maynard. 1999. Ecological Benefits of Contaminated Sediment Remediation in the Great Lakes Basin. Available online at: http://www.ijc.org/php/publications/html/ecolsed.

APPENDIX A

Relevant Studies, Projects, and Reports Within and Adjacent to the Study Area

1. Federal Projects

Numerous federal shoreline projects have been funded, authorized, and carried out along the Rockaway shoreline and within Jamaica Bay. The names and descriptions of these projects are listed below.

Rockaway Beach Erosion Control and Hurricane Protection Project

The original Rockaway Beach project was authorized by the Flood Control Act of 1965 and later modified by the Water Resources Development Act (WRDA) of 1974 for a 10-year period. The original project included a 100-200 feet (ft) wide beach at an elevation of 10 feet above Mean Low Water (MLW) from Beach 149th Street to Beach 19th Street. From 1977 until 2004, the U.S. Army Corps of Engineers (Corps) designed, constructed, and maintained the project. A second major construction effort was authorized through section 934 of the WRDA of 1986, allowing continued federal participation in periodic beachfill nourishment. The U.S. Fish and Wildlife Service (Service) prepared a final FWCA 2b report for the Corps' new component of this project as authorized by the WRDA of 1986 (Public Law 99-662). The project consisted of a 6.2-mile (mi), 100-ft berm width at an elevation of +10 ft National Geodetic Vertical Datum (NGVD). Additionally, the project included the construction of six (6), 300-ft T-groins with sheet-pile/timber stems. The Service provided a number of recommendations in the 1993 and the 2000 FWCA reports.

U.S. Fish and Wildlife Service. 1993. Atlantic Coast of New York City – East Rockaway Inlet to Rockaway Inlet, Fish and Wildlife Coordination Act 2(b) Report. U.S. Fish and Wildlife Service, Long Island Field Office, Islip, NY.

U. S. Fish and Wildlife Service. 2000. Atlantic Coast of New York City - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York Storm Damage Reduction Project, Fish and Wildlife Coordination Act Section 2 (b) Report . U.S. Fish and Wildlife Service, Long Island Field Office, Islip, NY.

East Rockaway Inlet Federal Navigation Channel Project

The East Rockaway Inlet Federal Navigation Project was authorized by the Rivers and Harbors Act (RHA) of 1930. The project provides for a 0.9 mi long, 250 ft wide, 12 ft deep MLW channel. During the 2017 fiscal year, approximately 270,000 cubic yards (cy) of sand were dredged and placed along Atlantic Ocean Rockaway Beach shoreline.

U.S. Fish and Wildlife Service. 2016. ESA/MBTA/FWCAR letter. U.S. Fish and Wildlife Service, Long Island Field Office, Shirley, NY.

Rockaway Inlet Federal Navigation Channel Project

The Rockaway Inlet Federal Navigation channel, located in Jamaica Bay, New York, was authorized by the RHA of 1910 and later modified by the RHAs of 1945 and 1950. The existing project provides for a 1.7 mi long, 1,000 ft wide, entrance channel that is 20 ft deep at MLW, and connects two interior channels with deep water in the Atlantic Ocean.

Atlantic Coast of New York City – Rockaway Inlet to Norton Point, Shore Protection Project

This storm damage protection project is located along 3 miles of Coney Island shoreline. The Project was authorized by the WRDA of 1986, as modified by section 1076 of the Intermodal Surface Transportation and Efficiency Act of 1991. Public Law (PL) 99-662 of the 1986 Act called for federal participation in beach restoration 250 ft beyond the historic shoreline at Coney Island. The project was further modified by the WRDA of 2000 (PL 106-541) to include the construction of T-groins in the area west of the West 37th Street terminal groin. The project included the construction of a 100 ft wide beach berm at an elevation of 13 ft above sea level, the construction of an 850 ft long terminal groin at West 37th Street, and periodic nourishment of the restored beaches on 10-year cycle for a period of 50 years.

The following information was excerpted from the Corps' fact sheet on this project (http://www.nan.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/487599/fact-sheet-rockaway-inlet-to-norton-point-coney-island/). *The Corps completed a Reevaluation Report & Environmental Assessment in January 2005, which recommended the construction of a series of T-groins to the west of the West 37th Street groin as a long-term solution to beach erosion and sand accumulation problems that have occurred in the Sea Gate area. A condition survey of the project area was completed in spring 2011. The plans & specifications for this section are nearing completion, and a new Project Partnership Agreement, necessary to initiate project construction, is currently being coordinated with the project sponsors, the State and City of New York. The Sea Gate portion of the project is considered to be an Authorized but Unconstructed project according to PL 113-2 (The Disaster Relief Appropriations Act of 2013). Because of this, the Sea Gate portions of the project will be funded at 100 percent federal cost. Project construction began in December 2014 and is scheduled and was completed June 2016.*

U.S. Fish and Wildlife Service. 2000. Final Fish and Wildlife Coordination Act 2(b) Report, Atlantic Coast of New York City – Rockaway Inlet to Norton Point (Coney Island Area), Shore Protection Project. U.S. Fish and Wildlife Service, Long Island Field Office, Islip, NY.

Atlantic Coast of Long Island, Jones Inlet to East Rockaway Inlet, Long Beach Island, New York, Storm Damage Reduction Project

This Storm Damage Reduction project extends 9 miles along the south shore of Long Island from Jones Inlet to East Rockaway Inlet. The project was authorized by a resolution by the Committee on Public Works and Transportation of the U.S. House of Representatives adopted

October 1, 1986. Project construction was authorized by the WRDA of 1996. The proposed action included the rehabilitation/repair of 17 groins; rehabilitation and extension of the eastern terminal groin in Point Lookout; construction of a new groin field at Point Lookout; construction of 57 timber/gravel dune walkovers, extensions of existing dune walkovers, and vehicle access ways; construction of 35,000 linear ft of dune and beachfill from an offshore borrow area for the initial fill placement; and the installation of 75,000 linear ft of sand fence and dune grass planting. The first phase of construction began in the fall of 2016.

U.S. Fish and Wildlife Service. 2015. Final Fish and Wildlife Coordination Act 2(b) Report, Atlantic Coast of Long Island, Jones Inlet to East Rockaway Inlet, Long Beach Island, New York, Storm Damage Reduction Project. U.S. Fish and Wildlife Service, Long Island Field Office, Shirley, NY.

U.S. Army Corps of Engineers. 2015. Atlantic Coast of Long Island: Jones Inlet to East Rockaway Inlet Long Beach Island, New York Hurricane and Storm Damage Reduction Hurricane Sandy Limited Reevaluation Report Environmental Assessment. U.S. Army Corps of Engineers, New York District, New York, NY.

Hudson Raritan Estuary Project, Ecosystem Restoration Feasibility Study

The purpose of the Corps' Hudson Raritan Estuary (HRE) Feasibility Study is to identify water resource issues, discuss existing environmental conditions, and highlight factors contributing to environmental degradation in the HRE. Through proposed restoration at 33 sites across the estuary, the HRE Feasibility Study also strives to contribute to ecosystem restoration, by building upon existing restoration and section 404 of the Clean Water Act (CWA; 33 U.S.C. 1344 *et seq*.) mitigation efforts. The HRE Feasibility Study was authorized by House of Representatives' Committee on Transportation and Infrastructure Resolution dated April 15, 1999, Docket Number 2596.

U.S. Fish and Wildlife Service. 2018. Final Fish and Wildlife Coordination Act 2(b) Report, Hudson-Raritan Estuary (HRE) Comprehensive Restoration Plan and HRE Ecosystem Restoration Feasibility Study. U.S. Fish and Wildlife Service (Long Island Field Office, Shirley, NY; New York Field Office, Cortland, NY; and New Jersey Field Office, Galloway, NJ).

Jamaica Bay, Marine Beach, and Plumb Beach Ecosystem Restoration Feasibility Study

This Study determined the feasibility of improvements for beach erosion control, hurricane protection and environmental improvements at seven sites within Jamaica Bay, including Brant Point, Spring Creek, Bayswater Park, Dubos Point, Hawtree Point, Fresh Creek, and Dead Horse Bay.

U.S. Army Corps of Engineers. 2013. Jamaica Bay, Marine Beach, and Plumb Beach Ecosystem Restoration Feasibility Study. U.S. Army Corps of Engineers, New York District, New York, NY.

Spring Creek Park (North) Ecosystem Restoration Project

This ecosystem restoration project comprises a 47 acre (ac) portion of Spring Creek Park located adjacent to the banks of Spring Creek and Ralph's Creek, tributaries to Jamaica Bay. The proposed project would restore 13 ac of intertidal saltmarsh, 22.1 ac of maritime upland habitat, and 2.4 ac of maritime upland. The project was authorized under the Continuing Authorities Program, section 1135(b) of the WRDA of 1986, as amended (33 U.S.C. 2309[a]) and further amended under the Water Resource Reform and Development Act (WRRDA) of 2014(f), further amended section 1135(d) of WRDA of 1986 (33 U.S.C. 2309a (d)). The Service provided an updated FWCA report in October of 2016.

U.S. Fish and Wildlife Service. 2004. Final Fish and Wildlife Coordination Act 2(b) Report, Spring Creek Restoration Project. U.S. Fish and Wildlife Service, Long Island Field Office, Islip, NY.

U.S. Fish and Wildlife Service. 2018. Final Fish and Wildlife Coordination Act 2(b) Report, Spring Creek Ecosystem Restoration Project Spring Creek Park Brooklyn and Queens, NY. U.S. Fish and Wildlife Service, Long Island Field Office, Islip, NY.

Gerritsen Creek - Marine Park Ecosystem Restoration Project

The Corps' Gerritsen Creek - Marine Park Ecosystem Restoration Project (see http://www.nan.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/487245/fact-sheet-gerritsen-creekmarine-park-ny/) improved the aquatic and coastal grassland habitats located in the northeastern section of Marine Park, Brooklyn, New York. The project restored 31 ac of saltmarsh and 23 ac of rare coastal grassland habitat.

West Pond Breach Repair

During Hurricane Sandy, the West Pond of the Jamaica Bay Wildlife Refuge was breached. Repairs include repairing the embankment at the breach and installing a water control structure and a groundwater well. The purpose of the proposed project was to provide for environmentally sensitive and resilient conditions along the West Pond Trail area that support a diversity of Jamaica Bay habitats and wildlife. The breach closure was completed in January of 2017.

U.S. Fish and Wildlife Service. 2016. ESA Concurrence letter for the Jamaica Bay Wildlife Refuge West Pond Trail Breach Repair. U.S. Fish and Wildlife Service, Long Island Field Office, Shirley, NY.

National Park Service. 2015. Jamaica Bay Wildlife Refuge West Pond Trail Breach Repair Environmental Assessment. National Park Service, Staten Island, NY.

Fort Tilden Shore Access and Resiliency Project

Hurricane Sandy caused physical changes to the Fort Tilden coastal area, displacing the established foredune system and affecting historic resources on and adjacent to the beach,

including Shore Road, the bulkhead and groin system, Battery Kessler, Buildings 15-18, and the Telephone Pit Building, and created new beach habitat suitable for threatened and endangered shorebirds and plants. The National Park Service (NPS) proposed to reconstruct Shore Road with a pathway of sustainable clay base with shell aggregate and partially removes the bulkhead and completely removes the wooden groins located on the beach.

U.S. Fish and Wildlife Service. 2016. ESA Concurrence letter for the Fort Tilden Shore Access and Resiliency Project. U.S. Fish and Wildlife Service, Long Island Field Office, Shirley, NY.

National Park Service. 2016. Fort Tilden Shore Access and Resiliency Project Environmental Assessment. National Park Service, Staten Island, NY.

Jamaica Bay Marsh Island Restoration: Elders East, Elders West, Yellow Bar Hassock, Black Wall, and Rulers Bar

Between 2006-2014, under the Corps' Continuing Authorities Program (CAP), the Corps, in partnership with the Port Authority of New York and New Jersey (PANYNJ), the New York State Department of Environmental Conservation (NYSDEC), the New York City Department of Environmental Protection (NYCDEP), and the NPS, restored marshes at Elders Point East and West, Yellow Bar Hassock, Black Wall, and Rulers Bar using dredged material from the Corps' New York Harbor Deepening Project.

North Atlantic Coast Comprehensive Study

The Corps completed the North Atlantic Coast Comprehensive Study and released the report in 2015. The Corps conducted the study over a two-year period, during which they examined coastal storm and flood risk to vulnerable populations, property, ecosystems, and infrastructure affected by Hurricane Sandy in the United States' North Atlantic region. According to the Corps' website, the study "is designed to help local communities better understand changing flood risks associated with climate change and to provide tools to help those communities better prepare for future flood risks. It builds on lessons learned from Hurricane Sandy and attempts to bring to bear the latest scientific information available for state, local, and tribal planners. The conclusions of the study, as detailed in the final report, include several findings, outcomes, and opportunities, such as the use of a nine-step Coastal Storm Risk Management Framework that can be customized for any coastal watershed." More information about the study can be found online at: http://www.nad.usace.army.mil/CompStudy/.

New York New Jersey Harbor and Tributaries Coastal Storm Risk Management Study

The New York New Jersey Harbor and Tributaries Coastal Storm Risk Management Study (CSRM) spans the New York and New Jersey Harbor and the tidally-affected tributaries encompassing all of New York City, the Hudson River to Troy, New York; the lower Passaic, Hackensack, Rahway, and Raritan Rivers; and the Upper and Lower Bays of New York Harbor, Newark, Jamaica, Raritan and Sandy Hook Bays; the Kill Van Kull, Arthur Kill and East River tidal straits; and western Long Island Sound. This focus area feasibility study is one of nine that

the Corps' North Atlantic Coast Comprehensive Study (NACCS) Report, issued January 2015, identified for further study. This study is authorized by PL 84-71, June 15, 1955 (69 Stat. 132), which directs the examination of damages in coastal and tidal areas due to coastal storms such as hurricanes and of possible means of preventing loss of human lives and damages to property, with due consideration of the economics of proposed storm risk measures.

The initial focused array of alternatives has been formulated ranging from harbor-wide coastal storm risk management methods to land-based, perimeter CSRM methods, with three alternatives between. Coastal storm risk measures proposed in the alternatives include storm surge barriers, floodwalls, and levee systems. All alternatives are anticipated to also include non-structural measures and natural and nature based features as appropriate.

2. Federally Authorized/Funded State or Local Actions

Additional projects which are proposed or currently underway that are relevant to the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay include:

Arverne Urban Renewal Development

The construction of the Arverne East residential development is proposed to occur north of the boardwalk between Beach 32nd and Beach 44th Streets and includes up to 1500 units of housing, up to 500,000 square ft of commercial/recreational space, and 15.5 ac of open space/nature preserve. Although no known federal funding or authorizations are required for this project, the Service provided technical assistance letters to the New York City Department of Housing, Preservation and Development (NYCDHPD) in June of 2002 and October of 2003 providing conservation measures intended to avoid/minimize impacts to federally-listed species, which the NYCDHPD incorporated into their project description.

Spring Creek (South) Storm Resilience and Ecosystem Restoration Project

The Spring Creek South Storm Resilience and Ecosystem Restoration project includes a berm and restoration of wetland and maritime forest habitats. This site is located south of the Spring Creek North project. The project is funded by a grant awarded to the NYSDEC from the Federal Emergency management Agency's (FEMA) Hazard Mitigation Grant Program. The FEMA was identified as the lead agency in April of 2016.

Jamaica Bay Self-Sustaining Oyster Population project

The Jamaica Bay Self-Sustaining Oyster Population project is a NYCDEP project that was funded on June 16, 2014, by a Department of the Interior (DOI) Sandy Coastal Resiliency grant administered by National Fish and Wildlife Foundation (NFWF). In an effort to restore eastern oysters (*Crassostrea virginica*) to Jamaica Bay, the NYCDEP proposes to develop several donor and receiver oyster beds across half an acre in the northeastern end of Jamaica Bay at Head of Bay.

Rockaway Boardwalk

The Rockaway Boardwalk project included repairing and rebuilding approximately 5 mi of boardwalk from Beach 19th Street to 126th Street. The project included the replacement of pre-disaster wood with concrete decking; new beach and landside access ramps and stairs; installation of new utilities, bathrooms, and benches; steel pipe pilings for retaining wall and boardwalk; and elevated the boardwalk.

U.S. Fish and Wildlife Service. 2014. ESA Concurrence letter for the Rockaway Boardwalk reconstruction Project. U.S. Fish and Wildlife Service, Long Island Field Office, Shirley, NY.

Plumb Beach Coastal Storm Management Project

This coastal storm management project included the construction of a beach berm with sections planted with dune grass, two terminal groins and a breakwater to minimize long-term erosion and reduce the need for future renourishments of the berm. The beach berm was constructed in 2012, and the groins and breakwater were constructed in 2013.

Breezy Point Risk Mitigation System

The proposed project would protect the Breezy Point and Roxbury Beach communities located on the western end of Rockaway peninsula from flooding. Rockaway Point Boulevard, the main ingress and egress, was flooded during Sandy, preventing firefighters from combating a fire that destroyed 115 homes. The goal of the project is to provide coastal flood protection to both Breezy Point and Roxbury with a system of dunes and other flood protective structures that work together to create a more resilient community and withstand storm and tidal forces that may impact the coastline in future years.

3. Completed and Ongoing Studies and Reports

NYCDEP's Jamaica Bay Watershed Protection Plan 2016 Update (New York City Department of Environmental Protection 2016) provides a summary of the completed and ongoing projects being carried out within the project area. A summary of the projects and their description were excerpted from the 2016 update. More information about these projects can be found at online at: http://www.nyc.gov/html/dep/pdf/jamaica_bay/jbwpp_update_10012016.pdf.

Project	Location	Description
Ribbed Mussel Pilot	Fresh Creek Tributary	To study whether the filtering capacity of mussels can be adapted to the practical application of filtering discharges to improve water quality.
Oyster Reef Pilot	Jamaica Bay	A small oyster bed and a field of reef balls were placed within Jamaica Bay to evaluate oyster growth, survival and reproduction, as well as potential water quality and ecological benefits.

Project	Location	Description
Head of Bay Oyster Project	Head of Bay	A floating "nursery" of 50,000 adult oysters was installed in Head of Bay in an effort to evaluate natural recruitment, as this has been one of the more challenging aspects to fully understand. The project includes donor and receiver beds to study recruitment within Jamaica Bay.
Jamaica Bay Wastewater Treatment Plant Upgrades	Jamaica Bay	Jamaica Bay Wastewater Treatment Plant Upgrades Description: NYCDEP is improving the overall water quality and ecology of Jamaica Bay by reducing nitrogen discharges from Jamaica Bay's wastewater treatment plants (WWTPs) through a number of innovative plant upgrades.
Long Term Control Plan	Jamaica Bay and Tributaries	NYCDEP is developing and executing a detailed water quality planning and improvement process for NYC's local waterways, as documented in ten waterbody specific Long Term Control plans (LTCPs) and one citywide Combined Sewer Overflow (CSO) LTCP.
Area-wide Sewer Improvements Description	Bay-wide	Area-wide Sewer Improvements Description: NYCDEP is designing and constructing multiple critical infrastructure projects to reduce chronic flooding and increase environmental restoration in southeast Queens, which is in the Jamaica Bay watershed. Additional sewer separation and repair projects are ongoing in the Jamaica Bay watershed as well.
Floating Wave Attenuator Study	Brant Point	A wave attenuator pilot study, acting as a proxy for future oyster beds, was implemented around a section of saltmarsh in Jamaica Bay. The objective of the study is to determine if attenuators are cost effective methods for slowing the rate of wetland loss and accreting marsh sediments to improve salt marsh resiliency. The project was constructed in August 2015.
Spring Creek South Storm Resilience and Ecosystem Restoration Project	Spring Creek	The Spring Creek South Storm Resilience and Ecosystem Restoration project will reduce the risk of storm damage and flooding in the Howard Beach neighborhood by creating a protective berm and restoring over 225 ac of wetland and coastal forest. By reshaping the landscape and adding nature-based resilience features, Spring Creek South will complement other storm resilience projects in the area to manage this region's vulnerability to coastal storms.
Paerdegat Basin Natural Area Park & Ecology Park	Paerdegat Basin	To improve water quality, reestablish native habitat, and create recreational and educational opportunities for the public, NYCDEP established 52 ac of restored wetlands, including a public Ecology Park, along the shores of Paerdegat Basin. This educational park includes restored NYC coastal and adjacent upland habitat.
Green Infrastructure Description	Bay-wide	In 2012, NYCDEP and NYSDEC signed a groundbreaking agreement to reduce combined sewer overflows (CSOs) using a hybrid green and gray infrastructure approach. NYCDEP has identified 11 Priority CSO Tributary Areas for green infrastructure implementation within the Jamaica Bay watershed. Through NYCDEP 's area-wide strategy, four of these areas have completed design and/or construction contracts for green infrastructure on City-owned streets and sidewalks. The design process for the other seven Priority CSO Tributary Areas have begun and are expected to finish design in 2017.

The Science and Resilience Institute at Jamaica Bay

The Science and Resilience Institute at Jamaica Bay is a partnership among academic institutions, nongovernmental organizations and community groups. The Institute promotes the understanding of resilience in the urban ecosystem and surrounding communities. The institute is engaged in research to understand the temporal nature and robustness of the resilience of Jamaica Bay, New York Harbor, Hudson Raritan Estuary and Gateway National Recreation Area; develop models for studying the fundamental nature of resilient systems and determine how best to manage ecosystems to ensure resilience and sustainability; provide technical assistance and guidance to the institute's governmental partners, including the NPS, New York City Parks and the NYCDEP; and serves as a center for education and the dissemination of knowledge about processes that affect resilience and contribute to the changes in the urban ecosystem (http://www.brooklyn.cuny.edu/web/academics/centers/sri.php).

APPENDIX B

Rockaway Peninsula Bird Species

Table 1. Bird species located at three bay side sites on the Rockaway Peninsula (Veit *et al.* 2002)**.**

Species	Scientific Name	Bayswater State Park	Dubos Point	Brant Point
American Bittern	*Botaurus lentiginosus*		X	
American Black Duck	*Anas rubripes*	X	X	X
American Crow	*Corvus brachyrhynchos*	X	X	X
American Golden-plover	*Pluvialis dominica*		X	
American Goldfinch	*Carduelis tristis*		X	X
American Kestrel	*Falco sparverius*	X	X	X
American Oystercatcher	*Haematopus palliates*	X	X	X
American Redstart	*Setophaga ruticilla*	X	X	X
American Robin	*Turdus migratorius*	X	X	X
American Tree Sparrow	*Spizella arborea*	X	X	X
American Wigeon	*Anas americana*	X	X	X
American Woodcock	*Scolopax minor*		X	
Atlantic Brant	*Branta bernicla*	X	X	X
Baltimore Oriole	*Icterus galbula*	X	X	
Bank Swallow	*Riparia riparia*		X	
Barn Swallow	*Hirundo rustica*	X	X	X
Belted Kingfisher	*Ceryle alcyon*		X	X
Black Skimmer	*Rynchops niger*	X	X	
Black-and-white Warbler	*Mniotilta varia*	X		
Black-bellied Plover	*Pluvialis squatarola*	X	X	X
Black-capped Chickadee	*Poecile atricapillus*	X		
Black-crowned Night-Heron	*Nycticorax nycticorax*	X	X	X
Blackpoll Warbler	*Dendroica striata*	X		
Black-throated Green Warbler	*Dendroica virens*	X	X	
Blue Jay	*Cyanocitta cristata*	X	X	X
Blue-gray Gnatcatcher	*Polioptila caerulea*	X		
Blue-headed Vireo	*Vireo solitarius*	X		
Boat-tailed Grackle	*Quiscalus major*	X	X	
Bobolink	*Dolichonyx oryzivorus*	X		
Brown Thrasher	*Toxostoma rufum*	X	X	
Brown-headed Cowbird	*Molothrus ater*	X	X	X
Bufflehead	*Bucephala albeola*	X	X	X

Species	Scientific Name	Bayswater State Park	Dubos Point	Brant Point
Canada Goose	*Branta canadensis*	X	X	X
Carolina Wren	*Thryothorusludovicianus*	X	X	
Cedar Waxwing	*Bombycilla cedrorum*	X	X	
Chimney Swift	*Chaetura pelagica*		X	X
Chipping Sparrow	*Spizella passerina*	X		
Clapper Rail	*Rallus longirostrus*	X	X	X
Common Grackle	*Quiscalus quiscula*	X	X	X
Common Loon	*Gavia immer*	X	X	
Common Snipe	*Gallinago gallinago*		X	
Common Tern	*Sterna hirundo*	X	X	X
Common Yellowthroat	*Geothlypis trichas*	X	X	X
Cooper's Hawk	*Accipiter cooperii*		X	
Double-crested Cormorant	*Phalacrocorax auritus*	X	X	X
Downy Woodpecker	*Picoides pubescens*	X		
Dunlin	*Calidris alpina*			X
Eastern Kingbird	*Tyrannus tyrannus*	X		
Eastern Meadowlark	*Sturnella magna*	X		
Eastern Phoebe	*Sayornis phoebe*	X	X	X
Eastern Towhee	*Pipilo erythrophthalmus*	X	X	
Eastern Wood-Pewee	*Contopus virens*		X	
European Starling	*Sturnus vulgaris*	X	X	X
Fish Crow	*Corvus ossifragus*	X	X	X
Forster’s Tern	*Sterna forsteri*		X	
Gadwall	*Anas strepera*		X	
Glossy Ibis	*Plegadis falcinellus*	X	X	X
Golden-crowned Kinglet	*Regulus satrapa*	X	X	X
Gray Catbird	*Dumatella carolinensis*	X	X	X
Great Black-backed Gull	*Larus marinus*	X	X	X
Great Blue Heron	*Ardea herodias*	X	X	X
Great Cormorant	*Phalacrocorax carbo*	X	X	X
Great Egret	*Ardea alba*	X	X	X
Great-crested Flycatcher	*Myiarchus crinitus*	X		
Greater Snow Goose	*Tringa melanoleuca*	X		
Greater Yellowlegs	*Tringa melanoleuca*	X		
Green Heron	*Butorides virescens*	X	X	
Herring Gull	*Larus argentatus*	X	X	X
Hooded Merganser	*Lophodyets cucullatus*		X	
Horned Grebe	*Podiceps auritus*		X	
House Finch	*Carpodacus mexicanus*	X	X	X
House Sparrow	*Passer domesticus*	X	X	X

Species	Scientific Name	Bayswater State Park	Dubos Point	Brant Point
House Wren	*Troglodytes aedon*	X	X	
Indigo Bunting	*Passerina cyanea*	X	X	
Laughing Gull	*Larus atricilla*	X	X	X
Least Flycatcher	*Empidonax minimus*	X		
Least Sandpiper	*Calidris minutilla*	X	X	X
Least Tern	*Strnula antillarum*	X	X	X
Lesser Scaup	*Aythya affinis*	X		
Lesser Snow Goose	*Chen caerulescens*		X	X
Lesser Yellowlegs	*Tringa flavipes*		X	
Magnolia Warbler	*Dendroica magnolia*	X	X	
Mallard	*Anas platyrhynchos*	X	X	X
Marsh Wren	*Cistothorus palustris*	X	X	
Merlin	*Falco columbarius*		X	
Mourning Dove	*Zenaida macroura*	X	X	X
Mute Swan	*Cygnus olor*	X		
Myrtle Warbler	*Dendroica coronata coronata*	X	X	X
Nashville Warbler	*Vermivora ruficapilla*	X		
Northern Cardinal	*Cardinalis cardinalis*	X	X	
Northern Flicker	*Colaptes auratus*	X	X	X
Northern Harrier	*Circus cyaneus*	X	X	
Northern Mockingbird	*Mimus polyglottus*	X	X	X
Northern Waterthrush	*Seiurus noveboracensis*	X		X
Orchard Oriole	*Icterus spurius*	X		
Osprey	*Pandion haliaetus*	X		
Peregrine Falcon	*Falco Peregrinus*		X	X
Pied-billed Grebe	*Podillymbus podiceps*		X	
Purple Finch	*Carpodacus purpureus*	X		
Red Knot (rufa ssp.)	*Calidris anutus*		X	X
Red-bellied Woodpecker	*Melanerpes carolinus*	X		
Red-breasted Merganser	*Mergus serrator*	X	X	X
Red-eyed Vireo	*Vireo olivaceus*	X	X	
Red-tailed Hawk	*Buteo jamaicensis*	X	X	
Red-throated Loon	*Gavia stellate*			X
Red-winged Blackbird	*Agelaius phoeniceus*	X	X	X
Ring-billed Gull	*Larus delawarensis*	X	X	X
Ring-necked Pheasant	*Phasianus colchicus*	X	X	X
Rose-breasted Grosbeak	*Pheucticus ludovicians*		X	
Rough-legged Hawk	*Buteo lagopus*	X		
Royal Tern	*Sterna maxima*		X	X
Ruby-crowned Kinglet	*Regulus calendula*	X	X	

Species	Scientific Name	Bayswater State Park	Dubos Point	Brant Point
Ruby-throated Hummingbird	*Archilochus colubris*	X		
Ruddy Turnstone	*Arenaria interpres*		X	
Rusty Blackbird	*Euphagus carolinus*	X		
Saltmarsh Sharp-tailed Sparrow	*Ammodramus caudacutus*		X	X
Savannah Sparrow	*Passerculus sandwichensis*	X	X	X
Seaside Sparrow	*Ammodramus maritimus*		X	
Semipalmated Plover	*Charadrius semipalmatus*		X	
Semipalmated Sandpiper	*Calidris pusilla*	X	X	X
Sharp-shinned Hawk	*Accipiter striatus*	X	X	
Short-billed Dowitcher	*Limnodromus griseus*		X	
Short-eared Owl	*Asio flammeus*		X	
Slate-colored Junco	*Junco hyemalis hyemalis*	X		
Snowy Egret	*Egretta thula*	X	X	X
Song Sparrow	*Melospiza melodia*	X	X	X
Spotted Sandpiper	*Actitis macularia*	X	X	X
Surf Scoter	*Melanitta perspicillata*	X	X	
Swamp Sparrow	*Melospiza georgiana*	X	X	X
Tree Swallow	*Tachycineta bicolor*	X	X	X
Western Palm Warbler	*Dendroica palmarum palmarum*	X	X	
Western Sandpiper	*Calidris mauri*		X	
Whimbrel	*Numenius phaeopus*	X		
White-crowned Sparrow	*Zonotrichia leucophrys*	X		
White-rumped Sandpiper	*Calidris fuscicollis*			X
White-throated Sparrow	*Zonotrichia albicollis*	X	X	X
Willet	*Catoptrophorus semipalmatus*	X	X	X
Willow Flycatcher	*Empidonax traillii*	X	X	X
Yellow Palm Warbler	*Dendroica palmarum hypochrysea*		X	X
Yellow Warbler	*Dendroica petechia*	X	X	X
Yellow-bellied Sapsucker	*Sphyrapicus varius*	X	X	
Yellow-crowned Night-Heron	*Nyctanassa violacea*		X	

REFERENCES

Veit, R.R., A. Bernick, and J. Santora. 2002. Birds of the Jamaica Bay Ecosystem. In Jamaica Bay Ecosystem Research and Restoration Team Final Report. National Park Service, Division of Natural Resources, Gateway National Recreation Area, Staten Island, NY.

APPENDIX C

Jamaica Bay Fish Species

Table 1. Fish species found within Jamaica Bay (Compiled from: National Park Service 2007; U. S. Fish and Wildlife Service 1997; and New York State Department of State 1992).

Common Name	Scientific Name
Alewife	*Alosa pseudoharengus*
American eel	*Anguilla rostrata*
American shad	*Alosa sapidissima*
Atlantic cod	*Gadus morhua*
Atlantic menhaden	*Brevoortia tyrannus*
Atlantic silverside	*Menidia menidia*
Atlantic sturgeon	*Acipenser oxyrhynchus*
Banded Killifish	*Fundulus diaphanus*
Bay Anchovy	*Anchoa mitchilli*
Black Sea Bass	*Centropristis striata*
Blueback Herring	*Alosa aestivalis*
Bluefish	*Pomatomus saltatrix*
Cunner	*Tautogolabrus adspersus*
Inland silversides	*Menidia berylinna*
Kingfish	*Menticirrhus saxatilis*
Mummichog	*Fundulus heteroclitus*

Common Name	Scientific Name
Northern Pipefish	*Syngnathus fuscus*
Scup	*Stenotomus chrysops*
Searobin	*Prionotus spp*.
Striped Bass	*Morone saxatilis*
Striped Killifish	*Fundulus majalis*
Striped Searobin	*Prionotus evolans*
Stripped Bass	*Morone saxatilis*
Summer flounder	*Paralichthys dentatus*
Tautog	*Tautoga onitis*
Weakfish	*Cynoscion regalis*
White Mullet	*Mugil curema*
White Perch	*Morone americana*
Windowpane Flounder	*Scophthalmus aquosus*
Winter Flounder	*Pseudopleuronectes americanus*

REFERENCES

National Park Service. 2007. Jamaica Bay Bioblitz, September 7-8, 2007. Jamaica Bay Institute. Data available online at: https://www.nps.gov/gate/jamaica-bay bioblitz.htm#CP_JUMP_3604782 .

New York State Department of State. 1992. *Jamaica Bay Significant Coastal Fish and Wildlife Habitats*. New York State Department State Office of Planning and Development. Available online at: https://www.dos.ny.gov/opd/programs/consistency/Habitats/nyc/Jamaica_Bay.pdf.

U.S. Fish and Wildlife Service. 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. U.S. Fish & Wildlife Service, Southern New England, New York Bight Coastal Ecosystems Program, Charlestown, RI.

APPENDIX D

Marine Nearshore and Offshore Fish Species

Table 1. Summary of Marine Nearshore and Offshore Fish (Compiled from: U.S. Fish and Wildlife Service 1997; Edinger *et al.* 2014; National Oceanic and Atmospheric Administration 2018; New York State 2005)**.**

Common Name	Scientific Name
American sandlance	*Ammodytes americanus*
Atlantic Butterfish	*Peprilus triacanthus*
Atlantic Cod	*Gadus morhua*
Atlantic Croaker	*Micropogonias undulates*
Atlantic Herring	*Clupea harengus*
Atlantic Mackerel	*Scomber scombrus*
Atlantic Menhaden	*Brevoortia tyrannus*
Atlantic Silverside	*Menidia menidia*
Atlantic Sturgeon	*Acipenser oxyrhynchus oxyrhynchus*
Black Sea Bass	*Centropristis striata*
Bluefin Tuna	*Thunnus thynnus*
Bluefish	*Pomatomus saltatrix*
Blue Shark	*Prionace glauca*
Clearnose Skate	*Raja eglanteria*
Cobia	*Rachycentron canadum*
Common Thresher Shark	*Alopias vulpinus*
Cunner	*Tautogolabrus adspersus*
Dusky Shark	*Carcharhinus obscurus*
King Mackerel	*Scomberomorous cavalla*

Common Name	Scientific Name
Little Skate	*Leucoraja erinacea*
Longfin Inshore Squid	*Loligo pealeii*
Monkfish	*Lophius americanus*
Northern Kingfish	*Menticirrhus saxatilis*
Pollock	*Pollachius virens*
Red Hake	*Urophycis chuss*
Sandbar Shark	*Carcharhinus plumbeus*
Sand Tiger Shark	*Carcharias taurus*
Scup	*Stenotomus chrysops*
Silver Hake	*Merluccius bilinearis*
Skipjack Tuna	*Katsuwonus pelamis*
Smooth Dogfish	*Mustelus canis*
Spanish Mackerel	*Scomberomorous maculates*
Spot	*Leiostomas xanthurus*
Striped Bass	*Morone saxatilis*
Summer Flounder	*Paralichthys dentatus*
Tautog	*Tautoga onitis*
Tiger Shark	*Galeocerdo cuvier*
Weakfish	*Cynoscion regalis*
White Shark	*Carcharodon carcharias*
Whiting	*Merluccius bilinearis*
Windowpane Flounder	*Scophthalmus aquosus*
Winter Flounder	*Pseudopleuronectes americanus*

Common Name	Scientific Name
Winter Skate	*Leucoraja ocellata*
Yellowtail Flounder	*Limanda ferruginea*

REFERENCES

Edinger, G.J., D.J. Evans, S. Gebauer, T.G. Howard, D.M. Hunt, and A.M. Olivero (editors). 2014. *Ecological Communities of New York State.* Second Edition. A revised and expanded edition of Carol Reschke's Ecological Communities of New York State. New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY.

National Oceanic and Atmospheric Administration. 2018. NOAA Habitat Conservation. Habitat Protection. National Marine Fisheries Service. Available online at: https://www.fisheries.noaa.gov/resource/map/essential-fish-habitat-mapper . Accessed: September 13, 2018.

New York State. 2005. New York State Comprehensive Wildlife Strategy. Major contributors: New York State Department of Environmental Conservation; New York State Department of State; and New York State Office of Parks, Recreation, and Historic Preservation. Available online at: https://www.dec.ny.gov/animals/30483.html .

U.S. Fish and Wildlife Service. 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. U.S. Fish & Wildlife Service, Southern New England, New York Bight Coastal Ecosystems Program, Charlestown, RI.

APPENDIX E

Jamaica Bay Aquatic Invertebrate Species

Table 1. Aquatic invertebrate species found within Jamaica Bay (Compiled from: U.S. Fish and Wildlife Service 1997 and National Park Service 2007).

Common Name	Scientific Name
Acorn Worm spp.	*1. Enteropneusta spp.*
Amethyst Gem Clam	*Gemma gemma*
Amphipod	*Gammarus spp.*
Amphipod	*Gammuarus fasciatus*
Amphipod	*Hyalella spp.*
Arboreal Glass Snail	*Zonitoides arboreus*
Asian Shore Crab	*Hemigrupsiis sanguineus*
Atlantic Assiminea	*Assiminea succinea*
Atlantic Oyster Drill	*Urosalpinx cinerea*
Atlantic Surf Clam	*Spisula solidissima*
Banacle	*Bulonus spp.*
Barnacle	*Semi-bulenus balanoides*
Bay Scallop	*Argopecten irradians*
Blue Crab	*Callinectes sapidus*
Blue Mussel	*Mytilus edulis*
Circumpolar Fairy Shrimp	*Branchinecta paludosa*
Clam Worm	*Nereis succinea*
Comb Jelly	*Mnemopsis leidyi*
Common Atlantic Slippershell	*Crepidula fornicata*

Common Name	Scientific Name
Common Periwinkle	*Littorina littorea*
Compound Coil	*Helicodiscus parallelus*
Convex Slippershell	*Crepidula convexa*
Copepods	*Cyclops spp.*
Copepods	*Diaptomus spp*.
EA Oyster	*Crassostrea virginica*
Eastern Melampus	*Melampus bidentatus*
Eastern Mudsnail	*Ilyanassa obsoleta*
English Garden Snail	*Cepaea nemoralis*
False Angelwing	*Petricola pholadiformis*
Fiddler Crab	*Uca pugnax*
Fingerling Clam	*Sphaerlum spp.*
Glossy Pilar	*Cionella lubrica*
Golden Fossaria	*Fossaria obrussa*
Grass Shrimp	*Palaemonetes pugio*
Grass Shrimp	*Palaemonetes vulgaris*
Heavy Marsh Crab	*Sesarma reticulatum*
Horseshoe crab	*Limulus polyphemus*
Jacknife Clam	*Ensis directus*
Larvae	*Cyprinotus inconruens*
Long Clawed Hermit Crab	*Pagarus longicarpus*
Meadow Slug	*Deroceras laeve*
Mottled Dog Whelk	*Nassarius vibex*

Common Name	Scientific Name
Mouse-ear Ovatella	*Ovatella myosotis*
Mud Crab	*Panopeus herbstii*
Netted Slug	*Deroceras reticulatum*
Northern Dwarf Tellin	*Tellina agilis*
Northern Quahog/Hardshell Clam	*Mercinaria mercenaria*
Ostracod	*Ostracoda spp.*
Ovate Vertigo	*Vertigo ovata*
Pewter Physa	*Physella heterostropha*
Pygmy Fossaria	*Fossaria parva*
Ribbed Mussel	*Geukensia demissa*
Rotifer	*Philodina roseola*
Rough Periwinkle	*Littorina saxatilis*
Softshell Clam	*Mya arenaria*
Spotted Leopard Slug	*Limax maximus*
Stout Tagelus	*Tagelus plebeius*
Thick Lipped Drill	*Eupleura caudata*
Tube Worm	*Hydroides elegans*
Two Sutured Odostome	*Boonea bisuturalis*
Water flea	*Bosmina spp.*
Water flea	*Chydons spp*.
Water flea	*Cladocera spp,*
Water flea	*Daphnia pule*x
Wharf Crab	*Sesarma cinereum*

Common Name	Scientific Name
White Slippershell	*Crepidula plana*

REFERENCES

National Park Service. 2007. Jamaica Bay Bioblitz, September 7-8, 2007. Jamaica Bay Institute. Data available online at: https://www.nps.gov/gate/jamaica-bay bioblitz.htm#CP_JUMP_3604782 .

U.S. Fish and Wildlife Service. 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. U.S. Fish and Wildlife Service, Southern New England, New York Bight Coastal Ecosystems Program, Charlestown, RI.

APPENDIX F

Jamaica Bay Insect, Moth, and Butterfly Species

Table 1. The insects, skippers and butterflies found within Jamaica Bay (Compiled from: U.S. Fish and Wildlife Service 1997, National Park Service 2007, New York State Department of State 1992, Waldman 2008).

Species Common Name and Scientific	Species Common Name and Scientific Name
5-Banded Tiphid Wasp (*Myzinum quinquecinctum*)	Bent-winged Owlet (*Bleptina caradrinalis*)
Abagrotis spp. (*Abagrotis cupida*)	Black Saddlebags Dragonfly (*Tramea lacerata*)
Ailanthus Webworm Moth (*Atteva punctella*)	Black Swallowtail (*Papilio polyxenes*)
Ambiguous Moth (*Lascoria ambigualis*)	Black Widow Spider (*Latrodectus mactans*)
American Copper Butterfly (*Lycaena phlaeas*)	Black-banded Brocade (*Oligia modica*)
American Hover Fly (*Metasyrphus americanus*)	Blackberry Looper Moth (*Chlorochlamys chloroleucaria*)
American Idia (*Idia americalis*)	Blow Fly (*Phaenicia sericata*)
American Lady Butterfly (*Vanessa virginiensis*)	Blue Dasher Dragonfly (*Pachydiplax longipennis*)
Angular Wing Katydid (*Microcentrum retinerve*)	Bristly Cutworm Moth (*Lacinipolia renigera*)
Annual/Dog Day Cicada (*Tibicen canicularis*)	Broadwinged Skipper Butterfly (*Poanes viator*)
Appalachian azure (*Celastrina neglectamajor*)	Brown Sting Bug (*Euschistus spp.*)
Arcigera Flower Moth (*Schinia arcigera*)	Brown-collared Dart (*Protolampra brunneisollis*)
Armyworm Moth (*Mythimna unipuncta*)	Bumble Bee (*Megabombus pensylvanicus*)
Asiatic Garden Scarab Beetle (*Maladera castaneawas*)	Bumble Bee Moth (*Hermaris diffinis*)
Bee (*Agapostemon splendens*)	Cabbage Webworm Moth (*Hellula rogatalis*)
Bee (*Apis mellifera*)	Cabbage White Butterfly (*Pieris rapae*)
Bee (*Ausochlora pura*)	Caddishfly (*Trichoptera spp.*)
Bee (*Bombus citrinus, B. griseocollis, B. impatiens*)	Camphorweed Flower Moth (*Schinia nubila*)
Bee (*Cerutina calcarata*)	Carabidae Beetle (*Catadromus lacordairei*)

Species Common Name and Scientific	Species Common Name and Scientific Name
Bee (*Halictus ligatus, H. affinis, H. mesillae, B. modestus*)	Carpenter Bee (*Xylocopa virginica*)
Bee (*Lasioglossum marinum, L. spp., L. vierecki*)	Carrion Beetle (*Nicrophorus marginatus*)
Bee (*Masachile centuncularis*)	Celery Leaf Tier Moth (*Udea rubigalis*)
Bee (*Mesachile mendica*)	Celery Webworm Moth (*Nomophila nearctica*)
Bee (*Perdita swenki*)	Centipede (*Scolopendra spp*.)
Beetle (*Rhipiphorus spp*.)	Checkered White Butterfly (*Pontia protodice*)
Bent-line Carpet (*Orthonama centrostrigaria*)	Chernetid (*Chthoniidae spp*.)
Chickweed Geometer (*Haematopis grataria*)	Drab Brown Wave (*Lobocleta ossularia*)
Cicada Killer (*Sphecius speciosius*)	Drone Fly (*Eristalis tenax*)
Cicada Spp.	Earthworm (*Lumbricus terrestris*)
Citrine Forktail (*Ischnura hastata*)	Eastern Pond Hawk Dragonfly (*Erythemis simplicicollis*)
Clouded Sulfur Moth (*Colias philodice*)	Eastern Tailed Blue Butterfly (*Everes comyntas*)
Cloudless Sulfur Moth (*Pheobis sennae*)	Elegant Crab Spider (*Xysticus elegans*)
Clover Looper Moth (*Caenurgina crassiuscula*)	Elongated Long-Jawed Orbweaver (*Araneus spp*.)
Clubfoot Dragonfly (*Gamhidae spp*.)	European Earwig (*Forficula auricularia*)
Common Black Ground Beetle (*Pterostichus spp*.)	Faint-spotted Palthis (*Palthis asopialis*)
Common Buckeye Butterfly (*Junonia coenia*)	Fall Webworm Moth (*Hyphantria cunea*)
Common Eupithecia (*Eupithecia miserulata*)	Familiar Bluet Damselfly (*Enallagma civile*)
Common Forktail Damselfly (*Ischnura verticalis*)	Field Cricket (*Gryllus pensylvanicus*)
Common Gray (*Anavitrinella pampinaria*)	Fiery Skipper Butterfly (*Hylephila phyleus*)
Common Idia Moth (*Idia aemula*)	Flatid Planthopper (*Anormenis spetentrionalis*)
Common Pinkband (*Ogdoconta cinereola*)	Florida Tetanolita (*Tetanolita floridana*)

Species Common Name and Scientific	Species Common Name and Scientific Name
Common Sprageua (*Spragueia leo*)	Forage Looper Moth (*Caenurgina erechtea*)
Common Tan Wave (*Pleuroprucha insulsaria*)	Forest Wolf Spider (*Lycosa gulosa*)
Confused Eusarca (*Eusarca confusaria*)	Fragile Forktail Damselfly (*Ischnura posita*)
Corn Earwom Moth (*Helicoverpa zea*)	Funnel Spider (*Agelenidae spp.*)
Crab Spider (*Thomisidae*)	Garden Tortrix (*Clepsis peritana*)
Crambid sp. (*Parapediasia*)	Garden Webworm Moth (*Achyra rantalis*)
Daddy Longlegs (*Phalangiidae spp.*)	Gasteruptiidae (*Gasteruptiidae spp.*)
Damsel Fly (*Zygoptera*)	Giant Leopard Moth (*Hypercompe scribonia*)
Darkling Beetle (*Alabates pennsylvanica*)	Giant Swallowtail Butterfly (*Papilio cresphontes*)
Deerfly (*Chrysops spp.*)	Glossy Black Idia (*Idia lubicalis*)
Differential Grasshopper (*Melanoplus differentialis*)	Goldenrod Crab Spider (*Misumena vatia*)
Dingy Cutworm Moth (*Feltia jaculifera*)	Grateful Midget (*Elaphria grata*)
Gray Hairstreak Butterfly (*Strymon melinus*)	Locust Borer (*Megacyllene robiniae*)
Green Cloverworm Moth (*Plathypena scabra*)	Long Legged Fly (*Dolichopus longipennis*)
Green Darner Dragonfly (*Anax junius*)	Longhorned Beetle (*Parandra brunnea*)
Green Lacewing (*Chrysopa ornata*)	Lunate Zale Moth (*Zale lunata*)
Green Lyssomanes (*Lyssomanes viridis*)	Mantidfly (*Mantispidae spp.*)
Green Peach Aphid (*Myzus persicae*)	Master's Dart (*Feltia herilis*)
Green Stink Bug (*Acrosternum hilare*)	Mayfly (*Ephemeroptera spp.*)
Halictid Bee (*Augochloropsis metallica*)	Migrating Grasshopper (*Melanoplus sanguinipes*)
Hawaiin Beet Webworm Moth (*Spoladea recurvalis*)	Mining Bee (*Andrena spp.*)
Homoptera Red/Green Hopper Bug (*Comellus comma*)	Minor Angle (*Semiothisa minorata*)
House Fly (*Musca domestica*)	Miranda Moth (*Proxenus miranda*)

Species Common Name and Scientific	Species Common Name and Scientific Name
Hummingbird Sphinx Moth (*Hemaris thysbe*)	Monarch Butterfly (*Danaus plexippus*)
Ichneumon (*Ichneumonidae spp*.)	Mosquito (*Anopheles spp*.)
Implicit Arches (*Lacinipolia implicata*)	Nebraska Conehead (*Neoconocephalus nebrascensis*)
Ipsilon Dart (*Agrotis ipsilon*)	no common name (*Crambus praefectellus*)
Jumping Spider (*Salticidae*)	no common name (*Dolichomia olinalis*)
June Beetle (*Phyllophaga spp*.)	no common name (*Glaphyria sequistrialis*)
Juniper Geometer (*Patalene olyzonaria*)	no common name (*Loxostege cereralis*)
Knee-joint Dart (*Trichosilia geniculata*)	no common name (*Microcrambus elegans*)
Lady Bug (*Coccinelliae spp*.)	no common name (*Mythimna oxygala*)
Large Lace-boarder Moth (*Scopula limboundata*)	no common name (*Promalactis suzukiella*)
Large Maple Spanworm Moth (*Prochoerodes*	no common name (*Pyrausta rubricalis*)
Large Milkweed Bug (*Oncopeltus fasciatus*)	no common name(*Hypenodes palustrus*)
Large Yellow Underwing (*Noctua pronuba*)	Olethreutine sp.
Leaf Beetle (*Calligrapha spp*.)	Olive-shaded Bird-dropping M. (*Tarachidia candefacta*)
Lesser Grapevine Looper Moth (*Eulithis*	Orange Sulfur Butterfly (*Colias eurytheme*)
Lesser Vagabond Crambus (*Agriphila ruricolella*)	Orbweaver (*Araneus spp*.)
Pale Lichen Moth (*Crambidia pallida*)	Small Milkweed Bug (*Lygaeus kalmii*)
Parsitic Wasp (*Ischumonidae*)	Smoky Tetanolita (*Tetanolita mynesalis*)
Pearl Crescent Butterfly (*Phycoides tharos*)	Snout Butterfly (*Libythea carinenta*)
Pecks Skipper Butterfly (*Plites peckius*)	Snowy Dart (*Euagrotis illapsa*)
Pepper-and-salt Geometer (*Biston betularia*)	Snowy Tree Cricket (*Oecanthus fultoni*)
Phragmites Wainscot (*Leucania phragmitidicola*)	Sod Webworm Moth (*Pediasia trisecta*)
Pillbug (*Armadillidium vulgare*)	Soft-lined Wave (*Scopula inductata*)

Species Common Name and Scientific	Species Common Name and Scientific Name
Pink-barred Lithacodia (*Lithacodia carneola*)	Somber Carpet (*Disclisioprocta stellata*)
plume moth (*Emmelina monodactyla*)	Sorghum Webworm Moth (*Nola sorghiella*)
Praying Mantis (*Mantis religiosa*)	Southern Emerald (*Synchlora frondaria*)
Predaceous Diving Beetle spp.	Southern Green Sting Bug (*Nezara viridula*)
Ramburs Forktail Damselfly (*Ischnura ramburii*)	Sphinx Moth (*Hiles lineata*)
Red Admiral Butterfly (*Vanessa atalata*)	Spider Wasp (*Pompilidae spp*.)
Red Banded Hairstreak Butterfly (*Calycopis cecrops*)	Spotless Ninespotted Ladybug/Beetle (*Coccinella*
Red Saddlebags Dragonfly (*Tramea carolina*)	Spotted Beet Webworm Moth (*Hymenia perspectalis*)
Red Spotted Purple Butterfly (*Limenitis arthemis*)	Spotted Datana (*Datana perspicua*)
Red-Tailed Ichneumon (*Scambus hispae*)	Stilt bug (*Berytidae spp*.)
Ruddy Quaker (*Protorthodes oviduca*)	Subgothic Dart (*Feltia subgothica*)
Rustic Quaker (*Orthodes crenulata*)	Summer Azure Butterfly (*Celastrina neglecta*)
Sachem Skipper Butterfly (*Atalopedes campestris*)	Swarthy Skipper Butterfly (*Nastra Iherminier*)
Salt Marsh Caterpillar Moth (*Estigmene acrea*)	Syrphid Fly (*Allograpta obliqua*)
salt marsh skipper (*Panoquina panoquin*)	Tawny Emperor (*Asterocampa clyton*)
Sawfly (*Sawfly spp*.)	Tent Caterpilar (*Tolype*)
Seed Bug (*Lygaeidae sp*.)	The Gem (*Orthonama obstipata*)
Showy Emerald (*Dichorda iridaria*)	The Slowpoke (*Anorthodes tarda*)
Skimmer Dragonfly (*Libellulidae spp*.)	The Sweetheart (*Catocala amatrix*)
Slender Clear Wing Moth (*Hemaris gracilis*)	Wheat-head Armyworm Moth (*Faronta diffusa*)
Tricosa Dart (*Feltia tricosa*)	white m hairstreak (*Parrhasius m-album*)
Tufted Apple Budworm (*Platynota idaeusalis*)	Woolly Bear (*BeetleIsia isabella*)
Twelve Spotted Skimmer Dragonfly (*Libellua*	Woolly Pine Adelgid (*Pineus spp*.)

Species Common Name and Scientific	Species Common Name and Scientific Name
Unicorn Catepillar (*Schizura unicornis*)	Yellow Deerfly (*Chrysops vittatus*)
Ursula Wainscot (*Leucania ursula*)	Yellow Jacket (*Vespula maculifrons*)
Vagabond Crambus (*Agriphila vulgivagella*)	Yellow-striped Armyworm Moth (*Spodoptera ornithogalli*)
Variegated Leafroller (*Platynota flavedana*)	Zabulon Skipper Butterfly (*Poanes zabulon*)
Velvet Ant (*Dasymutilla occidentalis*)	Wasp (*Vespula spp*.)
Veriegated Fritillary Butterfly (*Euptoieta claudia*)	Wasp (*Oxybelus psp*.)
Viceroy Butterfly (*Limenitis archippus*)	Wasp (*Pemphredonini spp*.)
Violet Dancer Damselfly (*Argia violacea*)	Wasp (*Podulonia spp*.)
Wasp (*Crabronini spp*.)	Wasp (*Polistes dominulus*)
Wasp *(Eumenes fruternus, Eumeninae spp.*)	Water Strider (*Gerridae spp*.)
Wasp (*Isodontia mexicana*)	Wavy-lined Emerald (*Synchlora aerata*)
Wasp (*Monodontia quadridens*)	Wheat Head Armyworm Moth (*Faronta diffusa*)
Wasp (*Tachyles spp*.)	

REFERENCES

National Park Service. 2007. Jamaica Bay Bioblitz, September 7-8, 2007. Jamaica Bay Institute. Data available online at: https://www.nps.gov/gate/jamaica-bay bioblitz.htm#CP_JUMP_3604782 .

New York State Department of State. 1992. *Jamaica Bay Significant Coastal Fish and Wildlife Habitats*. NYS Department State Office of Planning and Development. Available online at: https://www.dos.ny.gov/opd/programs/consistency/Habitats/nyc/Jamaica_Bay.pdf.

U.S. Fish and Wildlife Service. 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. U.S. Fish and Wildlife service, Southern New England, New York Bight Coastal Ecosystems Program, Charlestown, RI.

Waldman, J. 2008. *Research Opportunities in the Natural and Social Sciences at the Jamaica Bay Unit of Gateway National Recreation Area*. Prepared for the National Park Service, Jamaica Bay Institute. Queens College, Biology Department, Flushing, NY.

APPENDIX G

Army Corps of Engineers' Responses to Draft Fish and Wildlife Coordination Act Report

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK
10278-0090

Environmental Analysis Branch

November 16, 2018

Mr. David Stilwell
Field Supervisor
U.S. Fish and Wildlife Service 3817
Luker Road
Cortland, New York 13045

Dear Mr. Stilwell:

The U.S. Army Corps of Engineers (USACE), New York District (District) is in receipt of your draft FWCAR, dated October 2018 submitting recommendations on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Study.

Please find attached our responses to your Planning and Mitigation Recommendations. The District looks forward to working with your office throughout the Pre-Engineering and Design and Construction phases of this study and thank you for your continued assistance and input to this process which helps to advance the execution of this regionally-significant project.

If you require any additional information, please feel free to contact Ms. Daria Mazey Project Biologist/Planner at 917-790-8726.

Sincerely,

WEPPLER.PETER.M.1228647353

Digitally signed by WEPPLER.PETER.M.1228647353
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=WEPPLER.PETER.M.1228647353
Date: 2018.11.15 13:19:13 -

Peter Weppler
Chief, Environmental Analysis Branch

USACE concurs with the Service's overall Planning and Mitigation Recommendations. We are committed to coordination and collaborating with FWS to advance our joint goals and obligations to ensure environmental protection and sustainability, and we offer responses to specific Recommendations, as follows:

XII. Service Planning and Mitigation Recommendations

B. Planning Recommendations

1. Habitat Loss, Degradation, and Fragmentation

FWS Recommendation: "*An adaptive management plan for mitigation measures should be developed to ensure implementation and success. Further coordination with the Service under a separate scope of work will be necessary to achieve this goal.*"

Response: Habitat mitigation is not associated with the proposed project. As part of the integrated approach for the Rockaway/Jamaica Bay study, the District considered human and ecosystem community resilience as part of the overall solution to manage risk associated with the high frequency flood areas. To minimize erosion, maximize stability and longevity, and attenuate wave energy that could cause scour within the locations of the HFFRRFs, the NED Plan has been designed to minimize and in some areas preserve the functional effectiveness of the bayside habitat.

In the Pre-Construction and engineering/design (PED) phase, further evaluation will be undertaken to minimize impacts associated with the project. If it is determined that there will be mitigation, the District will working with the resource agencies for the appropriate mitigation measure(s) per ER 1105-2-100, Planning Guidance Notebook.

3. Wildlife Management

FWS Recommendation: "*In accordance with the 2003 MOA entitled, "Aircraft-Wildlife Strikes," and the subsequent 2007 circular entitled, "Hazardous Wildlife Attractants on or Near Airports," the Corps should commence coordination with the Service and the FAA for activities in close proximity to JFK Airport so that the NNBFs can be sited and designed without creating hazardous conditions for aircraft."*

Response: In accordance with the FAA Advisory Circular 150/5200-33B and the Memorandum of Agreement with FAA to address aircraft-wildlife strikes, when considering proposed flood risk management measures and mitigation areas, USACE must take into account whether the proposed action could increase wildlife hazards. The FAA recommends minimum separation criteria for land-use practices that attract hazardous wildlife to the vicinity of airports. These criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure airspace or air operations area (AOA).

These separation criteria include:

- Perimeter A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000 feet from the nearest AOA;
- Perimeter B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000 feet from the nearest AOA; and
- Perimeter C: Five-mile range to protect approach, departure, and circling airspace.

As stated, the closest airport to the study area that must comply with these standards is the John F. Kennedy International Airport, Queens County, New York. The natural features in the recommended alternative are within the limits of the 5-mile perimeter of the airport, and as designed are note expected to introduce hazardous wildlife attractants. Also, the habitat acreage created is not large enough provide nesting habitat for the potential species that cause hazards. The District will confirm these designs with the FAA and PANYNJ.

4. Environmental Contaminants

FWS Recommendation: "*We recommend pre-construction monitoring for sediment contaminants at the locations of the NNBFs. Construction should not proceed without prior screening for contaminants. If concentrations of contaminants in sediment exceed acceptable thresholds, biological testing and/or remediation may be necessary."*

Response**:** Hazardous, Toxic and Radioactive Waste (HTRW) can occur within the urban environment such as NYC. In the PED phase, a scope of work will be prepared to conduct specific testing for HTRW in the HFFRRF areas. If it is determined, during sampling that HTRW contamination exists, the District will assess if the project can be realigned to avoid the contaminated site. In accordance with ER 1165-2-132, if the project alignment cannot be revised, the project's non-Federal sponsor would be responsible for the removal of any contaminants to allow the construction of the alignment. The non-federal sponsor will conduct, at 100 percent their expense, those remedial activities necessary to remove contaminated materials in accordance with ER 1165-2-132. USACE will continue to coordinate with all parties, including the State of New York, City of New York, and NPS.

C. Mitigation Recommendations

1. Habitat Loss and Modification

b. Composite Seawall

FWS Recommendation: "*As it is designed, the landward side of the composite seawall is exposed at the crest of the dune. Based on the current project description, it appears this would result in the loss of approximately 9 ac of sandy maritime dune habitat that may serve as has habitat for beach-nesting birds. The Corps should mitigate for this loss of habitat."*

Response. During PED, the District will evaluate potential options of covering the exposed portion of the composite seawall.

e. HFFRRFs: Shoreline Armoring

FWS Recommendation: "*The Service requests that further consideration is given to the proposed construction of bulkhead along the shoreline of Thursby Basin Park on the western shore of Sommerville Basin. We recommend evaluating the feasibility of a structure further landward around the perimeter of the undeveloped lot, instead of hardening the shoreline at this location."*

Response: During PED, the alignment of hard structures will be located to minimize impacts to sensitive areas.

f. HFFRRFs: Natural and Nature Based Features

FWS Recommendation: "*Recognizing the impacts of nourishment on beach invertebrates and shorebird foraging, and that renourishment is scheduled to occur every four years for the life of the project, we recommend that Corps mitigate by creating potential shorebird foraging habitat elsewhere within the Study Area."*

Response: It is acknowledged that beach nourishment results in short-term declines in abundance, biomass, and taxa richness. However, studies within the NY/NJ Bight have shown recovery of intertidal assemblages are complete within 2-6.5 months of the conclusion of filling. Differences in the rate of recovery were most likely due to differences in when nourishment was complete. Recovery was the quickest when filling was completed before the low point in the seasonal cycle of infaunal abundance. It is important that the grain size of the fill material matched that of the beaches to be nourished.

D. Enhancement Opportunities

FWS Recommendation: "*A number of areas of saltmarsh habitat along the north shore of the Rockaway Peninsula were identified as potential restoration areas in the Corps' Jamaica Bay Navigational Channels and Shoreline Environmental Surveys Final Report (U.S Army Corps of Engineers 1997). Some of these areas are within or adjacent to the proposed HFFRRFs. The Corps may consider restoring saltmarsh and other coastal communities in these areas in order to provide added habitat for fish and wildlife.*"

Response: The purpose of this study was to provide coastal storm risk management measures to the study area. The Hudson Raritan Estuary Ecosystem Restoration Study will be focusing and recommending restoration opportunities within the Jamaica Bay Planning Region.

APPENDIX H

NOAA Fisheries' Comments on Draft Fish and Wildlife Coordination Act Report

NOAA Fisheries transmitted the following comments and attachment to the Service via e-mail on December 6, 2018:

The report was comprehensive and very thorough. We just have a few comments:

1) Please update the URL for our EFH mapper in your document. Here's the link: https://www.fisheries.noaa.gov/resource/map/essential-fish-habitat-mapper
The URL that you have listed is an old one from several years ago. Also, I have attached our scoping letter so that you can see the species that the mapper picked up (including highly migratory species) to revise/update your list.

2) Also in our attached scoping letter you'll see at the end of the letter some up-to-date information on NOAA MMPA and ESA species to check against the info in your report. That information is directly from our Protected Resources Division.

E-mail Attachment:

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive Gloucester, MA 01930-2276

OCT 3 1 2018

Peter Weppler
Chief Environmental Analysis Branch Planning Division
New York District
U.S. Army Corps of Engineers 26 Federal Plaza
New York, NY 10278-0900

RE: Draft Final Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement, Essential Fish Habitat Assessment Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Dear Mr. Weppler:

We have reviewed the Draft Final Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (DEIS) and essential fish habitat (EFH) assessment for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study. The project area includes the Atlantic coast of New York City between East Rockaway Inlet and Rockaway Inlet, areas within Jamaica Bay, and an offshore borrow area.

The report addresses the reevaluation of solutions to flooding attributed to storm surges in Jamaica Bay that inundate the bay shorelines of Rockaway (back bay flooding) and that overtop the Rockaway beachfront and flow across the peninsula to meet the surge into Jamaica Bay (cross shore flooding). The Recommended Plan (RP) has been formulated with two planning reaches, including 1) a reinforced dune and berm construction on the Atlantic shorefront and 2) high frequency flood risk reduction features (HFFRRF) in locations surrounding Jamaica Bay.

The Atlantic shorefront planning reach includes Rockaway Beach between Beach 9th Street and Beach 169th Street and an offshore borrow area in the Atlantic Ocean. The RP includes beach renourishment and construction of a 60 ft. wide beach berm for the length of the reach resulting in approximately 259 acres of dune and beachfill, as well as beach renourishment on a four year cycle for the 50-year life of the project. An approximately 33,000 If composite seawall, extension of five existing groins and construction of 13 new groins are also proposed. The sand material for beach fill and berm construction will be dredged from an existing, 1830-acre offshore borrow area, two miles south of East Rockaway in waters depths of 35 - 60 feet.

The HFFRRF planning reach consists of flood control subreaches in Cedarhurst-Lawrence, Motts Basin North, Mid-Rockaway- Edgemere, Mid-Rockaway - Arveme, and Mid-Rockaway

- Hammels. The RP for all of these subreaches includes construction of 11 acres of rock sills and 5,250 lf of bulkhead, modification of existing and construction of new stormwater outfalls and culverts, and installation of pump stations. The rock sills are components of natural and nature-based features (NNBFs) proposed for the Mid-Rockaway- Edgemere and Mid-Rockaway- Arverne subreaches, Tidal marsh habitats with upland buffers will be created, restored or enhanced shoreward of the sills and will be designed to allow their shoreward migration with rising sea levels.

Magnuson Stevens Fisheries Management and Conservation Act (MSA)

The project area has been designated as EFH for a number of federally managed species including Atlantic butterfish *(Peprilus triacanthus),* Atlantic mackerel *(Scomber scombrus),* Atlantic sea herring *(Clupea harengus),* black sea bass *(Centropristis striata),* bluefish *(Pomatomus saltatrix),* clearnose skate *(Raja eglanteria),* cobia *(Rachycentron canadum),* king mackerel *(Scomberomorus cavalla),* little skate *(Leucoraja erinacea),* long-finned inshore squid *(Loligo pealei),* monkfish *(Lophius americanus),* red hake *(Urophycis chuss),* scup *(Stenotomus chrysops),* Spanish mackerel *(Scomberomorus maculates),* summer flounder *(Paralichthys dentatus),* whiting *(Merluccius bilinearis),* windowpane flounder *(Scophthalmus aquosus),* winter flounder *(Pseudopleuronectes americanus),* winter skate *(Leucoraja ocellata)* and others.

The project area is also EFH for several highly migratory species including blue shark *(Prionace glauca),* dusky shark *(Carcharhinus obscurus),* sandbar shark *(Carcharhinus plumbeus),* and sand tiger shark (*Odontaspis taurus).* Sand tiger and dusky sharks have also been designated as Species

of Concern by NOAA. Species of Concern are those about which we have concerns regarding their status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act (ESA). The goal of designating a species as a Species of Concern is to promote proactive conservation efforts for these species in order to preclude the need to list them in the future.

The MSA requires federal agencies to consult with us on projects such as this that may affect EFH adversely. This process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments, lists the required contents of EFH assessments, and generally outlines each agency's obligations in this consultation procedure.

The EFH final rule published in the Federal Register on January 17, 2002 defines an adverse effect as "any impact which reduces the quality and/or quantity of EFH" and further states that:

> An adverse effect may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystems components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

We have reviewed the EFH assessment for this project. The assessment adequately evaluates many of the impacts of the project on EFH in the Atlantic shorefront and Jamaica Bay project reaches, and we agree with your conclusions on those impacts. However, some information, such as a full evaluation of impacts of dredging on the borrow area, was not provided. We understand that at this stage of the planning process, site specific information and design details are not yet available; as a result additional coordination and consultation will take place during the Preconstruction, Engineering and Design Phase of the project so our EFH conservation recommendations provided in this letter can be refined.

The Atlantic shorefront project plan includes seawall and groin construction, dredging and beach renourishment that will result in 259 acres of dune and beach fill with subsequent renourishment efforts every four years. The NNBF rock sills constructed as part of the Jamaica Bay HFFRRF project have been designed to control erosion, help manage coastal storm risk, and provide opportunities for habitat restoration and enhancement. Construction of the sills will result in a habitat conversion of 11 acres of unconsolidated bottom to hard structure in two sub-reaches. Tidal marshes will be created, restored, or enhanced shoreward of the sills in eroded and/or degraded subtidal and intertidal habitats, and will be designed to allow their shoreward migration with rising sea levels. Construction of the NNBFs will create a mix of low and high marsh habitat and upland buffers that will have a positive effect on EFH, federally managed species and NOAA trust resources.

In the DEIS it states that as HFFRRF features are further developed, additional NEPA documentation and resource agency coordination would be provided, as necessary. We agree with this process. Also, impacts to EFH for longfin inshore squid in the borrow area were not fully evaluated because you were not aware of new research examining squid spawning in the area offshore of Long Island. We will continue to coordinate with your office to further evaluate

impacts to EFH of longfin inshore squid in the borrow area, including providing additional EFH conservation recommendations as necessary.

Aquatic Resources

Long/in Inshore Squid
Longfin inshore squid spawn throughout the New York Bight; early life stages are found in coastal waters and throughout Jamaica Bay. Egg masses are demersal and are typically attached to low-relief structure (e.g. rocks, small boulders) on sandy or muddy substrate in water depths less than 50 feet (Jacobson 2005). Recent research indicates that spawning may be concentrated in coastal waters off of the Rockaway peninsula (D. Stevenson, personal communication, 2018), which could result in increased vulnerability to EFH of longfin inshore squid to dredging operations. Our office is currently investigating the locations of highest egg mass concentration, seasonal occurrence, and egg mass residence time to better define EFH, in order to evaluate dredging impacts to the species in the Atlantic shorefront borrow area.

Shellfish
Surf clam *(Spisula solidissima),* razor clam *(Ensis directus),* and tellin *(Tellina agillis)* occur in the vicinity of the offshore borrow area. Shellfish also occur in the Jamaica Bay portion of the project area, including hard clam *(Mercenaria mercenaria),* soft shell clam *(Mya arenaria),* blue mussel *(Mytilus edulis),* oyster *(Crassostrea virginica),* blue crab *(Callinectes sapidus),* and horseshoe crab *(Limulus polyphemus).*

Coen and Grizzle (2007) discuss the ecological value of shellfish habitat to a variety of managed species (e.g. American lobster, American eel, and winter flounder) and have suggested its designation as EFH for federally managed species. Clams are a prey species for a number of federally managed fish including skates, bluefish, summer flounder and windowpane; siphons of hard clams provide a food source for winter flounder and scup (Steimle et al. 2000). Infaunal species such as clams filter significant volumes of water, effectively retaining organic nutrients from the water column (Nakamura and Kerciku 2000; Forster and Zettler 2004).

Horseshoe crabs may use multiple habitats along the shoreline of the Jamaica Bay reach, including subtidal bottoms, intertidal mudflats, and sandy beaches (Botton et al. 2006). Their eggs are a key seasonal food resource for a number of fish species including summer flounder and winter flounder (Botton and Shuster 2003); as a prey species, horseshoe crabs are considered EFH for those fishes.

Winter flounder
Winter flounder transit inlets such as East Rockaway Inlet to reach spawning areas within mid-Atlantic estuaries when water temperatures begin to decline in the fall. Tagging studies show that most return repeatedly to the same spawning grounds (Lobell 1939, Saila 1961, Grove 1982 in Collette and Klein-MacPhee 2002). Winter flounder typically spawn in the winter and early spring, although the exact timing is temperature dependent and thus varies with latitude (Able and Fahay 1998), however movement into these spawning areas may occur earlier, generally from mid- to late November through December. Winter flounder have demersal eggs that sink and remain on the bottom until they hatch. After hatching, the larvae are initially planktonic, but following metamorphosis they assume an epibenthic existence. Winter flounder larvae are negatively buoyant (Pereira et al. 1999) and are typically more abundant near the bottom (Able and Fahay 1998). These life stages are less mobile

and thus more likely to be affected adversely by any impact to benthic habitat. As adults often spawn in shallow water within estuaries such as Jamaica Bay, they are especially vulnerable to benthic impacts associated with construction of the NNBFs in the Jamaica Bay HFFRRF reach.

Anadromous Fishes
Anadromous fishes such as river herring (alewife *Alosa pseudoharengus* and blueback herring *Alosa aestivalis)* use inlets such as East Rockaway Inlet as a migratory pathway to nursery and forage habitat within the estuary beyond the inlet. Alewife and blueback herring spend most of their adult life at sea, but return to freshwater areas to spawn in the spring. Both species are believed to be repeat spawners, generally returning to their natal rivers (Collette and Klein- MacPhee 2002). Because landing statistics and the number of fish observed on annual spawning runs indicate a drastic decline in alewife and blueback herring populations throughout the mid- Atlantic since the mid-1960's (ASMFC 2007), they have been designated as Species of Concern by NOAA.

Increases in turbidity due to the resuspension of sediments into the water column during renourishment can degrade water quality, lower dissolved oxygen levels, and potentially release chemical contaminants bound to the fine-grained estuarine/marine sediments, and can impede river herring migration (Auld and Schubel 1978; Breitburg 1988; Newcombe and MacDonald 1991; Burton 1993; Nelson and Wheeler 1997). Noise from beach renourishment activities may also result in adverse effects. Our concerns about noise effects come from an increased awareness that high-intensity sounds have the potential to harm both terrestrial and aquatic vertebrates (Fletcher and Busnel 1978; Kryter 1984; Popper 2003; Popper et al. 2004). Buckel and Conover (1997) in Fahay et al. (I 999) reported that diet items of juvenile bluefish include *Alosa* species such alewife and blueback herring. Juvenile *Alosa* species have also been identified as prey species for windowpane flounder and summer flounder in Steimle et al. (2000). As a result, activities that adversely affect the spawning success and the quality for the nursery habitat of these anadromous fish can adversely affect the EFH for juvenile bluefish, windowpane and summer flounder by reducing the availability of prey items.

Wetlands
Jamaica Bay is regionally significant for shellfish and marine, estuarine, and anadromous fishes, as well as for its significant migratory and wintering waterfowl concentrations. The wetlands and uplands in the bay are important as fish nursery areas and foraging areas for shorebirds and waterbirds. Wetlands in the project area perform many important ecological functions including water storage, nutrient cycling and primary production, sediment retention, water filtration or purification, and groundwater recharge. The estuary is subject to severe anthropogenic impacts, and has incurred a loss of 63% of wetlands between 1951 and 2003. During this time period, the rate of marsh loss increased from 17 acres lost per year during 1951 - 1974 to 33 acres lost per year during 1989 - 2003 (NPS 2007). Vegetated wetlands are also considered to be special aquatic sites under the Clean Water Act. Because of their ecological value, impacts on these special aquatic sites should be avoided and minimized; wetlands should be created, restored, or enhanced where feasible.

Tidal wetlands provide nursery habitat for many species of fish, including winter flounder and summer flounder. Summer flounder larvae migrate inshore into estuarine nursery areas, settling to the bottom of tidal marsh creeks to transform to their juvenile stage. These juveniles will then make extensive use of the creeks, preying on creek fauna such as Atlantic silversides and mummichogs. Juvenile summer flounder may also be found in salt marsh cord grass habitat

during flood tides. Juveniles utilize the marsh edges for shelter, burying themselves in the muddy substrates. Keefe and Able (1992) in Packer et al. (1999) found that summer flounder juveniles that inhabit tidal marsh creeks exhibit the fastest growth. Larval and juvenile black sea bass also concentrate and feed extensively and shelter within these habitats. As a consequence, growth rates are high and predation rates are low, which makes these habitats effective nursery areas. Juvenile black sea bass are also known to inhabit the mouths of tidal marsh creeks as well as shallow shoals and tidal marsh edge habitat. Within these habitats, young-of-year black sea bass display high site fidelity; they may be territorial and move very little (Musick and Mercer 1977; Werme 1981; Able and Hales 1997). Black sea bass have been observed defending small areas of nursery habitat rather than fleeing to other suitable areas (Able and Fahay 1998).

An unimpeded marsh edge is important to estuarine and tidal marsh community dynamics, both to allow tidal flushing and concomitant transport of plankton, nekton, nutrients and sediment as well as to enable access to edge habitat by estuarine biota, including federally managed species, diadromous fishes, and other important prey for federally managed species. Marshes and marsh edge habitat can therefore be considered EFH for summer flounder, black sea bass, and other species.

Atlantic Shorefront

Beach Nourishment and Dredging

The dredging of sand for beach nourishment has the potential to impact both the EFH of a particular species as well as the organisms themselves in a variety of ways. Dredging can result in the impingement of eggs and larvae in the dredge plant and create undesirable suspended sediment levels in the water column. As stated above, increased suspended sediment levels can reduce dissolved oxygen, mask pheromones used by migratory fishes, and smother immobile benthic organisms and newly-settled juvenile demersal fish (Auld and Schubel 1978; Breitburg 1988; Newcombe and MacDonald 1991; Burton 1993; Nelson and Wheeler 1997). Sustained water column turbulence can reduce the feeding success of sight-feeding fish such as winter flounder and summer flounder.

Dredging can remove the substrate used by federally managed species as spawning, refuge and forage habitat. Benthic organisms that are food sources for federally managed species may also be removed during dredging. These impacts may be temporary if the substrate returns to preconstruction condition and the benthic community recovers with the same or similar organisms. The impacts may be pe1manent if the substrate is altered in a way that reduces its suitability as habitat, and if the benthic community is altered in a way that reduces its suitability as forage.

Overall, the dredging and placement of sand along the coastline will have some adverse effects on EFH and federally managed species due to the entrainment of early life stages in the dredge, alteration or loss of benthic habitat and forage species, and altered forage patterns and success due to increased, noise, turbidity and sedimentation. We agree that some effects will be temporary and others can be minimized using some of the management practices mentioned in the EFH assessment, such as dredging in the fall to avoid sensitive life stages of certain species, not dredging deep holes and leaving similar substrate in place to allow for recruitment.

Dredging in the borrow area can also affect EFH adversely through impacts to prey species. The EFH final rule states that the loss of prey may be an adverse effect on EFH and managed species because

the presence of prey makes waters and substrate function as feeding habitat; the definition of EFH includes waters and substrate necessary to fish for feeding. Steimle et al. (2000) reported that winter flounder diets include the siphons of surf clams *(Spisula solidissima).* As a result, activities that adversely affect surf clams can adversely affect the EFH for winter flounder by reducing the availability of prey items

According to the DEIS, the offshore borrow area provides habitat for Atlantic surf clams; however surveys conducted by the USACE in 2003 and by the NYSDEC in 2012 indicate that the borrow area itself contains very low to no localized populations of surf clams. To ensure that impacts to surf clams are minimized, the borrow areas should be surveyed prior to each dredging cycle and areas of high densities should be avoided. Copies of the shellfish survey results should also be provided to us prior to any dredging in the borrow area.

The Mid-Atlantic Fisheries Management Council (MAFMC) has developed a policy statement on sand mining and beach nourishment activities that may affect federally managed species under their purview including summer flounder, scup, black sea bass, monkfish and butterfish. These policies are intended to articulate the MAFMC's position on various development activities and facilitate the protection and restoration of fisheries habitat and ecosystem function. The MAFMC's policies on beach nourishment are:

1. Avoid sand mining in areas containing sensitive fish habitats (e.g., spawning and feeding sites, hard bottom, cobble/gravel substrate, shellfish beds).

2. Avoid mining sand from sandy ridges, lumps, shoals, and rises that are named on maps. The naming of these is often the result of the area being an important fishing ground.

3. Existing sand borrow sites should be used to the extent possible. Mining sand from new areas introduces additional impacts.

4. Conduct beach nourishment during the winter and early spring, when productivity for benthic infauna is at a minimum.

5. Seasonal restrictions and spatial buffers on sand mining should be used to limit negative impacts during fish spawning, egg development, young-of-year development, and migration periods, and to avoid secondary impacts to sensitive habitat areas such as SAV.

6. Preserve, enhance, or create beach dune and native dune vegetation in order to provide natural beach habitat and reduce the need for nourishment.

7. Each beach nourishment activity should be treated as a new activity (i.e., subject to review and comment), including those identified under a programmatic environmental assessment or environmental impact statement.

8. Bathymetric and biological monitoring should be conducted before and after beach nourishment to assess recovery in beach borrow and nourishment areas.

9. The effect of noise from mining operations on the feeding, reproduction, and migratory

behavior of marine mammals and finfish should be assessed.

10. The cost effectiveness and efficacy of investments in traditional beach nourishment projects should be evaluated and consider alternative investments such as non-structural response and relocation of vulnerable infrastructure given projections of sea level rise and extreme weather events.

Sand Placement Effects on Fishes
Beach renourishment activities produce turbidity and sound impacts; fish may move away from those impacts in open water but cannot avoid them in inlets and channels. Fish that transit through inlets and channels on spawning migrations are therefore vulnerable to these impacts. As discussed earlier, winter flounder and river herring ingress through inlets to access estuarine spawning habitats. Winter flounder migrate into mid-Atlantic estuaries from mid-November through December. River herring enter these same estuaries on their spawning migrations from early March through May. Because project plans include beach renourishment along Rockaway Beach at East Rockaway Inlet, sequencing of beach nourishment activities may be necessary in order to avoid impacts to ingressing winter flounder and river herring. This may include seasonal in-water work restrictions for winter flounder from November 15 through December 31 and from March 1 to May 31 for river herring. Any in-water work undertaken at the inlet at other times of the year should be designed with 50% of the inlet unobstructed to allow ingress and egress of fish past the work site.

Jamaica Bay HFFRRF

Impacts ofNNBF Construction on EFH
The Jamaica Bay HFFRRF project plan proposing construction of NNBFs in the Edgemere and Arverne subreaches will result in permanent impacts to shallow water and tidal wetland habitat, including EFH for winter flounder. Rock sills are proposed for two subreaches of the Jamaica Bay HFFRRF, including four sections in Edgemere totaling approximately 3100 If and three sections in Arverne totaling approximately 4800 If, with a combined footprint of 11 acres. Tidal marshes will be created, restored, or enhanced shoreward of the proposed rock sills and will be designed to allow their shoreward migration with rising sea levels. We appreciate the Corps' use of NNBFs in this project and encourage their use in future projects when practicable.

The construction of the NNBFs, including rock sills and tidal wetlands, will result in a permanent loss of winter flounder EFH associated within the footprints of the sills and in areas shoreward of the sills due to natural sediment accretion and tidal wetlands creation. Seasonal in- water work restrictions from January 1 to May 31 will minimize impacts to winter flounder early life stages and their EFH during the construction activities and the NNBF features will provide habitat for other aquatic resources.

Impacts to Prey Species
Construction of the NNBFs may impede access by horseshoe crabs to spawning beaches. Horseshoe crab eggs are an important seasonal food source for summer flounder and winter flounder. Seasonal in-water work restrictions in areas suitable for horseshoe crab spawning from April 15 to July 15 minimize adverse effects to this prey species. Shellfish are also prey species for a number of federally managed fish including bluefish, scup, skates, summer flounder, windowpane and winter flounder. Site design and placement of the NNBFs should include an evaluation of shellfish

resources in the project area; NNBFs should not be placed in areas of moderate to high densities of shellfish.

Tidal flushing and access to tidal marsh fringe habitat are important to maintain estuarine and marsh community dynamics; impediments to marsh edge habitat may therefore impact EFH for federally managed species, including winter flounder and summer flounder. Seven rock sills, approximately 350 lf to 2000 lf, are proposed in the Edgemere and Arverne subreaches. The individual sills as proposed appear to be of solid construction, with gaps between each sill but no gaps (vents/windows) within the sills. Vents/windows provide a number of benefits, including facilitating transport of plankton, nekton, sediment and nutrients into aquatic food webs that include federally managed species, diadromous fishes, and other important prey for federally managed species. These openings should generally be 10-15 feet in width, as measured from the bottom, and spaced evenly across the sill (e.g., one every 100 feet). Rock sills without vents/windows placed at regular intervals can severely restrict biological functions and impact the marsh community. Additionally, though rare, displacement of sills either as a whole or as individual elements is a concern in highly dynamic environments.

All living shorelines must be properly maintained, which may require periodic repair of sills/reefs. A long-term maintenance plan should be developed for the proposed NNBFs, including plans to address the potential migration of hardened materials/structures. As we continue to coordinate on this project and plans are developed, information on incorporation of vents/windows and dropdowns into the sill design, overall wetland design, invasive species management, and monitoring, maintenance, and long-term stewardship of the NNBFs should be provided to us.

Essential Fish Habitat Conservation Recommendations

Pursuant to Section 305 (b) (4) (A) of the MSA, we offer the following EFH conservation recommendations to minimize adverse effects to EFH for summer flounder, bluefish, windowpane, little skate and other federally managed species:

Atlantic Shorefront

1. Coordinate with our office to determine impacts of dredging in the borrow area to longfin inshore squid EFH. If warranted, we will provide you with additional EFH conservation recommendations to address impacts to longfin inshore squid as information becomes available. We will work with you to incorporate conservation recommendations into the initial construction or subsequent maintenance dredging events.

2. Reinitiate consultation prior to each dredging event. Notification should be provided to our office prior to commencement of each dredging event and should include the location of the segment to be nourished, volume of sand to be dredged, depth of sand to be removed and the boundaries of the dredging within the borrow area.

3. Design and undertake dredging within the borrow areas in a manner that maintains geomorphic characteristics of the borrow area. Employ best management practices such as not dredging too deeply and leaving similar substrate in place to allow for benthic community recovery.

4. Incorporate MAFMC policies on sand mining and beach nourishment into the final design of this project and its long-term management plan as practicable.

5. Avoid areas of high surf clam densities within the borrow area. To ensure that impacts to surf clams are minimized, the borrow areas should be surveyed prior to each dredging cycle and areas of high densities should be avoided. Copies of the shellfish survey results should also be provided to us prior to any dredging in the borrow area.

6. Avoid turning on the intakes on the dredge plant until the dredge head is in the sediment and turn off before lifting out of the sediment to minimize larval entrainment in the dredge.

7. Provide annual reports to us on the acres of borrow area disturbed, dredging location, cubic yardage removed, depth of removal and post-dredging bathymetry of the borrow area.

8. Avoid beach renourishment activities in East Rockaway Inlet from November 15 to December 31 (winter flounder) and March 1 to May 31 (river herring) of each year to maintain access to estuarine and freshwater spawning habitats. At other times of the year, at least 50 % of the channel should remain unobstructed to allow ingress and egress of these species.

9. Use best management practices to minimize the release of suspended sediments during beach nourishment activities, including placing the material above the spring high tide line at low tide where possible and using turbidity barriers where feasible.

Jamaica Bay HFFRRF

10. Avoid construction of NNBFs below mean low water (MLW) from January 1 to May 31 of each year to minimize impacts to EFH for winter flounder. Work is permissible above MLW when the work area is exposed during low tide cycles.

1I. Avoid construction of NNBFs from April 15 to July 15 of each year to protect horseshoe crab spawning habitat.

12. NNBFs should not be placed in areas of moderate to high shellfish density as practicable.

13. Incorporate vents/windows and dropdowns into rock sill design according to best management practices. Sills should be designed to optimize tidal flow and to ensure that horseshoe crabs do not get trapped behind them.

14. Provide design plans for tidal wetland creation/restoration and enhancement as well as monitoring, maintenance, adaptive management and long-term stewardship plans to us for review prior to construction.

15. Continue to coordinate with us during the Preconstruction, Engineering and Design Phase of the project.

Please note that Section 305 (b)(4)(B) of the MSA requires you to provide us with a detailed written response to these EFH conservation recommendations, including the measures adopted by you for avoiding, mitigating, or offsetting the impact of the project on EFH. In the case of a response that is inconsistent with our recommendations, Section 305 (b)(4)(B) of the MSA also indicates that you must explain your reasons for not following the recommendations. Included in such reasoning would be the scientific justification for any disagreements with us over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate or offset such effect pursuant to 50 CFR 600.920 (k). Please also note that a distinct and further EFH consultation must be reinitiated pursuant to 50 CRF 600.920 (j) if new information becomes available, or if the project is revised in such a manner that affects the basis for the above EFH conservation recommendations.

Endangered Species Act

Atlantic Large Whales

Federally endangered North Atlantic right and fin whales occur year round off the New York coast in the Atlantic Ocean. Right whales are most likely to occur in the offshore borrow areas between November and April and fin whales are most likely to occur between October and January. Right whales feed on copepods and could be foraging in the action area if suitable forage is present; right whales are also likely to occur in the action area while migrating along the Atlantic coast. Fin whale sightings off the eastern United States are centered along the 100m isobath, but fin whales are well spread out over shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1987; Hain et al. 1992). Fin whales feed on small schooling fish, squid, and crustaceans, including krill. Sperm and sei whales are limited to the offshore area beyond the continental shelf.

Sea Turtles

Four species of ESA listed threatened or endangered sea turtles under our jurisdiction are seasonally present off the New York coast in the Atlantic Ocean and could occur in the Rockaway Inlets and Jamaica Bay: the threatened Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead, the threatened North Atlantic DPS of green, and the endangered Kemp's ridley and leatherback sea turtles. Sea turtles typically occur along the Long Island coast from May to mid-November, with the highest concentration of sea turtles present from June through October.

Atlantic Sturgeon

Atlantic sturgeon are present off the New York coast in the Atlantic Ocean and could occur in the Rockaway Inlets and Jamaica Bay. The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPS of Atlantic sturgeon are endangered; the Gulf of Maine DPS is threatened. Adult and subadult Atlantic sturgeon originating from any of these DPSs could occur in the proposed project area. As young remain in their natal river/estuary until approximately age 2, and early life stages are not tolerant of saline waters, no eggs, larvae, or juvenile Atlantic sturgeon will occur within the waters off the New York coast in the Atlantic Ocean or in the Rockaway Inlets and Jamaica Bay.

Shortnose Sturgeon

Shortnose sturgeon are not expected to be present in waters south of Long Island.

As project details develop, we recommend you consider the following effects of the project on whales, sea turtles, and sturgeon:

- For any impacts to habitat or conditions that temporarily render affected water bodies unsuitable for the above-mentioned species, consider the use of timing restrictions for in water work.
- For activities that increase levels of suspended sediment, consider the use of silt management and/or soil erosion best practices (i.e., silt curtains and/or cofferdams).
- Consider the related effects to water quality after an outfall is built (i.e. , will the standards still be met, will the effluent volume change, and will there be any effects to the species).
- For pile driving or other activities that may affect underwater noise levels, consider the use of cushion blocks and other noise attenuating tools to avoid reaching noise levels that will cause injury or behavioral disturbance to sea turtles, and sturgeon - see the table below for more information regarding noise criteria for injury/behavioral disturbance in sturgeon or sea turtles.

Organism	**Injury**	**Behavioral Modification**
Sturgeon	206 dB re 1 µPaPeak and 187 dB cSEL	150 dB re 1 µPaRMS
Sea Turtles	180 dB re I µPaRMS	166 dB re I µPaRMS

Depending on the amount and duration of work that takes place in the water, listed species of whales, sea turtles, and sturgeon may occur within the vicinity of your proposed project. The Corps will be responsible for determining whether the proposed action may affect listed species. If you determine that the proposed action may affect a listed species, you should submit your determination of effects, along with justification and a request for concurrence to the attention of the Section 7 Coordinator, NMFS, Greater Atlantic Regional Fisheries Office, Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930 or nmfs.gar.esa.section7@noaa.gov Please be aware that we have recently provided on our website guidance and tools to assist action agencies with their description of the action and analysis of effects to support their determination. See http://www.greateratlantic.fisheries.noaa.gov/section7. After receiving a complete, accurate comprehensive request for consultation, in accordance to the guidance and instructions on our website, we would then be able to conduct a consultation under section 7 of the ESA. Should project plans change or new information become available that changes the basis for this determination, further coordination should be pursued. If you have any questions regarding these comments, please contact Edith Carson-Supino (978-282-8490; Edith.Carson- Supino@noaa.gov).

We look forward to our continued coordination with your office on this project as it moves forward. We can work with your staff to complete a programmatic consultation for the beach replenishment portion of the project to reduce the need for individual consultations. If you have any questions or need additional information, please do not hesitate to contact Ursula Howson at ursula.howson@noaa.gov or (732) 872-3116.

Sincerely,

Louis A. Chiarella,
Assistant Regional Administrator
for Habitat Conservation

cc:
ACOE- C. Alcoba, D. Mezey
PRO - D. Marrone, E. Carson-Supino
FWS - S. Sinkevich
EPA - D. Montella
NYSDEC- D. McReynolds
NEFMC - T. Nies
MAFMC - C. Moore
ASMFC - L. Havel

Literature Cited

Able, K.W. and M.P. Fahay. 1998. The First Year in the Life of Estuarine Fishes of the Middle Atlantic Bight. Rutgers University Press. New Brunswick, NJ

Able, K.W. and L.S. Hales Jr. 1997. Movements of juvenile black sea bass *Centropristis striata* (Linnaeus) in a southern New Jersey estuary. J. Exp. Mar. Biol. Ecol. 213:153-167.

Atlantic States Marine Fisheries Commission. 2007. Species Profile: shad and river herring: Atlantic states seek to improve knowledge of stock status and protect populations coast wide. www.asmfc.org. Washington, DC.

Auld, A.H. and J.R. Schubel. 1978. Effects of suspended sediments on fish eggs and larvae: a laboratory assessment. Estuar. Coast. Mar. Sci. 6:153-164.

Botton, M.L. And C. N. Shuster. 2003. Horseshoe crabs in a food web: Who eats whom? In C. N. Shuster, R. B. Barlow, and H.J. Brockmann (eds.), The American Horseshoe Crab. Harvard University Press, Cambridge, Massachusetts, pp. 133-153.

Botton, M.L., R.E. Loveland, J.T. Tanacredi, T. Itow. 2006. Horseshoe crabs *(Limulus polyphemus)* in an urban estuary (Jamaica Bay, New York) and the potential for ecological restoration. Estuaries Coasts, 29:820-830.

Breitburg, D.L. 1988. Effects of turbidity on prey consumption by striped bass larvae. Trans. Amer. Fish. Soc. 117: 72-77.

Buckel, *I.A.* and D.O. Conover. 1997. Movements, feeding periods, and daily ration of piscivorous young-of-the-year bluefish, *Pomatomus saltatrix,* in the Hudson River estuary. Fish. Bull. (U.S.) 95(4):665-679.

Burton, W.H. 1993. Effects of bucket dredging on water quality in the Delaware River and the potential for effects on fisheries resources. Prepared for: Delaware Basin Fish and Wildlife Management Cooperative, by Versar Inc, Columbia MD.

Coen LD, Grizzle RE. 2007. The importance of habitat created by molluscan shellfish to managed species along the Atlantic coast of the United States. Atlantic States Marine Fisheries Commission. Habitat Management Series#8.

Collette, B.B. and G. Klein-MacPhee. eds. 2002. Bigelow and Schroeder's fishes of the Gulf of Maine. Smithsonian Institution. Washington, D.C.

Fahay, M.P., P.L. Berrien, D.L. Johnson and W.W. Morse. 1999. Essential Fish Habitat Source Document: Bluefish *Pomatomus sa/tatrix* life history and habitat characteristics. U.S. Dep. Commer., NOAA Technical Memorandum NMFS-NE-144.

Fletcher, J. L. and R. G. Busnel. 1978. Effects of Noise on Wildlife. Academic Press, New York.

Forster S, Zettler ML. 2004. The capacity of the filter-feeding bivalve *Mya arenaria* L. to affect water transport in sandy beds. Marine Biology 144:1183-1189.

Grove, C.A. 1982. Population biology of the winter flounder, *Pseudopleuronectes americanus,* in a New England estuary. M.S. thesis, University of Rhode Island, Kingston, 95 pp.

Hain, J. H. W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The Fin Whale, *Balaenoptera physalus,* in Waters of the Northeastern United States Continental Shelf. Reports of the International Whaling Commission 42:653-669.

Jacobson, L. 2005. Essential fish habitat source document: Longfin inshore squid, Loligo pealeii, life history and habitat characteristics. NOAA Tech Memorandum NMFS- NE- 193. Woods Hole, MA. 52 p.

Keefe, M. and K.W. Able. 1992. Habitat quality in New Jersey estuaries: habitat-specific growth rates in juvenile summer flounder in vegetated habitats. Final Rep. for the New Jersey Dep. of Environmental Protection. Trenton, NJ. 26 p.

Kenney, R.D. and Winn, H.E. 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/slope areas. *Continental Shelf Research,* 7(2):107-114.

Kryter, K D. 1985. The Handbook of Hearing and the Effects ofNoise (2nd ed.). Academic Press, Orlando, Florida.

Lobell, M.J. 1939. A biological survey of the salt waters of Long Island. Report on certain fishes: Winter flounder *(Pseudopleuronectes americanus).* New York Conserv. Dept. 28th Ann. Rept. Suppl., Part I: 63-96.

Musick, J.A. and L.P. Mercer. 1977. Seasonal distribution of black sea bass, *Centropristis striata,* in the Middle Atlantic Bight with comments on the ecology and fisheries of the species. Trans. Am. Fish. Soc. 106:12-25.

Nakamura Y, Kerciku F. 2000. Effects of filter-feeding bivalves on the distribution of water quality and nutrient cycling in a eutrophic coastal lagoon. Journal of Marine Systems 26(2):209- 221.

National Park Service (NPS). 2007. An update on the disappearing salt marshes of Jamaica Bay, New York. Gateway National Recreation Area, National Park Service, Dept. of the

Interior. 78 p.

Nelson, D.A. and J.L. Wheeler. 1997. The influence of dredging-induced turbidity and associated contaminants upon hatching success and larval survival of winter flounder, *Pleuronectes americanus,* a laboratory study. Final report, Grant CWF #321-R, to Connecticut Department Environmental Protection, by National Marine Fisheries Service, Milford CT.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. N. Amer. J. Fish. Manag. 11:72-82.

Packer D.B., S. J. Griesbach, P.L. Berrien, C. A. Zetlin, C., D.L. Johnson D.L. and W.W. Morse. 1999. Essential fish habitat source document: summer flounder, *Paralichthys dentatus,* life history and habitat characteristics. NOAA Tech Memorandum NMFS- NE- 151. Woods Hole, MA. 88p.

Pereira, J. J., R. Goldberg, J. J. Ziskowski, P.L. Berrien, W.W. Morse and D.L. Johnson.. 1999. Essential Fish Habitat Source Document: Winter Flounder, *Pseudopleuronectes americanus,* life history and habitat characteristics. U.S. Dep. Commer., NOAA Technical Memorandum NMFS- NE-138.

Popper, A.N. 2003. Effects of anthropogenic sound on fishes. Fisheries 28:24-31.

Popper, AN., J. Fewtrell, ME. Smith, and R.D. McCauley. 2004. Anthropogenic sound: Effects on the behavior and physiology of fishes. MTS J. 37: 35-40.

Saila, S.B. 1961. The contribution of estuaries to the offshore winter flounder fishery in Rhode Island. Proc. Gulf. Carib. Fish. Inst. 14:95-109.

Steimle, F.W., R.A. Pikanowski, D.G. McMillan, C.A. Zetlin, S.J. Wilk. 2000. Demersal fish and American lobster diets in the Lower Hudson-Raritan Estuary. NOAA Technical Memorandum NMFS-NE-161. Woods Hole, MA. 106 p.

Stevenson, D. *NOAN* NMFS/ Greater Atlantic Regional Fisheries Office. Personal Communication, October 2, 2018.

Werme, C.E. 1981. Resource partitioning in a salt marsh fish community. PhD. Dissertation, Boston Univ., Boston, MA. 132 p.

APPENDIX I

New York State Department of Environmental Conservation's Comments on Draft Fish and Wildlife Conservation Act Report

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Off ice of Natural Resources, Region 2
47-40 21st Street, Long Island City, NY 11101
P: (718) 482 -6464 IF: (718) 482-4502
www.dec .ny.gov

December 5, 2018

Kerri Dikun
Fish and Wildlife Biologist
USFWS - Long Island Field Office
340 Smith Road
Shirley, NY 11967

Dear Ms. Dikun:

Thank you for providing the New York State Department of Environmental Conservation (the Department) the opportunity to review the U.S. Fish and Wildlife Services' (Service) Draft Fish and Wildlife Coordination Report for the *Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study.*

The Department shares the Services' endorsement of the proposed project, provided that the Services' recommendations regarding additional surveys to further delineate and quantify potential impacts to the aquatic and shoreline environment, as well as its recommendations to minimize impacts to sensitive natural resources and to compensate to the fullest practicable extent for any unavoidable impacts to these resources are followed.

We look forward to working with the Service and the U.S. Army Corps of Engineers to achieving the project objectives while preserving and perhaps enhancing the State's valuable natural resources.

Sincerely,

Ken Scarlatelli
Regional Natural Resources Supervisor

cc: Daria Mazey, USAGE
Pete Weppler, USAGE
Matt Cheblus, NYSDEC

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D2a
Endangered Species Act Compliance
Biological Assessment For:

Piping Plover (*Charadrius melodus*)

Seabeach Amaranth (*Amaranthus pumilus*)

Rufa Red Knot (*Calidris canutus)*

USACE has requested that USFWS issue their Biological Opinion, which may include an Incidental Take Statement (ITS), as/if necessary, based upon the analyses provided in this Biological Assessment, according to and in compliance with our joint Section 7 obligations. USACE is in active coordination with USFWS regarding the preparation of the Biological Opinion which is expected mid-December.

November 2018

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Purpose and Objective of the Biological Assessment 1
1.2 List of Species 1
1.3 Objectives for this BA 3
1.4 Project Background 3
1.5 Project Area Description 4
1.6 Description of Habitat and Species 5
1.6.1 Habitat Types 5
1.6.2 Tides and Tidal Currents 6
1.6.3 Finfish and Shellfish 7
1.6.4 Invertebrate Communities 7
1.6.5 Significant Habitats 7
1.6.6 Listed Species 8
2 PROPOSED FEDERAL ACTION 9
2.1 Study Objectives 9
2.2 Recommended Plan Description 9
2.3 Recommended Plan: Atlantic Shorefront 9
2.4 Recommended Plan: Jamaica Bay 15
2.4.1 Cedarhurst-Lawrence 15
2.4.2 Motts Basin North (Eliminated) 17
2.4.3 Mid-Rockaway - Edgemere Area 19
2.4.4 Mid-Rockaway - Arverne Area 22
2.4.5 Mid-Rockaway - Hammels Area 26
2.5 Project Elements 29
2.5.1 The Atlantic Ocean Shorefront Beachfill 30
2.5.2 Atlantic Ocean Shorefront: Construction of New Groins and Extension of Existing Groins 31
2.5.3 Sand Removal from Offshore Borrow Area 32
2.6 Reasonably Foreseeable Future Actions 33
3 SPECIES OCCURENCE 34
3.1 PIPING PLOVER 34
3.1.1 Life History 34
3.1.2 Life History 36
3.1.3 Threats to Species 37
3.1.4 Human Disturbance 38

3.1.5 Habitat Loss/Alteration 39
3.1.6 Predation 40
3.2 Seabeach Amaranth 40
3.2.1 Threats to Species 42
3.2.2 Human Disturbance 43
3.2.3 Habitat Loss/Alteration 43
3.2.4 Herbivory/Predation 44
3.3 RUFA RED KNOT 44
3.3.1 Life History 45
3.3.2 Threats to Red Knot 46
3.3.3 Human Disturbance 48
3.3.4 Habitat Loss 49
3.3.5 Predation 49
4 EFFECT ANAYLSIS 51
4.1 Piping Plover 51
4.1.1 Historic Trends 51
4.1.2 No Action 54
4.1.3 Proposed Action 55
4.1.4 Cumulative Effects 57
4.2 Seabeach Amaranth 58
4.2.1 Historic Trends 60
4.2.2 No Action 60
4.2.3 Proposed Action 60
4.2.4 Cumulative Effects 62
4.3 Red Knot 62
4.3.1 No Action 62
4.3.2 Proposed Action 63
4.3.3 Cumulative Effect 64
5 RECOMMENDATIONS 66
5.1 PIPING PLOVER and RUFA RED KNOT 66
5.2 SEABEACH AMARANTH 66
6 CONCLUSIONS 67
7 REFERENCES 68

LIST OF TABLES

Table 1: Protection Status of Species that Utilize Habitats Similar to those in the Project Area .. 8
Table 2: Initial Construction Beachfill Quantities 31
Table 3: Summary of Groin Lengths 32
Table 4: Piping plover pair and fledgling count at RBESNA from 1996 to 2017 53
Table 5: Piping plover productivity rate for RBESNA and New York State (USFWS, 2016) from 1996 to 2017 53
Table 6: Data Collected from 1996 to the present (2017) for piping plovers nesting at RBESNA 54
Table 7: Summary of Project Effects on Populations of Piping Plover 55
Table 8: Seabeach Amaranth Survey Results 58
Table 9: Summary of Project Effects on Populations of Seabeach Amaranth 61
Table 10: Summary of Project Effects on Populations of Red Knot 63

LIST OF FIGURES

Figure 1: Project Area Location 2
Figure 2a: Atlantic Ocean Shorefront Component of Recommended Plan (1 of 4) 11
Figure 2b: Atlantic Ocean Shorefront Component of Recommended Plan (2 of 4) 12
Figure 2c: Atlantic Ocean Shorefront Component of Recommended Plan (3 of 4) 13
Figure 2d: Atlantic Ocean Shorefront Component of Recommended Plan (4 of 4) 14
Figure 3: Cedarhurst-Lawrence HFFRRF Project Plan 16
Figure 4: Motts Basin North HFFRRF Project Plan (Eliminated) 18
Figure 5: Mid Rockaway – Edgemere Area HFFRRF Project Plan 21
Figure 6: Mid Rockaway – Arverne Area HFFRRF Project Plan 25
Figure 7: Mid Rockaway – Hammels Area HFFRRF Project Plan 28
Figure 8: Composite Seawall Beach 19th St. to Beach 126th St 30
Figure 9: Composite Seawall Beach 126th St. to Beach 149th St 30
Figure 10: Location of the East Rockaway Borrow Area 33
Figure 11: 2017 Nesting Season 52
Figure 12: Seabeach Amaranth 2017 Location Map 59

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

Revised Draft General Reevaluation Report and Environmental Impact Statement

Environmental Compliance Appendix Attachment D2a Endangered Species Act Compliance

1 INTRODUCTION

1.1 Purpose and Objective of the Biological Assessment

This Biological Assessment (BA) has been prepared in accordance with requirements identified in the Endangered Species Act (ESA) of 1973, to identify and discuss potential impacts to federally-listed threatened and endangered (T&E) species caused by the U.S. Army Corps of Engineers (USACE), New York District (District) activities associated with implementation of the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet, New York Hurricane Sandy General Reevaluation (Project), Queens County, New York (Figure 1). T&E species include those species federally- listed and protected by the U.S. Department of the Interior, Fish and Wildlife Service (USFWS) under the ESA.

In accordance with Section 7(a)(2) of the ESA, as amended, federal agencies are required to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of any habitat of such species determined to be critical unless an exemption has been granted. Additionally, a BA must be prepared if listed species or critical habitat may be present in an area to be impacted by a "major construction activity." A major construction activity is defined at 50 CFR §402.02 as a construction project (or an undertaking having similar effects) which is a major federal action significantly affecting the quality of the human environment as referred to in the National Environmental Policy Act (NEPA) (42 U.S.C. 4332(2)(C)).

1.2 List of Species

The USFWS, through its historical formal consultation with the District regarding implementation of the Project, identified three T&E species as being present in or near the Project Area. Based on habitat and life history assessments, recommendations from the USFWS in the original (currently being updated) Fish and Wildlife Coordination Act 2B Report (USFWS 1995a) and follow-up consultation for this Project with the New York State Department of Environmental Conservation (NYSDEC) and New York City Department of Parks and Recreation (DPR), the District has determined that the following federally-listed species are likely to occur in the East Rockaway Project Area and warrant impact analyses within a BA:

- Piping Plover (*Charadrius melodus*), federally threatened;
- Seabeach Amaranth (*Amaranthus pumilus*), federally threatened; and
- Rufa Red Knot (*Calidris canutus),* federally threatened.

Figure 1: Project Area Location

The state-listed threatened common tern (*Sterna hirundo*) and least tern (*Sterna antillarum*) and the federally and state-listed Endangered roseate tern (*Sterna dougallii*), utilize beach habitat similar to that of the piping plover and seabeach amaranth, and have been identified as species that may occur in the Project Area (USACE 1998, USFWS 1995a). Additionally, the state species of special concern, black skimmer (*Rynchops niger*), also is known to nest on coastal beaches and frequently nests in or near tern nesting areas (NatureServe 2002). None of these species have been identified by the USFWS as species requiring further ESA consultation (USFWS 1995a). However, measures taken to avoid and protect piping plover, red knot and seabeach amaranth habitats would benefit and protect these species as well.

1.3 Objectives for this BA

This BA will support the Environmental Impact Statement (EIS) that will identify and evaluate potential environmental impacts associated with the proposed Project, and will maintain compliance with Section 7(a)(2) of the ESA. The BA is designed to provide the USFWS with the required information for their assessment of the effects of the proposed Project on federally-listed endangered and threatened species.

Specific objectives of this BA are to:

1. Ensure Project actions do not contribute to the loss of viability of T&E species;
2. Comply with the requirements of the ESA, as amended, that Project actions not jeopardize or adversely modify critical habitat for federally-listed T&E species;
3. Analyze the effects of implementation of Project actions on federally-listed T&E species;
4. Recommend impact avoidance, minimization, and measures to offset impacts to federally- listed T&E species; and,
5. Provide biological input to ensure District compliance with the NEPA and the ESA.

1.4 Project Background

Rockaway, New York, has an extensive history of property damage and economic loss as a result of coastal flooding and erosion associated with frequent storms. Significant beach erosion and sand loss has reduced the width of the protective beach front and has exposed properties to a high risk of damage from ocean flooding and wave attack, and existing groins and jetties along the island have deteriorated and are becoming less effective at reducing sand loss along the shoreline and providing wave protection. Non shorefront flooding in Rockaway is attributed to storm surges in Jamaica Bay inundating the bay shorelines of Rockaway (Back Bay Flooding) and storm surges that overtop the high elevations located near the Rockaway beachfront flowing across the peninsula to meet the surge into Jamaica Bay (Cross Shore Flooding).

The Reformulation Study for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay was authorized by the House of Representatives, dated 27 September 1997, as stated within the Congressional Record for the US House of Representatives. It states, in part:

> *"With the funds provided for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York project, the conferees direct the Corps of Engineers to initiate a reevaluation report to identify more cost-effective measures of providing storm damage protection for the*

project. In conducting the reevaluation, the Corps should include consideration of using dredged material from maintenance dredging of East Rockaway Inlet and should also investigate the potential for ecosystem restoration within the project area."

Public Law 113-2 (29Jan13), The Disaster Relief Appropriations Act of 2013 (the Act), was enacted in part to "improve and streamline disaster assistance for Hurricane Sandy, and for other purposes". The Act directed the Corps of Engineers to:

> *"…reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy" (PL 113-2).*

In partial fulfillment of the requirements detailed within the Act, the Corps produced a report assessing "authorized Corps projects for reducing flooding and storm risks in the affected area that have been constructed or are under construction". The East Rockaway Inlet to Rockaway Inlet, NY project met the definition in the Act as a constructed project. In accordance with the Act, the Corps is proceeding with this GRR to address resiliency, efficiency, risks, environmental compliance, and long-term sustainability within the study area (USACE, 2013a).

1.5 Project Area Description

The communities located on the Rockaway peninsula from west to east include Breezy Point, Roxbury, Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammels, Arverne, Edgemere and Far Rockaway. The former Fort Tilden Military Reservation and the Jacob Riis Park (part of the Gateway National Recreation Area) are located in the western half of the peninsula between Breezy Point and Neponsit. The characteristics of nearly all of the communities on the Rockaway peninsula are similar. Ground elevations rarely exceed 10 feet, except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from 5 feet, increasing to 10 feet further south toward the Atlantic coast. An estimated 7,900 residential and commercial structures on the peninsula fall within the FEMA regulated 100-year floodplain.

During Hurricane Sandy, tidal waters and waves directly impacted the Atlantic Ocean shoreline. Tidal waters amassed in Jamaica Bay by entering through Rockaway Inlet and by overtopping and flowing across the Rockaway Peninsula. Effective coastal storm risk management for communities within the study area requires reductions in risk from two sources of coastal storm damages: inundation, wave attack with overtopping along the Atlantic Ocean shorefront of the Rockaway peninsula and flood waters amassing within Jamaica Bay via the Rockaway Inlet.

The study area (Figure 1), consisting of the Atlantic Coast of New York City between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York is vulnerably located within the Federal Emergency Management Agency (FEMA) regulated 100-year floodplain. The shorefront area, which is a peninsula approximately 10 miles in length, generally referred to as Rockaway, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, New York City, and a section at the eastern end, known as Head-of-Bay, lies in Nassau County. More than 850,000 residents, 48,000 residential and commercial structures, and scores of

critical infrastructure features such as hospitals, nursing homes, wastewater treatment facilities, subway, railroad, and schools are within the study area

The Project Area consists of beaches, sand dunes, low-growing shrubs, and tidal flats, and has been highly modified as a result of human development. Upland areas in the vicinity of the Project have been committed to residential, commercial and recreational development. Near shore and upper beach areas in the Project Area are heavily utilized for beach recreation. Numerous stone groins currently exist in the Project Area. The shoreline has been stabilized since the 1880s with beach fill, groins, bulkheads, and a stone jetty at Rockaway Inlet.

1.6 Description of Habitat and Species

Oceanfront beach, bayfront and deepwater ocean habitats constitute the majority of the Project Area. The beach community includes upper, intertidal, and nearshore subtidal areas. Except for the sparsely vegetated herb and herb/shrub community associated with the upper beach/dune area, most of the Project Area is devoid of vegetation and is significantly impacted from human use of the area for recreational activities. In addition, significant development abuts the upper beach zone in most of the Project Area.

Jamaica Bay which is located on the north side of the peninsula is the largest estuarine waterbody in the New York City metropolitan area covering an approximately 20,000 acres (17,200 of open water and 2,700 acres of upland islands and salt marsh). Jamaica Bay measures approximately 10 miles at its widest point east to west and four miles at the widest point north to south, including approximately 26 square miles in total. The mean depth of the bay is approximately 13 feet with maximum depths of 60 feet in the deepest borrow pits. Navigation channels within the bay are authorized to a depth of 20 feet. Jamaica Bay has a typical tidal range of five to six feet. The portions of New York City and Nassau County surrounding the waters of Jamaica Bay are urbanized, densely populated, and very susceptible to flooding. An estimated 41,000 residential and commercial structures within the FEMA regulated 100-year Jamaica Bay floodplain.

The Rockaway Beach Endangered Species Nesting Area was established in 1996 by New York City as a response to the piping plovers nesting in Far Rockaway, Queens.

1.6.1 Habitat Types

Jamaica Bay, formed by the barrier created by the Rockaway Peninsula, and its saltmarsh islands form one of the most recognizable and striking natural features within the urban landscape of NYC. Prior to the extensive urban development occurring over the past 150 years, tidewater grasslands colonized postglacial outwash plains at the ends of many creeks and streams in Jamaica Bay creating fringing salt marshes which encircled Jamaica Bay. Extensive saltmarsh islands and many more thousands of acres of fringing marshes and transitional uplands once adjoined the mainland, and the Rockaway peninsula did not extend much past what is now Jacob Riis Park. Under current conditions, the Rockaway peninsula has been substantially extended to the west, creating a more funnel shaped Rockaway Inlet; islands have been removed by dredging or extended to the nearby mainland by fill; shorelines have been altered by dredge and fill activities; bulkheads have been installed to stabilize and protect shorelines; channels and borrow areas have been dredged, altered bottom contours affecting flows; and natural tributaries have essentially disappeared causing

sediment input from these tributaries to be mainly silts and particulates from urban runoff (DEP, 2007).

Existing coastal habitats within both planning reaches generally occur along an ecological continuum dependent upon tidal influence. The critical tidal elevations that help define these habitats include MLLW, MHW, and mean higher high water (MHHW).

Biological communities were classified into twelve distinct habitat types that were identified and mapped throughout the study area. They represent the range of conditions and habitat quality observed throughout the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach, including both native habitats and those resulting from long-term anthropogenic disturbances. Specifically, the Atlantic Ocean Shorefront Planning Reach consists of oceanfront beach habitat with isolated dune habitats. Most of the study area is devoid of vegetation and is significantly impacted by human use of the area for recreational activities and significant development that abuts the upper beach zone in most of the Study Area. The Jamaica Bay Planning Reach consists of a diverse mosaic of the twelve habitat types. While many native communities can be found throughout Jamaica Bay, it is also characterized by dense urban development that has altered and/or created new habitats indicative of the historic anthropogenic disturbance.

The intertidal zone extends from the low tide line to the high tide line and is submerged and exposed according to daily tidal cycles. The zone is unvegetated and consists of fine-grained sand substrate. Wrack and ocean debris are common within this zone. Species diversity is relatively low due to limited ability of species to withstand the daily submersion and exposure. Micro and macro-invertebrates known to inhabit this zone include crabs, shrimp, bivalves, and worms. The intertidal zone provides key foraging habitat for shorebirds/seabirds, which feed on these organisms.

The affected near shore subtidal zone extends from the low water line down to 25 feet (ft) below mean low water (MLW) and is nearly continuously submerged. The zone is unvegetated and consists of fine-grained sand substrate. The area contains a rich diversity of species including crabs, shrimp, bivalves, worms, and finfish. In addition, numerous man-made groins extend from the intertidal zone into the subtidal zone from 200 to 600 ft (USACE 1998). These structures provide habitat for numerous fish, macro-invertebrates, and birds.

Throughout both reaches of the study area, many natural shorelines have been replaced with hardened structures such as groins, bulkheads, revetments, or rip rap. These hardened structures have interrupted the naturally occurring ecological continuum and caused an unnatural transition from upland areas (i.e., usually impervious surfaces associated with urban areas) immediately into deep subtidal area. These shorelines provide limited habitats and services to a suite of resources identified as critical to the Jamaica Bay ecosystem.

1.6.2 Tides and Tidal Currents

The mean tidal range along the Atlantic Ocean Shorefront project area is 4.5 ft and the spring tidal range reaches 5.4 ft The Mean High Water (MHW) level and Mean Low Water (MLW) level relative to NAVD88 are +1.5 ft and - 3.0 ft, respectively for the Atlantic Coast.

With respect to the Bay, the MHW level and MLW level relative to NAVD88 within the Bay are +2.4 and -3.07 respectively.

Currents at East Rockaway Inlet have average maximum velocities of 3.1 and 2.3 knots at flood tide, and 2.6 and 2.2 knots at ebb tides. Rockaway Inlet is the only tidal inlet to Jamaica Bay with high currents at its narrowest point which is 0.63 miles with an average depth of 23 feet (USFWS 1997). At the entrance to Rockaway Inlet, the prevailing currents slow as they enter the mouth of the Bay and turn to the east and again slow which significantly reducing tidal exchange. Tides in Jamaica Bay are semi-diurnal and average 5 feet. Dredging has deepened the mean depth of the bay from approximately 3 feet in the past to 13 feet now, which has increased the residence time of water from 11 days to an average of 33 days but varying by depth and location (USFWS 1997). The maximum tidal current speeds in North Channel at Canarsie Pier are 0.5 knots (0.84 ft/s) flood and 0.7 knots (0.84 ft/s) ebb (USACE 2005). USGS observations of flow speeds at the USGS Rockaway Inlet gage are generally 1.0 knots or less during neap tide periods and 1.7 knots or less during spring tide periods (Arcadis 2016b).

1.6.3 Finfish and Shellfish

The nearshore waters of the Project Area support seasonally abundant populations of many recreational and commercial finfish (USACE 1998, USFWS 1982, 1995a). Primary recreational fish species include black sea bass (*Centropristis striata*), summer flounder (*Paralichthysdentatus*), winter flounder (*Pseudopleuronectes americanus*), weakfish (*Cynosion regalis*), bluefish (*Pomatomus saltatrix*), scup (*Stenotomus chrysops*), striped bass (*Morone saxatillis*), and Atlantic mackerel (*Scomber scombrus*) (USFWS 1989). Nearshore waters also contain a number of migrant anadromous and catadromous species such as the Atlantic sturgeon (*Acipenser oxyhinchus*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), striped bass, and American eel (*Anguilla rostrata*) (Woodhead 1992).

1.6.4 Invertebrate Communities

The benthic community of the greater Project Area is dominated by polychaetous annelids, followed by malacostracans, bivalves, and gastropods (Reid et al. 1991, Ray and Clarke 1995, Ray 1996, USACE 2006). Common shellfish species in the Project Area are the hardshell clam (*Mercenaria mercenaria*), softshell clam (*Mya arenaria*), telling (*Tellina agilis*), razor clam (*Ensis directus*), rock crab (*Cancer irroratus*), lady crab (*Ovalipes ocellatus*), American lobster (*Homarus americanus*), hermit crab (*Homarus americanus*) and blue crab (*Callinectes sapidus*) (USACE 1998, 2005). Mussels (*Mytilus* spp) dominate man-made structures such as groins and jetties in the Project Area (USACE 1998). Ghost crabs (*Ocypode* spp) and sand fleas (*Talorhestia* spp.) dominate the beach community (USACE 1998). Surveys conducted by the USACE in 2003 indicate that the borrow area itself contains very small, to no, localized populations of surf clam (USACE 2006).

1.6.5 Significant Habitats

No federally designated critical habitat is found within or near the proposed project area. Jamaica Bay and Breezy Point have been designated Significant Coastal Fish and Wildlife Habitat by the New York State Department of State (NYSDOS), Division of Coastal Resources. Jamaica Bay, Breezy Point, and Rockaway Beaches have also been designated globally Important Bird Areas by Audubon New York. The federally-listed threatened piping plover (Charadrius melodus) and threatened seabeach amaranth (Amaranthus pumilus) have been identified within the project area.

1.6.6 Listed Species

The federally and state-listed piping plover, seabeach amaranth, rufa red knot, and roseate tern, as well as the state-listed common tern and least tern, and the state species of special concern black skimmer, all nest or carry out a major portion of their life cycle activities (i.e., breeding, resting, foraging) within essentially the same habitat (Table 1). This habitat encompasses areas located between the high tide line and the area of dune formation and consists of sand or sand/cobble beaches along ocean shores, bays and inlets and occasionally in blowout areas located behind dunes (Bent 1929, NatureServe 2002, NJDEP 1997, USACE 2006, USFWS 2004a).

Table 1: Protection Status of Species that Utilize Habitats Similar to those in the Project Area

Common Name	Federal Status	State Status
Common Tern	Not Listed	Threatened
Least Tern	Not Listed	Threatened
Piping Plover	Threatened	Endangered
Roseate Tern	Endangered	Endangered
Seabeach Amaranth	Threatened	Threatened
Rufa Red Knot	Threatened	Endangered

Piping plover have been identified and are known to nest within upper beach areas located within the Project Area (USACE 1998, USFWS 1995a, b, 2002). Red knots migrate through the project area and are dependent on intertidal and sand and mud flats for foraging and resting. Although not commonly seen in large numbers, there have been recent sightings of a few red knots in the vicinity of the Project. The USFWS has determined that habitats that occur in the Project Area are suitable for piping plover and seabeach amaranth (USFWS 1995a). Therefore, the life histories of piping plover and seabeach amaranth and potential impacts to these species and their associated habitats are discussed in detail in this Biological Assessment. The black skimmer and least, roseate, and common terns, could potentially utilize habitats within the Project Area. Measures taken to avoid and protect plover and seabeach amaranth habitats would benefit and protect these species, as well as numerous other shorebird/seabird species that depend on coastal habitats.

2 PROPOSED FEDERAL ACTION

The Recommended Plan for this Project is a component of the USACE response to the unprecedented destruction and economic damage to communities within the study area caused by Hurricane Sandy. The recommendations herein include a systems-based approach for coastal storm risk management that provides a plan for the entire area, which has been formulated with two planning reaches to identify the most efficient solution for each reach. Project partners include the New York State Department of Environmental Conservation, the New York City (NYC) Mayor's Office of Recovery and Resiliency, the NYC Department of Parks and Recreation, the NYC Department of Environmental Protection, and the National Park Service.

2.1 Study Objectives

Five principal planning objectives have been identified for the study, based upon a collaborative planning approach. These planning objectives are intended to be achieved throughout the study period, which is from 2020 – 2070:

1. Reduce vulnerability to storm surge impacts;
2. Reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities;
3. Reduce the economic costs and risks associated with large-scale flood and storm events;
4. Improve community resiliency, including infrastructure and service recovery from storm effects
5. Enhance natural storm surge buffers and improve coastal resilience.

2.2 Recommended Plan Description

The Coastal Storm Risk Management (CSRM) Recommended Plan for the area from East Rockaway Inlet to Rockaway Inlet and the lands within and surrounding Jamaica Bay New York consists of the following components, which are generally described for 2 Planning Reaches: 1) A reinforced dune and Berm Construction, in conjunction with groins in select locations along the Atlantic Ocean Shoreline; 2) High Frequency Flood Risk Reduction Features (HRFRRF) features in locations surrounding Jamaica Bay. In general, these features are intended to provide a design height of +6 ft NAVD through various methods to reduce frequent flooding. As HRFRRF features are further developed, additional NEPA documentation and resource agency coordination would be provided, as necessary. This Recommended Plan description includes the maximum footprint for the plan; however the footprint may be changed based on public and agency comments as well as new information.

2.3 Recommended Plan: Atlantic Shorefront

The general approach to developing CSRM along Rockaway Beach (between Beach 9th Street and Beach 169th Street, which the east and west tapers are included) was to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective renourishment approach prior to the evaluation of alternatives for coastal storm risk management. The most cost effective erosion control alternative is beach restoration with increased erosion control. This constitutes of a beach berm width of 60ft at an elevation of +8ft NAVD88 constructed

by a beach fill quantity of 1.6 million CY for the initial placement and with a 4-year 1,021,000 CY renourishment cycle, as needed, for the life of the project (50 years). In addition, a screening analysis was performed to evaluate the level of risk reduction provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with the beach restoration with increased erosion control to optimize CSRM at Rockaway Beach. A composite seawall was selected as the best coastal storm risk management alternative. The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding. The Recommended Plan spans from Beach 20th Street to Beach 149th Street (Reach 3 through Reach 6b) and combines Beach Restoration and Erosion Control and two tapered beach sections at both the east and west end of the project (Beach 9-19, and Beach 150-Beach 169, respectively), which are described below. In summary, the Recommended Plan has the following features:

- A composite seawall with a structure crest elevation of +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet;
- A beach berm elevation of +8 ft NAVD and a depth of closure of -25 ft NAVD;
- A total beach fill quantity of 1.6 million CY for the initial placement, including tolerance, overfill and advanced nourishment with a 4-year renourishment cycle of 1,021,00 cy, resulting in a minimum berm width of 60 feet;
- Extension of 5 existing groins; and
- Construction of 13 new groins.

The east beachfill taper is approximately 3,000 ft in shorefront length from Beach 19th Street east to Beach 9th Street. The taper comprises of approximately 1,000 ft of dune and beach taper including reinforced dune feature and approximately 2,000 ft of dune and beach fill without reinforced dune feature. In addition to the tapering of berm width, the dune elevation also tapers from an elevation of +18 ft NAVD at 19th Street down to approximately +12 ft NAVD at Beach 9th Street which will be tied into the existing grade. The west beachfill taper is approximately 5,000 ft in shorefront length from Beach 149th Street west to Beach 169th street fronting Riis Park. The beachfill taper will be beach fill only with a berm width tapered from the design width at 149th Street to the existing width and height at 169th Street. In addition to the beachfill taper, a tapered groin system comprised of three (3) rock groins is included for this section.

Figures 2a through 2d show the Atlantic Ocean Shorefront component of the Recommended Plan.

Figure 2a: Atlantic Ocean Shorefront Component of Recommended Plan (1 of 4)

Figure 2b: Atlantic Ocean Shorefront Component of Recommended Plan (2 of 4)

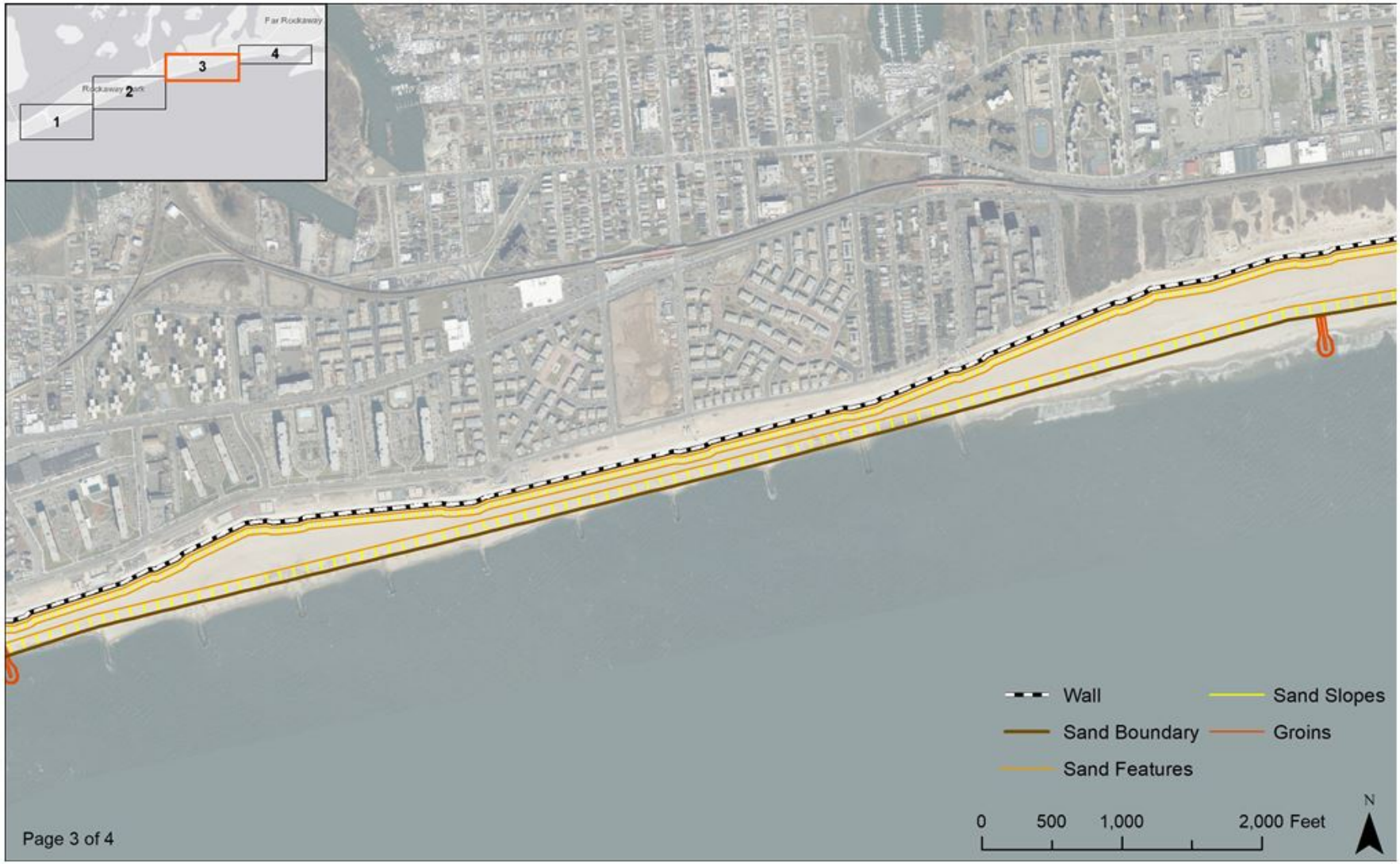


Figure 2c: Atlantic Ocean Shorefront Component of Recommended Plan (3 of 4)

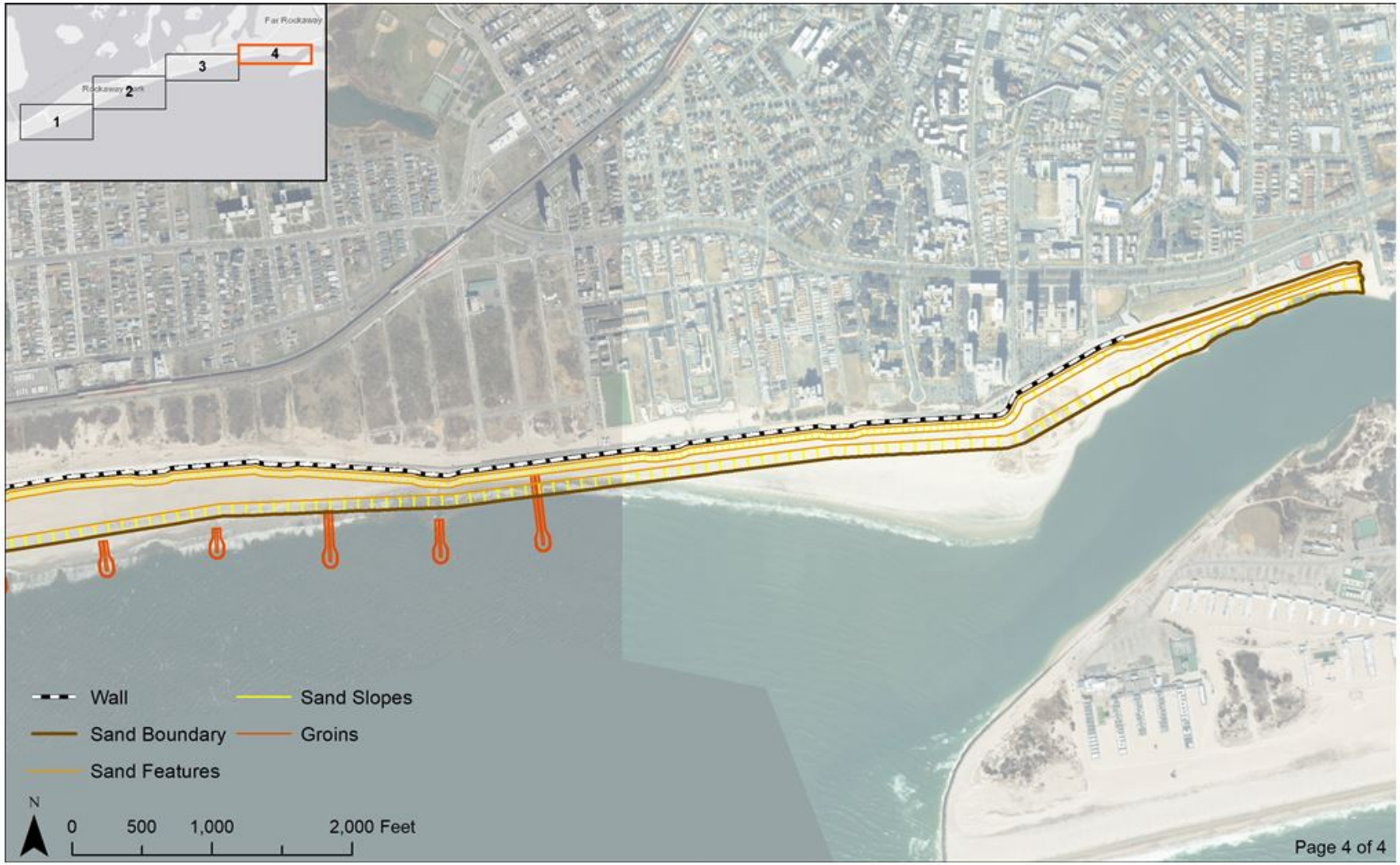


Figure 2d: Atlantic Ocean Shorefront Component of Recommended Plan (4 of 4)

2.4 Recommended Plan: Jamaica Bay

2.4.1 Cedarhurst-Lawrence

The Cedarhurst-Lawrence project (Figure 3) begins on the east side of the channel near the driveway to Lawrence High School. It consists of approximately 1000 feet of deep bulkhead that follows the existing bulkhead line around the southern end of the channel at Johnny Jack Park, and continues north along the west side before being connected to high-ground behind the Five Towns Mini Golf & Batting Facility with a 23 foot segment of medium floodwall. The project is located in Nassau County and crosses the border between the Village of Cedarhurst and the town of Hempstead. Project design elevations have preliminarily been established based on expected wave exposure are set at an elevation of +10.0ft NAVD88.

There are three existing outfalls in the area where the bulkhead will be raised. Each of the outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch or drainage collection pipe, with inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station capacity is estimated to be approximately 40 cubic feet per second (cfs), which will be refined during the design phase.

CEDARHURST-LAWRENCE OUTLET TABLE

Drainage Area	**Outfall Size**	**Outfall Location**
Drainage Basin L1	TBD	Existing Outfall
Drainage Basin L1	TBD	Existing/New Culvert (500 feet from Peninsula Boulevard).
Drainage Basin L1	TBD	Existing/New Culvert (500 feet from Peninsula Boulevard).
Drainage Basin L1	5’x3’	Outfall L-1, Approximately 250 feet from Peninsula Boulevard

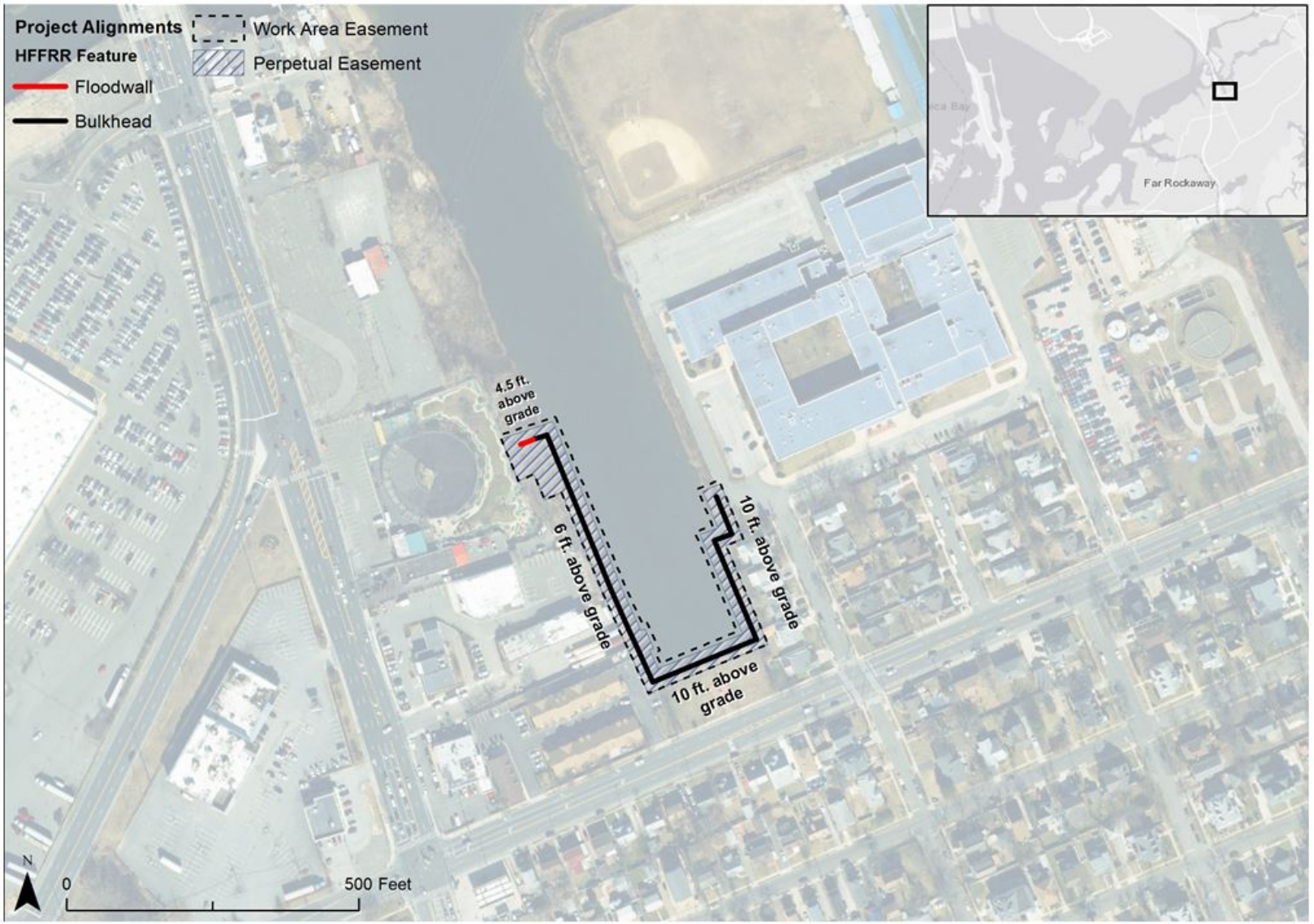


Figure 3: Cedarhurst-Lawrence HFFRRF Project Plan

2.4.2 Motts Basin North

This project consists of a medium floodwall beginning just north of the corner of Alemada Ave. and Waterfront Blvd. and continuing to the east along the south side of Waterfront Blvd. for approximately 540 feet (Figure 4). The line of protection then shifts to a section of medium floodwall above an existing outfall, continuing east for 47 feet before transitioning back into a low floodwall for an additional 105 feet. Project design elevations vary have preliminarily been established based on the expected wave exposure and are +8.0ft.

The existing outlet will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch. Inlets will connect to the existing and one proposed additional drainage outlets.

THIS PROJECT ELEMENT OF THE JAMAICA BAY PLAN HAS BEEN ELIMINATED FROM CONSIDERATION.

MOTTS OUTLET TABLE

Drainage Area	**Outfall Size**	**Outfall Location**
Drainage Basin L1	TBD	Existing Outfall

Figure 4: Motts Basin North HFFRRF Project Plan- ELIMINATED FROM THE RECOMMENDED PLAN

2.4.3 Mid-Rockaway - Edgemere Area

The eastern end of the project area (Figure 5) begins at high ground near the intersection of Beach Channel Drive and Beach 35th Street. The project moves north and then west following parallel to Beach 35th Street before jogging to the north and crossing the abandoned portion of Beach 38th Street and continuing west. The project turns north and runs along the peninsula between Beach 43rd Street and the coastal edge. This approximately 3,200 foot section of hybrid berm has been maintained as far landward as possible and weaves in and out between the properties. The hybrid berm is strategically used at these locations to minimize and avoid impacts to existing healthy wetland habitats. This area has also been identified as a good candidate for the use of Natural and Nature Based Features (NNBFs). The NNBF design includes placement of a stone toe protection and rock sill structure just off the existing shoreline to attenuate wave action and allow tidal marsh to establish between the rock sill and the berm. In some locations the eroded/degraded shoreline (subtidal) will be regraded to allow for the development of low marsh (*Spartina alterniflora*) to provide productive nursery habitats behind the sill structures. The shore slope behind the structure will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for establishment of a high tidal marsh, designated as scrub shrub areas in the figure. In addition, the graded habitat behind the structure will be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems. On the north east of the Edgemere peninsula the project then transitions into 200 feet of shallow bulkhead, which continues north along existing water front properties and bulkheads. Approximately 200' of medium floodwall then cuts west across, at the tip of the Edgemere peninsula. A road ramp on Beach 43rd Street has been included to maintain both pedestrian, and vehicle access to the coastal edge at north end of Beach 43rd street. The floodwall continues in southwest direction along the coastline after which it transitions into a 750 foot section of high berm. The berm continues west from Beach 43rd Street before turning south just to the east of the unpaved extension of Beach 44th Street. The project then transitions into a 660 foot section of high floodwall which continues southwest staying as far landwards as possible to avoid an existing restoration project. Near the intersection of Norton Avenue and Beach 46th Street, north of Norton Avenue, the floodwall transitions back into a low berm which runs parallel to Norton Avenue southwest and then turns northwest along Conch Place. The area waterward of this berm has also been identified as a good location for the use of NNBFs and to restore high marsh habitat. Project design elevations vary and have preliminarily been established based on expected wave exposure. Project elevations range between +8.0ft and +9.5t NAVD88.

The Edgemere interior drainage basin has two subbasins, E1 and E2 covering approximately 194 acres and 274 acres, respectively. The Edgemere drainage basin is almost fully developed and predominantly residential, except for a stretch of undeveloped, grassy area along the southern part of E1 and southwestern part of E2. Subbasin E1 was estimated to require 9 outlets, including 2 existing outlets. Subbasin E2 was estimated to require 6 outlets, including 1 existing outlet (See Edgemere Outlet Table). Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage

outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations are desired in the Edgemere Area. Due to the length of the area and difficulties in draining all of the area to a single site, drainage subbasin E1 is proposed to have two pump stations one pump station would be located near Norton Avenue and Beach 49th Street and the other near Beach 43rd Street and Hough Place with a combined capacity of about 210 cfs. Subbasin E2 is proposed to have one pump station located near Beach 38th Street with an estimated capacity of 120 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

EDGEMERE OUTLET TABLE

Drainage Basin	**Outfall Size**	**Outfall Location**
Drainage Basin E1	TBD	Existing Outfall ROC-648
Drainage Basin E1	5'x3'	Outfall E1-1 located on Norton Avenue between Beach 47th and 48th Streets.
Drainage Basin E1	5'x3'	Outfall E1-2 located on Norton Avenue between Beach 46th and 45th Streets.
Drainage Basin E1	5'x3'	Outfall E1-3 located on Beach 45th Street north of Hough Place.
Drainage Basin E1	5'x3'	Outfall E1-4 located on the north end of Beach 45th Street.
Drainage Basin E1	5'x3'	Outfall E1-5 located 550 feet north of Hough Place.
Drainage Basin E1	5'x3'	Outfall E1-6 located 500 feet north of Hough Place.
Drainage Basin E1	TBD	Existing Outfall ROC-637
Drainage Basin E1	5'x3'	Outfall E1-7 located north of Beach 40th Street.
Drainage Basin E2	TBD	Existing Outfall ROC-638
Drainage Basin E2	5'x3'	Outfall E2-1 located 50 feet east of Beach 37th Street.
Drainage Basin E2	5'x3'	Outfall E2-2 located 50 feet east of Beach 37th Street.
Drainage Basin E2	5'x3'	Outfall E2-3 located 50 feet east of Beach 36th Street.
Drainage Basin E2	5'x3'	Outfall E2-4 located 50 feet east of Beach 36th Street.
Drainage Basin E2	5'x3'	Outfall E2-5 located between Beach 36th Street and Beach 35th Street.

Figure 5: Mid Rockaway – Edgemere Area HFFRRF Project Plan

2.4.4 Mid-Rockaway - Arverne Area

This area of the project (Figure 6) begins at high ground to the north of Almeda Avenue and Beach 58th Street. An approximately 1,100 foot section of low berm runs south along Beach 58th Street. The berm has been maintained as far landward as possible to avoid healthy habitat. This segment has been identified as a candidate for the use of NNBFs. Much of the area is identified as existing quality wetlands, but a portion of fill area has been identified where intermediate marsh (*Spartina patens*) will be restored. The project then transitions to an approximately 1,200 foot long medium floodwall which, for feasibility level analysis, is purposefully sited along property boundaries at the southern end of the channel to minimize impacts to the existing waterfront businesses. A road ramp has been included to maintain access to the marina. At the southwest corner of the channel the project transitions to run along the coastal edge north for approximately 1,700 feet. This segment transitions between revetments and bulkheads to match the existing coastline conditions and uses. The portion between Thursby Avenue and Elizabeth Road has been aligned such that it can be integrated into the planned NYC DPR Thursby Basin Park project. Just north of De Costa Avenue, the project transitions to low berm for approximately 1,600 feet and runs west along De Costa Avenue and around the edges of healthy habitat while also creating an area for stormwater storage and a pump station just north of Beach Street. At the corner of De Costa Avenue and Beach 65th Street the low berm transitions into a hybrid berm to minimize habitat impacts. The hybrid berm continues west and then north for 300 feet to the corner of Beach 65th Street and Bayfield Avenue. The project then transitions to a 2,400 foot long shallow bulkhead which travels west along the line of existing bulkheads where they exist and parallel with Bayfield Avenue in areas without existing bulkhead. The bulkhead section ends just west of the corner of Bayfield Avenue and Beach 72nd Street. The area west of Beach 69th Street and the eastern end of De Costa Ave has been identified as a good candidate for NNBF. Based on existing elevations and profiles, a combination of either fill or excavation is used to provide the appropriate elevations shoreward of the rock sills to maximize healthy subtidal habitats, with restoring a transition area for low to high intertidal marsh. Eroded shorelines were replaced with low intertidal (*Spartina alternaflora*) habitats, and transition to either intermediate (*Spartina patens*) and/or high marsh (scrub-shrub) habitats. From the end of the bulkhead section the project continues south with a 120 foot section of medium floodwall connecting the bulkhead to a 1,080 foot section of high berm. The berm runs south along Beach 72nd Street and turns west at Hillmeyer Avenue and continues west past the corner of Barbados Drive and Hillmeyer Avenue, where it turns north and transitions to a flood wall to minimize the features footprint. The berm section has been position close to the roads to minimize impacts on habitat. The berm section transitions into a high floodwall which goes west and then runs parallel to the coast southwest for 440 feet, ending at a bulkhead section just west of the end of Hillmeyer Avenue. The Brant Point area includes the creation of wetlands between the berm and the rock sills that are placed just off the coastal edge. The rock sill will protect the shoreline where eroded areas will be restored to low marsh habitats protecting the existing high quality habitats shoreward. The areas behind the existing wetlands areas will be graded to provide a transition area to high marsh and then uplands where practical. The existing uplands areas will be replanted as necessary to provide for a high quality maritime forest habitat, with appropriate tree species. South of Hillmeyer Avenue the alignment follows the bulkheaded coastal edge. The project proposes a high frequency flood risk reduction bulkhead feature that follows an existing bulkhead along the coastal edge for approximately 270 feet ending just south of Almeda Avenue. From this point a low floodwall runs parallel with the coastal edge southeast for 700 feet then

transitions into a deep bulkhead. This section of bulkhead continues southeast along the line of existing bulkhead for approximately 540 feet to the end of Thursby Avenue. The project continues as a low floodwall for approximately 1,400 feet, traveling east along Thursby Avenue and then south, parallel with Beach 72nd Street turning west and running along Amstel Boulevard, ending just past Beach 74th street. Two road ramps and one vehicular gate are included to maintain access to the waterfront. The final segment is approximately 250 feet of medium floodwall which runs along the coastal edge and connect the low floodwall to high ground in the west. Project design elevations vary and have preliminarily been established based on the expected wave exposure. Project elevations range between +8.0ft and +11.5t.

The Arverne drainage basin has three subbasins A1, A2, and A3, covering 76 acres, 139 acres, and 209 acres, respectively. The Arverne drainage basin is almost fully developed and predominantly residential, with a few, scattered undeveloped areas.. Subbasin A1 was estimated to require 8 outfalls, including 5 existing outfalls. Subbasin A2 was estimated to require 3 outlets. Subbasin A3 was estimated to require 5 outlets, including 3 existing outlets. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts (See Arverne Outlet Table). Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations are desired in the Arverne Area. Drainage subbasin A1 is proposed to have a pump station located adjacent to DE Costa Avenue near Beach 72nd with a capacity of about 70cfs. Subbasin A2 is proposed to have one pump station located on DE Costa Avenue near Beach 63rd Street with an estimated capacity of 180 cfs. Subbasin A3 is proposed to have one pump station located south of Thursby Avenue with an estimated capacity of 300 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

ARVERNE OUTLET TABLE

Drainage Basin	Outfall Size	Outfall Location
Drainage Basin A1	TBD	Existing Outfall ROC-633
Drainage Basin A1	TBD	Existing Outfall ROC-634
Drainage Basin A1	TBD	Existing Outfall ROC-40062
Drainage Basin A1	5'x3'	Outfall A1-1 located at the end of Hillmyer Avenue.
Drainage Basin A1	5'x3'	Outfall A1-2 located adjacent to Hillmyer Avenue and Barbadoes Avenue.
Drainage Basin A1	TBD	Existing Outfall ROC-658
Drainage Basin A1	5'x3'	Outfall A1-3
Drainage Basin A1	TBD	Existing Outfall ROC-659
Drainage Basin A2	5'x3'	Outfall A2-1 located on Bayfield Avenue 150 feet west of Beach 65th Street.
Drainage Basin A2	5'x3'	Outfall A2-2 located at the east end of DE Costa Avenue.
Drainage Basin A2	5'x3'	Outfall A2-3 located at the east end of Burchell Road.
Drainage Basin A3	TBD	Existing Outfall ROC-??? Located at the east end of Thursby Avenue.
Drainage Basin A3	TBD'	Existing Outfall ROC-636
Drainage Basin A3	5'x3'	Outfall A3-1 located 250 north of Beach Channel Drive on 58 Street.
Drainage Basin A3	TBD	Existing Outfall ROC-635
Drainage Basin A3	5'x3'	Outfall A3-2 located 50 north of Beach Channel Drive on 58 Street.

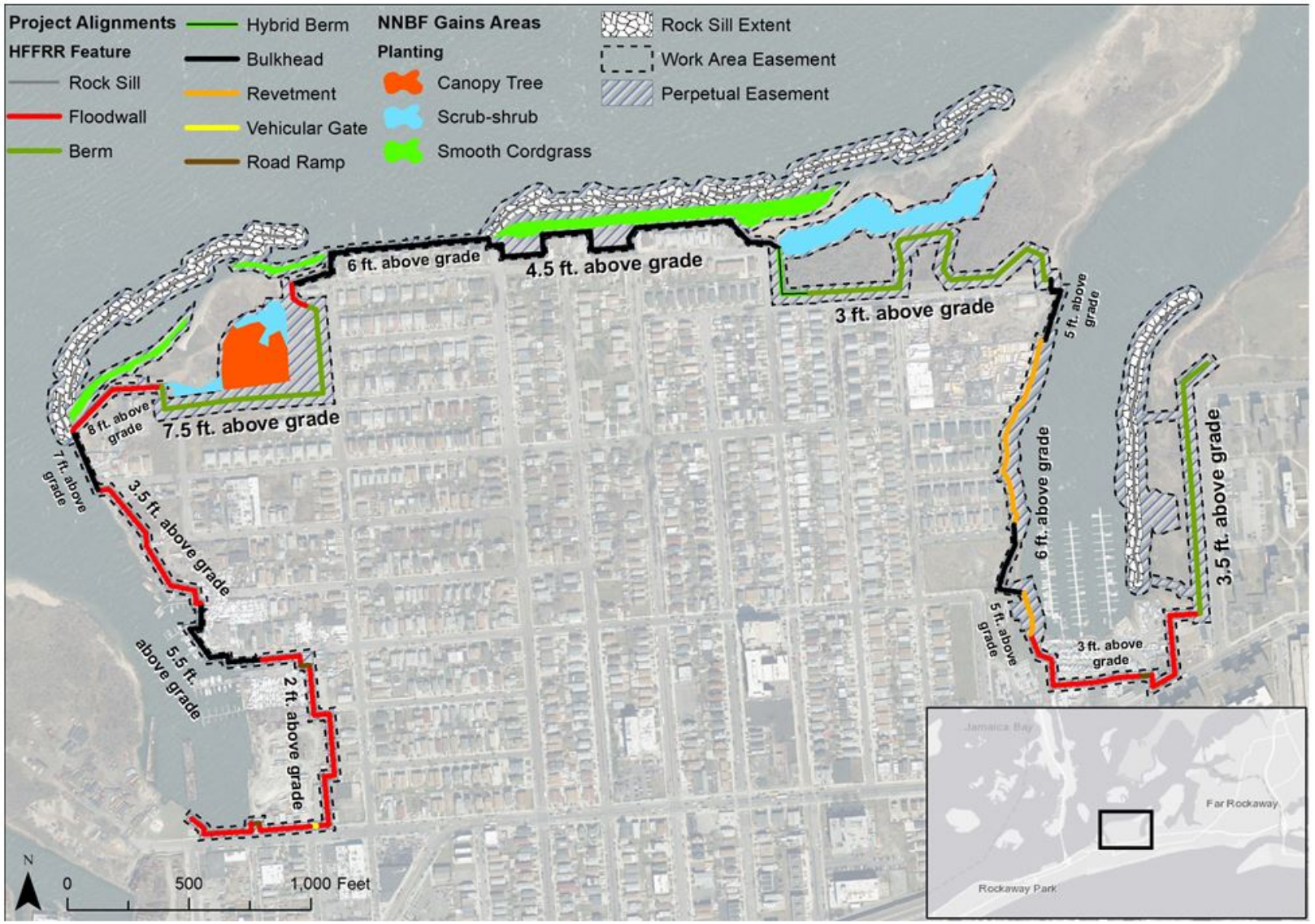


Figure 6: Mid Rockaway – Arverne Area HFFRRF Project Plan

2.4.5 Mid-Rockaway - Hammels Area

Two separate segments compose the Hammels area of the Mid-Rockaway project (Figure 7). The east segment begins approximately 320 feet west of the intersection of Beach 75th Street and Beach Channel Drive. It is composed of approximately 1,400 feet of low floodwall, running west along the north side of Beach Channel Drive, and parallel with the Rockaway Line elevated subway track. Three road ramps have been included to maintain access to the water front properties. The west segment consists of 1,400 feet of low floodwall beginning to the west of the MTA facility Hammels Wye adjacent to the Rockaway Line. The project heads west and south in a stair-step fashion avoiding impacts on existing structures, ending on the north side of Beach Channel Drive just west of Beach 87th Street. Three road ramps have been included to maintain access to the waterfront. Project design elevations have preliminarily been established based on the expected wave exposure, which is expected to be low, and are set at +8.0ft NAVD88.

The Hammels drainage basin includes two subbasins, H1 and H2, approximately 105 acres and 139 acres respectively. The Hammels drainage basin is almost fully developed, except for a few scattered grassy areas and is predominantly residential, with some commercial development. Subbasin H1 was estimated to require 3 outlets, including 2 existing outlets. Subbasin H2 was estimated to require 3 outlets, including 1 existing outlet. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system (See Hammels Outlet Table). The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that two pump stations are desired in the Hammels Area. Drainage subbasin H1 is proposed to have a pump station located at the southern end of Hammels near Beach 87th Street with a capacity of about 100cfs. Subbasin H2 is also proposed to have one pump station which is located at the northern end of Hammels near Beach Channel Drive with an estimated capacity of 180 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlets will be refined during the project design phase.

HAMMELS OUTLET TABLE

Drainage Area	Outfall Size	Outfall Location
Drainage Basin H1	TBD	Existing Outfall ROC-656
Drainage Basin H1	5'x3'	Outfall H1-1, Approximately 70 feet east of Beach 85th Street
Drainage Basin H1	TBD	Existing Outfall ROC-657
Drainage Basin H2	5'x3'	Outfall H2-1, Approximately 350 feet west of Beach 80th Street
Drainage Basin H2	5'x3'	Outfall H2-2, Approximately 100 feet east of Beach 79th Street
Drainage Basin H2	TBD	Existing Outfall ROC-653

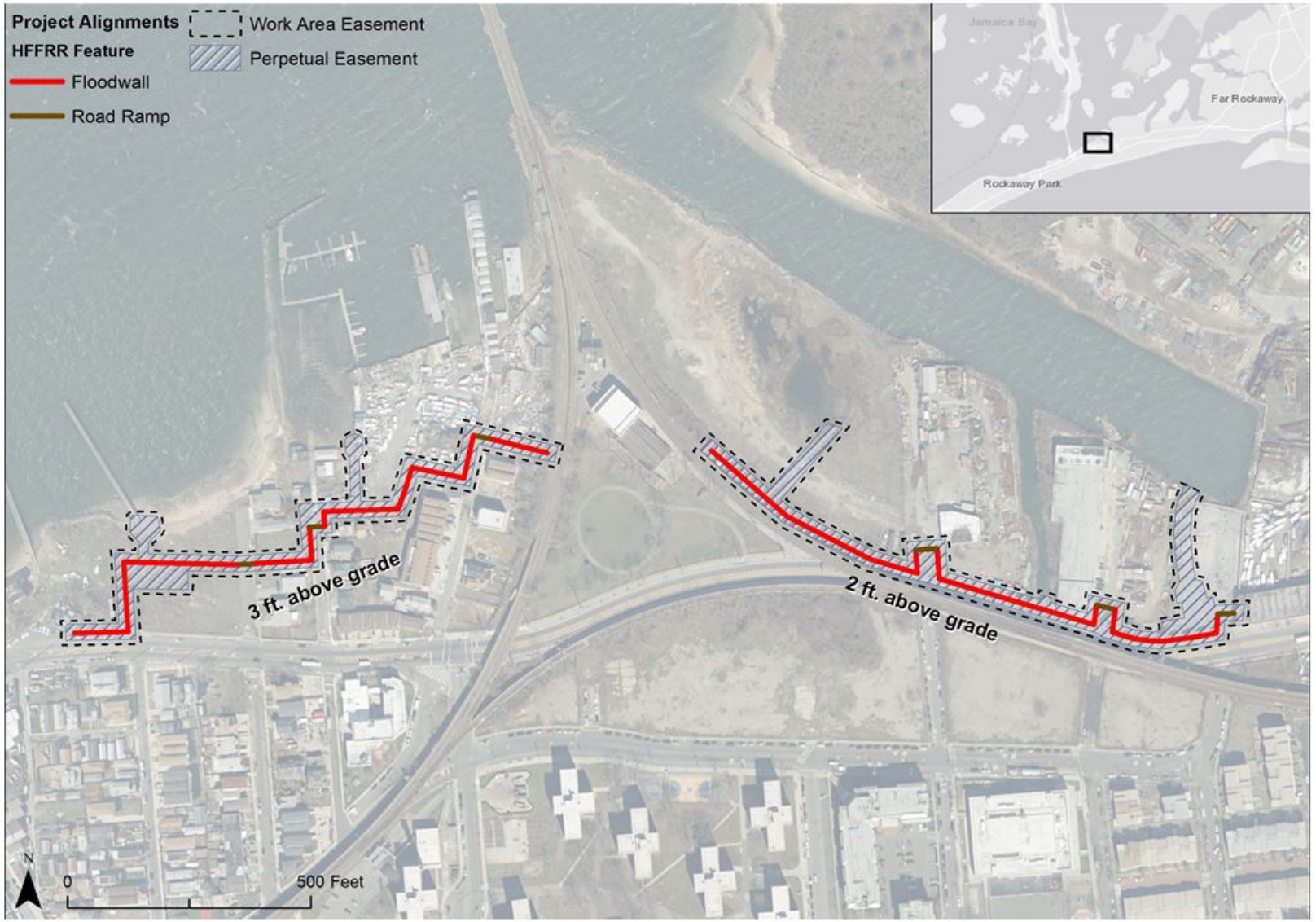


Figure 7: Mid Rockaway – Hammels Area HFFRRF Project Plan

2.5 Project Elements

Structural and non-structural management measures, including Natural and Nature-Based Features (NNBF), were developed to address one or more of the planning objectives for the project. Management measures were developed in consultation with the non-federal sponsor (NYSDEC), state and local agencies, and non-governmental entities. Measures were evaluated for compatibility with local conditions and relative effectiveness in meeting planning objectives. Effective measures were combined to create CSRM alternatives for two geographically discrete reaches: the Atlantic Ocean shorefront and Jamaica Bay. Integrating CSRM alternatives for the two reaches provides the most economically efficient system-wide solution for the vulnerable communities within the study area. It is important to note that any comprehensive approach to CSRM in the study area must include an Atlantic Ocean shorefront component because overtopping of the Rockaway peninsula is a source of flood waters into Jamaica Bay. Efficient CSRM solutions were formulated specifically to address conditions at the Atlantic Ocean shorefront. The best solution for the Atlantic Shorefront reach was included as a component of the alternative plans for the Jamaica Bay reach.

Project elements determined to potentially elicit adverse effects to protected species under USFWS jurisdiction are those alternatives identified for the Atlantic Ocean shorefront component of the project, only. The Jamaica Bay/Back Bay component of the project, therefore, has been determined not to introduce risk to the protected species due to the fact that there is no documentation of protected species occurrence or habitat in this area of effect, and, the CSRM features identified for this component of the project would not pose any risk or threat to protected species under USFWS jurisdiction if any occurrence or utilization were documented.

The Atlantic Ocean shorefront reach is subject to wave attack, wave run up, and over topping along the Rockaway peninsula. The general approach to developing CSRM along this reach was to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective renourishment approach prior to the evaluation of alternatives for coastal storm risk management. The most cost effective erosion control alternative is beach restoration with increased erosion control (See Figures 2a through 2d). This erosion control alternative had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life. A screening analysis was performed to evaluate the level of risk reduction provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with beach restoration with increased erosion control to optimize CSRM at the Atlantic Ocean shorefront.

Beach fill for the Atlantic Shoreline component of the proposed project is available from an offshore borrow area. The borrow area is located approximately two miles offshore (south) of the Rockaway peninsula.

Other factors such as prior projects at Rockaway Beach, project constraints, stakeholder concerns, and engineering judgment were also applied in the evaluation and selection. A composite seawall was selected as the best coastal storm risk management alternative. The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding (Figures 8 and 9). The structure crest elevation is +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet. The armor stone in horizontally composite structures significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls

to be used in the design if the face of the wall is completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding 1-layer of armor stone and extending the concrete cap up to the elevation of the armor stone.

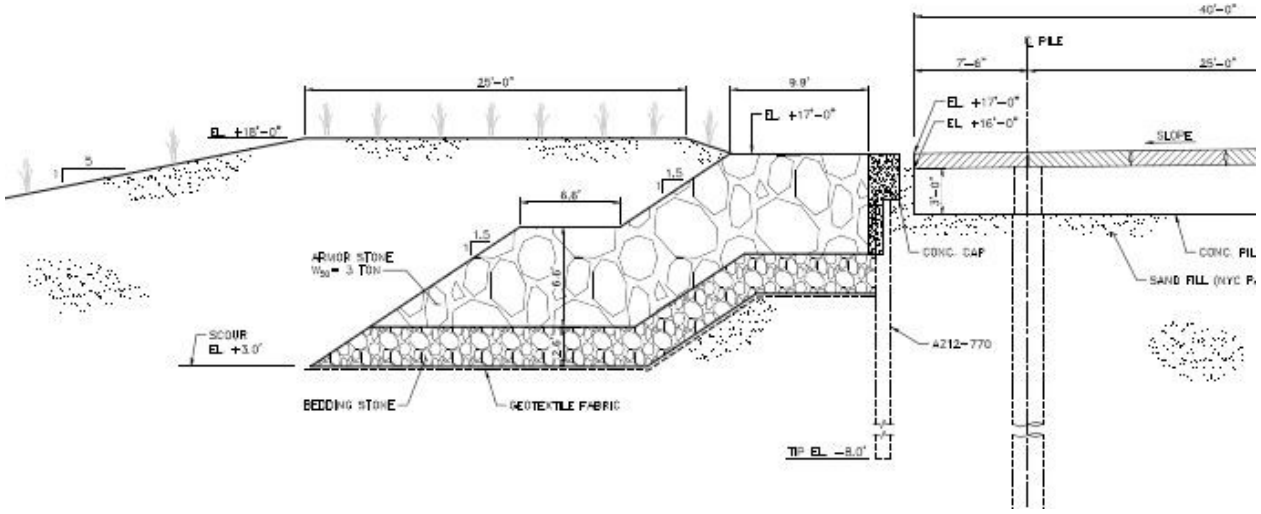


Figure 8: Composite Seawall Beach 19th St. to Beach 126th St

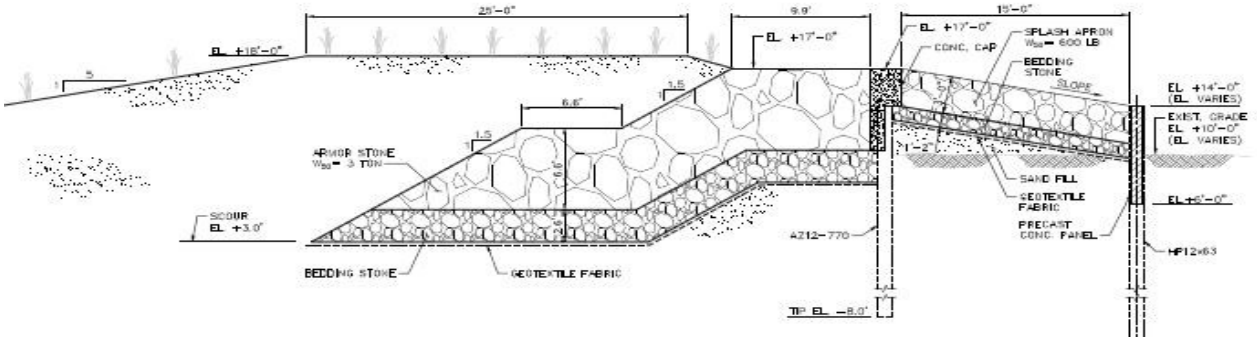


Figure 9: Composite Seawall Beach 126th St. to Beach 149th St.

2.5.1 The Atlantic Ocean Shorefront Beachfill

The selected storm damage reduction plan including changes from the authorized project, comprises approximately 152,000 If of dune and beach fill and generally extends from the eastern end of the barrier island at Beach 19th street to the western boundary of Breezy Point. This component of the Project includes the following: 1) a dune with a top elevation of +18 ft above NAVD88, a top width of 25 ft, and landward and seaward slopes of 1V:5H that will extend along the entire footprint (1V:3H on landward slope fronting the boardwalk). See Table 2.

All beachfill quantities include an overfill factor of 11% based on the compatibility analysis for the borrow areas. In addition the initial construction quantities include an additional 15% for

construction tolerance. It is noted that the advance fill and renourishment quantities do not include tolerance since the purpose of the advance fill and renourishment is to place a specific volume of sediment to offset anticipated losses between renourishment operations, rather than build a specific template. Beachfill quantities required for initial construction of each alternative are estimated based on the expected shoreline position in June of 2018. It is impossible to predict the exact shoreline position in June 2018 since the wave conditions vary from year to year and affect shoreline change rates. The shoreline position in June of 2018 was estimated based on a 2.5 year GENESIS-T simulation representative of typical wave conditions.

Table 2: Initial Construction Beachfill Quantities

Reach	Reach Length (ft)	Recommended Plan Fill Quantity (CY)
West Taper		306,000
Reach 3	10,320	356,000
Reach 4	5,380	294,000
Reach 5	10,650	321,000
Reach 6a	3,730	250,000
Reach 6b	2,000	20,000
East Taper		49,000
Total		**1,596,000**

2.5.2 Atlantic Ocean Shorefront: Construction of New Groins and Extension of Existing Groins

Three types of groin measures are considered in the alternative analysis: new groin construction, groin extension, and groin shortening. The exact dimensions and stone sizes of the existing groins at Rockaway is not available. Therefore, it is assumed that the existing groins in Reaches 5 and 6 are similar to the proposed new groin designs. Generally a groin is comprised of three sections: 1) horizontal shore section (HSS) extending along the design berm; (2) an intermediate sloping section (ISS) extending from the berm to the design shoreline, and (3) an outer sloping section (OS) that extends from the shoreline to offshore. The head section (HD) is part of the OS and is typically constructed at a flatter slope than the trunk of the groin and may require larger stone due to the exposure to breaking waves.

The spacing between groins in this study is based on the existing spacing in Reach 5 (720 ft) and Reach 6a (780 ft). The required lengths of the new groins is based on the GENESIS-T model simulations.

The Project requires the immediate construction of a 12 new groins in reach 3 and 4 (between 92nd Street to 121st Street) and an additional groin in reach 6a (34th street). The 5 groin extension are located in Reach 6a (between 37th Street – 49th Street). The extension of the groin lengths vary and range from 75 ft to 200 ft. Groin widths will be 13 ft. See Table 3.

Table 3: Summary of Groin Lengths

Alt	Reach	Number	Street	HSS (ft)	ISS (ft)	OS (ft)	Total (ft)	Notes:
3	6a	1	34th St	90	108	328	526	New 526’
3	6a	2	37th St	90	108	328	526	Extension 175’
3	6a	3	40th St	90	108	328	526	Extension 200’
3	6a	4	43rd St	90	108	228	426	Extension 75’
3	6a	5	46th St	90	108	228	426	Extension 150’
3	6a	6	49th St	90	108	228	426	Extension 200’
3	4	1	92nd St	90	108	128	326	New 326’
3	4	2	95th St	90	108	128	326	New 326’
3	4	3	98th St	90	108	128	326	New 326’
3	4	4	101st St	90	108	128	326	New 326’
3	4	5	104th St	90	108	128	326	New 326’
3	4	6	106th St	90	108	128	326	New 326’
3	4	7	108th St	90	108	128	326	New 326’
3	3	8	110th St	90	108	153	351	New 351’
3	3	9	113th St	90	108	178	376	New 376’
3	3	10	115th St	90	108	178	376	New 376’
3	3	11	118th St	90	108	178	376	New 376’
3	3	12	121st St	90	108	128	326	New 326’

2.5.3 Sand Removal from Offshore Borrow Area

An offshore borrow area which is 2.6 miles long and 1.1 miles wide, located approximately 2 miles south of East Rockaway (Figure 10) between 35 feet mean low water and about 60 feet mean low water, has been identified as a potential source of sand material for beach fill and dune construction activities.

Figure 10: Location of the East Rockaway Borrow Area

2.6 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions of the Project include beach renourishments and maintenance of beach access locations. Renourishments will be conducted every 4-years or as needed over the 50-year life of the Project. During each renourishment, approximately 1,100,000 CY of sand will be added to the beach from the borrow area located approximately 2 miles offshore to the south of East Rockaway. Inlet maintenance dredging (115,000 cy/yr) is included in the 1.1 million cy of material needed for the renourishment.

3 SPECIES OCCURENCE

Previous surveys conducted by USFWS and NYC DPR confirmed presence of piping plover and seabeach amaranth, as well as suitable habitat for red knot in the Atlantic Ocean Shoreline component of the Project Area (USFWS 1982, 1994a, 1995a, 1995b, 1996; NYC DPR 2017). Therefore, in accordance with the ESA recommendations, the following section provides species profiles for each of these federally-listed T&E species. This information, along with the knowledge of local experts, wildlife biologists, botanists, and District and USFWS personnel, was utilized to identify potential impacts to these species as a result of implementation of the proposed action.

3.1 PIPING PLOVER

On January 10, 1986, the piping plover was listed as threatened and endangered under provisions of the ESA. Three distinct populations were identified by the Service during the listing process: Atlantic Coast (threatened), Great Lakes (endangered), and Northern Great Plains (threatened). No critical habitat has been designated or proposed in the Atlantic Coast breeding area which is the focus of this BA.

The Atlantic Coast population breeds on coastal beaches from Newfoundland to North Carolina (NC) (and, occasionally, in South Carolina) and winters along the Atlantic Coast from NC southward, along the Gulf Coast, and in the Caribbean (Section 3 cited as Biological Assessment, Fire Island Inlet to Montauk Point Coastal Storm Risk Management, Suffolk County, New York. Prepared and submitted by: U.S. Fish and Wildlife Service, Chesapeake Bay Field Office and U.S. Army Corps of Engineers, New York District).

3.1.1 Life History

Piping plovers are small, sand-colored shorebirds approximately 7 inches long, with a wingspread of about 15 inches.

Breeding-Piping plovers begin returning to their Atlantic Coast nesting beaches in mid-March (Coutu et al. 1990; Cross 1990; Goldin 1990; MacIvor 1990; Hake 1993). Males establish and defend territories and court females by early April (Cairns 1982). Piping plovers are monogamous, but usually shift mates between years (Wilcox 1959; Haig and Oring 1988; MacIvor 1990; Strauss 1990) and, less frequently, between nesting attempts in a given year (Haig and Oring 1988, MacIvor 1990, Strauss 1990). Plovers are known to breed at one year of age (MacIvor 1990; Haig 1992), but the rate at which this occurs is unknown. Egg-laying and incubation can start as early as mid-April (USFWS 1996a).

Piping plovers nest on coastal beaches (NC to Newfoundland), sand spits at the end of barrier islands, gently sloping foredunes, blowout areas behind primary dunes, and in overwash-created bare sand areas cut into or between dunes. In the central portions of their Atlantic Coast range (including NY-NJ), they may also nest on areas where suitable dredged material has been deposited.

Nest sites are shallow-scraped depressions in substrates ranging from fine-grained sand mixtures to sand and pebbles, shells, or cobble (Bent 1929; Cairns 1982; Burger 1987; Patterson 1988; Flemming et al. 1990; MacIvor 1990; Strauss 1990). Nests may be difficult to detect, especially during the six-to seven-day egg-laying phase when the birds generally do not incubate (Goldin 1994). Eggs may be present on the beach from mid-April through late July and clutch size for an initial nest attempt is usually four eggs, with one egg laid every other day.

Full-time incubation usually begins with the completion of the clutch and is shared equally by both sexes for a period lasting from 27 to 28 days (Wilcox 1959; Cairns 1977; MacIvor 1990). Eggs in a clutch usually hatch within four to eight hours of each other, but the hatching period may extend to 48 hours.

Piping plovers generally fledge only a single brood (one or more chicks from a nest) per season, but may re nest several times if previous nests are lost or, infrequently, if a brood is lost within several days of hatching. A few rare instances of adults re-nesting following fledging of an early brood have also been observed. Chicks are precocial and are capable of foraging for themselves within several hours of hatching (Wilcox 1959; Cairns 1982) and may move hundreds of feet from the nest site during their first week of life (USFWS 1996a). Chicks may increase their foraging range up to 3,280 ft (Loegering 1992) or more based on observations from Fire Island to Moriches Inlet monitoring in 2016 (Carey et al. 2017), and will remain with both parents until they fledge at 25 to 35 days of age. Depending on the date of hatching, flightless chicks may be present from mid-May until late August, although most fledge by the end of July (Patterson 1988; Goldin 1990; MacIvor 1990; Howard et al. 1993). Nest success depends heavily on camouflage (Hull 1981). Cryptic coloration is a primary defense mechanism for this species; nests, adults, and chicks all blend in with their beach surroundings. Chicks sometimes respond to off-road vehicles (ORVs) and/or pedestrians by crouching and remaining motionless (Cairns 1977). Adult piping plovers respond to avian and mammalian predators by displaying a variety of distraction behaviors including squatting, false brooding, running, and injury feigning. Distraction displays may occur at any time during the breeding season, but are most frequent and intense during the time of hatching (Cairns 1977).

Migration-Fall migration to southern wintering grounds begins in mid-to late summer. Juvenile plover may remain on breeding grounds later but are generally gone mid-to late August (Cuthbert and Wiens 1982). A study of migration routes, duration, stopovers, and other behaviors of radio-tagged plovers is in progress (Loring et al. 2017). But the pattern of both spring and fall counts at migration suites along the southeastern Atlantic Coast demonstrates that many piping plovers make intermediate stopovers lasting from a few days up to one month during their migrations (Noel et al. 2006; Stucker and Cuthbert 2006).

Feeding-Piping plovers feed on invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks (Bent 1929; Cairns 1977; Nicholls 1989). Important feeding areas may include intertidal portions of ocean beaches, overwash areas, mudflats, sandflats, wracklines, sparse vegetation, and shorelines of coastal ponds, lagoons, or salt marshes (Gibbs 1986; Coutu et al. 1990; Hoopes et al. 1992; Loegering 1992; Goldin 1993; Elias-Gerken 1994; Cohen 2005; Houghton 2005). Studies by Cuthbert and Weins (1982) indicate that open shoreline areas are preferred and vegetated beaches are avoided. In Massachusetts, plover preferred mudflat, intertidal and wrack habitats for foraging (Hoopes et al. 1992). The relative importance of various feeding habitats may vary by site (Gibbs 1986; Coutu et al. 1990; McConnaughey et al. 1990; Loegering 1992; Goldin 1993; Hoopes 1993; Elias-Gerken 1994) and by stage in the breeding cycle (Cross 1990). Adults and chicks on a given site may use different feeding habitats in varying proportion (Goldin 1990). Most time-budget studies reveal that chicks spend a very high proportion of their time feeding. Cairns (1977) found that chicks typically tripled their weight during the first two weeks post-hatching; chicks that failed to achieve at least 60 percent of this weight-gain by day 12 were unlikely to survive. Feeding territories are generally contiguous to nesting territories (Cairns

1977). Feeding activities of both adults and chicks may occur during all hours of the day and night (Burger 1994) and at all stages during the tidal cycle (Goldin 1993; Hoopes 1993).

3.1.2 Life History

The piping plover is a small robin-sized shorebird 17–18 cm (7.25 in) in length, a wingspan of 47 cm (19 in), and an average weight of 55 g (1.9 oz) (Sibley 2000). Piping plover breed and nest on coastal beaches from Newfoundland and southeastern Quebec to North Carolina and winter primarily on the Atlantic coast from North Carolina to Florida. Along the Atlantic coast, plover nest mainly on gently sloping foredunes above the high tide line, in blow-out areas behind primary dunes of sandy coastal beaches, and on suitable dredge spoil deposits (USFWS 1988, Cashin Associates 1993, NPS 1994). Nests are usually found in sandy areas with little or no vegetation. Vegetation, when present, consists of beach grass, sea rocket, and/or seaside goldenrod.

Plover begin northward migration to breeding grounds from southern U.S. wintering areas in March, and arrive on nesting grounds from March – May; males arrive prior to females. Fall migration to southern wintering grounds begins in mid- to late summer. Juvenile plover may remain on breeding grounds later but are generally gone by mid- to late August (Cuthbert and Wiens 1982). Atlantic coast breeders migrate primarily to Atlantic coast sites located farther south of breeding areas (i.e., Virginia to Florida, Bahamas) (Haig and Oring 1988, Haig and Plissner 1993).

The adult males arrive earliest, select beach habitats, and defend established territories against other males (Hull 1981). When adult females arrive at the breeding grounds several weeks later, the males conduct elaborate courtship rituals including aerial displays of circles and figure eights, whistling song, posturing with spread tail and wings, and rapid drumming of feet. The breeding season begins when adult female plovers reach the breeding grounds in mid- to late-April or in mid-May in northern parts of the range. (Bent 1929, Hull 1981).

Plover typically return to the same general nesting area in consecutive years (but few return to natal sites). Plover are known to shift breeding location by up to several hundred kilometers between consecutive years (NatureServe 2002). However, Wilcox (1959) found that plover a relatively site faithful and only 20 percent settled at a nest site farther than 1,000 ft from the previous year's locality. Previous reproductive success does not appear to increase the probability of returning to specific breeding sites (NatureServe 2002).

Nest sites are simple depressions or scrapes in the sand (Bent 1929, Wilcox 1959). The average nest is about 6 to 8 cm in diameter, and is often lined with pebbles, shells, or driftwood to enhance the camouflage effect. Males make the scrapes and may construct additional (unused) nests in their territories, which may be used to deceive predators or may simply reflect over-zealousness (Wilcox 1959, Hull 1981). Occupied nests are generally 50 to 100 meters apart (Wilcox 1959, Cairns 1977, Cuthbert and Wiens 1982).

Egg-laying commences soon after mating (Hull 1981, Cuthbert and Wiens 1982). Eggs are laid every second day. The average clutch size is four eggs (Wilcox 1959) and three-egg clutches occur most commonly in replacement clutches. The average number of young fledged per nesting pair usually is two or fewer. The young hatch about 27 to 31 days after egg laying. Incubation is shared by both adults (Wilcox 1959, Hull 1981).

Young plover leave the nest about two hours after hatching and immediately are capable of running and swimming. The young usually remain within about 200 meters of the nest, although they do not return after hatching (Wilcox 1959, Johnsgard 1979, Hull 1981). When disturbed or threatened, the young either freeze or combine short runs with freezing and blend very effectively into their surroundings (Wilcox 1959, Hull 1981). Adults will feign injury to draw intruders away from the nest or young (Bent 1929, Wilcox 1959). Adults also defend the nest territory against other adult piping plovers, gulls, and songbirds (Wilcox 1959, Matteson 1980). First (unsustained) flight has been observed at around 18 days, with chicks molting into first juvenile plumage by day 22 (NatureServe 2002).

Nest success depends heavily upon camouflage (Hull 1981). Hatching success ranges widely as follows: 91 percent for undisturbed beaches on Long Island (Wilcox 1959), 76 percent for undisturbed beaches in Nova Scotia (Cairns 1977), 44 percent on relatively undisturbed beaches at Lake of the Woods (Cuthbert and Wiens 1982), and 30 percent maximum at disturbed Michigan beaches (Lambert and Ratcliff 1979).

Plover diet consists of worms, fly larvae, beetles, crustaceans, mollusks, and other invertebrates (Bent 1929). In New Jersey, intertidal polychaetes were the main prey of plovers (Staine and Burger 1994). Plover forage along ocean beaches, on intertidal flats and tidal pool edges. Studies by Cuthbert and Weins (1982) indicate that open shoreline areas are preferred and vegetated beaches are avoided. Plover obtain their food from the surface of the substrate, or occasionally will probe into the sand or mud.

Most time-budget studies reveal that chicks spend a very high proportion of their time feeding. Cairns (1977) found that chicks typically tripled their weight during the first two weeks post-hatching; chicks that failed to achieve at least 60 percent of this weight-gain by day 12 were unlikely to survive. Courtship, nesting, brood-rearing, and feeding territories are generally contiguous to nesting territories (Cairns 1977), although instances when brood-rearing areas are widely separated from nesting territories are common, thus increasing the geographic boundaries of their breeding area. Feeding activities of both adults and chicks may occur during all hours of the day and night (Burger 1994) and at all stages during the tidal cycle (Goldin 1993; Hoopes 1993).

In New York, 95.8 percent of piping plover pairs nested on non-federal land in 1999 (Rosenblatt 2000). Piping plover protection in this recovery unit, therefore, is highly dependent on the efforts of state and local government agencies, conservation organizations, and private landowners. Landowner efforts are often contingent on annual commitments. While many landowners are supportive and cooperative, others are not.

In Massachusetts, plover preferred mudflat, intertidal and wrack habitats for foraging (Hoopes et al. 1992a). On Assateague Island, bay beaches and island interiors were much more favorable as brood-rearing habitats than were ocean beaches (Patterson et al. 1992).

3.1.3 Threats to Species

The wide, flat, sparsely vegetated barrier beaches preferred by the piping plover are an unstable habitat, dependent on natural forces for renewal and susceptible to degradation by development and shoreline stabilization efforts. In high use recreational areas such as East Rockaway, the primary threat to piping plover is disturbance by recreational beach users during the breeding

season. Other significant threats include destruction and degradation of habitat and predation (USFWS 1988, 1995b, Burger 1993, NJDEP 1997).

Inundation of piping plover habitat by rising seas could lead to permanent loss of habitat if natural coastal dynamics are impeded by numerous structures or roads, especially if those shorelines are also armored with hardened structures. Without development or armoring, low undeveloped islands can migrate toward the mainland, pushed by the overwashing of sand eroding from the seaward side and being re-deposited in the bay (Scavia et al. 2002). Overwash and sand migration are impeded on developed portions of islands. Instead, as sea-level increases, the ocean-facing beach erodes and the resulting sand is deposited offshore. The buildings and the sand dunes then prevent sand from washing back toward the lagoons, and the lagoon side becomes increasingly submerged during extreme high tides (Scavia et al. 2002), diminishing both barrier beach shorebird habitat and protection for mainland developments.

Modeling for three sea-level rise scenarios (reflecting variable projections of global temperature rise) at five important U.S. shorebird staging and wintering sites predicted loss of 20-70 percent of current intertidal foraging habitat (Galbraith et al. 2002). These authors estimated probabilistic sea-level changes for specific sites partially based on historical rates of sea-level change (from tide gauges at or near each site); they then superimposed this on projected 50 percent and 5 percent probability of global sea-level changes by 2100 of 34 cm and 77 cm, respectively.

3.1.4 Human Disturbance

Recreational disturbance: Disturbance, i.e., human and pet presence that alters bird behavior, disrupts piping plovers as well as other shorebird species. Disturbance can cause shorebirds to spend less time roosting or foraging and more time in alert postures or fleeing from the disturbances (Johnson and Baldassarre 1988; Burger 1991; Burger 1994; Elliott and Teas 1996; Lafferty 2001a, 2001b; Thomas et al. 2002), which limits the local abundance of piping plovers (Zonick and Ryan 1995; Zonick 2000). Shorebirds that are repeatedly flushed in response to disturbance expend energy on costly short flights (Nudds and Bryant 2000). Shorebirds are more likely to flush from the presence of dogs than people, and birds react to dogs from farther distances than people (Lafferty 2001a, 2001b; Thomas et al. 2002). Dogs off leash are more likely to flush piping plovers from farther distances than are dogs on leash; nonetheless, dogs both on and off leashes disturb piping plovers (Hoopes 1993). Pedestrians walking with dogs often go through flocks of foraging and roosting shorebirds; some even encourage their dogs to chase birds.

Off-road vehicles (ORVs) can significantly degrade piping plover habitat (Wheeler 1979) or disrupt the birds' normal behavior patterns (Zonick 2000). The FWS Piping Plover Atlantic Coast Population Revised Recovery Plan cites tire ruts crushing wrack into the sand, making it unavailable as cover or as foraging substrate (Hoopes 1993; Goldin 1993). The Recovery Plan also notes that the magnitude of the threat from ORVs is particularly significant, because vehicles extend impacts to remote stretches of beach where human disturbance will otherwise be very slight. Godfrey et al. (1980 as cited in Lamont et al.1997) postulated that ORVs may compact the substrate and kill marine invertebrates that are food for the piping plover. Zonick (2000) found that the density of ORVs negatively correlated with abundance of roosting piping plovers on the ocean beach. Cohen et al. (2008) found that radio-tagged piping plovers using ocean beach habitat at Oregon Inlet in North Carolina were far less likely to use the north side of the inlet where ORV use is allowed, and recommended controlled management experiments to determine if recreational

disturbance drives roost site selection. Ninety-six percent of piping plover detections were on the south side of the inlet even though it was farther away from foraging sites (1.8 km from the sound side foraging site to the north side of the inlet versus 0.4 km from the sound side foraging site to the north side of the inlet; Cohen et al. 2008).

3.1.5 Habitat Loss/Alteration

Along the Atlantic coast, development, encroachment of beach vegetation, flooding and erosion are primary factors in the loss of suitable breeding and nesting habitat for piping plover (Haig 1992). In Maine, construction of seawalls, jetties, piers, homes, parking lots, and other structures has reduced historic nesting habitat by more than 70%; where more than 20 miles of historic habitat may have supported more than 200 pairs of piping plovers, 32 pairs nested in 1993 on habitat with an estimated capacity of 52 pairs (Maine Department of Inland Fisheries and Wildlife 1995). Wilcox (1959) pointed to summer home and road construction as causes of declining plover nesting along Moriches Bay on Long Island, New York, between 1939 and 1951. Raithel (1984) cited coastal development and shoreline stabilization, including construction and dredging of permanent breachways, building of breakwaters, and planting of dune areas, as major contributors to the decline of the piping plover in Rhode Island. Analysis of 4 years of piping plover nest location data on a New York site revealed that the nests were significantly farther from concrete walkways leading from the dunes to the berm than were random points, suggesting that the walkways decrease the carrying capacity of the beach (Hoopes 1995). In 1993 NYSDEC documented a reduction in nest sites and habitat use by piping plover and least terns at a colony on Long Island and attributed the reduction to severe erosion and loss of suitable habitat in the area (USACE 1998, USACE 2006).

The location of development on beaches where they are vulnerable to erosion often leads to impacts that go far beyond the footprint of the facilities themselves. Requests from private communities within the Fire Island National Seashore, New York, to construct artificial dunes on adjacent undeveloped National Park Service lands in 1993 (NPS 1992, 1993) exemplify situations where shoreline development has created demand to modify and stabilize habitat suitable for plover nesting.

Plover are also likely experiencing loss of habitat in areas where the vegetation in the upper beach zone exceeds levels desired by piping plover. In general, plover prefer to nest in sparsely vegetated areas (Cohen et al. 2002, 2003a, 2003b). However, dense vegetation located near the breeding area is also desirable for plover foraging and cover.

Important factors influencing future habitat losses and gains include the amount of sea-level rise, which may vary regionally due to subsidence or uplift and the specific landforms occurring within a region (Galbraith et al. 2005; Gutierrez et al. 2007). Gutierrez et al. (2007) predicted varying responses of spits, headlands, wave-dominated barriers, and mixed-energy barriers for four sea-level rise scenarios in the U.S. mid-Atlantic region (overlapping most of the piping plover's New York-New Jersey and southern recovery units). Development and testing of models linking predictions of sea-level rise, changes in beach geomorphology, and piping plover nesting habitat is currently in progress (Gutierrez et al. 2011; Gieder et al. 2014; Gutierrez et al. 2015). Human responses, especially coastal armoring, will play key roles in the effects of sea-level rise on the quantity, quality, and distribution of piping plover habitats.

3.1.6 Predation

Predation has been identified as a major factor limiting piping plover reproductive success at many Atlantic Coast sites (Burger 1987a, MacIvor 1990, Patterson et al. 1991, Cross 1992, Elias-Gerken 1994). As with other limiting factors, the nature and severity of predation is highly site-specific. Predators of piping plover eggs and chicks include red fox, striped skunk, raccoon, Norway rat, opossum, crows, ravens, gulls, common grackles, American kestrel, domestic and feral dogs and cats, and ghost crabs.

Human activities affect the types, numbers, and activity patterns of predators, thereby exacerbating natural predation. Human activities have abetted the expansions in the populations and/or range of other species such as gulls (Drury 1973, Erwin 1979) and opossum (Gardner 1982). The availability of trash at summer beach homes increases local populations of skunks, raccoons and fox (Raithel 1984, Strauss 1990). In Massachusetts, predators, primarily red fox (*Vulpes vulpes*), destroyed 52 – 81 percent of nests in one study area (MacIvor et al. 1990). Similarly, on Assateague Island, Maryland and Virginia, predators, mainly red fox and raccoon (*Procyon lotor*), accounted for about 90 percent of the known causes of nest loss (Patterson et al. 1992). In addition, gulls, grackles (*Quiscalus quiscula*), crows (*Corvus* spp.), and in developed, high recreational use areas such as East Rockaway, domestic and free-roaming cats and dogs are equally as detrimental to plover populations by direct predation or disturbance of nest sites (Cartar 1976, Lambert and Ratcliff 1979, Cairns and McLaren 1980, Nol 1980, USFWS 1988, Patterson et al. 1990, NJDEP 1997).

3.2 Seabeach Amaranth

Seabeach amaranth is a native annual plant that inhabits barrier island beaches along the Atlantic Coast. This plant historically occurred in 31 counties in nine states from Cape Cod in Massachusetts to South Carolina. However, by 1990, only 55 populations remained, which were located in South Carolina, North Carolina, and New York (USFWS 1996). In 1993, the USFWS listed the plant as a federally-threatened species because of the declining population and its overall vulnerability to habitat destruction (USFWS 1993). Seabeach amaranth is also listed as threatened or endangered throughout its current and historical range, including New York where it is imperiled (i.e., endangered). Accordingly, the ESA, as well as several state-level endangered species laws and regulations, protect this species.

Due to the protection afforded to it by the ESA and state laws, seabeach amaranth has returned to several states after years of extirpation. Known populations of this species occur in New York, Delaware, Maryland, Virginia, North Carolina, and South Carolina (USFWS 2004b). Many of these new occurrences are the result of reintroduction and restoration programs conducted by federal, state, and local governments and non-profit organizations. Long Island supports the largest population of seabeach amaranth within its historical range, which extends from South Carolina to Massachusetts. Each year Endangered Species Biologists from the Long Island Field Office of the USFWS assist the New York Natural Heritage Program in conducting annual surveys for this threatened species. Within New York and across its range, seabeach amaranth numbers vary from year to year. Data in New York is available from 1987 to 2016. Recently, the number of plants across the entire state dwindled from a high of 244,608 in 2000 to 4,985 in 2016. This trend of decreasing numbers is seen throughout its range. A total of 249,261 plants were found throughout the species' range in 2000. By 2016, those numbers had dwindled to 9,221 plants. Seabeach

amaranth is dependent on natural coastal processes to create and maintain habitat. However, high tides and storm surges from tropical systems can overwash, bury, or inundate seabeach amaranth plants or seeds, and seed dispersal may be affected by strong storm events (per Biological Assessment, Fire Island Inlet to Montauk Point Coastal Storm Risk Management, Suffolk County, New York. Prepared and submitted by: U.S. Fish and Wildlife Service, Chesapeake Bay Field Office and U.S. Army Corps of Engineers, New York District April 2018).

Life History

Seabeach amaranth germinates as small, unbranched, fleshy red colored sprigs between June and July in New York State (USFWS 2004b). These sprigs develop into a rosette of small, wrinkled leaves that branch out from the low-lying reddish stems. As the plant matures, it develops into a clump with numerous stems, which can reach a diameter of 3 ft. The small (1.3 to 2.5 centimeters in diameter) rounded leaves are clustered around the tip of the stems, exhibit a spinach-green color, and have a small notch at the rounded tip of the leaf (USFWS 1996). Inconspicuous flowers develop in clusters around the stem in mid-summer and can produce seed by July. Seed production continues until the plant dies, usually in mid to late fall, but can continue into January (USFWS 1996).

Seabeach amaranth is most likely wind-pollinated, based on the morphology of the flower and inflorescence and lack of visual, chemical, or nectar attractants. Additionally, this species is capable of self-pollination, as are other species of *Amaranthus* (USFWS 1996). Seed dispersal is carried out by water (hydrochory) and wind (anemochory) (USFWS 1996).

The primary habitat for seabeach amaranth consists of the dynamic and ever changing seaward facing areas of barrier islands, including overwash flats at accreting ends of islands, lower foredunes, and upper strands of non-eroding beaches located landward of the wrack line (USFWS 1996). Seabeach amaranth occasionally establishes populations in other habitats, including sound-side beaches, foredune blowouts, and on replenished beaches. Typical of the species, on Fire Island in New York, seabeach amaranth tends to grow on the ocean beach in bare or sparsely vegetated swales and along overwash zones (National Park Service [NPS] 1998).

Seabeach amaranth occupies a narrow beach zone that lies above mean high tide at the lowest elevations at which vascular plants regularly occur. Seaward, the plant grows only above the high tide line, as it is intolerant of even occasional flooding during the growing season.

Landward, seabeach amaranth does not occur more than a meter or so above the beach elevation on the foredune, or anywhere behind it, except in overwash areas. The species is, therefore, dependent on a terrestrial, upper beach habitat that is not flooded during the growing season.

This zone is absent on beaches that are experiencing high rates of erosion. Seabeach amaranth is never found on beaches where the foredune is scarped by undermining water at high or storm tides (Weakley and Bucher 1992).

No other vascular plant species regularly occupies a lower topographic position than seabeach amaranth (USFWS 1996). Seabeach amaranth's range correlates with a zone of tidal amplitude of 5 or 6 ft and occupies elevations that range from 8 inches (in) to 5 ft above high mean high tide (USFWS 1996). Although it grows in a very low topographical position, it is highly intolerant of inundation by saltwater, and often perishes if exposed (USFWS 1996). The plant is usually found

growing on nearly pure silica sand substrate, which is mapped as 'Beach-Foredune Association' or 'Beach (occasionally flooded)' by the U.S. Natural Resources Conservation Service (NRCS).

In areas where it occurs, seabeach amaranth is an important beach stabilizing and dune building species because it acts as a 'sand binder' by trapping wind-blown sand under its lower leaves and branches. This trapped sand accumulates in a mound and eventually buries the lower leaves and stems, while the plant continues to grow. A single large clump of seabeach amaranth can trap a mound of 2 to 3 cubic yards (cy) of sand (USFWS 1996).

Seabeach amaranth has a very low tolerance for vegetative competition and does not occur on well-vegetated sites. However, habitat occupied by seabeach amaranth may be sparsely vegetated with other annual forbs, or less commonly, perennial grasses and scattered shrubs (USFWS 1996). Once other vegetation, such as American beach grass, begins to encroach upon habitat occupied by seabeach amaranth, the amaranth is quickly out competed and the individual or population is replaced by the encroaching vegetation. Scientists believe that availability of water and certain plant species are probably the limiting factors because the more extensive root systems of species such as beach grass are more efficient for the uptake of these resources (USFWS 1996).

Ecologists consider seabeach amaranth a 'fugitive' species because of its ability to escape competition and to quickly occupy new habitat as it becomes available (Randall 2002). Hurricanes and storms that re-shape shorelines may have both a positive and negative effect on the species. For example, a storm event that causes severe beach erosion may displace existing individuals, but also may uncover seed banks that have been buried for years. Following hurricanes Bertha and Fran in 1996, several new populations of seabeach amaranth appeared that were likely linked to the effects of the storms (Randall 2002).

3.2.1 Threats to Species

Seabeach amaranth has been and continues to be threatened by destruction or adverse alteration of its habitat. As a fugitive species dependent on a dynamic landscape and large-scale geophysical processes, it is extremely vulnerable to habitat fragmentation and isolation of small populations. Further, because this species is easily recognizable and accessible, it is vulnerable to taking, vandalism, and the incidental trampling by curiosity seekers. The most serious threats to the continued existence of seabeach amaranth are construction of beach stabilization structures, natural and man-induced beach erosion and tidal inundation, fungi (i.e., white wilt), beach grooming, herbivory by insects and mammals, and off-road vehicles. Herbivory by webworms, deer, feral horses, and rabbits is a major source of mortality and lowered fecundity for seabeach amaranth. However, the extent to which herbivory affects the species as a whole is unknown.

Potential effects to seabeach amaranth from vehicle use on the beaches include vehicles running over, crushing, burying, or breaking plants, burying seeds, degrading habitat through compaction of sand and the formation of seed sinks caused by tire ruts. Seed sinks occur when blowing seeds fall into tire ruts, then a vehicle comes along and buries them further into the sand preventing germination. If seeds are capable of germinating in the tire ruts, the plants are usually destroyed before they can reproduce by other vehicles following the tire ruts. Those seeds and their reproductive potential become lost from the population.

Pedestrians also can negatively affect seabeach amaranth plants. Seabeach amaranth occurs on the upper portion of the beach which is often traversed by pedestrians walking from parking lots,

hotels, or vacation property to the ocean. This is also the area where beach chairs and umbrellas are often set up and/or stored. In addition, resorts, hotels, or other vacation rental establishments may set up volleyball courts or other sporting activity areas on the upper beach at the edge of the dunes. All of these activities can result in the trampling and destruction of plants. Pedestrians walking their dogs on the upper part of the beach, or dogs running freely on the upper part of the beach, may result in the trampling and destruction of seabeach amaranth plants. The extent of the effects that dogs have on seabeach amaranth is not known (per Biological Assessment, Fire Island Inlet to Montauk Point Coastal Storm Risk Management, Suffolk County, New York. Prepared and submitted by: U.S. Fish and Wildlife Service, Chesapeake Bay Field Office and U.S. Army Corps of Engineers, New York District. April 2018). .

3.2.2 Human Disturbance

Vehicular use on beaches generally has an adverse effect on seabeach amaranth. The plant is a brittle species and individuals generally do not survive even a single pass by an off road vehicle (ORV) tire (USFWS 1996). In northern beaches, such as in New York, these beaches are relatively narrow and vehicular traffic is often concentrated in the elevation zone required by seabeach amaranth (USFWS 1996). Accordingly, areas open to moderate to heavy ORV use during the seabeach amaranth growing season typically do not have populations of the plant in ORV travel corridors. However, during the dormant season, limited ORV use may actually be beneficial to seabeach amaranth because physical disturbance of the beach helps prevent colonization by perennial species, such as beach grass (USFWS 1996).

Another detrimental vehicle-based activity to seabeach amaranth is beach grooming (USFWS 1996). Mechanical rakes are dragged along the beach surface by a tractor or other vehicle to rid the beach of vegetation, trash, and wrack. This practice is usually carried out on heavily used bathing beaches and results in the exclusion of seabeach amaranth by precluding the plant from becoming established.

Humans use beaches for a variety of activities, including sunbathing, swimming, jogging, walking, birding, and beachcombing. Accordingly, pedestrians walking on beaches occupied by seabeach amaranth have the potential to crush individual plants. However, because most pedestrians prefer to walk on packed sand near the wetted shoreline seaward of seabeach amaranth habitat, the effects of pedestrian traffic are generally negligible (USFWS 1996).

3.2.3 Habitat Loss/Alteration

Shoreline stabilization is detrimental to pioneer species, such as seabeach amaranth, that require unstable, unvegetated, or ‘new’ land (USFWS 1996). Construction of both ‘hard’ and ‘soft’ shoreline stabilization structures are often associated with deteriorated seabeach amaranth habitat (USFWS 1996).

Hard structures are constructed of stone, concrete, steel, or wood and include rip-rap, seawalls, revetments, groins, terminal groins, and breakwaters. Soft structures include construction using non-permanent materials, such as sand, for replenishing beaches and dune construction, rehabilitation, or enhancement.

Many of these structures, both hard and soft, often occupy the same elevation range that is required by seabeach amaranth. Additionally, when structures such as bulkheads and seawalls are built,

wave action and wind often lower the beach profile seaward of the structure, creating an area unsuitable for seabeach amaranth (USFWS 1996). During seabeach amaranth status surveys conducted from 1987 to 1990, no seabeach amaranth populations were observed on shorelines that were associated with bulkheads, sea walls, or rip-rap zones (USFWS 1996).

Beach nourishment and dune stabilization have varying degrees of potential effects on seabeach amaranth. Beach nourishment, for example, may have both a negative and positive effect on seabeach amaranth populations (USFWS 1996). On one hand, an adverse effect of sand placement is burial of the existing seed bank within the placement zone. On the other hand, the new beach created by placement is without other vegetation that might out compete seabeach amaranth and would likely be at an elevation that is suitable for the reestablishment of seabeach amaranth if there is a seed source nearby.

Beach nourishment can have positive site-specific impacts on seabeach amaranth. Although more study is needed before the long-term impacts can be accurately assessed, seabeach amaranth has colonized several nourished beaches, and has thrived in some sites through subsequent re-applications of fill material (FWS 1993). However, on the landscape level, beach nourishment is similar to other beach stabilization efforts in that it stabilizes the shoreline and curtails the natural geophysical processes of barrier islands.

3.2.4 Herbivory/Predation

Herbivory by webworms (caterpillars of small moths) may be detrimental to localized populations of seabeach amaranth (USFWS 1996). Although not unheard of in the northern part of seabeach amaranth range, herbivory appears to be a much more common problem in southern populations (USFWS 1996). In South Carolina, four species of webworm are known to consume seabeach amaranth and include beet webworm (*Loxostege similialis*), garden webworm (*Achyra rantilis*), southern beet webworm (*Herpetogramma bipunctalis*), and Hawaiian beet webworm (*Spoladea recurvalis*) (USFWS 1996). The ranges of several of these species extend into New York. In 1994, an infestation of saltmarsh moth (*Estigmene acraea*) caterpillars totally consumed leaves of many seabeach amaranth plants at Jones Beach Island East (USFWS 1996).

3.3 RUFA RED KNOT

The red knot (*Calidris canutus*) was added to the list of federal candidate species in 2006. The species was listed as Endangered in 2014. Red knots are federally protected under the Migratory Bird Treaty Act, and are New Jersey State-listed as endangered. The red knot is currently listed as endangered or threatened in New York State.

Red knots were heavily hunted for both market and sport during the 19th and early 20th centuries in the Northeast and the mid-Atlantic. Red knot population declines were noted by several authors of the day, whose writings recorded a period of intensive hunting followed by the introduction of regulations and at least partial population recovery.

Calidris canutus is classified in the Class Aves, Order Charadriiformes, Family Scolopacidae, Subfamily Scolopacinae. Six subspecies are recognized, each with distinctive morphological traits (i.e., body size and plumage characteristics), migration routes, and annual cycles. Each subspecies is believed to occupy a distinct breeding area in various parts of the Arctic but some subspecies overlap in certain wintering and migration areas. (FWS BO for Long Beach, NY Project 2014).

Calidris canutus canutus, C. c. piersma, and *C. c. rogersi* do not occur in North America. The subspecies *C.c. islandica* breeds in the northeastern Canadian High Arctic and Greenland, migrates through Iceland and Norway, and winters in Western Europe (Committee on the Status of Endangered Wildlife in Canada. *C. c. rufa* breeds in the central Canadian Arctic (just south of the *C. c. islandica* breeding grounds) and winters along the Atlantic coast and the Gulf of Mexico coast (Gulf coast) of North America, in the Caribbean, and along the north and southeast coasts of South America including the island of Tierra del Fuego at the southern tip of Argentina and Chile (Ibid).

3.3.1 Life History

The rufa red knot is a medium-sized shorebird about 9 to 11 inches (in) (23 to 28 centimeters (cm)) in length. The red knot migrates annually between its breeding grounds in the Canadian Arctic and several wintering regions, including the Southeast United States (Southeast), the Northeast Gulf of Mexico, northern Brazil, and Tierra del Fuego at the southern tip of South America. During both the northbound (spring) and southbound (fall) migrations, red knots use key staging and stopover areas to rest and feed (Ibid).

The red knot is a large, bulky sandpiper with a short, straight, black bill. During the breeding season, the legs are dark brown to black, and the breast and belly are a characteristic russet color that ranges from salmon-red to brick-red. Males are generally brighter shades of red, with a more distinct line through the eye. When not breeding, both sexes look alike – plain gray above and dirty white below with faint, dark streaking. As with most shorebirds, the long-winged, strong-flying knots fly in groups, sometimes with other species. Red knots feed on invertebrates, especially small clams, mussels, and snails, but also crustaceans, marine worms, and horseshoe crab eggs. On the breeding grounds, knots mainly eat insects (Ibid).

Small numbers of red knots may occur in New Jersey year-round, while large numbers of birds rely on New Jersey's coastal stopover habitats during the spring (mid-May through early June) and fall (late-July through November) migration periods. Smaller numbers of knots may spend all or part of the winter in New Jersey. Red knots also rely on New York's coastal stopover habitats during the spring and fall migration periods. As stated above, several stopover habitats in New York are being proposed for critical habitat designations (Ibid).

The primary wintering areas for the rufa red knot include the southern tip of South America, northern Brazil, the Caribbean, and the southeastern and Gulf coasts of the U.S. The rufa red knot breeds in the tundra of the central Canadian Arctic. Some of these robin-sized shorebirds fly more than 9,300 miles from south to north every spring and reverse the trip every autumn, making the rufa red knot one of the longest-distance migrating animals. Migrating red knots can complete non-stop flights of 1,500 miles or more, converging on critical stopover areas to rest and refuel along the way. Large flocks of red knots arrive at stopover areas along the Delaware Bay and New York/New Jersey's Atlantic coast each spring, with many of the birds having flown directly from northern Brazil. The spring migration is timed to coincide with the spawning season for the horseshoe crab (*Limulus polyphemus*). Horseshoe crab eggs provide a rich, easily digestible food source for migrating birds. Mussel beds on New Jersey's southern Atlantic coast and intertidal/wrack line areas on New York's coast are also important forage habitats for migrating knots. Birds arrive at stopover areas with depleted energy reserves and must quickly rebuild their body fat to complete their migration to Arctic breeding areas. During their brief 10- to 14-day spring stay in the mid-Atlantic, red knots can nearly double their body weight.

Major spring stopover areas along the Atlantic coast include Río Gallegos, Península Valdés, and San Antonio Oeste (Patagonia, Argentina); Lagoa do Peixe (eastern Brazil, State of Rio Grande do Sul); Maranhão (northern Brazil); the Virginia barrier islands (United States); and Delaware Bay (Delaware, New Jersey and New York, United States) (Cohen *et al.*. 2009, p. 939; Niles *et al.*. 2008, p. 19; González 2005, p. 14). However, large and small groups of red knots, sometimes numbering in the thousands, may occur in suitable habitats all along the Atlantic and Gulf coasts from Argentina to Massachusetts (Niles *et al.*. 2008, p. 29). In Massachusetts, red knots use sandy beaches and tidal mudflats during fall migration. In New York and the Atlantic coast of New Jersey, knots use sandy beaches during spring and fall migration (Niles *et al.*. 2008, p. 30).

From geolocators, examples of spring migratory tracks are available for three red knots that wintered in South America. One flew about 4,000 mi (6,400 km) over water from northeast Brazil in 6 days. Another flew about 5,000 mi (8,000 km) from the southern Atlantic coast of Brazil (near Uruguay) over land and water (the *eastern* Caribbean) in 6 days. Both touched down in North Carolina, and then used Delaware Bay as the final stopover before departing for the arctic breeding grounds (Niles *et al.*. 2010a, p. 126). A third red knot, which had wintered in Tierra del Fuego, followed an overland route through the interior of South America, departing near the Venezuela-Colombia border. This bird then flew over the Caribbean to Florida, and finally to Delaware Bay (Niles 2011a).

In Delaware Bay, red knots preferentially *feed* in microhabitats where horseshoe crab eggs are concentrated, such as at horseshoe crab nests (Fraser et al.. 2010, p. 99), at shoreline discontinuities (e.g., creek mouths) (Botton et al.. 1994, p. 614), and in the wrack line (Nordstrom et al.. 2006a, p. 438; Karpanty et al.. 2011, pp. 990, 992). (The wrack line is the beach zone just above the high tide line where seaweed and other organic debris are deposited by the tides.) Wrack may also be a significant foraging microhabitat outside Delaware Bay, for example, where mussel spat (i.e., juvenile stages) are attached to deposits of tide-cast material. Wrack material also concentrates certain *invertebrates* such as amphipods, insects, and marine worms (Kluft and Ginsberg 2009, p. vi), which are secondary prey species for red knots.

For many shorebirds, the supra-tidal (above the high tide) sandy habitats of inlets provide important areas for roosting, especially at higher tides when intertidal habitats are inundated (Harrington 2008, pp. 4–5). Along the Atlantic coast, dynamic and ephemeral features are important red knot habitats, including sand spits, islets, shoals, and sandbars, often associated with inlets (Harrington 2008, p. 2). From South Carolina to Florida, red knots are found in significantly higher numbers at inlets than at other coastal sites (Harrington 2008, pp. 4–5).

The District has been undertaking comprehensive monitoring of red knots on the South Shore of Staten Island (SSSI), New York project area for two years. To date, no rufa red knot have been observed within the SSSI project are, but, red knot were observed at Great Kills, NY (Ebird website-http://ebird.org/ebird/subnational2/US-NY-103/hotspots).

3.3.2 Threats to Red Knot

Much of the U.S. coast within the range of the red knot is already extensively developed. Direct loss of shorebird habitats occurred over the past century as substantial commercial and residential developments were constructed in and adjacent to ocean and estuarine beaches along the Atlantic and Gulf coasts. In addition, red knot habitat was also lost indirectly, as sediment supplies were reduced and stabilization structures were constructed to protect developed areas.

Sea level rise and human activities within coastal watersheds can lead to long-term reductions in sediment supply to the coast. Damming of rivers, bulkheading highlands, and armoring coastal bluffs have reduced erosion in natural source areas and, consequently, the sediment loads reaching coastal areas. Although it is difficult to quantify, the cumulative reduction in sediment supply from human activities may contribute to the long-term shoreline erosion rate. Along coastlines subject to sediment deficits, the amount of sediment supplied to the coast is less than that lost to storms and coastal sinks (inlet channels, bays, and upland deposits), leading to long- term shoreline recession.

Red knots require open habitats that allow them to see potential predators and that are away from tall perches used by avian predators. Invasive species, particularly woody species, degrade or eliminate the suitability of red knot roosting and foraging habitats by forming dense stands of vegetation. Although not a primary cause of habitat loss, invasive species can be a regionally important contributor to the overall loss and degradation of the red knot's nonbreeding habitat.

Commercial harvest of horseshoe crabs has been implicated as a causal factor in the decline of the rufa red knot by decreasing the availability of horseshoe crab eggs in the Delaware Bay stopover (Niles *et al*.. 2008, pp. 1-2). Notwithstanding the importance of the horseshoe crab and Delaware Bay, other lines of evidence suggest that the rufa red knot also faces threats to its food resources throughout its range.

About 40 percent of the U.S. coastline within the range of the red knot is already developed, and much of this developed area is stabilized by a combination of existing hard structures and ongoing beach nourishment programs. In those portions of the range for which data are available (New Jersey and North Carolina to Texas), about 40 percent of inlets, a preferred red knot habitat, are hard-stabilized, dredged, or both. Hard stabilization structures and dredging degrade and often eliminate existing red knot habitats, and in many cases prevent the formation of new shorebird habitats. Beach nourishment may temporarily maintain suboptimal shorebird habitats where they would otherwise be lost as a result of hard structures, but beach nourishment also has adverse effects to red knots and their habitats. Demographic and economic pressures remain strong to continue existing programs of shoreline stabilization and to develop additional areas, with an estimated 20 to 33 percent of the coast still available for development. However, we expect existing beach nourishment programs will likely face eventual constraints of budget and sediment availability as sea level rises. In those times and places that artificial beach maintenance is abandoned, the remaining alternatives would likely be limited to either a retreat from the coast or increased use of hard structures to protect development. The quantity of red knot habitat would be markedly decreased by a proliferation of hard structures. Red knot habitat would be significantly increased by retreat, but only where hard stabilization structures do not exist or where they get dismantled. The cumulative loss of habitat across the nonbreeding range could affect the ability of red knots to complete their annual cycles, possibly affecting fitness and survival, and is thereby likely to negatively influence the long-term survival of the rufa red knot.

In wintering and migration areas, the most common predators of red knots are peregrine falcons (*Falco peregrinus*), harriers (*Circus* spp.), accipiters (Family Accipitridae), merlins (*F. columbarius*), shorteared owls (*Asio flammeus*), and greater black-backed gulls (*Larus marinus*) (Niles *et al*. 2008, p. 28). In addition to greater black-backed gulls, other large gulls (e.g., herring gulls (*Larus argentatus*)) are anecdotally known to prey on shorebirds. Predation by a great horned owl (*Bubo virginianus*) has been documented in Florida Nearly all documented predation of

wintering red knots in Florida has been by avian, not terrestrial, predators (2014 FWS BO). However, in migration areas like Delaware Bay, terrestrial predators such as red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) may be a threat to red knots by causing disturbance, but direct mortality from these predators may be low (Niles *et al.* 2008, p. 101).

Red knots' selection of high-tide roosting areas on the coast appears to be strongly influenced by raptor predation, something well demonstrated in other shorebirds (Niles *et al.*. 2008, p. 28). Red knots require roosting habitats away from vegetation and structures that could harbor predators (Niles *et al.*. 2008, p. 63). Red knots' usage of foraging habitat can also be affected by the presence of predators, possibly affecting the birds' ability to prepare for their final flights to the arctic breeding grounds (Watts 2009) (e.g., if the knots are pushed out of those areas with the highest prey density or quality). In 2010, horseshoe crab egg densities were very high in Mispillion Harbor, Delaware, but red knot use was low because peregrine falcons were regularly hunting shorebirds in that area (Niles 2010a). Growing numbers of peregrine falcons on the Delaware Bay and New Jersey's Atlantic coasts are decreasing the suitability of a number of important shorebird areas (Niles 2010a). Analyzing survey data from the Virginia stopover area, Watts (2009) found the density of red knots far (greater than 3.7 mi (6 km)) from peregrine nests was nearly eight times higher than close (0 to 1.9 mi (0 to 3 km)) to peregrine nests. In addition, red knot density in Virginia was significantly higher close to peregrine nests during those years when peregrine territories were not active compared to years when they were (Watts 2009).

The quantity and quality of red knot prey may also be affected by the placement of sediment for beach nourishment or disposal of dredged material. Invertebrates may be crushed or buried during project construction. Although some benthic species can burrow through a thin layer of additional sediment, thicker layers (over 35 in (90 cm)) smother the benthic fauna. By means of this vertical burrowing, recolonization from adjacent areas, or both, the benthic faunal communities typically recover. Recovery can take as little as 2 weeks or as long as 2 years, but usually averages 2 to 7 months (Burlas et al 2001; Peterson and Manning 2001, p.1). Although many studies have concluded that invertebrate communities recovered following sand placement, uncertainty remains about the effects of sand placement on invertebrate communities and how these impacts may affect red knots.

3.3.3 Human Disturbance

Sea level rise and human activities within coastal watersheds can lead to long-term reductions in sediment supply to the coast. Damming of rivers, bulkheading highlands, and armoring coastal bluffs have reduced erosion in natural source areas and, consequently, the sediment loads reaching coastal areas. Although it is difficult to quantify, the cumulative reduction in sediment supply from human activities may contribute substantially to the long-term shoreline erosion rate. Along coastlines subject to sediment deficits, the amount of sediment supplied to the coast is less than that lost to storms and coastal sinks (inlet channels, bays, and upland deposits), leading to long-term shoreline recession

In addition to reduced sediment supplies, other factors such as stabilized inlets, shoreline stabilization structures, and coastal development can exacerbate long-term erosion (Herrington 2003). Coastal development and shoreline stabilization can be mutually reinforcing. Coastal development often encourages shoreline stabilization because stabilization projects cost less than the value of the buildings and infrastructure. Conversely, shoreline stabilization sometimes

encourages coastal development by making a previously high-risk area seem safer for development (U.S. Climate Change Science Program [CCSP] 2009). Protection of developed areas is the driving force behind on-going shoreline stabilization efforts. Large-scale shoreline stabilization projects became common in the past 100 years with the increasing availability of heavy machinery. Shoreline stabilization methods change in response to changing new technologies, coastal conditions, and preferences of residents, planners, and engineers. Along the Atlantic and Gulf coasts, an early preference for shore-perpendicular structures (e.g., groins) was followed by a period of construction of shore-parallel structures (e.g., seawalls), and then a period of beach nourishment, which is now favored (Morton et al. 2004; Nordstrom 2000).

3.3.4 Habitat Loss

Structural development along the shoreline and manipulation of natural inlets upset the naturally dynamic coastal processes and result in loss or degradation of beach habitat (Melvin et al. 1991). As beaches narrow, the reduced habitat can directly lower the diversity and abundance of biota (life forms), especially in the upper intertidal zone. Shorebirds may be impacted both by reduced habitat area for roosting and foraging, and by declining intertidal prey resources, as has been documented in California (Defeo et al. 2009; Hubbard 2003). In an estuary in England, Stillman et al. (2005) found that a 2 to 8 percent reduction in intertidal area (the magnitude expected through sea level rise and industrial developments including extensive stabilization structures) decreased the predicted survival rates of 5 out of 9 shorebird species evaluated (although not of *Calidris canutus*).

In Delaware Bay, hard structures also cause or accelerate loss of horseshoe crab spawning habitat (U.S. Climate Change Science Program [CCSP] 2009; Botton et al. *in* Shuster et al. 2003; Botton et al. 1988), and shorebird habitat has been, and may continue to be, lost where bulkheads have been built (Clark 2009). In addition to directly eliminating red knot habitat, hard structures interfere with creation of new shorebird habitats by interrupting the natural processes of overwash and inlet formation. Where hard stabilization is installed, the eventual loss of the beach and its associated habitats is virtually assured (Rice 2009), absent beach nourishment, which may also impact red knots as discussed below. Where they are maintained, hard structures are likely to significantly increase the amount of red knot habitat lost as sea levels continue to rise.

3.3.5 Predation

In wintering and migration areas, the most common predators of red knots are peregrine falcons (*Falco peregrinus*), harriers (*Circus* spp.), accipiters (Family Accipitridae), merlins (*F. columbarius*), shorteared owls (*Asio flammeus*), and greater black-backed gulls (*Larus marinus*) (Niles et al. 2008). In addition to greater black-backed gulls, other large gulls (e.g., herring gulls [*Larus argentatus*]) are anecdotally known to prey on shorebirds (Breese 2010). Predation by a great horned owl (*Bubo virginianus*) has been documented in Florida (Schwarzer, *pers. comm*., June 17, 2013). Nearly all documented predation of wintering red knots in Florida has been by avian, not terrestrial, predators (Schwarzer, *pers. comm*., June 17, 2013). However, in migration areas like Delaware Bay, terrestrial predators such as red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) may be a threat to red knots by causing disturbance, but direct mortality from these predators may be low (Niles et al.et al. 2008).

At key stopover sites, however, localized predation pressures are likely to exacerbate other threats to red knot populations, such as habitat loss, food shortages, and asynchronies between the birds' stopover period and the occurrence of favorable food and weather conditions. Predation pressures worsen these threats by pushing red knots out of otherwise suitable foraging and roosting habitats, causing disturbance, and possibly causing changes to stopover duration or other aspects of the migration strategy.

4 EFFECT ANAYLSIS

4.1 Piping Plover

The piping plover area managed by the NYC Department of Parks and Recreation (DPR) is located at the Rockaway Peninsula which extends from Beach 9th Street to Beach 149th Street on the ocean side, accounting for 6.5 miles of coastline. This stretch of beach is split into three continuous management areas Far Rockaway (Beach 9th Street - Beach 35th Street), Arverne by the Sea (Beach 35th Street – Beach 73rd Street) and Rockaway Beach (Beach 73rd Street - Beach 149th Street). Collectively, these three management areas are known as the Rockaway Beach Endangered Species Nesting Area (RBESNA). RBESNA has been managed as a breeding site for piping plovers since 1996.

According to the 2017 RBESNA Final Report (DPR 2017) 20 pairs of piping plovers had a total of 42 fledglings resulting in a productivity of 2.1 for all of RBESNA. Overall, piping plovers had a nest success rate of 79%, with 19 out of the 24 nests created resulting in at least one fledgling per nest. When separated by location, Arverne by the Sea had the highest productivity rate: 15 piping plover pairs fledged 35 chicks with a productivity rate of 2.33 and a nest success of 88% (15 out of 17 nests). The success of this area is partly due to the fencing off of the dunes and shore areas, which are essential for chick survival. Interestingly, the pair that nested at the B64th Street site, in a swim beach, fledged four chicks, for a productivity rate of 4.0 in that site.

Far Rockaway had five piping plover pairs that fledged seven chicks for a productivity rate of 1.40, and 57% of its nests succeeded (four out of seven nests). It is also interesting to note that the vegetation density and overall layout of the beach in Far Rockaway differed greatly from Arverne by the Sea, with Far Rockaway being a flat and open beach with a sparsely vegetated back dune, compared to Arverne by the Sea which has a higher density of vegetation. Far Rockaway also does not host any colonies of terns or black skimmers. Because of the high success during the breeding seasons of 2014 (UPR, 2014) and 2015 (UPR, 2015), the 2015 seasonal science team recommended that Far Rockaway become a pre-fenced area as suggested by the Piping Plover (Charadrius melodus) Atlantic Coast Population Revised Recovery Plan (USFWS, 1996), for areas with recurring nesting three years in a row.

4.1.1 Historic Trends

According to the 2017 RBESNA Final Report, the 2017 piping plover breeding season had a total of 20 nesting pairs, an increase over the 17 pairs from 2016 (UPR, 2016). There were a record number of fledglings for RBESNA in 2017, with a total of 42 fledglings, compared to 31 fledglings in 2016 (Table 4).

Figure 11: 2017 Nesting Season

Table 4: Piping plover pair and fledgling count at RBESNA from 1996 to 2017

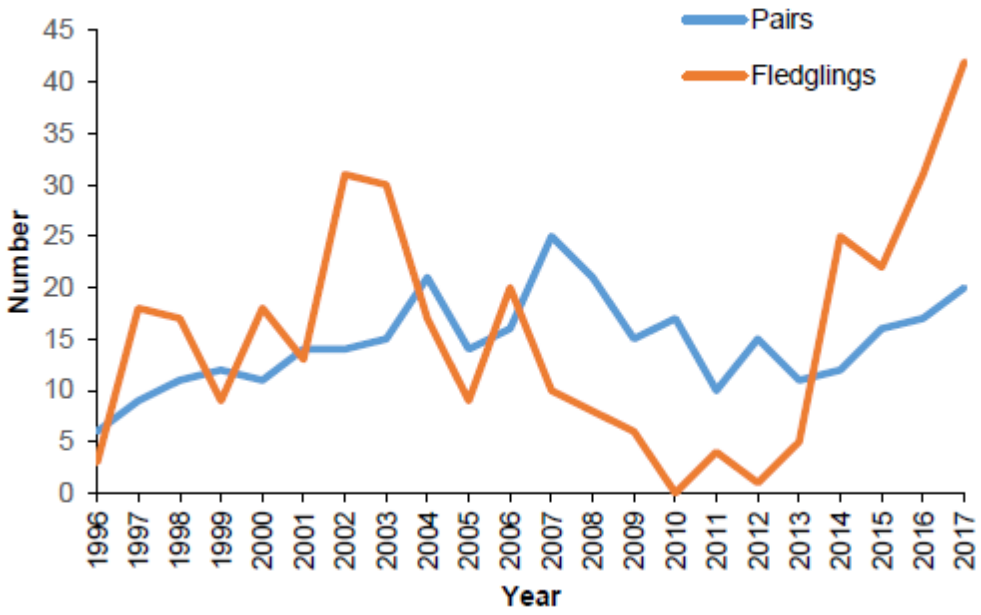
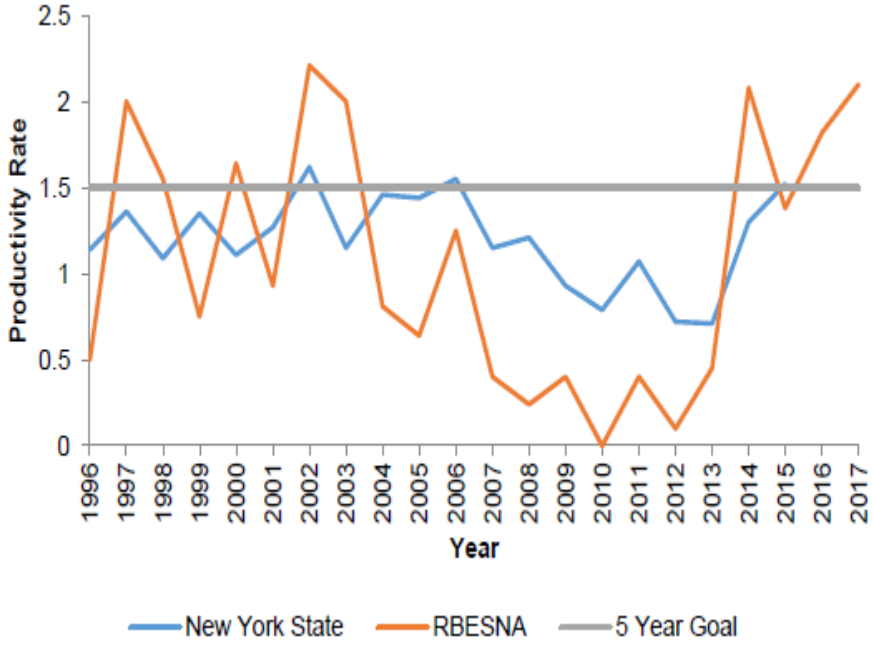


Table 5: Piping plover productivity rate for RBESNA and New York State (USFWS, 2016) from 1996 to 2017



According to the 2017 RBESNA Final Report, the RBESNA exceeded the productivity goal set out by the USFWS. The RBESNA productivity generally follows the same trend that the New York State productivity follows. If the productivity trend continues to increase as it has since 2013, RBESNA and New York State might be able to reach the goal of achieving a productivity rate of 1.5 for five years in a row. The piping plover productivity in 2017 was 2.1, an increase from 2016, and the second highest productivity at RBENSA in 21 years. Table 6 presents a summary of data collected from 1996-2017.

Table 6: Data Collected from 1996 to the present (2017) for piping plovers nesting at RBESNA

Year	Pairs	Nests	Eggs	Chicks	Fledglings	Productivity Rate
1996	6	8	26	3	3	0.50
1997	9	11	39	27	18	2.00
1998	11	16	62	30	17	1.55
1999	12	18	64	24	9	0.75
2000	11	17	53	35	18	1.64
2001	14	20	63	38	13	0.93
2002	14	18	65	44	31	2.21
2003	15	28	87	47	30	2.00
2004	21	27	95	53	17	0.81
2005	14	18	68	39	9	0.64
2006	16	27	103	40	20	1.25
2007	25	35	128	53	10	0.40
2008	21	32	108	29	8	0.24
2009	15	23	68	41	6	0.40
2010	17	23	83	51	0	0.00
2011	10	12	42	30	4	0.40
2012	15	19	69	50	1	0.10
2013	11	14	51	36	5	0.45
2014	12	14	54	43	25	2.08
2015	16	18	64	51	22	1.38
2016	17	22	80	49	31	1.82
2017	20	24	83	56	42	2.10

4.1.2 No Action

Future habitat conditions in the Project Area without the Project would be varied. Based on past experience in coastal areas of New York and New Jersey, the upper beach zone and dunes would continue to erode in many areas and may even be eliminated entirely in areas of severe erosion. This would result in significant loss of habitat upon which the piping plover and other shorebirds/seabirds depend on for nesting habitat. However, in other areas along the shoreline, the upper beach zone could accrete sand and increase in size, thereby potentially increasing

available piping plover habitat. Although some accretion may occur in the Project Area over time, many areas are expected to experience erosion and loss of upper beach and dune habitats without the proposed Project activities (USACE 1989, 1998, 2002, 2005). The intertidal and subtidal zones would retain their current width and substrate composition. However, the locations of these zones would shift off-shore or on-shore depending on erosion and accretion rates in the area. Accordingly, the overall impact of the No Action alternative on piping plover habitat would likely be negative.

4.1.3 Proposed Action

Although some minor, short-term, impacts to plover food resources and habitat could result from proposed Project modifications, overall improvements to plover habitat can be expected to result from the proposed activity. Therefore, after a full evaluation of plover life history, habitats in the Project Area, plover management activities, and proposed Project activities, a conservative May Affect, Likely to Adversely Affect (LAA) determination was made by the District on populations of piping plover as a result of implementation these proposed activities (Table 7). Details of this determination are provided below.

Table 7: Summary of Project Effects on Populations of Piping Plover

Activities	Potentially Beneficial	Not Likely to Adversely Affect	Likely to Adversely Affect	No Effect
No-Action				
Project				
Staging Area Construction and Use				X
Beach Fill			X	
Groin Extension			X	
Groin Construction			X	
Dune and Seawall Construction			X	
HRFRRF				X
Cumulative Impacts				
Periodic re-nourishment	X	X		
Periodic maintenance of infrastructure			X	
Long Term Impacts from Groins	X	X	X	
Long Term Impacts from HRFRRF	X			

The primary direct impacts resulting from implementation of the Project will be disturbance and direct impact of benthic, immobile invertebrate and plant communities currently living in these areas due to burial from beach fill material. As a result, piping plover could experience some short-term loss of food resources within the beach fill placement. However, the direct placement of beach fill is not expected to cause long-term significant impacts on the piping plover. The area of actual permanent plover habitat loss due to permanent structures is small and would result in a negligible loss of foraging substrate for the species. In addition, although plover would avoid foraging within areas of direct sand placement in the intertidal zone until benthic food sources recolonized the site, recolonization of benthic communities in the intertidal zones typically takes place within six months to two years following beach fill placement activities (USFWS 1991, Burlas et al 2001, Peterson

and Manning 2001). Regardless of the long term benefits resulting from the implementation of the project, a conservative May Affect (LAA), Likely to Adversely Affect determination was made by the District as a result of implementation of these proposed activities.

Placement of beach fill and dune restoration is likely to increase overall habitat value for piping plover along the affected beachfront by expanding the area of suitable breeding, nesting and foraging habitat. Therefore, a Potentially Beneficial Impact determination was made by the District for piping plover for this proposed Project activity for the reasons stated below. Studies of beach nourishment projects along the Atlantic Coast have documented that when construction windows and best plover management practices are adhered to, beach nourishment generally provides valuable habitat for beach nesting birds such as the piping plover (NJDEP 1997, USFWS 2004a). Construction activities occurring in the Project Area are likely to halt further loss of existing plover nesting habitat and will likely increase the amount of suitable habitat by increasing the size of the upper beach zone. Unpublished data from piping plover monitoring conducted by the District in beach fill placement areas near Shinnecock and the Hamptons, Long Island, NY, shows that piping plover and least terns (species that nest on upper beach habitats) returned to breed on sites within 1 year following construction activities (Cohen et al. 2002, 2003a, 2003b).

Permanent hard structures such as seawall, groins, sand fence, access ways, and walkovers also would eliminate any suitable foraging or nesting areas directly within the footprint of these structures. However, the area of overall impact from these structures is expected to be minimal (< 1.0 ac) and most of the habitat that will be impacted is not of high habitat value to plover. Specifically, plover forage primarily in the intertidal zone and nest in the upper beach zone in front of dunes. The areas in which hard structures are proposed include mostly subtidal areas that would be affected from groin placement, and portions of the upper dune that would be affected by buried seawall, fence, access ways, and walkovers. Overall impacts directly within the footprint of these structures would be permanent, but are not expected to significantly affect piping plover breeding or foraging activities for the long term. Regardless of the possible short term adverse effects vs. long term benefits, a conservative May Affect, Likely to Adversely Affect (LAA) determination was made by the District as a result of implementation of these proposed activities.

Other short-term impacts, such as a slight decrease in water quality and an increase in turbidity, also are likely to occur during beach fill and groin construction and rehabilitation activities. Changes in water quality and turbidity may cause some short-term avoidance of the intertidal zone by piping plover during periods of low water quality resulting from construction activities. These impacts to plover foraging activities will be short term and will have a minimal effect on plover because plover are mobile and can utilize unaffected foraging areas nearby. In addition, construction activities will be scheduled to avoid any active plover nesting periods (i.e., construction scheduled from approximately September 2 through March 31), which will avoid potential impacts to less-mobile plover chick foraging activities. Plover also are expected to avoid active construction areas due to noise and activities. Limiting construction in known active nesting areas to September 2 through March 31 will also minimize this impact. Impacts from these activities are expected to be short-term and cause no significant or long term negative effects on plover populations. Regardless of the mitigation measures incorporated as BMPs for the construction of the project, to be conservative, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District for piping plover for these proposed activities.

Construction of new vehicle and pedestrian access points pose potential threat to piping plover because these activities are likely to provide access to new areas of the beach and may increase vehicle and public use of beach areas. This increase in human activity may disrupt nesting plover in areas in proximity to access points and beach activities. Plover are known to be sensitive to disturbance and experience lower reproductive success in areas where they are disturbed frequently (Flemming et al. 1988, Burger 1991, 1994, Goldin 1992, 1993, Cross and Terwilliger 1993, Collazo et al. 1995).

Despite the fact that much of the Project Area is currently highly developed and is used extensively for recreational activities by humans, the District will follow recommendations provided by the NYSDEC and USFWS, to reduce the impacts to plover in the Project Area (USFWS 1989, 1994, 1999, USACE 1998,). These impact minimization measures are detailed in Section 5.

Efforts to restrict human access and activities near the nest sites, and use of exclusion devices to reduce predation are believed to be major contributing factors in nesting success of plovers in coastal areas such as those found in the project area (USFWS 1995b, 2003, Cohen et al. 2002, 2003a, 2003b). In addition, NatureServe (2002) notes that population declines may have been countered with intensive management efforts that include creation of habitat using dredge material. Thus, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District on piping plover for proposed Project activities.

4.1.4 Cumulative Effects

The proposed beach renourishment activities would cause short-term impacts to plover foraging by directly covering the benthic organisms that plover feed on and causing short term availability in benthic species (USFWS 1991, Burlas et al 2001, Peterson and Manning 2001). These impacts are similar to the impacts from initial beach fill activities as discussed above. However, as discussed previously, these impacts will have minimal short-term impact on plover populations. Renourishment activities will provide long-term protection of potential breeding and nesting areas in the upper beach and primary dune areas. To further reduce potential impacts, beach renourishment activities will adhere to recommended construction windows. In addition, the District will support the conduct of pre-nourishment field surveys for active piping plover nesting areas. Beach fill would not be placed within 1000 m of active populations of piping plover or other state or federally-listed shorebirds/seabirds during the breeding season. Even though multiple Potentially Beneficial activities were identified as compared with only one Likely to Affect activity, a conservative May Affect, Likely to Adversely Affect (LAA) determination has been made for these proposed activities.

Occasional maintenance of beach access locations, boardwalks, and comfort stations will be required. These activities have the potential to disturb plover. However, as noted above, the District will support NYC DPRs efforts to identify the location of nesting plover in the vicinity of these areas, and maintenance activities would be scheduled outside of key breeding and nesting periods.

Groin construction and extension may cause habitat degradation by robbing sand from the down-drift shoreline. For example, the Coastal Barriers Study Group (1987) and the Ocean City, Maryland and Vicinity Water Resources Study Reconnaissance Report (USACE 1994) attribute the accelerated, landward shoreline recession of the north end of Assateague Island in Maryland to cumulative effects on the natural drift system from inlet stabilization and nourishment of the

rapidly eroding beaches at Ocean City. However, loss of sand down-drift of a jetty or groin may be partially off-set by habitat accretion on the up-drift side of a structure. Breezy Point at the western end of southern Long Island, New York, serves as an example of concentrated piping plover numbers on the accreting side of a jetty (Goldin 1990). Beaches on the accreting side of jetties may also be subject to plant succession that makes them less attractive to piping plovers over time (NJDEP 1997, USFWS 2004). The District will monitor the long-term effects of groin placement on habitat for known populations of piping plover or other state or federally-listed shorebirds/seabirds identified in the greater Project Area and appropriate ameliorative action would be taken. Even though the potential impacts and benefits are offsetting with the long term project condition ensuring the sustainability of nesting habitat, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District for piping plover from this proposed Project activity.

4.2 Seabeach Amaranth

According to the 2017 RBESNA Final Report, a total of 4,881 seabeach amaranth plants were located, flagged, and measured in August and the first week in September (Table 8). This is a large increase from the 2,517 plants counted in 2016. Most plants were found in Arverne by the Sea between Beach 57th Street and Beach 38th Street inside the fenced off area. Diameter of the plants fluctuated from 0.30 to 47 centimeters. Most plants had a diameter of 2.0 centimeters, and the biggest plant presented mature infructescences with seeds. This year NRG put cage-like exclosures around plants not within symbolic fencing. These were used to prevent accidental crushing by pedestrians or vehicles.

Table 8: Seabeach Amaranth Survey Results

Count	Mean	Median	Mode	Minimum	Maximum
4,881 plants	3.14 cm	2.20 cm	2.0 cm	0.30 cm	47.0 cm

Figure 12: Seabeach Amaranth 2017 Location Map

4.2.1 Historic Trends

Historically, seabeach amaranth occurred in nine states from Massachusetts to South Carolina. The populations, which have been extirpated, are believed to have succumbed as a result of hard shoreline stabilization structures, erosion, tidal inundation, and possibly, herbivory by webworms (U.S. Fish and Wildlife Service 1994). The continued existence of the plant is threatened by these activities (Elias-Gerken 1994, Van Schoik and Antenen 1993), as well as the adverse alteration of essential habitat primarily as a result of "soft" shoreline stabilization (beach nourishment, artificial dune creation, and beach grass plantings), but also from beach grooming and other causes (Murdock 1993). Populations of seabeach amaranth at any given site are extremely variable (Weakley and Bucher 1992) and can fluctuate by several orders of magnitude from year to year. For example, seabeach amaranth declined from 55,832 plants in 2003 to 2,639 plants in 2006 at the Westhampton Island West survey site (NYNHP 2006). The primary reasons for the natural variability of seabeach amaranth are the dynamic nature of its habitat and the significant effects of stochastic factors, such as weather and storms, on mortality and reproductive rates. Although wide fluctuations in species populations tend to increase the risk of extinction, variable population sizes are a natural condition for seabeach amaranth; the species is well-adapted to its ecological niche (U.S. Fish and Wildlife Service 1996a).

Seabeach amaranth has been identified as occurring within the Project Area. Seabeach amaranth inhabits dynamic, sparsely vegetated seaward facing beaches at elevations of 8 in to 5 ft above mean high water. Habitat such as this is known to be present within the Project Area and is likely to experience some impacts as a result of proposed Project activities. The following section provides an evaluation of the potential impacts from No-Action and proposed Project alternatives on populations of seabeach amaranth.

4.2.2 No Action

As with the no-action scenario for piping plover, future habitat conditions without the Project would include both loss and accretion of sediment in the upper beach and dune areas. However, much of the Project Area is expected to experience erosion and loss of upper beach and dune habitats without the proposed Project activities (USACE 1989, 1998, 2002, 2005). In these areas, the upper beach zone would lose sand and would decrease in size, thereby potentially reducing available seabeach amaranth habitat. The width of intertidal and subtidal zones will remain stable. But, locations of these zones may shift off-shore or on-shore depending on erosion and accretion rates in the area. Accordingly, the overall impact of the No Action alternative on seabeach amaranth habitat would likely be negative.

4.2.3 Proposed Action

Implementation of the Project actions will affect the upper, intertidal, nearshore subtidal beach zones and primary dune areas of coastal beaches in the Project Area through the direct placement of beach fill and structures such as retaining walls, walkovers, and beach access areas. These activities could bury amaranth communities and historic seed banks. In addition, hard structures such as groins, would not result in any permanent loss of potential habitat because these structures will impact areas of the beach/dune that are not typically suitable for amaranth. A summary of Project activities and their effects on populations of seabeach amaranth are presented in Table 9.

Table 9: Summary of Project Effects on Populations of Seabeach Amaranth

Activities	Potentially Beneficial	Not Likely to Adversely Affect	Likely to Adversely Affect	No Effect
No-Action				
Project				
Staging Area Construction and Use				X
Beach Fill			X	
Groin Extensions			X	
Groin Construction			X	
Dune and Seawall Construction			X	
HRFRRF				X
Cumulative Impact				
Periodic Re-nourishment	X	X		
Periodic Maintenance of Dunes and Infrastructure	X		X	
Long term impacts from Groins	X	X		
Long term impacts HRFFRF	X			X

Vehicle and pedestrian access points pose potential threats to seabeach amaranth because these activities are likely to provide access to new areas of the beach and may increase vehicle and public use of beach areas. This increase in human activity could directly impact unprotected amaranth if they were to occur in the Project Area. In addition, similar to the recommendations provided by NYSDEC and USFWS for the piping plover, the District will implement several measures in an effort to minimize potential adverse impacts to existing seabeach amaranth populations (USACE 1998, USFWS 1999). These impact minimization measures are detailed in Section 5 and in summary include the following: support NYC DPR pre and post-construction surveys of the Project Area to determine the presence/absence of seabeach amaranth as well as education of residents, landowners, beach visitors, and beach managers and the use of physical deterrents to deter human use of potential seabeach amaranth habitat and limiting construction activities during the growing season within areas of known amaranth populations (i.e., limited activities from approximately June through November); Even though mitigation measures will be taken to avoid and minimize access to areas that are shown to have seabeach amaranth, a conservative May Affect, Likely to Adversely Affect (LAA) determination was made by the District for populations of seabeach amaranth related to the implementation of the overall action.

Construction of the Project is likely to increase overall habitat suitability for seabeach amaranth along the affected beachfront in the long term. Although the planned beach berm is designed for an elevation of 9ft NAVD, which is slightly higher than seabeach amaranth's preferred elevation, as the beach berm slopes toward the ocean, there will be a zone that falls within the plants preferred elevation range. Expanding the beach and particularly the zone most suitable for amaranth would likely provide habitat for seabeach amaranth. Even though a Potentially Beneficial Impact determination is identified for some aspects of this proposed plan, to be conservative, a May Affect, Likely to

Adversely Affect (LAA) determination was made by the District for seabeach amaranth from this overall proposed Project activity.

4.2.4 Cumulative Effects

The proposed beach renourishment activities will provide long-term protection of potential habitat for seabeach amaranth in the upper beach and primary dune areas. Beach fill material would not be placed within 25 ft of the perimeter of population clusters or individual stems of seabeach amaranth. To further reduce potential direct impacts, the District will support NYC DPRs conduct of pre-nourishment field surveys for amaranth.

Although there is likely a limited extent of disturbance to seabeach amaranth from the project and because the species was identified as occurring in only a small portion of the Project Area, implementation of the proposed action could not reasonably be considered as contributing to cumulative adverse impacts on seabeach amaranth. Additionally, some elements of the proposed Project would serve to protect amaranth habitat. Regardless, so as to be conservative, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District for seabeach amaranth from this proposed Project activity.

4.3 Red Knot

There have been recent sightings and documentation of a few red knots in the vicinity of the Project. Despite the development and high recreational use of the area by humans, red knot are utilizing the suitable habitats in the Project Area. As a result, the USFWS has requested a Potential Effect determination on populations of red knot related to the implementation of the proposed action. Red knot are typically dependent upon intertidal and upper beach zones, using gradually sloping sparsely vegetated areas of the upper beach, bay shoreline and intertidal areas for foraging. Habitats such as these are known to be present within the Project Area and are may experience some impacts as a result of proposed Project activities. The following section provides an evaluation of the potential impacts from No-Action and proposed the Project alternative on populations of red knot. Affect determinations for the No-Action alternative and for various components of the proposed Project are presented in Table 12.

4.3.1 No Action

As with the no-action scenario for piping plover, future habitat conditions without the Project would include both loss and accretion of sediment in the upper beach and dune areas. However, much of the Project Area is expected to experience erosion and loss of upper beach and dune habitats without the proposed Project activities (USACE 1989, 1998, 2002, 2005). In these areas, the upper beach zone would lose sand and would decrease in size, thereby potentially reducing available red knot habitat. The width of intertidal and subtidal zones will remain stable. But, locations of these zones may shift off-shore or on-shore depending on erosion and accretion rates in the area. Accordingly, the overall impact of the No Action alternative on red knot habitat would likely be negative.

Table 10: Summary of Project Effects on Populations of Red Knot

Activities	Potentially Beneficial	Not Likely to Adversely Affect	Likely to Adversely Affect	No Effect
No-Action				
Project				
Staging Area Construction and Use				X
Beach Fill			X	
Groin Extension			X	
Groin Construction			X	
Dune and Seawall Construction			X	
HRFRRF				X
Cumulative Impacts				
Periodic Re-nourishment	X	X		
Periodic Maintenance of Infrastructure				X
Long Term Impacts from Groins	X	X		
Long Term Impacts from HRFRRF	X	X		

4.3.2 Proposed Action

Although some minor, short-term, impacts to the red knot food resources and habitat will result from proposed Project modifications, overall improvements to habitat can be expected to result from the proposed activity. Therefore, after a full evaluation of red knot life history, habitats in the Project Area, management activities, and proposed Project activities, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District on populations of red knot as a result of implementation the overall proposed activities (Table 10). Details of this determination are provided below.

The primary direct impacts resulting from implementation of the Project will be disturbance and direct impact of benthic, immobile invertebrate and plant communities currently living in these areas due to burial from beach fill material, and from addition of or extension of groins, which could provide habitat for predators of red knot. As a result, red knots will experience some short-term loss of food resources within the beach fill placement, and possible increased risk of predation. However, the direct placement of beach fill is not expected to cause long-term significant impacts on the red knot, and the predator population is not expected to increase due to human use of the project area. The area of actual permanent red knot habitat loss due to permanent structures is small and would result in a negligible loss of foraging substrate for the species. In addition, although the red knot would avoid foraging within areas of direct sand placement in the intertidal zone until benthic food sources recolonized the site, recolonization of benthic communities in the intertidal zones typically takes place within six months to two years following beach fill placement activities.

Therefore, because most elements of the proposed Project are expected to be short-term and insignificant, and not likely to negatively affect red knot populations in the long term, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District as a result of implementation of the overall proposed activities.

Placement of beach fill and dune restoration is likely to increase overall habitat value along the affected beachfront by expanding the area of suitable foraging habitat. Therefore, a Potentially Beneficial Impact determination was made by the District for Red Knot for this proposed Project activity for the reasons stated below. Studies of beach nourishment projects along the Atlantic Coast have documented that when construction windows and best management practices are adhered to, beach nourishment generally provides valuable habitat for beach nesting birds such as the red knot. Construction activities occurring in the Project Area are likely to halt further loss of existing habitat and will likely increase the amount of suitable habitat by increasing the size of the upper beach zone.

Permanent hard structures such as groins, would eliminate any suitable foraging habitat directly within the footprint of these structures since red knot forage primarily in the intertidal zone along the coastline and bay shoreline, and they also could provide habitat for predators of red knot. However, the area of overall impact from these structures is expected to be minimal and most of the habitat that will be impacted is not of high habitat value to red knot, and predator populations are not anticipated to increase due to human use of the project area. The areas in which hard structures are proposed include mostly subtidal areas that would be affected from groin placement. Overall impacts directly within the footprint of these structures would be permanent, but are not expected to significantly affect red knot foraging activities in the long term. Therefore, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District as a result of implementation of the overall activities.

Other short-term impacts, such as a slight decrease in water quality and an increase in turbidity, also are likely to occur during beach fill and groin construction and rehabilitation activities. Changes in water quality and turbidity may cause some short-term avoidance of the intertidal zone by the red knot during periods of low water quality resulting from construction activities. These impacts to their foraging activities will be short term and will have a minimal effect on them because red knot are mobile and can utilize unaffected foraging areas nearby. In addition, construction activities will be scheduled to avoid any active plover nesting areas (i.e., construction scheduled from approximately September 2 through March 31), which will avoid potential impacts to the red knot foraging activities. Impacts from these activities are expected to be short-term and cause no significant negative effects on plover populations. Therefore, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District for the red knot, for the proposed activities.

These impact minimization measures are detailed in Section 5 and in summary include the following: supporting NYC DPRs pre and post-construction surveys of the Project Area to determine the presence of red knot; restricting construction activities within areas of known red knot populations; supporting NYC DPRs education of residents, landowners, beach visitors, and beach managers; Regardless, so as to be conservative, a May Affect, Likely to Adversely Affect (LAA) determination was made by the District for rufa red knot from this proposed Project activity.

4.3.3 Cumulative Effect

The proposed beach renourishment activities would cause short-term impacts to red knot foraging by directly covering the benthic organisms that red knot feed on and causing short term availability in benthic species (USFWS 1991, Burlas et al 2001, Peterson and Manning 2001). These impacts are similar to the impacts from initial beach fill activities as discussed above. However, as discussed previously, these impacts will have minimal short-term impact on red knot populations. Renourishment activities will provide long-term protection of potential stop over areas in the upper

beach and primary dune areas. To further reduce potential impacts, beach renourishment activities will adhere to recommended construction windows. In addition, the District will conduct pre-nourishment field surveys for active red knots in the area. Therefore, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District for red knot from the proposed Project activity.

Occasional maintenance of beach access locations, boardwalks, and comfort stations will be required. These activities have the potential to disturb red knots. However, as noted above, the District will conduct surveys to identify the location of red knots in the vicinity of these areas. Maintenance activities would be scheduled outside of key stop over periods.

Groin construction and extension may cause habitat degradation by robbing sand from the down- drift shoreline. For example, the Coastal Barriers Study Group (1987) and the Ocean City, Maryland and Vicinity Water Resources Study Reconnaissance Report (USACE 1994) attribute the accelerated, landward shoreline recession of the north end of Assateague Island in Maryland, to cumulative effects on the natural drift system from inlet stabilization and nourishment of the rapidly eroding beaches at Ocean City. However, loss of sand down-drift of a jetty or groin may be partially off-set by habitat accretion on the up-drift side of a structure. Therefore, a May Affect, but Not Likely to Adversely Affect (NLAA) determination was made by the District for red knot from this proposed Project activity.

5 RECOMMENDATIONS

To minimize potential adverse impacts on the piping plover and seabeach amaranth, the USACE will follow recommendations previously provided by the NYSDEC and USFWS as described below (USACE 1998, USFWS 1999). These measures are expected to minimize potential adverse impacts on numerous other species that may use coastal habitats in the Project Area, including several state-listed shorebird species. Time of year (TOY) no-dredge/work restriction recommendations are as follows: for piping plover and rufa red knot from April 1 through September 2, and for seabeach amaranth from June 1 through November 1, when the presence of these species within an area of potential effect is confirmed.

5.1 PIPING PLOVER and RUFA RED KNOT

1) The USACE will coordinate with NYCDPR, and as deemed necessary, will either provide funding for or supplement their monitoring surveys during the nesting season, and prior to and post construction activities, to identify nesting plover in the Project Area and to document all known locations of plover.
2) The USACE will conduct construction activities near active plover nesting areas only from September 2 through March 31 to avoid the protected shorebird nesting period.
3) Construction activities will avoid all delineated locations of the species during the breeding season and will undertake all practicable measures to avoid incidental taking of the species.
4) The USACE will reinitiate consultation with the USFWS to identify acceptable protective measures should any changes to the project or species elicit a trigger to support such reinitiation.
5) The USACE will coordinate with NYCDPR so as to support their endeavors to educate residents, landowners, beach visitors and beach managers on piping plover.

5.2 SEABEACH AMARANTH

1) The USACE will coordinate with NYCDPR, and as deemed necessary, will either provide funding for or supplement their monitoring surveys prior to and post construction activities, to identify SBA in the Project Area and to document all known locations of SBA.
2) The USACE will restrict construction activities in areas of known SBA populations during the growing season (allow limited activities only, from June through November).
3) Construction activities will avoid all delineated locations of the plant and will undertake all practicable measures to avoid incidental taking of the plant.
4) The USACE will reinitiate consultation with the USFWS to identify acceptable protective measures should any seabeach amaranth plants be identified within the direct construction footprint.
5) The USACE will coordinate with NYCDPR so as to support their endeavors to educate residents, landowners, beach visitors and beach managers on seabeach amaranth.

6 CONCLUSIONS

When trying to promote conservation goals using iconic species such as Piping Plover and Seabeach Amaranth, it is important to keep in mind that there are conflicting measures and recommendations among stakeholders with competing legitimate goals. When a consensus is met on the management goals among these stakeholders, the accomplishment of a more productive public policy to protect the species ensues.

To accomplish the goals of this management consensus for this project, USACE will coordinate and collaborate with USFWS, NYSDEC and NYC DPR to review management practices aimed at urban ecosystems, which differ greatly from managing forever wild or rural locations. There are many reports on urban ecosystems that successfully support native wildlife, as well as the active management efforts that accomplish this specific goal (DiCicco 2014, Feinburg et al. 2014, Fisher 2011, Flores et al. 1998,). Central Park is an example of an early planned construction intended as a naturalistic pastoral design (Brown 2013). Urbanization produces a variety of unprecedented and intense manipulations to an ecosystem. These include changes in disturbance regimes, biota, landscape structure, physiological stresses (e.g. air pollution), as well as include extensive cultural, economic and political factors (McDonnell and Pickett 1990).

It is the USACE's determination, that implementing the proposed action in accordance with the standards and guidelines (including mitigation measures that include protective and conservative best management practices) recommended by USFWS and NYSDEC, will not jeopardize the continued existence or contribute to the loss of viability of either piping plover or seabeach amaranth populations that occur or utilize the project area, and the proposed action would not significantly contribute to cumulative impacts associated with piping plover and seabeach amaranth, the USACE concludes that the overall project results in a May Affect is Likely to Adversely Affect (LAA) determination for piping plover and seabeach amaranth, and a May Affect, but Not Likely to Adversely Affect (NLAA) determination for red knot.

USACE has requested that USFWS issue their Biological Opinion, which may include an Incidental Take Statement (ITS), as/if necessary, based upon the analyses provided in this Biological Assessment, according to and in compliance with our joint Section 7 obligations. USACE is in active coordination with USFWS regarding the preparation of the Biological Opinion which is expected mid-December.

7 REFERENCES

Bent, A.C. 1929. Life histories of North American shorebirds (Part II). U.S. Natl. Mus. Bull. 146. Washington, D.C.

Bergstrom, P.W. 1991. Incubation temperatures of Wilson's plovers and killdeers. Condor 91: 634- 641.

Botton, M.L., Loveland, R.E., and T.R. Jacobsen. 1988. Beach Erosion and Geochemical Factors: Influence on Spawning Success of Horseshoe Crabs (*Limulus polyphemus*) in Delaware Bay. *Marine Biology* 99(3): 325-332.

Botton, M.L., R.E. Loveland, and T.R. Jacobsen. 1994. Site selection by migratory shorebirds in Delaware Bay, and its relationship to beach characteristics and abundance of horseshoe crab (*Limulus polyphemus*) eggs. The Auk 111(3):605-616.

Brotherton, D. K., J. L. Behler, and R. Cook. 2003. Fire Island National Seashore Amphibian and Reptile Inventory, March–September 2002. National Park Service and Wildlife Conservation Society Cooperative Agreement #1443CA4520-98-017. (In draft)

Brown, J.L., 2013. The making of central park. Civil Engineering—ASCE, 83:4043.

Burger, J. 1987. Physical and social determinants of nest-site selection in piping plover in New Jersey. Condor 89: 811-818.

Burger, J. 1991. Foraging Behavior and the Effect of Human Disturbance on the Piping Plover (*Charadrius melodus*). Journal of Coastal Research 7(1):39-52.

Burger, J. 1993. Shorebird squeeze. Natural History 5/93, pp. 8-14.

Burger, J. 1994. The effect of human disturbance on foraging behavior and habitat use in piping plover (*Charadrius melodus*). Estuaries 17(3): 695-701.

Burlas, M, GL Ray, and D. Clark. 2001. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey: Asbury Park to Manasquan Section Beach Erosion Control Project, Final Report. US Army Corps of Engineers New York District, Engineer Research and Development Center, Waterways Experiment Station.

Cairns, W. E. 1977. Breeding biology and behavior of the piping plover (*Charadrius melodus*) in southern Nova Scotia. Dalhousie University, Halifax, Nova Scotia. M.S. thesis. 155 pp.

Cairns, W. E., and I. A. McLaren. 1980. Status of the piping plover (*Charadrius melodus*) on the East Coast of North America. American Birds 34:206-8.

Cartar, R. 1976. The status of the piping plover at Long Point, Ontario, 1966-1974. Ont. Field Biol. 30:42-5.

Cashin Associates, P.C. 1993. The environmental impacts of barrier island breaching with particular focus on the south shore of Long Island, New York. Prepared for State of New York, Division of Coastal Resources and Waterfront Revitalization, Albany, New York. 44 pp. and appendix.

Clark, K.E., Porter, R.R., and J.D. Dowdell. 2009. The Shorebird Migration in Delaware Bay. *New Jersey Birds* 35(4): 85-92.

Coastal Barriers Study Group. 1987. Draft report to Congress: Coastal barrier resources system.

Executive summary. Department of the Interior, Washington, D.C. 25 pp.

Cohen, J., L. Houghton, A. Novak, J. Fraser, and S. Elias-Gerken. 2002. Limiting Factors of Piping Plover Nesting Pair Density and Productivity on Long Island, New York. Interim Report for the 2001 Breeding Season. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA. January 2002. 79pp.

Cohen, J., L. Houghton, A. Novak, J. Fraser, and S. Elias-Gerken. 2003a. Limiting Factors of Piping Plover Nesting Pair Density and Productivity on Long Island, New York. Interim Report for the 2002 Breeding Season. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA. January 2003. 91pp.

Cohen, J., L. Houghton, A. Novak, J. Fraser, and S. Elias-Gerken. 2003b. Limiting Factors of Piping Plover Nesting Pair Density and Productivity on Long Island, New York. Interim Report for the 2003 Breeding Season. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA. December 2003. 90pp.

Cohen, J.B., S.M. Karpanty, J.D. Fraser, B.D. Watts, and B.R. Truitt. 2009. Residence probability and population size of red knots during spring stopover in the mid-Atlantic region of the United States. Journal of Wildlife Management 73(6):939-945.

Collazo, J.A., J.R. Walters, and J.F. Parnell. 1995. Factors affecting reproduction and migration of waterbirds on North Carolina barrier islands. Final report to the National Park Service, Cape Hatteras and Cape Lookout National Seashores.

Connor, P.F. 1971. The Mammals of Long Island, New York. New York State Museum and Science Service Bulletin 416. 78 pp.

Cross, R. R. 1992. Effects of predator control on piping plover reproductive success. Abstract, 6th Annual Meeting of the Society for Conservation Biology, p. 49.

Cross, R.R. and K. Terwilliger. 1993. Piping plover flushing distances recorded in annual surveys in Virginia 1986-1991. Virginia Department of Game and Inland Fisheries, Richmond, Virginia. 5 pp

Cuthbert, F. J., and T. Wiens. 1982. Status and breeding biology of the piping plover in Lake of the Woods County, Minnesota. Report submitted to Non-Game Program, Minnesota Department of Natural Resources. 18 pp.

Defeo, O., McLachlan, A., Schoeman, D.S., Schlacher, T., Dugan, J.E., Jones, A., Lastra, M., and F. Scapini. 2009. Threats to Sandy Beach Ecosystems: A Review. *Estuarine, Coastal and Shelf Science* 81(1): 1-12.

DiCicco, J.M., 2014. LongTerm Urban park Ecological Restoration: A Case Study of Prospect Park, Brooklyn, NY. Ecological Restoration, 32:314326.

Downer, R.H, and C.E. Leibelt. 1990. 1989 Long Island colonial waterbird and piping plover survey. Research report of the New York State Department of Environmental Conservation, Stony Brook, New York. 200 pp.

Drury, W. H. 1973. Population changes in New England seabirds. Bird Banding 44: 267-313.

Ducey-Ortiz, A.M., T.S. Litwin and D.C. MacLean. 1989. 1988 Long Island colonial waterbird and piping plover survey. Unpublished report. Seatuck Research Program, Cornell Laboratory of Ornithology, Islip, New York. 8 pp.

Eddings, K.J., and S.M. Melvin. 1991. Biology and conservation of piping plovers at Breezy Point, New York, 1991. Unpublished report submitted to the U.S. Fish and Wildlife Service, Newton Corner, Massachusetts. 38 pp.

Elias-Gerken, S.P. 1994. Piping plover habitat suitability on central Long Island, New York barrier islands. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 48 pp.

Elias-Gerken, S. P., J. D. Fraser, and P. A. Buckley. 1995. Piping plover habitat suitability on central Long Island, New York barrier islands. USDI National Park Service, North Atlantic region, Tech. Rep. NPS/NAROSS/NRTR/95-29. xvii + 246 pp.

Erwin, R.M. 1979. Historical breeding records of colonial seabirds and wading birds, 1900-1977, Cape Elizabeth, Maine to Virginia. Supplement to final report prepared for U.S. Fish and Wildlife Service, Coastal Ecosystems Project, Newton Corner, Massachusetts.

Feinburg, J.A., C.E. Newman, G.J. WatkinsColwell, M.D. Schlesinger, B. Zarate, B.R. Curry,

H.B. Shaffer, J. Burger, 2014. Cryptic Diversity in Metropolis: Confirmation of a New Leopard Frog Species (Anura: Ranidae) from New York City and Surrounding Atlantic Coast Regions. DOI: 0.1371/journal.pone.0108213; http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0108213

Fisher, C., 2011. Nature in the City: Urban Environmental History and Central Park. OAH Magazine of History, 25(4):2731.

Flemming, S. P., R. D. Chiasson, P. C. Smith, P. J. Austin-Smith, and R. P. Bancroft. 1988.

Piping Plover status in Nova Scotia related to its reproductive and behavioral responses to human disturbance. Journal of Field Ornithology 59:321-330.

Flores, A., S.T.A. Pickett, W.C. Zipperer, R.V. Pouyat, and R. Pirani, 1998. Adopting a modern ecological view of the metropolitan landscape: the case of a greenspace system for the New York City region. Landscape and Urban Planning, 39:295308.

Fraser, J.D., S.M. Karpanty, and J.B. Cohen. 2010. Shorebirds forage disproportionately in horseshoe crab nest depressions. Waterbirds 33(1):96-100.

Galbraith H., Jones, R., Park, R., Clough, J., Herrod-Julius, S., Harrington, B, and G. Page.2002. Global Climate Change and Sea Level Rise*:* Potential Losses of Intertidal Habitat for Shorebirds. Waterbirds 25*:* 173–183.

Gardner, A.L. 1982. Virginia opossum. Pp. 3-36 *in* J.A. Chapman and G.A. Feldhamer (eds.), Wild mammals of North America. John Hopkins University Press. Baltimore, Maryland.

Goldin, M.R. 1990. Reproductive ecology and management of piping plovers (*Charadrius melodus*) at Breezy Point, Gateway National Recreation Area, New York -- 1990. Unpublished report. Gateway National Recreation Area, Long Island, New York. 16 pp.

Goldin, M. R., et al. 1992. The effects of human disturbance and off-road vehicles on piping plover (*Charadrius melodus*) behavior and reproductive success. Abstract, 6th Annual Meeting of the Society for Conservation Biology, p. 65.

Goldin, M.R. 1993. Effects of human disturbance and off-road vehicles on piping plover reproductive success and behavior at Breezy Point, Gateway National Recreation Area, New York. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 128 pp.

González, P.M. 2005. Report for developing a red knot status assessment in the U.S. Unpublished report by Fundacion Inalafquen, Rio Negro, Argentina.

Griffin, C.R. and S.M. Melvin. 1984. Research plan on management, habitat selection, and population dynamics of piping plovers on outer Cape Cod, Massachusetts. University of Massachusetts. Research proposal submitted to U.S. Fish and Wildlife Service, Newton Corner, Massachusetts. 5 pp.

Haig, S. M., and L. W. Oring. 1988. Distribution and dispersal in the piping plover. Auk 105:630-638.

Haig, S.M. 1992. Piping Plover (*Charadrius Melodus*). In A. Poole, P. Stettenheim, and F. Gill, editors, The Birds of North America, No. 2. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, DC. 18 pp.

Haig, S. M., and J. H. Plissner. 1993. Distribution and abundance of piping plovers: results and implications of the 1991 international census. Condor 95:145-156.

Halbeisen, R. 1977. Disturbances of incubating snowy plovers on Pt. Reyes. Point Reyes Bird Observatory. 42:2-3.

Harrington, B.A. 2008. Coastal inlets as strategic habitat for shorebirds in the southeastern United States. DOER technical notes collection. ERDC TN-DOERE25. U.S. Army Engineer Research and Development Center, Vicksburg, MS. Available at <http://el.erdc.usace.army.mil/elpubs/pdf/doere25.pdf>.

Herrington, T.O. 2003. Manual for Coastal Hazard Mitigation. New Jersey Sea Grant Consortium, Fort Hancock, NJ. Available at: <http://www.state.nj.us/dep/cmp/coastal_hazard_manual.pdf>.

Hoopes, E. M., C. R. Griffin, and S. M. Melvin. 1992. Foraging ecology of piping plovers in Massachusetts. Abstract, 6th Annual Meeting of the Society for Conservation Biology, p. 74.

Hoopes, E.M. 1993. Relationships between human recreation and piping plover foraging ecology and chick survival. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 106 pp.

Hoopes, E.M. 1994. Breeding ecology of piping plovers nesting at Cape Cod National Seashore - 1994. National Park Service, South Wellfleet, Massachusetts. 34 pp.

Hoopes, E.M. 1995. Piping plover nest distribution with respect to concrete walkways at the Breezy Point Cooperative, New York, 1991-1994. Report for the U.S. Fish and Wildlife Service, Sudbury, Massachusetts. 6 pp.

Howard, J.M., R.J. Safran, and S.M. Melvin. 1993. Biology and conservation of piping plovers at Breezy Point, New York. Unpublished report. Department of Forestry and Wildlife Management, University of Massachusetts, Amherst. 34 pp.

Hubbard D.M., and J. E. Dugan. 2003. Shorebird Use of an Exposed Sandy Beach in Southern California. *Estuarine and Coastal Shelf Science* 58S: 169-182.

Hull, C. 1981. Great Lakes piping plover in trouble. Michigan Department of Natural Resources, Lansing, Michigan. 2 pp.

Johnsgard, P. A. 1979. Birds of the Great Plains: breeding species and their distribution. Univ. Nebraska Press, Lincoln. 539 pp.

Kluft, J.M., and H.S. Ginsburg. 2009. The effect of off-road vehicles on barrier beach invertebrates at Cape Cod and Fire Island National Seashores. Technical Report NPS/NER/NRTR—2009/138. Boston, MA.

Quinn, J. R., and R. B. Walden. 1966. Notes on the incubation and rearing of the piping plover (*Charadrius melodus*). Avicultural Mag. 72:145-6.

Lambert, A., and B. Ratcliff. 1979. A survey of piping plovers in Michigan, 1979. Report submitted to Michigan Department of Natural Resources, Lansing, Michigan.

Litwin, T.S., A. Ducey-Ortiz, R.A. Lent, and C.E. Liebelt. 1993. 1990-1991 Long Island colonial waterbird and piping plover survey. Volume I. New York State Department of Environmental Conservation, Stony Brook, New York. 109 pp.

Loegering, J.P. 1992. Piping plover breeding biology, foraging ecology and behavior on Assateague Island National Seashore, Maryland. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 247 pp.

Loegering, J.P., and J.D. Fraser, 1995. Factors affecting Piping Plover chick survival in different broodrearing habitats.

MacIvor, L.H. 1990. Population dynamics, breeding ecology, and management of piping plovers on outer Cape Cod, Massachusetts. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 100 pp.

MacIvor, L. H., S. M. Melvin, and C. R. Griffin. 1990. Effects of research activity on piping plover nest predation. J. Wildlife Management 54:443-447.

Maine Department of Inland Fisheries and Wildlife. 1995. Atlas of essential wildlife habitats for Maine's endangered and threatened species. 1995 edition. Augusta, Maine. Pp. 8-11.

Matteson, S. W. 1980. 1980 survey of breeding gulls and terns in Chequamegon Bay. Report submitted to Wisconsin Department of Natural Resources, Madison, Wisconsin. 19 pp.

Melvin, S.M., A. Hecht, and C.R. Griffin. 1994. Piping plover mortalities caused by off-road vehicles on Atlantic coast beaches. Wildlife Society Bulletin 22: 409-414.

Melvin, S.M., Griffin, C.R., and L.H. MacIvor. 1991. Recovery Strategies for Piping Plovers in Managed Coastal Landscapes. *Coastal Management* 19: 21-34.

Morton, R.A., Miller, T.L. and L.J. Moore. 2004. National Assessment of Shoreline Change: Part 1: Historical Shoreline Changes and Associated Coastal Land Loss Along the U.S. Gulf of Mexico. Open-file report 2004-1043. U.S. Geological Survey Center for Coastal and Watershed Studies, St. Petersburg, FL. Available at: <http://pubs.usgs.gov/of/2004/1043/>.

National Marine Fisheries Service (NMFS). 2004. Essential Fish Habitat. Available at: http://www.nmfs.noaa.gov/habitat/efh/

National Park Service. 1992. Environmental Assessment on management plan for the threatened piping plover, Sandy Hook Unit, Gateway National Recreation Area. Sandy Hook, New Jersey. 23 pp.

National Park Service. 1994. Environmental Assessment on management plan for shoreside species breeding habitat. Fire Island National Seashore, Patchogue, New York. 29 pp.

National Park Service. 1998. Fire Island National Seashore Environmental Assessment for Endangered Species Habitat Management. Prepared by National Park Service, Fire Island National Seashore, Patchogue, New York. http://www.nps.gov/fiis/plan/plan.html.

NatureServe. 2002. NatureServe Explorer: An online encyclopedia of life [web application].

Version 4.0. NatureServe, Arlington, Virginia. Available: http://www.natureserve.org/explorer. (Accessed: July 29, 2004).

New Jersey Department of Environmental Protection (NJDEP). 1997. Endangered Beach Nesting Bird Management on New Jersey's Municipal Beaches. NJDEP Division of Fish, Game and Wildlife: Endangered and Nongame Species Program, and the U.S. Fish and Wildlife Service (USFWS). http://www.state.nj.us/dep/fgw/ensphome.htm. (Retrieved 2001).

New York City Audubon. 2010. Shorebird and Horseshoe Crab Data Summary 2009 and 2010, Jamaica Bay, NY.

New York State Department of Environmental Conservation (NYSDEC). 2001. New York State Amphibians and Reptile Atlas Project. Available: http://www.dec.state.ny.us/website/dfwmr/wildlife/herp/index.html. Accessed July 2003.

New York City Department of Parks and Recreation, (NYCDPR), Wildlife Unit. 2017. Rockaway Beach Endangered Species Nesting Area (RBESNA) 2017 Final Report.

Niles, L.J. 2011. Blog - a rube with a view: Knot like quail. Available at <http://arubewithaview.com/2011/12/05/knot-like-quail/>.

Niles, L.J. 2010. Blog - A Rube with a View: Delaware Bay Update 5/28/10 - The Importance of Good Habitat. Available at: <http://www.arubewithaview.com/blog/2010/5/29/delaware-bay-update-52810-The importance-of-good-habitat.html>.

Niles, L.J., H.P. Sitters, A.D. Dey, P.W. Atkinson, A.J. Baker, K.A. Bennett, R. Carmona, K.E. Clark, N.A. Clark, and C. Espoza. 2008. Status of the red knot (*Calidris canutus rufa*) in the Western Hemisphere. Studies in Avian Biology 36:1-185.

Niles, L.J., J. Burger, R.R. Porter, A.D. Dey, C.D.T. Minton, P.M. González, A.J. Baker, J.W. Fox, and C. Gordon. 2010a. First results using light level geolocators to track red knots in the Western Hemisphere show rapid and long intercontinental flights and new details of migration pathways. Wader Study Group Bulletin 117(2):123-130.

Nol, E. 1980. Factors affecting the nesting success of the killdeer (*Charadrius melodus*) on Long Point, Ontario. University of Guelph, Ontario. M.S. thesis. 155 pp.

Nordstrom, K.F. 2000. Beaches and Dunes of Developed Coasts. Cambridge University Press, Cambridge, UK. 338 pp.

Patterson, M. E., J. D. Fraser and J. W. Roggenbuck. 1990. Piping plover ecology, management and research needs. Virginia Jour. Sci. 41(4A):419-26.

Patterson, M. E., J. D. Fraser, and J. W. Roggenbuck. 1991. Factors affecting piping plover productivity on Assateague Island. J. Wildlife Management 55:525-531.

Patterson, M. E., J. P. Loegering, and J. D. Fraser. 1992. Piping plover breeding biology and foraging ecology on Assateague Island National Seashore, Maryland. Abstract, 6th Annual Meeting of the Society for Conservation Biology, p. 103.

Peterson C. and L. Manning. 2001. How Beach Nourishment Affects the Habitat Value of Intertidal Beach Prey for Surf Fish and Shorebirds and Why Uncertainty Still Exists. Proceedings of the Coastal Ecosystems and Federal Activities Technical Training Symposium, August 20-22, 2001. University of North Carolina, Chapel Hill, Institute of Marine Sciences, Morehead City, NC, 2 pp.

Piersma, T., R. Hoekstra, A. Dekinga, A. Koolhaas, P. Wolf, P. Battley, and P. Wiersma. 1993. Scale and Intensity of Intertidal Habitat Use by Knots *Calidris canutus* in the Western Wadden Sea in Relation to Food, Friends and Foes. *Netherlands Journal of Sea Research* 31(4): 331-357.

Raithel, C. 1984. The piping plover in Rhode Island. Rhode Island Natural Heritage Program, Providence, Rhode Island. Unpublished report. 13 pp.

Randall, J. 2002. Bringing Back a Fugitive. U.S. Fish and Wildlife Service Endangered Species Bulletin, July-August, 2002.

Ray, G. and D. Clarke. 1995. Baseline Characterization of Benthic Resources and Their Use by Demersal Fishes at a Beach Renourishment Borrow Site off Coney Island, New York. Prepared for the U.S. Army Corps of Engineers, New York District, Environmental Analysis Branch.

Ray, G. 1996. Characterization of Benthic Resources at a Potential Beach Renourishment Borrow Site in the Vicinity of Coney Island, New York: June to September 1995. Prepared for the U.S. Army Corps of Engineers, New York District, Environmental Analysis Branch.

Reid, R.N., D.J. Rodosh, A.B. Frame, and S.A. Fromm. 1991. Benthic Macrofauna of the New York of the New York Bight, 1979-89, NOAA Tech. Report, NMFS 103. 50 pp. Rice, T.M. 2009. Best Management Practices for Shoreline Stabilization to Avoid and Minimize Adverse Environmental Impacts. Unpublished Report prepared for the U.S. Fish and Wildlife Service, Panama City Ecological Services Field Office. Available at: <http://www.fws.gov/charleston/pdf/PIPL/BMPs%20For%20Shoreline%20Stabilization%20To%20Avoid%20And%20Minimize%20Adverse%20Environmental%20Impacts.pdf

Roberts, T. S. 1955. A manual for the identification of the birds of Minnesota and neighboring states. University of Minnesota Press, Minneapolis, Minnesota. 738 pp.

Ryan, J. 1996. Plover on the run. Massachusetts Audubon Society. 31pp.

Sauer, J. R., J. E. Hines, and J. Fallon. 2005. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2004. Version 2005.2. Available at* http://www.mbr-pwrc.usgs.gov/bbs/

Scavia, D., Field, J.C., Boesch,D.F., Buddemeier, R.W., Burkett,V., Cayan, D.R., Fogarty, M., Harwell, M.A., Howarth, R.W., Mason, C., Reed, D.J., and *et al.* 2002. Climate Change Impacts on U.S. coastal and Marine Ecosystems. *Estuaries* 25(2):149-164.

Schupp, C.A., N.T. Winn, T.L. Pearl, J.P. Kumer, T.J.B. Carruthers, and C.S. Zimmerman, 2013. Restoration of Overwash Processes Creates Piping Plover (Charadrius melodus) Habitat on a Barrier Island (Assateague Island, Maryland). Estuarine, Coastal, and Shelf Science 116: 1120.

Sibley, D.A. 2000. The Sibley Guide to Birds, National Audubon Society. Alfred A. Knopf, Inc, New York. 545 pp.

Staine, K.J. and J. Burger. 1994. Nocturnal foraging behavior of breeding piping plovers (*Charadrius melodus*) in New Jersey. Auk 111(3): 579-587.

Stillman, R.A., West, A.D., Goss-Custard, J.D., McGrorty, S., Frost, N.J., Morrisey, D.J., Kenny, A.J., and A.L. Drewitt. 2005. Predicting Site Quality for Shorebird Communities: A Case Study on the Humber Estuary, UK. *Marine Ecology Progress Series* 305: 203-217

Strauss, E. 1990. Reproductive success, life history patterns, and behavioral variation in a population of piping plovers subjected to human disturbance (1982-1989). Ph.D. Dissertation. Tufts University, Medford, Massachusetts. 143 pp.

Tull, C.E. 1984. A study of nesting piping plovers of Kouchibouguac National Park 1983.

Unpublished report. Parks Canada, Kouchibouguac National Park, Kouchibouguac, New Brunswick. 85 pp.

U.S. Army Corps of Engineers. 1994. Ocean City, Maryland and vicinity water resources study reconnaissance report. Baltimore District.

U.S. Army Corps of Engineers (USACE). 2018. Biological Assessment, Fire Island Inlet to Montauk Point Coastal Storm Risk Management, Suffolk County, New York. Prepared and submitted by: U.S. Fish and Wildlife Service, Chesapeake Bay Field Office and U.S. Army Corps of Engineers, New York District.

United States Army Corps of Engineers (USACE). 2003. Final Avian Survey Summary Report for the Reformulation of the Shore Protection and Coastal Storm Risk Management Project, South Shore of Long Island, New York - Fire Island Inlet to Montauk Point. USACE, New York District, North Atlantic Division, October 2003.

United States Army Corps of Engineers (USACE). 2004. Final Small Mammal and Herpetile Survey Summary Report for the Reformulation of the Shore Protection and Coastal Storm Rish Mamagement Project, South Shore of Long Island, New York - Fire Island Inlet to Montauk Point. USACE, New York District, North Atlantic Division, January 2004.

U.S. Climate Change Science Program [CCSP]. 2009. Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region. U.S. Climate Change Science Program Synthesis and Assessment Product 4.1. U.S. Geological Survey, Reston, VA. Available at: <http://downloads.globalchange.gov/sap/sap4-1/sap4-1-final-reportall.pdf>.

United States Fish and Wildlife Service (USFWS). 1982. Fish and Wildlife Resource Studies for the Fire Island Inlet to Montauk Point, New York, Beach Erosion Control and Hurricane Protection Project Reformulation Study. U.S. Department of the Interior, Fish and Wildlife Service, Region 5, Cortland Office, Cortland, NY.112 pp.

United States Fish and Wildlife Service (USFWS). 1984. Piping Plover Proposed as an Endangered and Threatened Species. 50 CFR PART 17, 49 (218): 44712-44715.

United States Fish and Wildlife Service. 1985. Determination of endangered and threatened status for the piping plover: final rule. Federal Register 50(238): 50726-50734.

United States Fish and Wildlife Service (USFWS). 1988. Atlantic Coast Piping Plover Recovery Plan. U.S. Fish and Wildlife Service, Newton, MA. 77 pp.

United States Fish and Wildlife Service (USFWS). 1990. Endangered and threatened species recovery program: report to Congress. 406 pp.

United States Fish and Wildlife Service (USFWS). 1991. Characterization of the macro-infauna of the Lower Beach at Assateague Island, Maryland before and after dredged material disposal. Annapolis, Maryland. Report prepared for U.S. Army Corps of Engineers, Baltimore District, 14 pp.

United States Fish and Wildlife Service (USFWS). 1992. 1991 status update, U.S. Atlantic Coast piping plover. USFWS, Northeast Region, Newton Corner, Massachusetts.

United States Fish and Wildlife Service (USFWS). 1993. Endangered and threatened wildlife and plants: *Amaranthus pumilus* (Seabeach amaranth) determined to be threatened: Final rule. Federal Register 58 (65): 18035-18042.

United States Fish and Wildlife Service (USFWS). 1993a. Endangered and threatened wildlife and plants: *Amaranthus pumilus* (seabeach amaranth) determined to be threatened: Final rule. Federal Register 58 (65): 18035-18042.

United States Fish and Wildlife Service (USFWS). 1994. Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act. Northeast Region, U.S. Fish

and Wildlife Service April 15, 1994. Available at: http://www.fws.gov/northeast/pipingplover/recguide.html

United States Fish and Wildlife Service (USFWS). 1995b. Piping plover (*Charadrius Melodus*), Atlantic Coast population, revised recovery plan. Technical/agency draft. Hadley, Massachusetts. 238 pp.

United States Fish and Wildlife Service (USFWS). 1996. Recovery plan for seabeach amaranth (*Amaranthus pumilus*) Rafinesque. Atlanta, GA. 59 pp.

United States Fish and Wildlife Service. 2003. 2000-2001, 2002, and Preliminary 2003 status updates: U.S. Atlantic Coast piping plover population. Sudbury, Massachusetts. http://pipingplover.fws.gov/status/

United States Fish and Wildlife Service (USFWS). 2004a. Piping Plover Species Profile, USFWS Endangered Species Division, Long Island Field Office, Islip, New York. Available at: http://nyfo.fws.gov/es/list.htm

United States Fish and Wildlife Service (USFWS). 2004b. Seabeach Amaranth Species Profile.

USFWS Endangered Species Division, Long Island Field Office, Islip, New York. Available at: http://nyfo.fws.gov/es/list.htm.

United States Fish and Wildlife Service (USFWS). 2014. Biological Opinion and Conference Opinion, Jones Inlet to East Rockaway Inlet, Long Beach Island, New York. USFWS Endangered Species Division, Long Island Field Office, Islip, New York.

Watts, B. 2009. Conservation in conflict: Peregrines vs red knots. Available at <http://www.ccb- wm.org/news/2009_SeptDec/bojymetahi/conservation_conflict.html>.

Weakley, A., and M. Bucher. 1992. Status survey of seabeach amaranth (*Amaranthus pumilus rafinesque*) in North and South Carolina, second edition (after Hurricane Hugo). Report to North Carolina Plant Conservation Program, North Carolina Department of Agriculture, Raleigh, North Carolina, and Asheville Field Office,

U.S. Fish and Wildlife Service, Asheville, North Carolina. 149 pp. + appendices.

Welty, J.C. 1982. The life of birds. Sauders College Publishing, Philadelphia, Pennsylvania. 754 pp.

Wilcox, L. 1939. Notes on the life history of the piping plover. Pages 3-13 in The Birds of Long Island. Bird Club of Long Island, New York, New York.

Wilcox, L. 1959. A twenty year banding study of the Piping Plover. Auk 75:129-152. Ziewitz, J. W., J. G. Sidle, and J. J. Dinan. 1992. Habitat conservation for nesting least terns and piping plovers on the Platte River, Nebraska. Prairie Naturalist 24(1):1-20.

Woodhead, P.M.J. 1992. Assessments of the Fish Community and Fishery Resources of the Lower New York Bay Area in Relation to a Program of Sand Mining Proposed by New York State. Stony Brook: Marine Science Research, SUNY at Stony Brook.

Zonick, C.A. 2000. The Winter Ecology of the Piping Plover (*Charadrius melodus*) Along the Texas Gulf Coast. Ph.D. Dissertation. University of Missouri, Columbia, MO.

Zonick, C., and M. Ryan. 1996. The Ecology and Conservation of Piping Plovers (*Charadrius melodus*) Wintering Along the Texas Gulf Coast. 1995 Annual Report. Department of Fisheries and Wildlife, University of Missouri, Columbia, MO.

US Army Corps of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D2b
Endangered Species Act Compliance
NMFS NLAA Determination Concurrence

December 2018

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

JAN 1 2 2017

Mr. Peter Weppler, Chief
Environmental Analysis Branch
Planning Division
New York District
26 Federal Plaza
New York, NY 10278

Re: East Rockaway Inlet to Rockaway Inlet

Dear Mr. Weppler:

We have completed our consultation under section 7 of the Endangered Species Act (ESA) in response to your letter received January 5, 2017 regarding the above-referenced proposed project. We reviewed the action agency's consultation request document and related materials. Based on our knowledge, expertise, and the action agency's materials, we concur with the action agency's conclusion that the proposed action is not likely to adversely affect the ESA-listed species and/or designated critical habitat under our jurisdiction. Therefore, no further consultation pursuant to section 7 of the ESA is required.

Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in the consultation; (b) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this consultation; or (c) If a new species is listed or critical habitat designated that may be affected by the identified action. No take is anticipated or exempted. If there is any incidental take of a listed species, reinitiation would be required. Should you have any questions about this correspondence please contact Dan Marrone at 978-282-8465 or Daniel.Marrone@noaa.gov. For questions related to Essential Fish Habitat please contact Karen Greene with our Habitat Conservation Division at (732) 872-3023 or Karen.Greene@noaa.gov.

Sincerely,

Kimberly B. Damon-Randall
Assistant Regional Administrator
for Protected Resources

EC: Marrone NMFS/PRD; Gallo ACOE; Greene NMFS/HCD
PCTS: NER-2017-13934
File Code: H:\Section 7 Team\Section 7\Non-Fisheries\ ACOE\Informal\2017\New York\Pilot_East Rockaway Inlet

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D
Environmental Compliance

Attachment D1—USFWS Coordination Act Report
Attachment D2—Endangered Species Act Coordination with USFWS and NMFS
Attachment D3—Essential Fish Habitat Assessment
Attachment D4—404(b)(1)
Attachment D5—Coastal Zone Management Act
Attachment D6—Programmatic Agreement
Attachment D7—General Conformity
Attachment D8—Monitoring Plan

December 2018, amended as of July 2019
to include Attachment D2c, the USFWS Biological Opinion

US Army Corps
of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D2c

USFWS Biological Opinion

Biological Opinion

On the Effects of the U.S. Army Corps of Engineers' East Rockaway Inlet to Rockaway Inlet Coastal Storm Risk Management Project Queens County, New York, on the Piping Plover (*Charadrius melodus*), Red Knot (*Calidris canutus rufa*), and Seabeach Amaranth (*Amaranthus pumilus*)

Prepared for:

U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278-0900

Prepared by:

U.S. Fish and Wildlife Service
Long Island Field Office
Shirley, NY 11769

Field Supervisor:
David A. Stilwell

June 25, 2019

Table of Contents

INTRODUCTION 1

I. DESCRIPTION OF THE PROPOSED ACTION 1

A. Proposed Project 2

1. Atlantic Ocean Project Features 2

2. Composite Seawall and Berm Description 6

3. Dune and Berm Construction Description 7

4. Berm Construction Tapers 8

5. New Groin Construction, Existing Groin Extension and Rehabilitation 8

6. Jamaica Bay High-Frequency Flooding Risk Reduction Features (HFFRRF) 9

a. Cedarhurst-Lawrence 9

b. Motts Basin North 10

c. Mid-Rockaway 11

B. Endangered Species Avoidance and Minimization Measures 13

1. Piping Plover Avoidance and Minimization Measures 14

2. Red Knot Avoidance and Minimization Measures 16

3. Seabeach Amaranth Avoidance and Minimization Measures 17

II. ACTION AREA 18

A. Description of the Action Area 18

III. STATUS OF THE SPECIES 20

A. Piping Plover 20

B. Red Knot 21

C. Seabeach Amaranth 21

IV. STATUS OF CRITICAL HABITAT 22

V. ENVIRONMENTAL BASELINE 22

A. Status of the Species within the Action Area 22

1. Piping Plover 22

2. Red Knot 29

3. Seabeach Amaranth 29

VI. STATUS OF CRITICAL HABITAT WITHIN THE ACTION AREA 30
VII. FACTORS AFFECTING THE SPECIES ENVIRONMENT WITHIN 30
THE ACTION AREA 30
A. Beach Stabilization 31
B. Predation 32
C. Human Disturbance 32
D. Accelerating Sea-level Rise 34
VIII. EFFECTS OF THE ACTION 35
A. Effects from Construction Activities - All Species 36
1. Piping Plovers 36
2. Red Knots 37
3. Seabeach Amaranth 39
B. Habitat Loss and Modification - All Species 41
1. Piping Plover and Red Knot 41
a. Loss of early successional berm habitat 41
b. Loss of quality and access to foraging habitats 43
2. Seabeach Amaranth 46
C. Effects Due to Prey Resource Burial - Piping Plover and Red Knot 47
D. Predation - Piping Plover and Red Knot 49
E. Impacts Due to Recreation and Administrative ORV Use–All Species 49
1. Piping Plover and Red Knot 49
2. Seabeach Amaranth 51
IX. CUMULATIVE EFFECTS 51
X. JEOPARDY AND ADVERSE MODIFICATION ANALYSIS 52
A. Jeopardy Analysis Framework 52
B. Analysis for Jeopardy/Adverse Modification 52
XI. CONCLUSION 54
XII. INCIDENTAL TAKE STATEMENT 55
XIII. AMOUNT OR EXTENT OF TAKE ANTICIPATED 56
A. Piping Plover and Red Knot 56
1. Incidental Take from Direct Effects of the Initial Construction Activities 56

2. Incidental Take Due to Habitat Loss, Degradation, or Modification 57
3. Incidental Take Due to Reductions in Infauna in the Intertidal Zone and Subaerial Beaches 57
4. Incidental Take Due to Enhancement of Predator Habitat and Populations 57
5. Incidental Take Due to Recreation and ORV Activities 57
XIV. EFFECT OF THE TAKE 59
A. Piping Plover and Red Knot 59
XV. REASONABLE AND PRUDENT MEASURES 59
XVI. TERMS AND CONDITIONS 60
XVII. CONSERVATION RECOMMENDATIONS 69
A. Piping Plover 69
B. Red Knot 70
C. Seabeach Amaranth 70
XVIII. REINITIATION NOTICE 71
XIX. CONSULTATION HISTORY 72
XX. LITERATURE CITED 75

LIST OF FIGURES

Figure 1. Overview illustration of the proposed project for the Atlantic Ocean and Jamaica Bay shorelines. Illustration credit: USACE (2018a).

Figure 2. Enhanced overview of proposed project features on the ocean beach. Illustration credit: USACE (2018a).

Figure 3. Overview of ocean beach project features on the western end of the proposed project area. Illustration credit: USACE (2018a).

Figure 4. Overview of ocean beach project features in the central part of the proposed project area. Illustration credit: USACE (2018a).

Figure 5. Overview of ocean beach project features in the eastern portion of the proposed project area. Illustration credit: USACE (2018a).

Figure 6. Continuation of overview of ocean beach project features along the eastern end of the proposed project area. Illustration credit: USACE (2018a).

Figure 7. Composite seawall design—Beach 19th Street to Beach 126th Street. Illustration credit: USACE (2018a).

Figure 8. Composite seawall design—Beach 126th Street to Beach 149th Street. Illustration credit: USACE (2018a).

Figure 9. Construction of a composite seawall in Virginia. Illustration credit: USACE (1999), as cited in USACE (2018a).

Figure 10. Typical design cross-section of the proposed dune and berm. Illustration credit: USACE (2018a).

Figure 11. Cedarhurst-Lawrence HFFRRF Project Plan. Illustration credit: USACE (2018a).

Figure 12. Aerial photo with plan layout of Motts Basin North HFFRRF. Illustration credit: USACE (2018a).

Figure 13. Aerial photo with plan layout of Edgemere Area HFFRRF. Illustration credit: USACE (2018a).

Figure 14. Aerial photo with plan layout of Arverne Area HFFRRF. Illustration credit: USACE (2018a).

Figure 15. Aerial photo with plan layout of Hammels HFFRRF. Illustration credit: USACE (2018a).

Figure 16. Map showing location of piping plover, seabeach amaranth, and red knot action area and piping plover concentration areas.

Figure 17. Map of NYSDEC LICWS sites in the action area.

Figure 18. Dune and ephemeral pool complex near Beach 17th Street to Beach 20th Street. Photo credit: Steve Sinkevich, USFWS, November 2018.

Figure 19. Backshore area, Arverne by the Sea (Beach 35th Street to Beach 73rd Street) piping plover breeding area looking west. Photo credit: Kerri Dikun, USFWS, November 2018.

Figure 20. Landward side of artificial dune, Arverne by the Sea (Beach 35th Street to Beach 73rd Street) piping plover breeding area looking east. Photo credit: Kerri Dikun, USFWS, November 2018.

Figure 21. Piping plover nest distribution in the action area—2015 to 2018.

Figure 22. Total and site piping plover abundance given as number of census pairs in the action area—2000 to 2018.

Figure 23. Piping plover productivity pair abundance and productivity (fledglings/pair in the action area—2000 to 2018.

Figure 24. Total number of seabeach amaranth in the action area during annual surveys—1990 and 2018.

Figure 25. Map showing location of plover nests (2015–2018) near the proposed composite seawall and berm design layout in the eastern portion of the proposed project area.

Figure 26. Map showing location of plover nests (2014–2018) near the proposed beach taper and groin design layout in the western portion of the project area.

Figure 27. Beach nourishment equipment on the beach. Photo credit: Steve Papa, USFWS, 2004.

Figure 28. Dredge pipe and equipment on the beach. Photo credit: Steve Papa, USFWS, 2015.

Figure 29. Sand fence installed in the Corps' Westhampton Interim Storm Damage Protection Project area to promote lateral expansion of the dune at the expense of berm habitat. Photo credit: NYSDEC 2012.

Figure 30. A widened berm and scarp formation at Smith Point County Park, Suffolk County, New York, during construction of the Corps' Fire Island Inlet to Moriches Inlet Stabilization Project. Photo credit: Steve Papa, USFWS, March 2015.

Figure 31. Erosion of nourished beach within the Corps' FIMI Project area 3 years after construction. Narrowing of berm seen in foreground. Extreme erosion seen in shoreline at top of photo. Photo credit: Steve Papa, USFWS, June 2018.

LIST OF TABLES

Table 1. Red knot counts in the action area's ocean beach reported on https://eBird.org as of December 2018 (eBird 2018).

Table 2. Sea-level rise prediction for New York City and the Lower Hudson Region. From (https://www.dec.ny.gov/regulations/103877.html).

Table 3. Amount and type of anticipated incidental take.

INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (Service or USFWS) Biological Opinion (Opinion), in accordance with section 7 of the Endangered Species Act, as amended (Act; 87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq*.). It evaluates the effects of the U.S. Army Corps of Engineers' (Corps or USACE) proposed project entitled, "East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study, Queens County, New York" (hereafter referred to as the proposed project) on the federally listed Atlantic Coast piping plover (*Charadrius melodus*; threatened), seabeach amaranth (*Amaranthus pumilus*; threatened), and red knot (*Calidris canutus rufa*; threatened). The proposed project is a coastal storm risk reduction project on the Rockaway Peninsula, involving the construction and maintenance of dunes, berms, seawalls, groins, rock sills, and other features over 50 years.

This Opinion is based on information provided in the USACE's Draft General Reevaluation Report/Environmental Impact Statement (GRR/EIS; cited as USACE 2018a) and biological assessment (BA; cited as USACE 2018b) dated August 2018. Both reports are incorporated by reference into the Opinion. Additional project information was obtained via coordination with the Corps, field investigations, and other sources. A complete administrative record of this consultation is on file in this office.

In addition to the species listed above, the federally listed roseate tern (*Sterna dougallii dougallii*; endangered) is occasionally observed roosting on the Rockaway Peninsula and Jamaica Bay portions of the project area. The BA did not provide a determination for roseate tern. After consideration of the project description and the avoidance and minimization measures, the Service does not anticipate any adverse impacts to this species. Therefore, no further consultation with the Service is required pursuant to the Act. Should project plans change, or if additional information on this species becomes available, this evaluation may be reconsidered.

The proposed project has a 50-year project life, but is currently at a 15 to 30 percent design level. As a result, the project description may change based on public and agency comments on the Draft GRR/EIS, as well as new information (Mazey pers. comm. February 20, 2019). Consequently, the Corps will need to consult with the Service to determine if re-initiation of formal consultation is warranted.

I. DESCRIPTION OF THE PROPOSED ACTION

As defined in section 7 of the Act, "action" means "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas." The "action area" is defined as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 CFR 402.02).

A. Proposed Project

The proposed project area stretches from East Rockaway Inlet to Rockaway Inlet, Queens County, New York (NY) (Figure 1). An overview of the proposed project is shown in Figure 1. The Atlantic Ocean component consists of dune and beach construction with periodic renourishment over 50 years, groin extension and rehabilitation, construction of new groins, sand fence installation, vegetation planting, vehicle access ways, pedestrian walkovers, and a composite seawall. The proposed project also includes construction of bulkheads, floodwalls, drainage, and pump stations, rock sills, and wetland restoration in Jamaica Bay in the neighborhoods of Cedarhurst-Lawrence, Edgemere, Arverne, Hammels, and Motts Basin.

Figure 1.—Overview illustration of the proposed project for the Atlantic Ocean and Jamaica Bay shorelines. Illustration credit: USACE (2018a).

In correspondence dated April 25, 2019, the Corps has informed us that the Motts Basin project area is no longer in the Recommended Plan.

1. Atlantic Ocean Project Features

An enhanced overview of the proposed project on the ocean beach is shown in Figure 2. Detailed plan overviews are shown in Figures 3 through 6.

The oceanside project features span 7.7 miles (mi) of shorefront from Beach 9th Street to Beach 169th Street and include:

- A composite seawall with a crest elevation of +17 feet (ft) North American Vertical Datum 1988 (NAVD88) and a sand dune elevation of +18 ft NAVD88

from Beach 19th Street to Beach 149th Street. The bottom of the proposed composite dune/seawall extends to 15 ft below the dune crest.

- A design beach berm with a width of 60 ft and elevation of +8 ft NAVD88 from Beach 9th Street to Beach 149th Street;
- A total beachfill quantity of about 1,600,000 cubic yards (CY) for initial construction and 1,021,000 CY for renourishment every 4 years;
- A sand borrow area located approximately 2 mi south of the Rockaway Peninsula and 6 mi east of the Rockaway Inlet (The sand borrow area is about 2.6 mi long, 1.1 mi wide, and has depths between 35 and 60 ft. It contains about 17 million CY of sand, which exceeds the required initial fill and all periodic renourishment fill operations); and
- The extension of five existing groins and construction of 13 new groins.

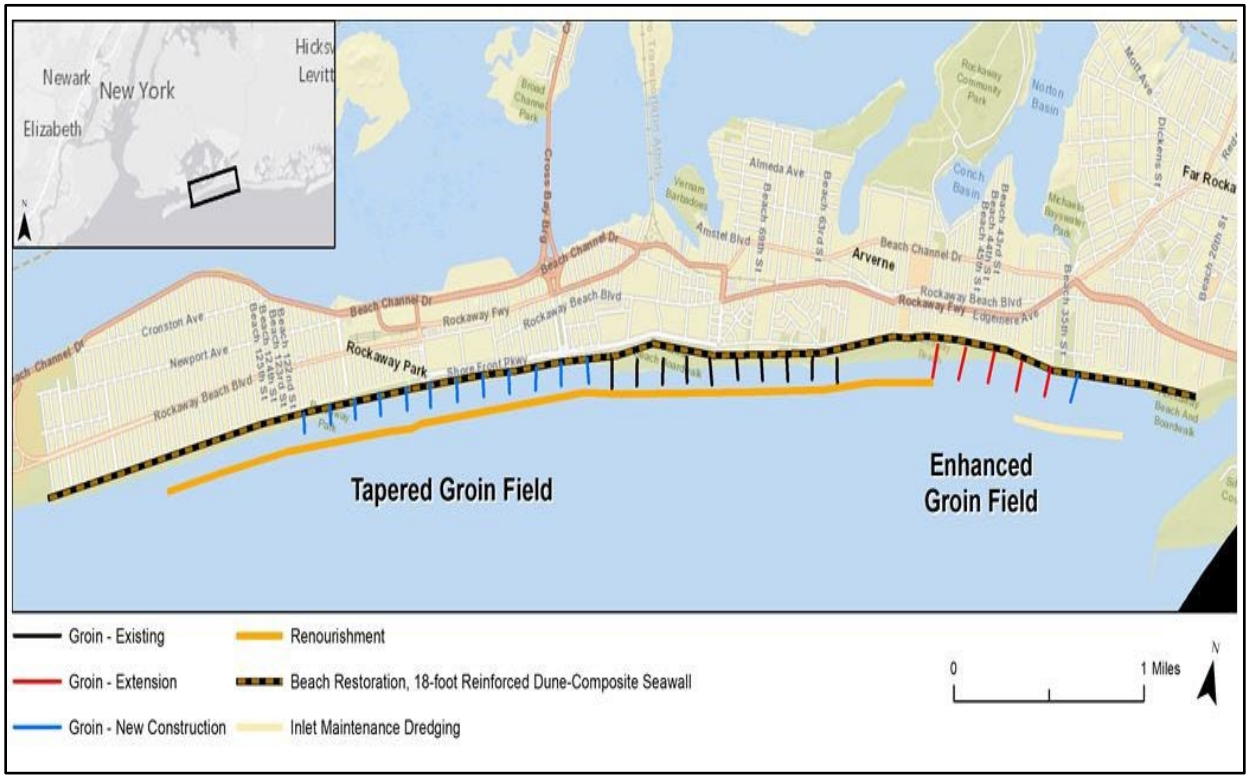


Figure 2.—Enhanced overview of proposed project features on the ocean beach. Illustration credit: USACE (2018a).

FIGURE 3.—Overview of ocean beach project features on the western end of the proposed project area. Illustration credit: USACE (2018a).

FIGURE 4.—Overview of ocean beach project features in the central part of the proposed project area. Illustration credit: USACE (2018a).

FIGURE 5.—Overview of ocean beach project features in the eastern portion of the proposed project area. Illustration credit: USACE (2018a).

FIGURE 6.—Continuation of overview of ocean beach project features along the eastern end of the proposed project area. Illustration credit: USACE (2018a).

2. Composite Seawall and Berm Description

Design profiles of the composite seawall are shown in Figures 7 and 8. A composite seawall in New Jersey (NJ), similar to the design proposed for this project, is shown in Figure 9.

The composite seawall is planned from Beach 16th Street to Beach 149th Street. It would consist of an impermeable core of steel sheet-pile and concrete cap, with a rock mound structure located seaward of the wall. In certain areas, the seawall would be covered with sand and only the top and concrete cap would be exposed on the landward side of the structure. Between Beach 126th Street and Beach 149th Street, a modified version of the seawall would include a splash apron on the landward side of the sheet-pile. The seawall may be adapted in the future to rising sea levels by adding a layer of armor stone and extending the concrete cap up to the elevation of the armor stone (USACE 2018a).

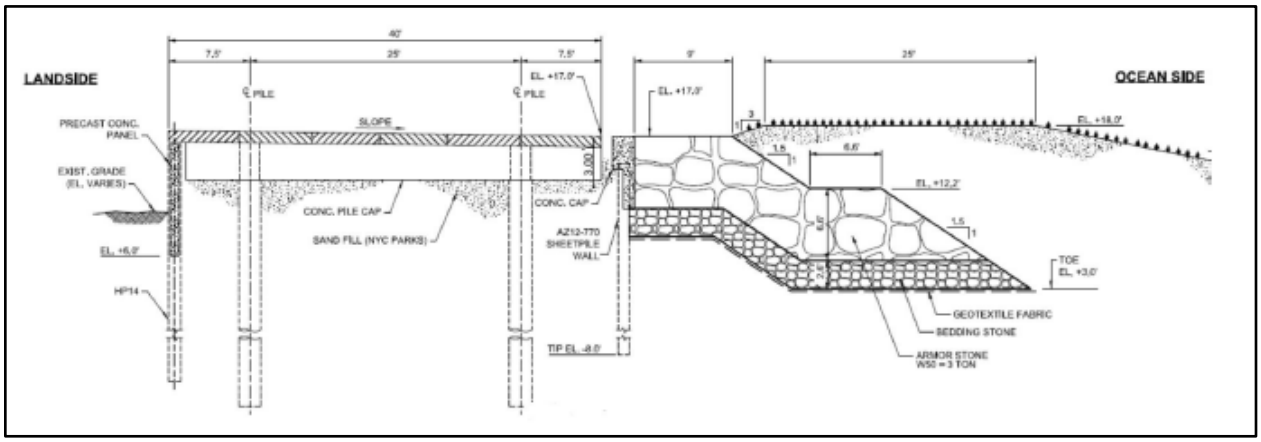


FIGURE 7.—Composite seawall design—Beach 19th Street to Beach 126th Street. Illustration credit: USACE (2018a).

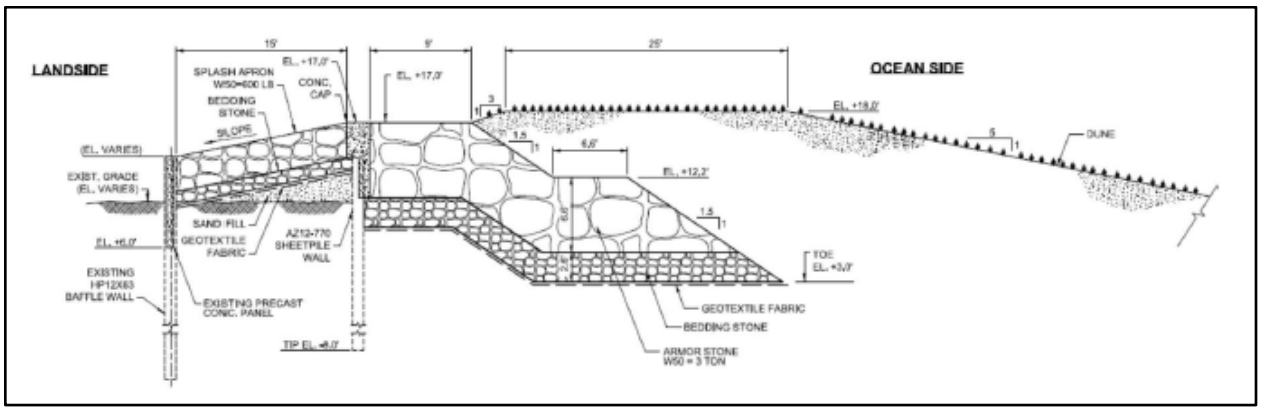


FIGURE 8.—Composite Seawall Design—Beach 126th Street to Beach 149th Street. Illustration credit: USACE (2018a)

FIGURE 9.—Construction of a composite seawall in Virginia. Illustration credit: USACE (2018a).

3. Dune and Berm Construction Description

Dune and berm construction (including tapers) would extend from Beach 9th Street to Beach 169th Street. The dune design includes a top elevation of +18 ft above NAVD88, a top width of 25 ft, and landward and seaward slopes of 1 vertical (V):5 horizontal (H) that extend along the entire footprint (1V:3H on landward slope fronting the boardwalk) (Figure 10). The alignment of the dune follows the unnatural alignment of the boardwalk and, as a result, the distance between the toe of the dune and the seaward crest of the berm varies.

The width of the design berm is controlled by the alignment of the baseline, which is aligned with the natural shoreline. The distance from the baseline to the design shoreline is always 243 ft.

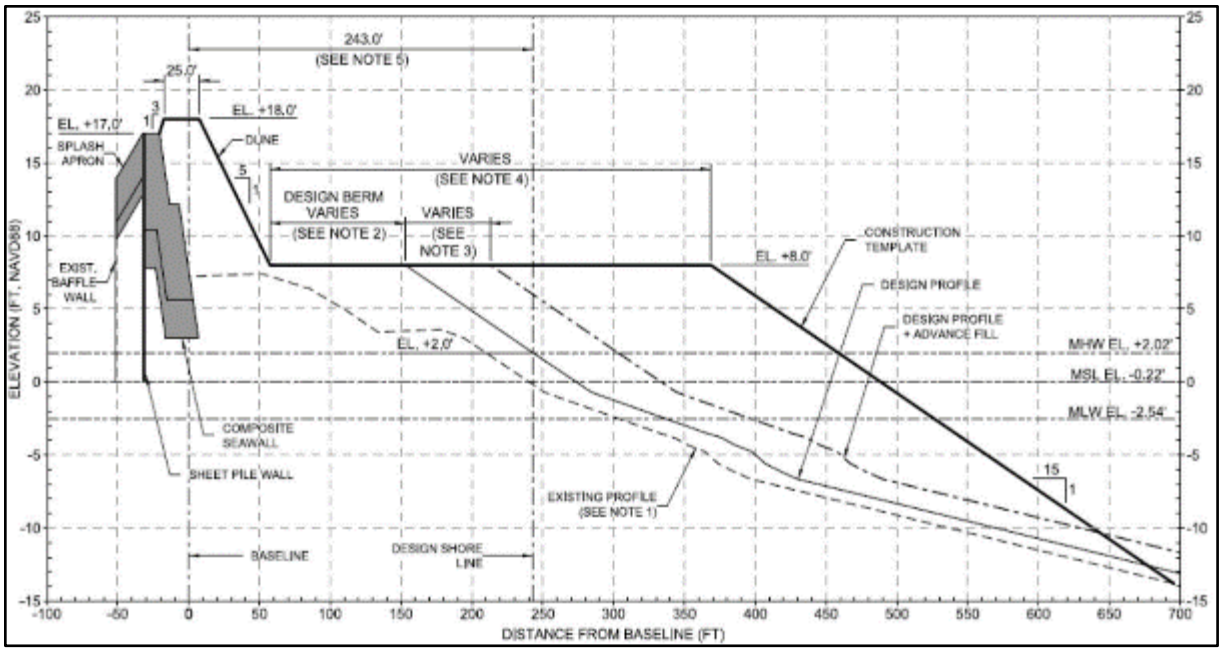


FIGURE 10.—Typical design cross-section of the proposed dune and berm. Illustration credit: USACE (2018a).

4. Berm Construction Tapers

In the eastern portion of the project area, the ocean berm will be tapered about 3,000 ft from Beach 9th Street to Beach 19th Street. Of the total taper length, there will be 1,000 ft of dune, composite seawall, and berm taper, and 2,000 ft of sand dune and berm tapers. In addition to the tapering of berm width, the dune elevation also tapers from an elevation of +18 ft NAVD88 at Beach 19th Street down to +12 ft NAVD88 at Beach 9th Street, which will be tied into the existing grade.

In the western portion of the project area, the ocean berm will be tapered 5,000 ft from Beach 149th Street to Beach 169th Street in front of the National Park Service's (NPS) Gateway National Recreation Area (GNRA) Jacob Riis Park. In addition, a tapered groin system comprised of three rock groins is proposed in this section.

5. New Groin Construction, Existing Groin Extension and Rehabilitation

The proposed project includes five new groins from Beach 110th Street to Beach 121st Street; seven new groins from Beach 92nd Street to Beach 108th Street; and one new groin plus five groin extensions between Beach 34th Street and Beach 49th Street. The extension lengths range from 75 to 200 ft. Three groins will also be rehabilitated in front of Jacob Riis Park.

6. Jamaica Bay High-Frequency Flooding Risk Reduction Features (HFFRRF)

The Jamaica Bay projects consist of three separate HFFRRFs, including Cedarhurst-Lawrence HFFRRF, Motts Basin North HFFRRF, and Mid-Rockaway HFFRRF. As described below, there are several proposed Nature and Nature Based Features (NNBF) within the Mid-Rockaway HFFRRF which are intended to contribute to coastal storm risk management.

a. Cedarhurst-Lawrence

The Cedarhurst-Lawrence HFFRRF (Figure 11) consists of about 1,000 ft of deep bulkhead that follows an existing bulkhead line around the southern end of the channel at Johnny Jack Park, and continues north along the west side before being connected to high-ground behind the Five Towns Mini Golf and Batting Facility with a 23-ft segment of medium floodwall. Preliminary design elevations have been established at +10 ft NAVD88. Three existing outfalls in the area where the bulkhead will be raised would be modified to add a valve chamber along with a sluice gate and flap valve. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch or drainage collection pipe, with inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide, the ditch or pipes will direct runoff towards a pump station.

FIGURE 11.—Cedarhurst-Lawrence HFFRRF Project Plan. Illustration credit: USACE (2018a).

b. Motts Basin North

The Motts Basin North HFFRRF consists of the construction of 540 ft of floodwall, beginning just north of the corner Alameda Avenue and Waterfront Boulevard, and running parallel to Waterfront Boulevard on its south side (Figure 12). The line of protection then shifts to a section of medium[1] floodwall above an existing outfall, continuing east for 47 ft before transitioning back into a low floodwall for an additional 105 ft. Project design elevations of +8 ft NAVD88 have preliminarily been established based on the expected wave exposure.

An existing outlet will be modified to add a valve chamber, sluice gate, and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch. Inlets will connect to an existing outlet and a single proposed outlets.

FIGURE 12.—Aerial photo with plan layout of Motts Basin North HFFRRF. Illustration credit: USACE (2018a).

[1] The floodwall "types" are defined in the Engineering and Design Appendix as low floodwall = +8 ft NAVD88, medium floodwall = +10 ft NAVD88, high floodwall = +11 ft NAVD88. These vary between 2 ft at grade to 5 ft at grade.

c. Mid-Rockaway

Edgemere Area

The Edgemere HFFRRF is aligned along the coastal edge of Edgemere (USACE 2018a; Figure 13). The alignment consists of approximately 480 ft of medium floodwall, 660 ft of high floodwall, 1,510 ft of low berm, 2,060 ft of medium berm, 80 ft of high berm, 2,260 ft of hybrid berm, and 250 ft of bulkhead. One road ramp is included to maintain access to the waterfront. Three existing outlets will be modified to prevent flow reversal and flooding through the drainage system. Twelve new outfalls and three new pump stations are included within the design. As described below, two NNBFs will be constructed in this area, east and west of the peninsula.

NNBF Descriptions:

- Edgemere 1: A rock sill is proposed on the west side of Edgemere to protect some of the existing eroding wetlands habitats and provide for the establishment of some high marsh – scrub/shrub habitat. The rock sills are also intended to provide habitat for attached fauna such as ribbed mussels (*Guekensia demissa*) and oysters (*Crassostrea virginica*).

- Edgemere 2: Intertidal habitat restoration is proposed, including planting of low and high marsh and ribbed mussel and oyster reef restoration, and removal of common reed (*Phragmites australis*).

Arverne Area

The Arverne Area HFFRRF would begin north of Alameda Avenue and Beach 58th Street (Figure 14). The alignment consists of the construction of approximately 3,170 ft of low floodwall, 480 ft of medium floodwall, 440 ft of high floodwall, 2,630 ft of low berm, 580 ft of hybrid berm, 890 ft of bulkhead, and 990 ft of revetment, as well as three areas where NNBFs are proposed as described below. Three road ramps and one vehicle access gate are included to maintain access to the waterfront. Eight existing drainage outlets will be modified to add a valve chamber that will include sluice gates and flap valves. Eight new outfalls (5 ft by 3 ft) and three new pump stations are included within the design.

NNBF Descriptions:

- Arverne 1: Rock sill construction is proposed on the north-west corner of Brant Point. A formal a wetland delineation has not yet been performed and the design of the rock sill is not final. Some existing uplands features are to be regraded to high marsh. A portion of the existing upland maritime forest between the berm feature and the wetlands are to remain undisturbed and expanded where practical.
- Arverne 2: Between Beach 69th Street and Beach 65th Street, construction of rock sills in Jamaica Bay to create a vegetated intertidal flat is proposed. To the

east, intertidal marsh would be regraded to provide high marsh habitat adjacent to the existing upland habitats. Additional materials or techniques for oyster and ribbed mussel restoration may be included in the final design.

- Arverne 3: To the east of Marina 59, intertidal flat restoration with a rock sill is proposed. Intertidal marsh creation, via the regrading of the higher elevation areas, is also proposed.

FIGURE 13.—Aerial photo with plan layout of Edgemere Area HFFRRF. Illustration credit: USACE (2018a).

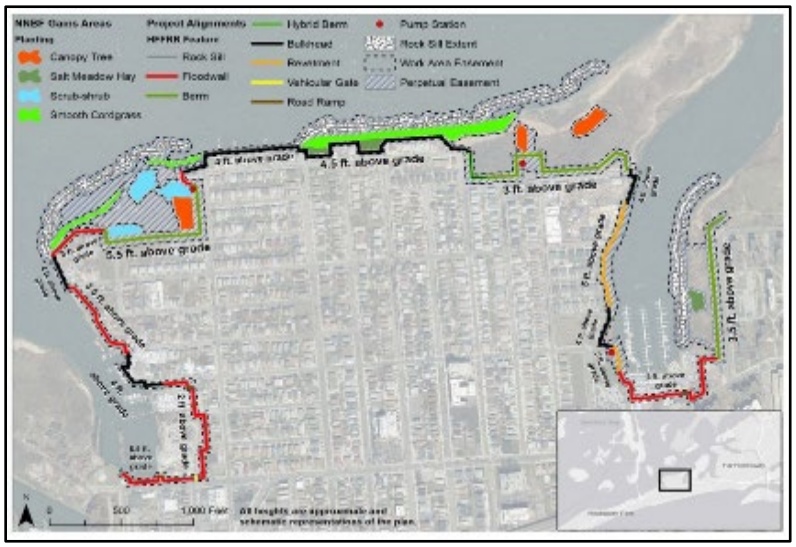


FIGURE 14.—Aerial photo with showing plan layout of Arverne Area HFFRRF. Illustration credit: USACE (2018a).

Hammels Area

The Hammels HFFRRF consists of approximately 2,550 ft of low floodwall, six road ramps, two pump stations, and three new outfalls (Figure 15). The three existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve.

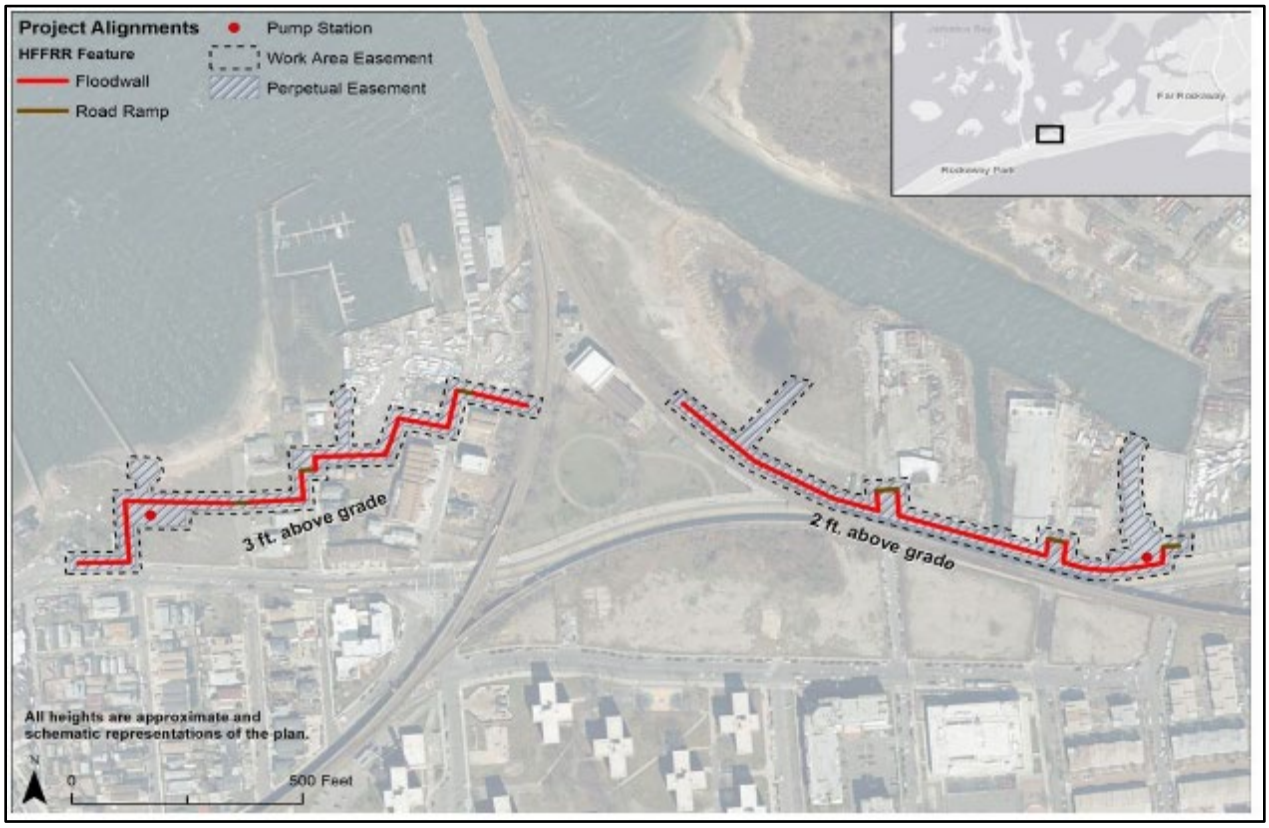


FIGURE 15.—Aerial photo with plan layout of Hammels HFFRRF. Illustration credit: USACE (2018a).

B. Endangered Species Avoidance and Minimization Measures

The project description includes the following avoidance and minimization measures (see USACE 2018b). The Corps indicated that additional measures could be developed during the preconstruction and engineering design phase of the project and will further consult with the Service, as appropriate (USACE 2018b). In some cases the avoidance and minimization measures have been modified based on coordination with the Corps.

1. Piping Plover Avoidance and Minimization Measures

1.1 A time-of-year (TOY) no-dredge/work restriction for piping plover from April 1 through September 1 beginning 1,000 meters (m) east of Beach 19th Street to 1,000 m west of Beach 70th Street. Pre-construction surveys will be undertaken to determine the presence of plovers in the remainder of the project area. If located, their breeding areas will be protected and no construction activities will occur within 1,000 m of the delineated breeding area and the Corps will undertake all practicable measures to avoid incidental taking of the species.

1.2 Breeding areas will be delineated by a qualified biologist on the basis of behavioral observations regarding territorial, courtship, nest building, egg-laying and brood rearing behaviors.

1.3 In the event of project delays due to bad weather or equipment failure, the Corps indicated they may have to work inside either end of the restriction window. In the event that occurs, construction activities will avoid all delineated locations of the species by maintaining a 1,000-m buffer (D. Mazey, USACE, email correspondence dated October 24, 2018) during the plover breeding season and will undertake all practicable measures to avoid incidental taking of the species.

1.4 The Corps will conduct or coordinate with existing land managers to conduct pre-, concurrent, and post-construction piping plover surveys in the project area. In the area from Beach 19th Street to Beach 70th Street the Corps will either obtain survey data from the New York City Department of Parks and Recreation (NYCDPR) or conduct the surveys via a qualified monitor. The Corps will coordinate with the land managers (NYCDPR) regarding funding/staff to undertake this effort prior to each nourishment cycle.

Surveys will occur during the spring/summer and prior to construction activities. Surveys will identify nesting plovers in the project area, document all known locations of plovers, and document any other federal- or state-listed wildlife species observed in the project area. The Corps will initiate consultation with the appropriate federal and state agencies as necessary.

Productivity and population surveys will be conducted each year for the life of the project. Population survey information shall include the total number of breeding pairs; the total number of piping plovers, paired and unpaired, within the action area; and detailed mapping of breeding (i.e., courtship, territorial, scrapes, egg-laying, incubating, and brood rearing) and foraging use habitats in the action area. Productivity information shall include the total number of nests, the total number of fledged chicks per pair, and quantification of take, if observed, including eggs, chicks, and adults, that occurred, including reasons for take and actions that are taken to avoid take.

Surveys will be recorded and summarized, and plover locations would be recorded on maps, indicating areas surveyed and habitat types. Daily reports shall be furnished to the Service and shall include the following:

- date;
- time begin/end;
- weather conditions;
- tidal stage;
- area of coverage;
- ownership of site;
- number of adults observed;
- number of pairs observed;
- habitat type;
- nearest known plover occurrence;
- banded plovers;
- predator trail indices and identification of predators;
- geographical position system (GPS) coordinates of symbolic fencing, and nest, brood, and adult foraging locations;
- location of nearest vehicle cuts; and
- reports of disturbance factors such as pedestrians, off-road vehicles (ORV), or fireworks.

Prior to implementation of the monitoring program, the Corps will consult with, and obtain agreement from, the Service on the methodology. Surveys would be conducted daily with observations evenly distributed over a minimum time period (to be determined). Survey time periods should be conducted during daylight hours from 30 minutes after sunrise to 30 minutes before sunset and should include a wide range of tidal conditions and habitat types. Areas should be surveyed slowly and thoroughly and should not be conducted during poor weather (e.g., heavy winds greater than 25 miles-per-hour [mph], heavy rains, and severe cold), since birds might seek protected areas during these times.

1.5 The Corps will erect symbolic fencing and signs around all plover nests and brood rearing areas located in the construction area to deter human use of the area and protect sites from incidental disturbance from construction activities.

1.6 The Corps will erect interpretive signs in the project area for seabeach amaranth, piping plover, and red knot. The Corps will also coordinate with the NYCDPR so as to support their endeavors to educate residents, landowners, beach visitors, and beach managers on piping plover.

1.7 The Corps will seek to minimize the loss of interdunal habitat on the ocean beach south of Beach 19th Street as much as possible. Further, the Corps will, in coordination with the Service, restore any of this lost habitat through the grading of this area to mimic pre-construction conditions.

1.8 In order to address the potential loss/degradation of piping plover breeding habitat, the Corps will conduct annual inspections of shoreline changes and downdrift erosion, groins, and composite seawall burial to assess project integrity and potential need to adjust the re-nourishment cycle and/or remedial actions. Additionally, pre-construction surveys of beach profiles will be conducted prior to renourishment.

1.9 The shorefront design is intended to balance the Atlantic Shorefront sediment transport such that erosion is reduced to minimize losses of sand from storms and seasonal variability. Should the project over time cause unintended persistent change in the shoreline position landward (i.e., create an erosional hotspot which reduces critical nesting habitat for plovers) at the plover nesting area between Beach 49th Street and Beach 60th Street, exceeding normal variability, then the Corps will take action to remediate the problem.

1.10 The Corps will reinitiate consultation with the Service to identify mutually agreed-upon acceptable protective measures should any changes to the project or species elicit a trigger to support such reinitiation as provided in 50 CFR part 402.16.

2. Red Knot Avoidance and Minimization Measures

2.1 On the Atlantic shorefront, the Corps will use the plover TOY restriction (April 1 to September 1), which will overlap with a portion of the red knot migration season (April 1 to November 30). From September 2 through November 20, the Corps will monitor construction activities and no work would occur within 300 m of any red knots (Mazey 2018, pers comm.).

2.2 NYCDPR will support the District's pre and post construction surveys related to initial construction and each renourishment cycle by conducting their regular shorebird monitoring program from April to August on an annual basis. The District will monitor for presence and absence of piping plovers and red knots prior to and during each construction/renourishment cycle.

2.3 The Corps will restrict construction activities within areas of known red knot populations.

2.4 The Corps will support the NYCDPR's education of residents, landowners, beach visitors, and beach managers.

2.5 The Corps will check for historical records of red knots at the Mid-Rockaway NNBF locations and will undertake spring and fall surveys at Mid-Rockaway NNBF locations to determine red knot presence during migration. The Corps will coordinate with the Service to develop a survey protocol (Mazey 2018, pers. comm.).

2.6 At Mid-Rockaway NNBF locations where red knot usage has been established, the Corps will enact a TOY restriction, which would preclude NNBF work from occurring from mid-May through early June and from late-July through November. NNBF work in areas where red knots are not detected would occur without a TOY restriction, but red knot monitoring would occur at the start of construction and periodically during construction. All other work associated with HFFRRFs would occur without a TOY restriction and without monitoring (Mazey 2018, pers. comm.).

2.7 The Corps will avoid activities likely to impact horseshoe crabs by potentially entrapping, entangling, or blocking adults; entraining larvae; interfering with spawning; or disturbing spawning habitat.

3. Seabeach Amaranth Avoidance and Minimization Measures

3.1 The Corps will coordinate with the NYCDPR and, as necessary, will either provide funding for, or supplement, surveys prior to and post construction, to identify seabeach amaranth in the project area and to document all known locations of the species.

3.2 Construction activities will avoid all delineated locations of the plant and the Corps will undertake all practicable measures to avoid incidental taking of the plant

3.3 A TOY no-dredge/work restriction for seabeach amaranth will be from June 1 through November 1, when the presence of this species within an area of potential effect (i.e., where plants have been established) is confirmed.

3.4 The Corps will erect symbolic fence and signs around all seabeach amaranth plants located in the construction area to deter use of the area and to protect plants.

3.5 For individual plants whose destruction could not be avoided, the Corps will ensure that: seed collection or transplants will be attempted as a means of mitigating potential loss; and seeds from plants to be translocated may be harvested prior to plants being moved.

With input from the Service and species experts, all or a portion of the seeds may be:

(a) immediately transferred to an area of suitable habitat elsewhere within the project area;
(b) stored under controlled conditions to be later replanted in the project area; or

(c) sent to a qualified greenhouse for germination and eventual replanting of germinated plants or propagated seeds in suitable habitats elsewhere in the project area.

If no seeds are collected on-site, then a portion of the transplanted plants may be sent to a qualified greenhouse and propagated to produce seeds or plants for the purposes listed above.

If translocation or seed collection are not viable options, or have proven ineffective, construction that would destroy live plants will be postponed, if possible, until individual plants in the construction footprint naturally die. Whether or not construction can be postponed until the death of plants in the construction footprint, the Corps will endeavor to salvage and transfer the seedbank of such plants to the extent practicable. Within a 3 m radius of each plant or group of plants (alive or recently alive), the top layer of sand substrate will be "scraped" and then re-spread on a suitable habitat in the project area.

3.6 The Corps will install interpretive signs for seabeach amaranth and will coordinate with the NYCDPR so as to support their endeavors to educate residents, landowners, beach visitors and beach managers on seabeach amaranth.

II. ACTION AREA

A. Description of the Action Area

The "action area" is defined as all areas to be affected directly, or indirectly, by the federal action, and not merely the immediate areas involved in the action. Action areas for each of the species have been defined below.

The action area on the oceanside stretches from Beach 9th Street to Beach 184th Street (Figure 16) for a total of 8.3 mi. Between Beach 19th Street and Beach 67th Street and at Fort Tilden, piping plover and seabeach amaranth occurrences are concentrated due to management activities. In the case of piping plover, individual occurrences have been reported outside these concentration areas where records show individual birds during the breeding and migration seasons. Known occurrences for red knot on the ocean beach portion of the project area are from eBird.org (Cornell Lab of Ornithology). These are somewhat limited in scope, but it is reasonable to expect the species is present along the ocean beach as it contains suitable foraging and roosting habitats for the species.

For much of this area, dense residential, commercial and infrastructure development generally extends to the ocean beach, except at Jacob Riis Park and Arverne by the Sea. A municipally-owned boardwalk runs immediately north of the beach from Beach 9th Street to Beach 126th Street, encompassing the entirety of the eastern portion of the action area.

The action area also includes bayside habitat for red knot. While many bayside areas of the Rockaway Peninsula have been hardened, red knot foraging and sheltering habitats are still present in the form of fringing saltmarsh and unvegetated intertidal areas. These habitats are adjacent to hardened and unhardened (i.e., around Dubos Point and Brant Point) shoreline areas. All lengths of shoreline with these habitats present within 500 m of proposed Mid-Rockaway Arverne and Edgemere HFFRRF projects and where disturbance to red knots would reasonably occur from construction activities are included in the bayside action area, totaling approximately 3.5 mi of shoreline. This determination was based on factors such as the types of construction activities, the equipment that would be involved, whether there were clear lines of sight, and avoidance or flight initiation distances for non-construction activities reported in the literature. The Jamaica Bay Ecosystem Research and Restoration Team (JABERRT) confirmed the presence of red knots at two locations within the Mid-Rockaway Arverne Area (Brant Point and Dubos Point) (Viet et al. 2002), however, the Service is not aware of any other systematic surveys on the Rockaway Peninsula.

FIGURE 16.—Map showing location of piping plover, seabeach amaranth, and red knot action area and piping plover concentration areas.

III. STATUS OF THE SPECIES

As per section 7 of the Act (50 CFR 402.14(g)(2)), it is the Service's responsibility to "evaluate the current status of the listed species or critical habitat."

To assess the current status of the species, it is helpful to understand the species' conservation needs which are generally described in terms of reproduction, numbers, and distribution (RND). The Service frequently characterizes RND for a given species via the conservation principles of resiliency (ability of species/populations to withstand stochastic events – numbers, growth rates), redundancy (ability of a species to withstand catastrophic events – number of populations and their distribution), and representation (variation/ability of a species to adapt to changing conditions) (collectively known as the three Rs).

A. Piping Plover

The rangewide status of the piping plover, along with its life history, habitat requirements, recovery strategy and criteria, population dynamics and demographic status, and threats are found in USFWS (1996 a/b and 2009, https://www.fws.gov/northeast/pipingplover, https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=6039), Cohen et al. (2009), Loegering and Fraser (1995), and Wilcox (1959), and the references contained therein, which are incorporated by reference into this Opinion.

The Atlantic Coast population grew from approximately 790 pairs in 1986 to an estimated 1,941 pairs in 2016, which has reduced the Atlantic Coast piping plover's vulnerability to extinction since listing under the Act. However, the distribution of population growth remains very uneven. The demographic status of each recovery unit and implications for the survival and recovery of the coastwide population are summarized at https://www.fws.gov/northeast/pipingplover/pdf/Abundance_Productivity_2016_Update_final.pdf, which discusses the population in terms of representation, redundancy, and resiliency.

Currently, as a whole, the rangewide status of piping plover is improving (https://www.fws.gov/northeast/pipingplover).

To meet the goal of recovery of the piping plover, the following criteria are required to support a delisting recommendation from the Service (from USFWS 1996a).

- Criterion 1: Increase and maintain for 5 years a total of 2,000 breeding pairs, distributed among four recovery units as specified below:

  - Atlantic Canada - 400 pairs
  - New England - 625 pairs
  - New York-New Jersey - 575 pairs
  - Southern (Delaware-Maryland-Virginia-North Carolina) - 400 pairs;

- Criterion 2: Verify the adequacy of a 2,000-pair population of piping plovers to maintain heterozygosity and allelic diversity over the long-term;

- Criterion 3: Achieve five-year average productivity of 1.5 fledged chicks per pair in each of the four recovery units described in criterion 1. Data to evaluate progress toward meeting this criterion should be obtained from sites that collectively support at least 90 percent of the recovery unit's population;

- Criterion 4: Institute long-term agreements among cooperating agencies, landowners, and conservation organizations that will ensure protection and management sufficient to maintain the population targets and average productivity for each recovery unit as specified in criteria 1 and 3; and

- Criterion 5: Ensure long-term maintenance of wintering habitat, sufficient in quantity, quality, and distribution to maintain survival rates for a 2,000-pair population.

The primary factors influencing the status of the piping plover include habitat loss and degradation via coastal development and stabilization, predation, and human disturbance.

B. Red Knot

The rangewide status of the species, life history, habitat requirements, recovery strategy and criteria, population dynamics and demographic status, and threats are found at https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=1864, https://www.fws.gov/northeast/redknot, and USFWS (2014).

Currently, as a whole, the rangewide status of red knot is declining (USFWS 2014).

A draft recovery outline for this species is under development at this time, so recovery goals and conservation needs have not been formally identified by the Service. However, threats to the species have been identified for conservation actions. A detailed discussion of threats is found in USFWS (2014).

The primary factor(s) affecting the status of the red knot include habitat loss and degradation via coastal development and stabilization, stability of foraging resources, and predation.

C. Seabeach Amaranth

The species description, life history, population dynamics, and threats to the population are described in USFWS (1996b and 2018) and https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=8549, which are incorporated by reference into this Opinion.

Since listing the species has remained extant in New York, North Carolina, and South Carolina and has been rediscovered in four states: New Jersey, Delaware, Maryland, and Virginia. There has been no change in historic range of the species since its listing. Populations in Maryland, Virginia, New Jersey, New York, and South Carolina have shown general trend of decline since

2002, while the total number of plants in North Carolina has increased during that time. For additional information see USFWS (2018).

Currently, as a whole, the rangewide status of seabeach amaranth is declining over most of its range (USFWS 2018).

Delisting of seabeach amaranth requires that the species exist in at least six of the states within its historic range and when a minimum of 75 percent of the sites with suitable habitat in those States are occupied by amaranth population for 10 consecutive years (USFWS 1996b and 2018).

The primary factors influencing the status of the seabeach amaranth include habitat loss and degradation via coastal development and stabilization, plant competition, and herbivory.

IV. STATUS OF CRITICAL HABITAT

Critical Habitat for piping plover has been designated in the wintering grounds in Texas and North Carolina (*Federal Register* Notices 74 FR 23476 and 73 FR 62816, respectively); however, this action does not affect these areas. No Critical Habitat has been designated for red knot or seabeach amaranth.

V. ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all federal, state, or private activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early consultation, and the impact of state or private actions that are occurring in the action area. As defined in 50 CFR §402.02, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole, or in part, by federal agencies in the United States or upon the high seas.

A. Status of the Species within the Action Area

1. Piping Plover

Surveys for piping plover occur at Fort Tilden and Jacob Riis Parks, Rockaway Beach, from Beach 19th Street to Beach 67th Street (including Arverne by the Sea, and Far Rockaway Long Island Colonial Waterbird and Piping Plover Survey (LICWS) sites) (Figure 17). The LICWS is an annual window count that occurs across Long Island. The window count aims to count plovers across Long Island during a standard window (June 1 - June 9) each year. The limited window helps to prevent double counting, as birds may move among sites throughout the season. Adjacent areas that have suitable habitat are monitored and managed for piping plover and seabeach amaranth by the NYCDPR when the species are detected. The NYCDPR also manages these areas for recreation and maintenance activities. Plover monitoring occurs at least 5 days a week (NYCDPR 2017), while monitoring of adjacent areas is less frequent due to limited resources and plover breeding history. The NYCDPR installs symbolic fencing (fence-posts connected by flagged string) between Beach 38th Street and Beach 57th Street by April 1

of each calendar year to protect breeding areas. The NYCDPR installs symbolic fencing in the areas between Beach 19th Street and Beach 38th Street and Beach 57th Street and Beach 149th Street once breeding behaviors (territory establishment, scrapes, mating, nests, etc.) are observed. The NPS sporadically monitors plovers at Jacob Riis Park due to the limited history of breeding, which is influenced by the extensive recreational activities coupled with low level of plover habitat management, and installs symbolic fencing when plover breeding behaviors are observed.

FIGURE 17.—Map of NYSDEC LICWS sites in the action area.

Existing habitat conditions are shown in Figures 18 through 20.

FIGURE 18.—Dune and ephemeral pool complex near Beach 17th Street to Beach 20th Street. Photo credit: Steve Sinkevich, USFWS, November 2018.

FIGURE 19.—Backshore area, Arverne by the Sea (Beach 35th Street to Beach 73rd Street) piping plover breeding area looking west. Photo credit: Kerri Dikun, USFWS, November 2018.

FIGURE 20.—Landward side of artificial dune, Arverne by the Sea (Beach 35th Street to Beach 73rd Street) looking east. Photo credit: Kerri Dikun, USFWS, November 2018.

In the action area, five NYSDEC LICWS sites are monitored for piping plover, three of which are active (Figure 17):

- Far Rockaway (Beach 9th Street to Beach 35th Street; managed by the NYCDPR);
- Arverne by the Sea (Beach 35th Street to Beach 72nd Street; managed by the NYCDPR); and
- Fort Tilden (managed by the NPS).

Piping plovers nest along the ocean beach from the areas above the high water line landward to the backdune areas. In some areas, the backdune areas are used as refugia from predators by adults with their unfledged chicks (NYCDPR 2017). While the ocean beach was renourished by the Corps as part of the post-hurricane Sandy beach stabilization efforts in 2014, important micro-habitats have since formed that provide forage and refugia habitats, such as those within the interdunal areas present on the ocean beach near Beach 19th Street.

Based on LICWS data, plover abundance ranged from 10 to 22 pairs, with an average of 17 pairs, from 2000 to 2018. The highest abundance of 22 pairs occurred in 2018. Twenty-one pairs were reported in 2004, 2010, and 2017. Arverne by the Sea is the major breeding area. Between 2000 and 2018, Arverne by the Sea accounted for 78 percent of the pairs in the action area and 32 percent of the pairs on the Rockaway Peninsula. Piping plover nest distribution is shown in Figure 21 and total and site abundances are shown in Figure 22.

In addition to the LICWS count, site managers also monitor sites for annual productivity (chicks fledged per pair). Productivity monitoring includes tracking the total pairs, total nests, and the total number of fledglings at each site throughout the breeding season. As plovers may move among sites throughout the season, productivity pair counts may differ from LICWS pair counts. From 2001 through 2018, productivity pairs within the action area ranged from 11 pairs to 26 pairs, with an average of 18 pairs. Productivity has varied over the past 18 years (Figure 23). In 2001, productivity was 1.0, and then increased to 2.0 in 2002. Between 2007 and 2013, productivity was below 1.24 chicks/pair or the minimum productivity rate necessary for a stable population (see USFWS 1996a). Productivity then increased to 2 in 2014. In 2015, productivity decreased to 1.41 and then increased to 1.94 and 2.1 in 2016 and 2017, respectively. Productivity dropped to 1.42 in 2018. Service biologists speculate that a decrease in predators (gulls and ghost crabs [*Ocypode quadrata*]), possibly associated with hurricane Sandy in 2012, may have contributed to increases after 2013.

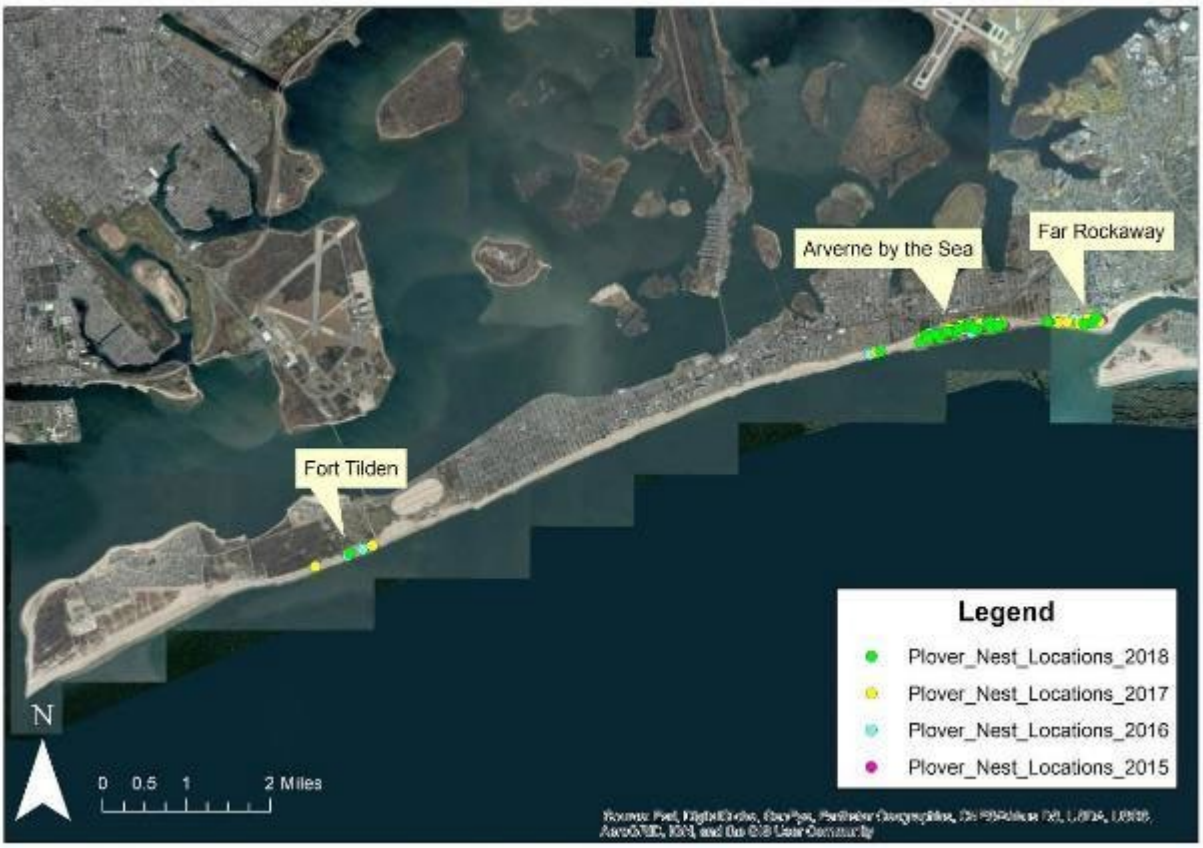


FIGURE 21.—Piping plover nest distribution in the action area, 2015 to 2018.

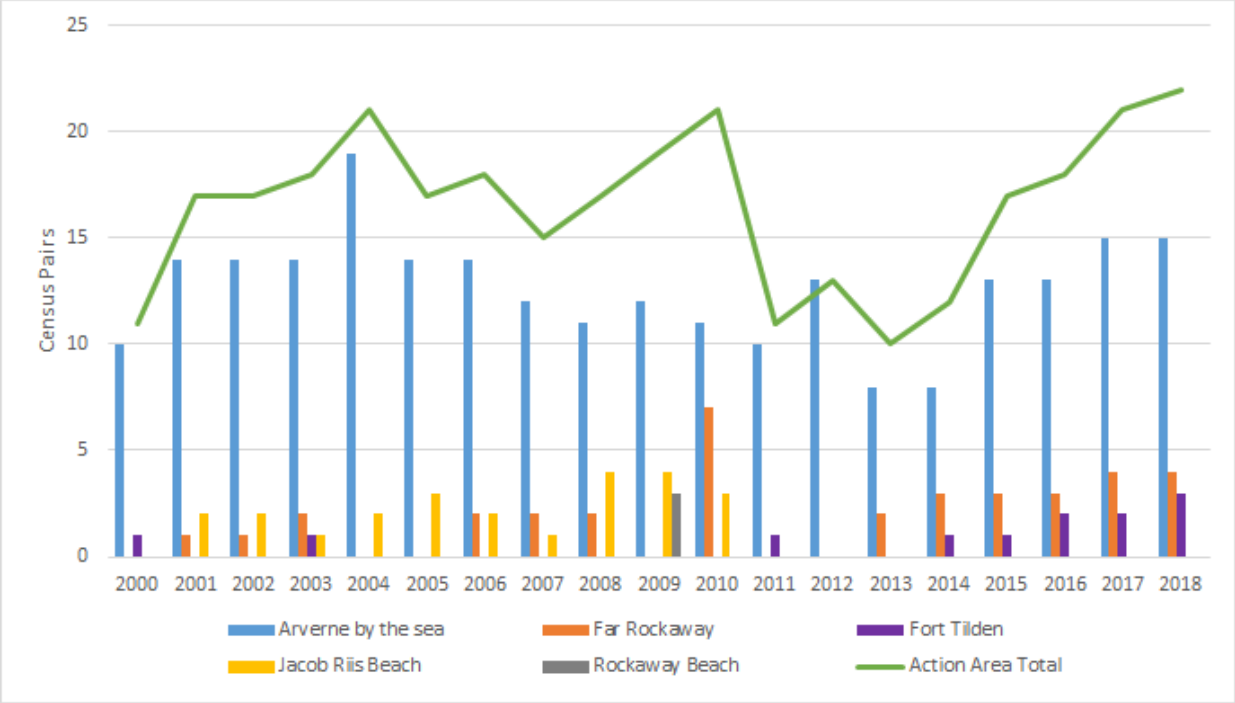


FIGURE 22.—Total and site piping plover abundance given as number of LICWS census pairs in the action area—2000 to 2018.

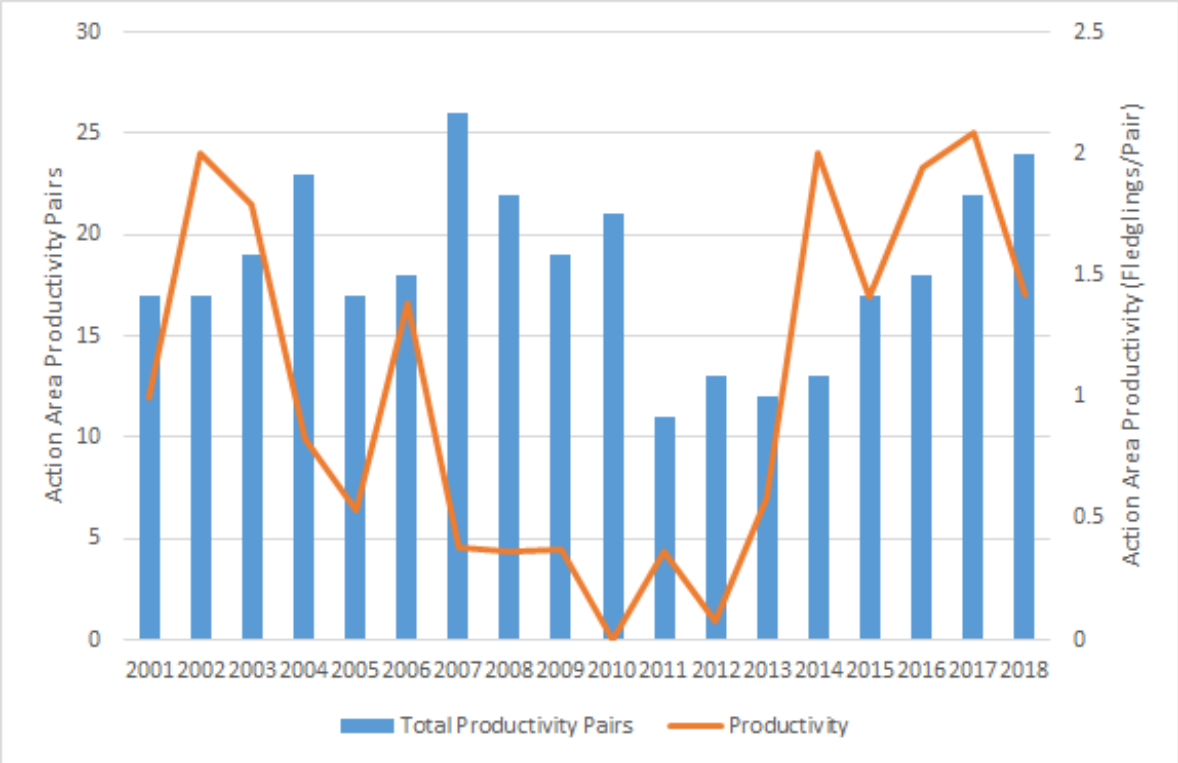


FIGURE 23.—Piping plover productivity pair abundance and productivity (fledglings/pair) in the action area—2001 to 2018.

2. Red Knot

In New York and New Jersey, red knots use sandy beaches and back-bay areas during spring and fall migration (Niles et al. 2008, as cited in USFWS 2014). As stated above, the Service is not aware of comprehensive monitoring of red knots within the action area, however, best available data from eBird.org and avian surveys performed in 2000 and 2001 by the JABERRT were used by the Service in describing the status of the species in the action area. Red knots were observed at Dubos Point and Brant Point (Viet et al. 2002) on the bayside, as well as at various locations on Rockaway Beach, Jacob Riis Park, and Fort Tilden (Table 1) on the oceanfront. Records from eBird.org do not reflect comprehensive survey efforts, and may not accurately represent the full extent of red knot presence within the action area.

TABLE 1.—Red knot counts for the action area's ocean beach (https://eBird.org as of December 2018).

Location	Red Knot Count or Range	Date or Date Range
Fort Tilden - Battery Harris Platform	1	10/6/2018
Fort Tilden - Battery Harris Platform	5	8/15/2014
Jacob Riis Park	1	9/3/2017
Rockaway Beach	23	8/4/2012
Rockaway Beach	4	8/31/2013
Rockaway Beach - Edgemere (Beach 32nd Street - Beach 56th Street)	1	8/28/2018
Rockaway Beach - Edgemere (Beach 32nd Street - Beach 56th Street)	1	8/26/2018
Rockaway Beach - Edgemere (Beach 32nd Street - Beach 56th Street)	1	6/9/2018
Rockaway Beach - Edgemere (Beach 32nd Street - Beach 56th Street)	1	9/6/2015

3. Seabeach Amaranth

Surveys for seabeach amaranth are conducted annually at Jacob Riis Park, Arverne by the Sea, and Far Rockaway beaches. Amaranth plants are generally found where symbolic fencing is installed for piping plover, least tern (*Sterna antillarum*), common tern (*Sterna hirundo*), black skimmer (*Rynchops niger*), and American oystercatcher (*Haematopus palliatus*) (NYCDPR 2017).

From 1990 until 2001, seabeach amaranth abundance generally increased, reaching a peak abundance of 5,889 plants in 2001 (Figure 24). From 2001 through 2009, the population declined from 5,889 to 6 plants. Abundance remained low until 2016 and 2017 when it increased to 2,517 and 4,881 plants, respectively. Abundance then decreased to 1,862 plants in 2018.

The action area has supported from 0 to 88 percent (16 percent average) of the NY population since 1990. From 2016 to 2018, the action area has supported between 26 and 57 percent of the NY population.

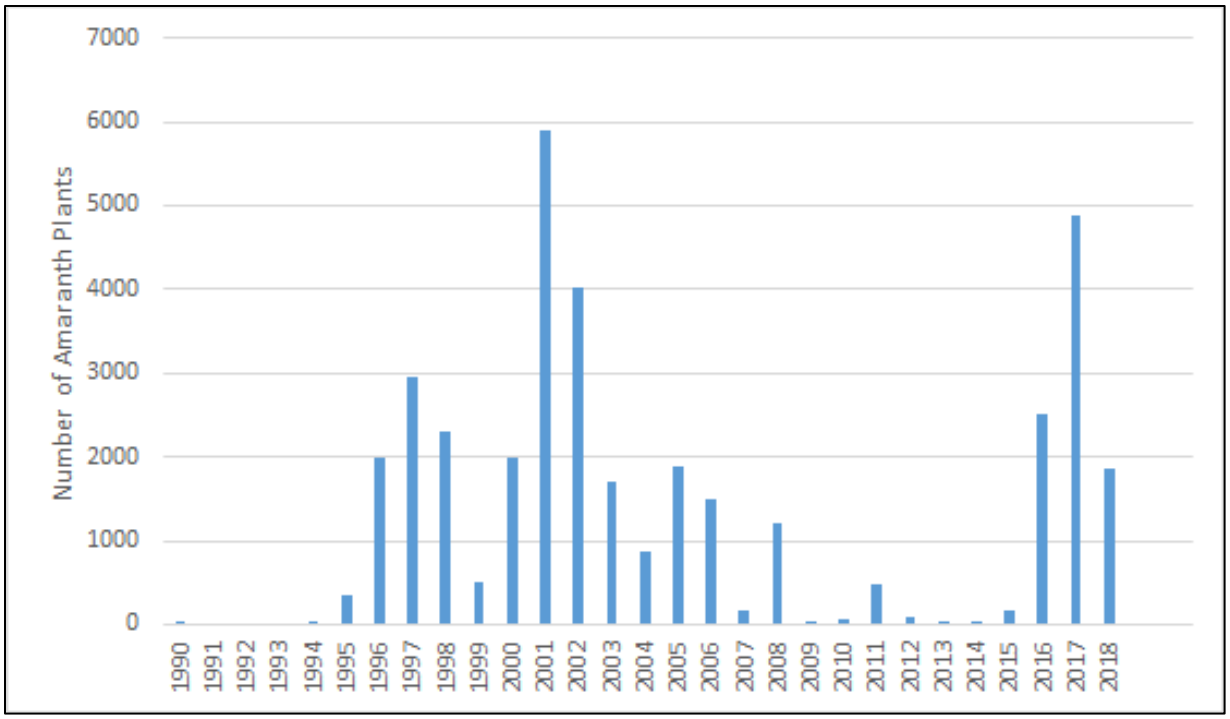


FIGURE 24.—Total number of seabeach amaranth in the action area—1990 to 2018.

VI. STATUS OF CRITICAL HABITAT WITHIN THE ACTION AREA

No Critical Habitat for piping plover, red knot, and seabeach amaranth is present in the action area.

VII. FACTORS AFFECTING THE SPECIES ENVIRONMENT WITHIN THE ACTION AREA

Habitat modification, loss, fragmentation, beach stabilization, predators, recreation, administrative and beach maintenance ORV use, and burial of food resources, are all factors that have negatively affected environment, distribution, reproduction and abundance of red knot and piping plover in the action area. Seabeach amaranth experiences all of these factors, as well, except for burial of food resources and predation. Piping plover and seabeach amaranth monitoring and protection programs are undertaken in the action area by the NPS and the

NYCDPR. Suitable piping plover habitats with a recent history or indication of breeding activities are delineated each year and protected with symbolic fencing and monitored by staff. There are currently no red knot management plans underway at this time in the action area.

A. Beach Stabilization

Public and private beach stabilization efforts have occurred over many decades and include beach scraping, sand fence installation, and structural shoreline stabilization (dunes, beaches, revetments, and groins). These activities affect dune and beach morphology by preventing the creation of transitory, storm-created habitats that are important to piping plover, red knot, and seabeach amaranth.

Over the last 10 years, the following federal beach stabilization projects have occurred within the action area:

- NPS GNRA Jacob Riis Beach Nourishment (2014) and Ongoing Beach Scraping: The NPS completed informal consultation under the Act and placed 200,000 CY of borrow-area dredged material at Jacob Riis Park. The NPS also continues to scrape sand at Jacob Riis Park, placing the scraped sand in eroded areas. All work is completed outside of the piping plover breeding season to avoid direct adverse effects from construction activities.

- Corps' Formerly Constructed Civil Engineering Project (Post-Hurricane Sandy Emergency Nourishment Project; 2014): The Corps informally consulted with the Service and completed an emergency storm damage protection project through the Public Law 84-99 authorization involving the placement of borrow-area dredged material on the Atlantic Beach shoreline from Beach 9th Street to Beach 149th Street. Any construction activities within historic breeding areas were completed outside of the breeding season while construction activities completed during the breeding season were conducted in areas where no plover breeding was observed.

- Corps' Operations and Maintenance Dredging of East Rockaway Inlet (Periodic): Maintenance dredging involves the dredging and disposal on the beach of approximately 500,000 CY from the federal channel every 3 to 4 years. Typically, dredge material is placed between Beach 27th Street and Beach 38th Street, and between Beach 92nd Street and Beach 103rd Street. The next maintenance cycle is planned for the winter/spring of 2019, extending into the early part of the piping plover breeding season and limited to areas where no historical breeding activity has occurred and 1,000 m from known breeding locations. Prior to this, the project was dredged in 2016 and completed outside of the piping plover breeding season as per informal consultation with the Service.

- New York City Parks Boardwalk Reconstruction (2015): Following Hurricane Sandy, the U.S. Department of Housing and Urban Development (HUD) funded the reconstruction of the boardwalk and pedestrian ramps present within the

action area. The New York City Office of Management and Budget, designated by the HUD as the non-federal representative, completed informal consultation under the Act, with major construction activities undertaken outside of the breeding season, but with hand tool construction activities during the season.

In addition, the Corps undertook projects between 1975 and 1978, and 1996 and 2004 on the Rockaway Peninsula beaches for beach erosion control.

Within the LICWS survey areas, there are beach stabilization structures. These have been inventoried in USACE (2018a). Within the plover concentration areas, rock groins extend from Beach 36th Street to Beach 57th Street, and from Beach 60th Street to Beach 67th Street. Wooden groins are visible on 2008 aerial photos of the area extending from Beach 32nd Street to Beach 39th Street. The eastern shoreline of Jacob Riis Park also contains several groin structures. Vegetative reinforcement of dunes and the installation of sand fences have been used, and are still common practices to achieve dune and beach stabilization in the action area. Both activities can prevent the formation of suitable nesting and foraging habitats for plovers (Massachusetts Barrier Beach Task Force 1994; MacIvor 1990; Elias-Gerken 1994) and growing areas for seabeach amaranth (USFWS 1996b). Dune building activities may destroy or prevent plovers from accessing preferred foraging and brood rearing habitats, including interdunal swales, wet meadows, and ephemeral pools (MacIvor 1990; Elias-Gerken 1994) or refugia present in the backdune and foredune habitats within the action area as described above in Section II (see NYCDPR 2017). The use of sand fences to capture drifting sand and/or to build dunes may produce steepened dune faces, or by themselves, create physical barriers to plover movement (Strauss 1990).

B. Predation

Piping plover and red knot are susceptible to predation in the action area. Predators include American crow (*Corvus brachyrhynchos*), greater black-backed gulls (*Larus marinus*), herring gulls (*L. argentatus*), feral cats (*Felis catus*), dogs (*Canis lupus familiaris*), raccoons (*Procyon lotor*) and possibly ghost crabs. Both red knots and piping plovers are less likely to escape detection by predators on stabilized beaches, which lack variability otherwise present on naturally functioning beaches. Hard structures such as groins can also provide perches for avian predators. The Service is unaware of any comprehensive predator control programs in the action area, beyond the use of predator exclosures.

C. Human Disturbance

Potential sources of human disturbance to listed species include, but are not limited to, beach raking and cleaning, recreational fishing, kite-flying, bird-watching, surfing, dog-walking, fireworks events, and municipal beach maintenance activities. Disturbance from all of these sources can cause plovers and red knots to spend less time roosting or foraging and more time in alert postures or fleeing from the disturbances (Johnson and Baldassarre 1988; Burger 1991; Burger 1994; Elliott and Teas 1996; Lafferty 2001a, 2001b; Thomas et al. 2002). Overall, these disturbances can affect local abundance, survival, and productivity of piping plovers (Zonick and Ryan 1995; Zonick 2000) and red knots.

In the context of recreational activities, pedestrians may flush incubating plovers from nests (Flemming et al. 1988; Cross 1990; Cross and Terwilliger 1993), exposing eggs to predators or excessive temperature. Repeated exposure of shorebird eggs on hot days may result in embryo death (Bergstrom 1991); excessive cooling may kill embryos, retard their development, or delay hatching dates (Welty 1982). Shorebirds that are repeatedly flushed in response to disturbance expend energy on costly short flights (Nudds and Bryant 2000). Disturbance can force unfledged chicks out of preferred habitats, resulting in a decrease in foraging time and expenditure of energy (Strauss 1990; Burger 1991; Loegering 1992; Hoopes 1993; Goldin 1993). Recreational activity on beaches can be responsible for plover chick displacement into habitats with lower food availability, resulting in lower feeding rates, slower growth, and decreased survival (DeRose-Wilson et al. 2018). Shorebirds are more likely to flush from the presence of dogs than people, and birds react to dogs from farther distances than from people (Lafferty 2001a/b; Thomas et al. 2002). Dogs which are off-leash are more likely to flush piping plovers from farther distances than are dogs on leash; nonetheless, dogs both on and off leashes disturb piping plovers (Hoopes 1993). Pedestrians walking with dogs often go through flocks of foraging and roosting shorebirds; some even encourage their dogs to chase birds.

Beaches with ORV use during the nesting and brood rearing periods generally have fewer breeding plovers than available nesting and feeding habitat can support. In contrast, plover abundance and productivity has increased on beaches where ORV restrictions during chick-rearing periods have been combined with protection of nests from predators (Goldin 1993).

Recreational threats to seabeach amaranth in the action area include pedestrians and ORVs. (https://www.nps.gov/search/?affiliate=nps&query=Off-Road+Recreational+Driving&sitelimit=nps.gov%2Fgate).

Mechanized beach raking represents one of the primary disturbances to seabeach amaranth. This practice can kill plants by ripping them from the substrate or by crushing. Since seabeach amaranth prefers habitats similar to those used by piping plovers, some protection for seabeach amaranth from beach raking is realized through the installation of symbolic fencing that keeps vehicles out of areas where the plants grow. The amount of symbolic fencing installed on the beach varies from year to year, depending on where federally and state-listed shorebirds and coastal plants occur. Typically, about 20 percent of the available habitat within the action area shoreline is fenced each season.

Beach raking can be deleterious to shorebirds as it removes the organic material including seaweed, seashells, driftwood and other materials deposited on beaches by tidal action, known as wrack, an important food source for shorebirds. Piping plovers feed on invertebrates, such as marine worms, fly larvae, beetles, crustaceans, and mollusks (Bent 1929; Cairns 1977; Nicholls 1989). Important feeding areas may include intertidal portions of ocean beaches, overwash areas, mudflats, sandflats, wrack lines, sparse vegetation, and shorelines of coastal ponds, lagoons, or saltmarshes (Gibbs 1986; Coutu et al. 1990; Hoopes et al. 1992; Loegering 1992; Goldin 1993; Elias-Gerken 1994; Cohen 2005; Houghton 2005). Jones (1997) identified the presence of wrack that supports abundant invertebrate fauna as a likely explanation for higher breeding success of piping plovers on ocean beaches at Cape Cod Seashore compared with

piping plover study sites further south. Piping plover chicks foraged extensively and exhibited high peck rates in wrack, where arthropod abundance indices were also high (Cohen et al. 2009). In oceanfront habitats, terrestrial invertebrates tend to be concentrated in the wrack line (Loegering and Fraser 1995; Hoopes et al. 1992), a habitat used by foraging plover adults and chicks (Goldin 1993; Hoopes 1993; Hoopes et al. 1992). Availability of wrack is especially important at sites where ephemeral pool and bayside foraging areas are not available (Elias et al. 2000). Consequently, the removal of wrack has a significant impact on piping plovers, such as decreased food availability and uptake, the expenditure of energy to move to areas where wrack is present, and susceptibility to predators.

In some states, wrack on ocean beaches is an important foraging resource and bayside beaches are important roosting habitat for red knots at their migration stopover sites (USFWS 2015). Wrack material concentrates certain invertebrates such as amphipods, insects, and marine worms (Kluft and Ginsberg 2009), which are secondary prey species for red knots. Because shorebird numbers are positively correlated with wrack cover and biomass of their invertebrate prey that feed on wrack (Dugan et al. 2003; Hubbard and Dugan 2003), beach grooming could potentially lower bird numbers (Defeo et al. 2009; USFWS 2015).

D. Accelerating Sea-level Rise

Over the past 100 years, the globally-averaged sea level has risen approximately 10 to 25 centimeters (cm) (Rahmstorf et al. 2007), a rate that is an order of magnitude greater than that seen in the past several thousand years (Douglas et al. 2001, as cited in Hopkinson et al. 2008). The International Panel on Climate Change (IPCC) suggests that by 2080, sea-level rise could convert as much as 33 percent of the world's coastal wetlands to open water (IPCC 2007). Although rapid changes in sea-level rise are predicted, estimated timeframes and resulting water levels vary due to the uncertainty about global temperature projections and the rate of ice sheets melting and slipping into the ocean (IPCC 2007; CCSP 2009). Inundation of piping plover, red knot, and seabeach habitat by rising seas could lead to permanent loss of habitat if natural coastal dynamics are impeded by numerous structures or roads, especially if those shorelines are also armored with hardened structures. Without development or armoring, low undeveloped islands can migrate toward the mainland, pushed by the overwashing of sand eroding from the seaward side and being re-deposited in the bay (Scavia et al. 2002). Overwash and sand migration are impeded on developed portions of islands. Instead, as sea level increases, the ocean-facing beach erodes and the resulting sand is deposited offshore. The buildings and the sand dunes then prevent sand from washing back toward the lagoons, and the lagoon side becomes increasingly submerged during extreme high tides (Scavia et al. 2002), diminishing both barrier beach shorebird and plant habitat and protection for mainland developments. Modeling for three sea-level rise scenarios (reflecting variable projections of global temperature rise) at five important U.S. shorebird staging and wintering sites predicted loss of 20 to 70 percent of current intertidal foraging habitat (Galbraith et al. 2002). These authors estimated probabilistic sea-level changes for specific sites partially based on historical rates of sea-level change (from tide gauges at or near each site); they then superimposed this on projected 50 percent and 5 percent probability of global sea-level changes by 2100 of 34 cm and 77 cm, respectively.

New York State has developed the sea-level rise projections for New York City/Lower Hudson Region as shown in Table 2, which spans the 50-year timeframe of the proposed project (https://www.dec.ny.gov/regulations/103877.html). It is not clear how the project features would respond to sea-level rise, nor the impacts they would cause to natural beach ecosystems under these scenarios, especially since the project is only at the 15 to 30 percent design phase.

TABLE 2.— Sea-level rise prediction for New York City and the Lower Hudson Region. From (https://www.dec.ny.gov/regulations/103877.html).

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Med-Projection	High Projection
2020s	2 inches	4 inches	6 inches	8 inches	10 inches
2050s	8 inches	11 inches	16 inches	21 inches	30 inches
2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	22 inches	36 inches	50 inches	75 inches

VIII. EFFECTS OF THE ACTION

Direct effects are the direct or immediate effects of the project on the species, its habitat, or designated/proposed critical habitat. Indirect effects are defined as those that are caused by the proposed action and are later in time, but still are reasonably certain to occur (50 CFR 402.02). An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation. Direct and indirect effects of the proposed project along with the effects of interrelated/interdependent activities are all considered together as the "effects of the action."

All of the proposed project activities may overlap with portions of piping plover breeding season, red knot migration season, and seabeach amaranth growing season causing impacts to these species over the long- and short-term.

Long-term and permanent impacts are anticipated in the form of:

(a) Adverse effects due to construction activities (all three species);
(b) Adverse effects due to habitat loss and modification (all three species);
(c) Adverse effects due to the prey resource burial (piping plover and red knot);
(d) Adverse effects due to predation (piping plover and red knot); and

(e) Adverse effects due to recreational, maintenance and patrol activities (all three species).

A. Effects from Construction Activities - All Species

We note that adhering to the TOY restrictions for each species is the recommended measure by the Service to preclude adverse impacts from construction activities to piping plover (April 1 to September 1), red knot (April 1 to November 30), and seabeach amaranth from (May 1 to November 1).

The use of heavy machinery and equipment (e.g., dredge pipes, trucks and bulldozers) may adversely affect piping plovers and red knot, causing disturbance and significant disruption of normal activities such as breeding, feeding, or sheltering. As discussed below, these activities while most likely limited to non-lethal effects to the species, could force birds to expend valuable energy reserves to seek available habitat elsewhere, delay feeding, breeding behaviors, or interfere with sheltering activities. Figures 25 and 26 illustrate the location of nests relative to project features proposed for construction. Construction activities are very disruptive to the beach environments and the habitats that support these listed species (Figures 27 and 28).

1. Piping Plovers

The Corps has proposed (1) an April 1 to September 1 TOY restriction for piping plovers between Beach 19th and Beach 70th Street, and (2) a 1000-m buffer between work activities and plovers exhibiting breeding behaviors (scraping, courtship, territorial displays, nesting) when they need to work for an unspecified amount of time at the beginning, or end, of the breeding season. If plovers exhibit breeding behavior within 1,000 m of work activities, the construction would stop and equipment would be removed from the buffer area.

Home range distances of breeding and non-breeding piping plovers, or distances traveled to and from forage and breeding areas, average between 500 m (Haffner et al. 2009) and 1,590 m (Hermanns et al. 2018), respectively. Considering this information, we anticipate that a 500-m buffer around adult breeding piping plovers would be protective. However, implementation of a buffer zone plus monitoring plan would be needed to determine whether the 500-m buffer is sufficiently protective of both breeding and non-breeding plovers in the project area,

The proposed TOY and 1,000-m buffer zone would permit heavy construction or demobilization activities directly along the borders of known and long established piping plover breeding areas, resulting in disturbance to feeding, breeding, and sheltering behaviors. We anticipate that such disturbances would be non-lethal yet still reduce individual fitness due to site abandonment, relocation to less suitable habitats, competition for nesting habitat with conspecifics, and loss of foraging opportunities. In addition, individuals outside the concentration areas would likely be subject to disruption of breeding, feeding, or sheltering behaviors due to heavy equipment operation, installation of the dredge pipe, and other

construction related activities. These effects would be additive to existing adverse effects to the species' distribution and abundance driven by habitat limitation due to existing land use.

Dredging and construction operations that encroach closer than 500 m of delineated plover breeding areas, or closer than 1,000 m from plover chicks[2], have the potential to disturb adult piping plover and piping plover chicks, resulting in territory abandonment, disruption of pair bonds, nest abandonment, elevated predation of eggs and chicks, and increased chick mortality due to reduced foraging opportunities. An inability to monitor at night would potentially cause injury to adult and unfledged piping plovers through disruption of foraging and sheltering behaviors. Without buffers or TOY restrictions for plovers observed outside of the concentration areas, we would expect plovers would be disturbed, at a minimum, from feeding and sheltering, and possibly breeding.

Overall, the timing and proximity of heavy construction activities, the limited nesting habitat, and the lack of detailed construction monitoring plans, create the likelihood of non-lethal adverse effects to plovers on edges of concentration areas between Beach 19th Street and Beach 67th and at Fort Tilden. Over the past four years, and average of five pairs have nested at the edges of these areas and within 500 m of proposed work. A proportion of these nests (depending on timing of work and nests, length of exposure to construction activities, distance from construction activities, and individual responses of birds) will experience reduced fitness during initial construction and each nourishment event. We also anticipate non-lethal effects of two piping plovers outside of the concentration areas due to inadequate buffer zones and unknown monitoring protocols for initial construction and each nourishment event.

2. Red Knots

The Corps will employ a red knot TOY restriction from mid-May through early June and then from late July through November for the Mid-Rockaway NNBFs if red knot presence has been established. Limiting the TOY restriction to only peak migration periods is not fully protective of the species as red knots may occur in the action area at any time from April 1 through November 30. TOY restrictions will not be used at Mid-Rockaway NNBF locations without confirmed red knot presence, but the Corps will monitor for red knots at the start of, and periodically during, construction in these areas.

Limiting surveys and monitoring to only the NNBF locations is not fully protective of the species because construction activities elsewhere at HFFRRF locations would likely prevent them from foraging or roosting, thereby reducing fitness of individuals on their migratory stopover site. Furthermore, details regarding monitoring protocols or actions to be taken if red knots are located on the bayside have not been provided. The Service, therefore, cannot fully evaluate if these measures will avoid or minimize effects on red knots.

[2] Patterson (1988), Cross (1990), Coutu et al. (1990), Strauss (1990), and Loegering (1992) observed that plover chicks may move up to 1,000 m from their nest sites, so a 1,000-m buffer zone would put activities at what may be considered an outer limit of movement based on these studies.

The Corps also proposed a 300-m buffer for the protection of red knot on the ocean beach and indicated that some activities such as beach nourishment would occur 24 hours non-stop. The lack of a detailed monitoring plan and inherent difficulties in monitoring at night would create conditions leading to impacts such as foraging and roosting area abandonment (Pfister et al. 1992). We note that specific studies on disturbance flush distances of red knots in response to major beach construction activities are not available, however, red knots avoid roost areas within 1,000 m of higher than average boat traffic (Peters and Otis 2007), and are generally very sensitive to disturbance (Pfister and Lavine 1992; Pfister et al. 1992).

The proportion of red knots using the ocean beach habitat to be directly impacted by these activities is anticipated to be small, on the order of two red knots during the initial construction and each renourishment cycle. This is a conservative estimate, given the species is likely under surveyed in the area.

FIGURE 25.—Map showing location of plover nests (2015-2018) near the proposed composite seawall and berm design layout in the eastern portion of the proposed project area.

FIGURE 26.—Map showing location of plover nests (2014 to 2018) near the proposed beach taper and groin design layout in the western end of the proposed project area.

3. Seabeach Amaranth

Seabeach amaranth would be protected from direct disturbance in the plover breeding areas and buffer areas from April 1 to September 1. However, after September 1, the Corps would try to implement mitigative measures such as transplantation or seed collection to avoid or minimize impacts to the species, but these measures represent adverse effects to the species, in and of themselves.

The Service anticipates that the proposed project would result in adverse effects to seabeach amaranth as beach nourishment would occur from September 1 to November 1, or possibly before September 1. The Corps has committed to avoid all delineated locations of the plant and undertaking all practicable measures to avoid taking of the plant (Mazey pers. comm. February 13, 2019). However, this will not completely avoid all impacts to the species. To address this, the Corps would attempt to either collect seed from these plants or transplant them as described in Section II. C.3 (3.5), above, if seabeach amaranth plants are identified within the direct construction footprint (Mazey pers. comm. February 13, 2019).

Composite seawall, groin, and beach construction can impact seabeach amaranth through direct loss of habitat, burial, trampling, or accelerated interspecific competition via planting of monotypic stands of perennial beachgrass (Murdock 1993). When beach nourishment is conducted during the growing season, plants that germinated may be killed and their seed destroyed (Weakley and Bucher 1992). Beach nourishment, which is conducted in the winter, would likely have minimal impacts to adult plants as they will already have set seed. But, burying seeds with up to 14 ft of sand would also severely affect their ability to germinate in the next growing season, having potential deleterious effects on local populations. Any seeds

dispersed to the project area from nearby populations prior to beach nourishment would also likely be buried after beach nourishment commenced. Overall, the Service expects up to 100 percent burial of the amaranth seed bank within the template of the beach nourishment design profiles contained in the proposed project.

FIGURE 27.—Beach nourishment equipment on the beach. Photo credit: Steve Papa, USFWS, 2004.

FIGURE 28.—Dredge pipe and equipment on the beach. Photo credit: Steve Papa, USFWS, 2015.

B. Habitat Loss and Modification - All Species

The proposed project will result in habitat loss and modification of piping plover and seabeach amaranth habitat within the concentration areas, and red knot habitat, through construction of composite seawall and berm, groins, walkovers, and road access points. Habitat loss and modification would affect or create the following conditions: loss of nesting habitat area, scarped shoreline conditions, reduced or degraded foraging and loafing areas, and plant competition, ultimately resulting in injury or death to piping plovers and injury to red knots

1. Piping Plover and Red Knot

a. Loss of early successional berm habitat

It is anticipated that all of the existing early successional beach habitat consisting of open, sparsely vegetated beach areas in the project area would be impacted by the proposed project through aspects of the project, including sand fence and beachgrass (*Ammophila breviligulata*) planting, berm, dune, seawall construction, groin, bulkhead, and rock sill construction.

Sand fences and beachgrass planting will likely promote the southern expansion of the dune at the expense of berm habitat (Figure 29), and can affect dune topography and promote the formation of steep, uniform dunes (Bocomazu et al. 2011). Cohen et al. (2008) noted that once beachgrass becomes dense, it may have to be thinned each growing season to retain characteristics of suitable piping plover nesting habitat. While the proposed project provides that beachgrass can be planted at 24-in on-center where piping plover nesting is present or has the potential for nesting, there are no plans to ensure that plant density remains low enough to support characteristics of early successional beach habitats that are preferred by plovers. Installation of sand fences and planting of beachgrass include potential for direct disturbance and injury to plovers if installed during the breeding season, as installation requires teams of workers, vehicles, and necessary equipment.

Berm and seawall construction is planned in areas where significant plover breeding activities occur. Specifically, berm construction would occur in habitat where 68 percent of the nests were located from 2015 to 2018. It would also bury existing vegetation and widen the beach in some areas, potentially providing a short-term benefit in terms of an increase in potential nesting habitat, but the suitability of such habitat of the engineered beach is unknown, considering impacts to foraging resources, substrate characteristics, predators, and recreational disturbance.

The constructed berm may provide only suboptimal habitat for red knots, as a steeper beach profile is created when sand is stacked on the beach during the nourishment process, sometimes taking a year for the beach equilibration process to reach the natural angle of repose. For some highly eroded beaches, nourishment may have a beneficial effect on the habitat's ability to support migrating red knots, but this is expected to be temporary due to the long-term erosion rates in the area and the impacts of sea-level rise.

Composite seawall and dune construction is planned where 32 percent of the piping plover nest site locations in the action area were located between 2015 and 2018, either removing or significantly modifying existing nesting habitat. In terms of habitat modification, the composite seawall capped with sand does not replicate a natural dune, and will not migrate or permit the formation of microhabitats such as dune blowouts or depressions. The construction of the proposed seawall will result in the permanent loss of around 4.2 acres (ac) of dune habitat. It is unknown if piping plovers would nest in the substrate above the buried seawall, or if plovers would avoid nesting there due to factors such as substrate temperature, settling of sediments into seawall crevices or holes, etc.

Both composite seawall and berm construction will also likely adversely affect a portion of the roughly 3.5 ac of interdunal and moist open sandy habitat near Beach 19th Street through direct or partial loss. This area is used for foraging and sheltering. The Corps indicated that it would attempt to minimize this loss as much as possible and restore any of the lost habitat; however, as of this time, plans have not been developed for the Service to review to determine whether restoration would be successful or not.

Loss of habitat may also be seen downdrift of the proposed tapered groins (USACE 2006, 2018a) through erosional processes. We recognize that sand accretion on the up-drift side of the groins may potentially offset potential decreases in habitat area (USACE 2018), but this is

uncertain and is not quantified in the BA. Since renourishment is scheduled every 4 years and is contingent upon available funding, any gains of available breeding, feeding, or roosting areas would be temporary in nature.

Coastal engineering features, such as stabilized dunes and vegetation planting, discourage shorebird occupancy throughout the breeding season (Webber 2011). These habitat types are important as they provide breeding, feeding, and sheltering areas for plover adults and chicks (Cohen et al. 2009; Elias et al. 2000), and sheltering and feeding areas for red knots. A reduction or loss of this habitat would negatively affect both species.

b. Loss of quality and access to foraging habitats

After construction, the berm is expected to equilibrate due to wave action, resulting in scarps, or sharp discontinuities in the beach slope (see Alegria-Arzaburu et al. 2013) (Figure 30). A scarp feature would inhibit the movement of plover chicks into intertidal foraging areas and delay the formation of wrack lines which are deposited on shallow-sloped beaches. Scarp formation plus impacts to the species' foraging resources from sand burial, and interruption of wrack delivery may lead to "population sinks" where plovers yield reproduction levels less than the level necessary to achieve a stationary population (see USFWS 1996a). It is not clear how long equilibration would take, and, therefore, how long habitats would be impacted from both a physical and biological perspective.

FIGURE 29.—Sand fence installed in the Corps' Westhampton Interim Storm Damage Protection Project area to promote lateral expansion of the dune at the expense of berm habitat. Photo credit: NYSDEC 2012.

FIGURE 30 .—A widened berm and scarp formation at Smith Point County Park, Suffolk County, New York, during construction of the Corps' Fire Island Inlet to Moriches Inlet Stabilization Project. Photo credit: Steve Papa, USFWS, March 2015.

These effects will likely reduce the amount of available habitat for this species and create degraded habitat conditions. Because piping plovers demonstrate breeding site fidelity (USFWS 1996a), they are likely to persist in attempting to breed in these areas, even if these habitats degrade and plover productivity declines in future years.

Chicks frequently move between the upper berm or foredune to access wrack lines to feed, as these features are a source of many invertebrate prey species. These foraging habitats will likely be temporarily impacted by beach nourishment activities. While the recovery rates of invertebrate prey resources in wrack is unknown following beach nourishment, they may be expected to be low during the winter period of low invertebrate activity and more rapid during warmer weather. The Service expects that prey abundance in the wrack will not be lowered for more than one nesting season following the initial berm construction or periodic nourishment cycle, except where curtailed or delayed by scarping.

It is also anticipated that the nourished beach, while initially providing some additional beach nesting habitat (provided ORV use is curtailed), is expected to erode back between renourishment cycles (Figure 31).

In addition to the Atlantic shorefront components, the proposed project also includes the construction of HFFRRFs on the bay shoreline. On the bayside, about 0.14 mi of shoreline

within the action area will be impacted by the installation of shoreline stabilization features such as revetments. Hard shore-parallel structures could have negative impacts on red knots in the action area by decreasing the amount or quality of potential foraging habitat due to potential erosional loss of intertidal habitat and creation of deeper waters (Prosser et al. 2017; Dugan et al. 2011). Intertidal habitat may also be reduced as a result of placement loss from shoreline structures. Armored shoreline may also cause loss of marsh and intertidal habitat as sea level rises and marshes are unable to migrate inland. In addition to decreased intertidal area, armored shorelines have lower intertidal invertebrate abundance and biomass, and fewer shorebirds (Dugan and Hubbard 2010).

NNBFs are proposed for approximately 1.6 mi of shoreline within the action area. The NNBFs will consist of rock sills coupled with saltmarsh restoration and creation efforts. Rock sills are hard structures and may cause impacts associated with traditional hard structures (e.g. end scour, placement loss). However, rock sills may also have positive impacts such as reduced erosion of existing saltmarsh or intertidal habitat, and can aid in restoration and creation of marsh habitat. As red knots use salt marsh as foraging habitat, this may protect existing, or create, additional foraging areas. However, it should be noted that red knot use of different foraging habitats may be disproportionate, so conversion of habitats (e.g., unvegetated intertidal to saltmarsh) resulting from the installation of rock sills or wetland creation may impact red knot foraging. Additionally, marshes behind sills may experience deposition of coarser sediments and lower organic matter than natural marshes (Bilkovic and Mitchell 2013), which may affect infauna colonization (Bilkovic et al. 2016; Sacco et al. 1994). Decreases in benthic invertebrates may negatively impact the quality of the habitat for foraging.

The design of a sill may also influence its relative impact on red knot habitat. Sill height, placement relative to the shore, sill porosity, and presence or absence of gaps can influence the quality and community structure of the saltmarsh behind the sill, tidal flushing, and the ability of aquatic organisms to access the marsh. Marsh sills placed too close to the marsh, that are designed too high, that do not have any gaps, or that have rock that is packed too tightly may limit tidal exchange, cause marsh to die off behind the sill, and restrict access of aquatic organisms (Bilkovic et al. 2016; Subramanian et al. 2008; Duhring 2008; Bosch et al. 2006). These impacts may lead to a loss of suitable foraging habitat for red knots within the action area.

FIGURE 31 .—Erosion of nourished beach within the Corps' FIMI Project area 3 years after construction. Narrowing of berm seen in foreground. Extreme erosion seen in shoreline at top of photo. Photo credit: Steve Papa, USFWS, 2018.

Overall, the proportion of red knots using the ocean beach and bay habitats impacted by the project is anticipated to be small, on the order of three red knots during the initial construction and each renourishment cycle. This is a conservative estimate, given the species is likely under surveyed in the area.

We anticipate that the habitat modifications resulting from the project will effect up to three pairs due to potential reduction in site capacity from loss of nesting habitat.

2. Seabeach Amaranth

As noted earlier, the action area has a history of significant development and stabilization which has limited seabeach amaranth to the ocean beach and isolated interdunal areas. The proposed project would perpetuate the artificial creation and maintenance of suboptimal barrier island habitats in the action area, leading to limits in available suitable habitat for growing, and accelerated plant competition. We anticipate that these effects will negatively influence the distribution and abundance of these species in the action area. Additional project effects include recreational activities and associated beach raking in growing areas (discussed below).

High-quality seabeach amaranth habitat is generally characterized by sparse vegetation. Unstabilized dunes and interdunal swales provide more potential seabeach amaranth habitat as they tend to have a more gently sloping foredune face than stabilized dunes. Conversely, artificially constructed and stabilized dunes provide less suitable habitat for seabeach amaranth (Weakley and Bucher 1992). This is especially likely with the creation of the rock/sand dunes that will be built along the ocean shoreline. The installation and maintenance of a continuous rock/sand dune line will indirectly affect this species by interrupting natural processes that maintain suitable habitat. Interdunal swales and gently-sloping foredune habitats become important when the berm has been narrowed by erosion, as happens following severe coastal storms or toward the end of a recurring sand renourishment cycle; this project will impede the formation of such features over the 50-year project life

Dune vegetation planting and sand fence will contribute to the habitat modifications that are detrimental to the species abundance and distribution in the action area. Weakley and Bucher (1992) report that stabilization of seabeach amaranth habitat allows for succession to a densely-vegetated perennial community, rendering the beaches only marginally suitable for seabeach amaranth. Because seabeach amaranth is susceptible to habitat fragmentation (Weakley and Bucher 1992; Murdock 1993), destruction of a single and sizeable population could result in local extirpation.

Seabeach amaranth is rarely encountered in areas that have been snow fenced (Weakley and Bucher 1992), but the relationship between snow fencing and seabeach amaranth populations has not been fully investigated on Long Island. Further, vertical sand accretion and burial caused by sand fences are detrimental to seabeach amaranth and their use is contradictory to seabeach amaranth recovery.

C. Effects Due to Prey Resource Burial - Piping Plover and Red Knot

The Service expects that 100 percent of the intertidal infaunal prey base within initial construction and renourishment areas will be covered by sand placement, based on the project description. Foraging resources include marine worms, fly larvae, beetles, crustaceans, and mollusks (Bent 1929; Cairns 1977; Nicholls 1989). On the oceanfront, terrestrial invertebrates tend to be concentrated in the wrack line (Loegering and Fraser 1995; Hoopes et al. 1992), a habitat used by foraging plover adults and chicks (Goldin 1993; Hoopes 1993; Hoopes et al. 1992). Availability of wrack is especially important at sites where ephemeral pool and bayside foraging areas are not available (Elias et al. 2000) or in short supply. Consequently, the proposed project will likely impact foraging habitats and prey resources in the ocean intertidal, foreshore, and backshore habitats through extreme burial and change in elevation of existing habitats.

Specifically, the proposed project will bury foraging resources with up to 14 ft of dredged material. Although some benthic invertebrate species can burrow through a thin layer of additional sediment (38 to 89 cm for different species), thicker layers (i.e., greater than 1 m) are likely to smother these sensitive benthic organisms (Greene 2002). If the material used in a sand placement project does not closely match the native material on the beach, the sediment

incompatibility may result in modifications to the macroinvertebrate community structure, because several species are sensitive to grain size and composition (Rakocinski et al. 1996; Peterson, Hickerson, and Johnson 2000; Peterson, Bishop, Johnson, D'Anna, and Manning 2006; Peterson and Bishop 2005; Colosio et al. 2007; Defeo et al. 2009).

Numerous studies of such effects indicate that the recovery of benthic fauna after beach nourishment can take anywhere from 6 months to 2 years, or possibly longer (Thrush et al. 1996; Peterson et al. 2000; Zajac and Whitlatch 2003; Bishop et al. 2006; Peterson et al. 2006, Wooldridge et al. 2016; USACE 2018b). Recovery rates vary depending on the timing of the fill activity relative to the periods of highest biological activity in these zones of the beach, as well as compatibility of the dredged material with the existing beach substrate.

As the timing of initial construction and each renourishment cycle is not known, except as constrained by an April 1 to September 1 TOY restriction between Beach 19th Street and Beach 67th Street, the Service must base its analysis of effects on a worst-case scenario. Therefore, renourishment starting in December or January and finishing close to March 15 would probably have the most severe adverse effects on piping plovers from depression of the intertidal prey resource, owing to the slowest recovery rates at that time of year.

Based on the above scenario, the Service anticipates that over the life of the project, there is the possibility of up to 24 full nesting and migration seasons (as a consequence of 12 renourishment cycles every 4 years over 50 years having effects lasting up to 2 years) of reduced prey availability along 5.2 mi of piping plover habitat within the concentration areas and 9.5 mi (7.7 mi of Atlantic shoreline and 1.8 mi of bay shoreline) of red knot habitat, causing reduced fitness for both species. Piping plovers breeding in the action area would potentially experience reduced productivity, or possibly abandonment of their breeding areas as a result of decreased foraging resources. Similarly, red knots would experience depressed foraging resources and be forced to seek suitable habitat elsewhere, expending vital energy resources in the process.

The Service anticipates that the physical configuration of the construction template will negatively affect the access to foraging habitats, and the prey available to adults and unfledged piping plover chicks for up to 2 years following initial construction and then for each renourishment. Chick home range may increase for adequate food intake, increasing the probability of intraspecific and interspecific competition, and disturbance from humans as plover chicks move from the protected areas. The potential effects include reduced or insufficient weight gain in chicks leading to delayed fledging or death, decreases in productivity, and possibly abandonment of nesting areas. Adults and post-fledged plovers preparing for migration would be similarly affected by reduced prey resources.

Additional adverse effects are likely if scarping occurs, which can prevent wrack deposition and limit chick foraging to upper beach areas following initial construction and each renourishment cycle. The overall effect on red knot is very similar, with the potential for reduced foraging opportunities during spring and fall migration. This would result in a potential reduction in individual fitness as energy must be expended to find alternative suitable foraging habitats. Long-term impacts could include a hindrance in the ability of migrating red knots to recuperate from their migratory flight to or from their breeding grounds or to build fat reserves in

preparation for migration. Long-term impacts may also result from changes in the physical characteristics of the beach from the placement of the sand.

Beach nourishment will occur across the entire plover concentration area from Beach 19th Street to Beach 67th Street, and therefore all chicks produced in that area have the potential to be impacted, although it is expected that only a proportion will be harmed. Some chicks will be able to find other foraging opportunities (e.g. newly deposited wrack, or sparsely vegetated areas) and some will successfully fledge despite lowered prey availability. From 2015 to 2018, the pairs in the plover concentration area produced, on average, 31 chicks per season. It is likely that due to lowered prey base and physical changes to the beach, a small proportion of these chicks that would otherwise survive to fledge would die.

D. Predation - Piping Plover and Red Knot

We anticipate that the proposed project would create habitat for, affect the movements of, and influence the search behaviors of mammalian and avian predators of the piping plover and red knot. We also anticipate that recreation will exacerbate predator activities and may lead to increased predator abundances in the action area. Beach construction, along with the installation of sand fences, planting of vegetation, and a hardened dune system creates a uniform beach system, affecting the species ability to evade detection as opposed to a natural beach system (Koivula and Ronka 1998). The expansion of planted beachgrass from the composite seawall to the berm would reduce the width of sparsely or unvegetated berm areas, lowering both species ability to elude predators more efficiently (Gomez-Serrano and Lopez-Lopez 2014; Rogers 2003; Rogers et al. 2006, as cited in Zimmerman 2010). Sand fence may increase the risk of depredation by providing cover for predators in close proximity to plover nests. The composite seawall will also provide an elevated feature which may be used as perches for avian predators and increase their search efficiency (e.g., Andersson et al. 2009).

Recreation would likely increase food availability (from litter or refuse) in the project area, thereby attracting and increasing the carrying capacity of predators. As a result, we anticipate that an increase in predator abundance would occur, causing increased risk of disturbance, nest loss, and adult mortality of plovers, and red knots. In response, both species may expend more energy in predator surveillance and avoidance, and that energy expenditure could decrease overall fitness. Overall, we would expect that predation pressures would result in some plover and red knot territory desertion, delayed or interrupted piping plover courtship, loss of adults, disturbance to incubating plovers with some loss of nests or delayed hatch times, and disturbance to foraging plover chicks with delayed fledging.

E. Impacts Due to Recreation and Administrative ORV Use–All Species

1. Piping Plover and Red Knot

The proposed project will initially widen, and over the long term, maintain wide beaches to meet the project's design criteria. As a result, it is anticipated that recreational activities will increase on the ocean beaches near existing piping plover breeding areas and new habitats

created as a result of the project to which plovers may be attracted (USACE 2018a and b). The proposed project will also create new vehicle and pedestrian access points that will pose potential threat to piping plover because they would provide access and increase vehicle and public use of beach areas, disrupting breeding plovers (USACE 2018b). The proposed avoidance and minimization measures will not completely avoid indirect adverse effects of recreational activities and will likely result in injury to piping plovers and red knot.

Recreational activities that may potentially adversely affect piping plovers include unleashed pets, fireworks, kite-flying, and an increase in garbage and refuse concomitant with recreational activities. Unleashed pets, such as dogs and cats, can prey on piping plovers. Kite-flying is also a popular recreational activity leading to disturbance of plovers, as it is believed that plovers perceive kites as avian predators, such as hawks, gulls, or crows. Adult plovers may abandon their nest site entirely, be flushed off their nest and, therefore, be unable to defend the nest from actual predators, or similarly be unable to defend their chicks from actual predators in these instances (USFWS 1996a).

The effects of foot traffic to breeding plovers can range from relatively minor disturbance that temporarily interferes with normal breeding, feeding, and sheltering behavior to injury or death of chicks, destruction of an entire nest, or sustained disturbance resulting in nest abandonment. After hatching, young plovers are likely to move away from nesting areas, making them vulnerable to these effects throughout a much larger area. Recreational use of coastal habitats can limit the functional availability of shorebird foraging habitat, particularly intertidal foraging habitat, resulting in demographic consequences (DeRose-Wilson et al. 2018). Plover chicks in areas with high recreational use can experience lower survival and longer times to fledging than chicks in areas with lower recreational use, as they are forced to move to areas with lower prey densities (DeRose-Wilson et al. 2018). Food resources may also be depleted in heavily-trafficked areas, with implications for reduced fitness and lowered survival rates for first year birds (Schlacher et al. 2016). Chicks may die because human disturbance hinders normal brooding such that chicks, especially young ones, are vulnerable to hypothermia during inclement weather (Colwell et al. 2007).

Further, beach maintenance and patrols may involve operation of vehicles or heavy equipment on the beach in areas where plovers may occur. Maintenance vehicles can crush nests, eggs, or hatchlings and they can also create ruts capable of trapping plover chicks. The continuation and possible increase of vehicles following implementation of the proposed project, suggests that the abundances of prey resources in wrack habitat would be reduced via mortality, displacement or lowered total amount of wrack (see Kluft and Ginsburg 2009).

As currently managed, the symbolic fencing installed by April 1 between Beach 38th Street and Beach 57th Street is expected to ameliorate the impacts associated with the increase in recreation in this portion of the beach to piping plovers, but these impacts could preclude plover breeding in the remaining areas of Beach 19th Street to Beach 38th Street and Beach 57th Street to Beach 149th Street where this fencing is not installed until plover breeding behaviors are observed.

Recreation will likely affect red knot and their foraging and roosting areas both directly and indirectly, causing habitat damage (Schlacher and Thompson 2008; Anders and Leatherman 1987), abandonment of preferred habitats, and disruption to the species' energy balances. Recreational activities can likewise affect the availability of shorebird food resources by causing direct mortality of prey.

Although red knots normally feed low on the beach, they may also utilize the wrack line (Karpanty et al. 2011). Beach raking removes wrack from the beach, and may therefore negatively impact red knot foraging. Kluft and Ginsberg (2009) found that ORVs (including beach raking/beach maintenance vehicles) killed and displaced invertebrates and lowered the total amount of wrack, in turn lowering the overall abundance of wrack dwellers. Other studies have found higher impacts to benthic invertebrates from driving (Sheppard et al. 2009; Schlacher, Thompson, and Walker 2008; Schlacher, Richardson, and McLean 2008; Wheeler 1979), although it can be difficult to discern results specific to the wet sand zone where red knots typically forage. The severity of direct impacts (e.g., crushing) depends on the compactness of the sand, the sensitivity of individual species, and the depth at which they are buried in the sand (Schlacher, Thompson, and Walker 2008; Schlacher, Richardson, and McLean 2008). The extent to which mortality of beach invertebrates from recreational activities propagates through food webs is unresolved (Defeo et al. 2009). However, the Service concludes that these activities likely cause at least localized reductions in red knot prey availability in a system that is already experiencing multiple stressors due to shoreline stabilization and high density human development.

Given documented past activity, it is likely that public harm or harassment will continue to occur in these areas. These recreational activities are likely to decrease reproductive success where they occur. The Corps has committed to working with local landowners regarding outreach efforts, such as posting signs that restrict access to breeding areas, which will contribute to reducing human disturbance during the nesting season.

2. Seabeach Amaranth

Within Sea Bright and Monmouth Beach, New Jersey, evidence of adverse impacts to seabeach amaranth was obvious in areas of intensive recreational use, such as at beach access paths or at a site near a volleyball net. The primary effect of recreation activities is trampling or crushing of plants. Colonization is unlikely to occur on intensively used recreational beaches, but would be more likely in areas fenced for the protection of piping plovers and other beach nesting birds (USFWS 2002).

IX. CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the area considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section, because they require separate consultation. This section combines the discussion for all three species as there is overlap in the cumulative effects on the species and their habitats.

Other than beach nourishment projects that would require federal (e.g., Corps) authorization, local/state actions that are reasonably certain to occur in the action area that could potentially affect the red knot, piping plover, and seabeach amaranth include beach cleaning, installation of sand fencing, recreational use of migratory stopover areas, and horseshoe crab harvesting. Each of these activities affects the species by contributing to piping plover breeding, seabeach amaranth growing habitat, and red knot foraging and loafing habitat degradation and loss.

Mechanized beach raking/cleaning is a beach management practice that does occur above the high tide line within the action areas. It crushes and removes invertebrates and the total amount of wrack, effectively lowering the overall abundance of wrack-dwelling species on which the red knot and piping plover feed.

Installation of snow fencing or the planting of beachgrass are common practices in attempting to stabilize nourished beaches and have occurred on other sites on Long Island without federal (Service, Corps) or state (NYSDEC) coordination/authorization. It is anticipated that these will be undertaken in the action area by the NPS and the NYCDPR. Vegetation planting and snow fence placement, in association with beach nourishment, will artificially accelerate growth of dense vegetation that precludes use of habitat by piping plover, red knot, and seabeach amaranth. Overall, these actions will limit the amount of available suitable habitat for all listed species and will create suboptimal habitat conditions.

The NYCDPR and the NPS authorize pedestrian access on the Rockaway Peninsula from Beach 9th Street through Beach 193rd Street. The impacts described in the **Effects of the Action** are incorporated by reference into this section.

X. JEOPARDY AND ADVERSE MODIFICATION ANALYSIS

Section 7(a)(2) of the Act requires that federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat.

A. Jeopardy Analysis Framework

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02). The following analysis relies on 4 components: (1) Status of the Species, (2) Environmental Baseline, (3) Effects of the Action, and (4) Cumulative Effects. The jeopardy analysis in this Opinion emphasizes the rangewide survival and recovery needs of the listed species and the role of the action area in providing for those needs. It is within this context that we evaluate the significance of the proposed federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

B. Analysis for Jeopardy/Adverse Modification

The jeopardy analysis in this Opinion relies on four components: (1) the Status of the Species, which describes the rangewide conditions of the species, the factors responsible for those conditions, and the survival and recovery needs; (2) the Environmental Baseline, which analyzes the conditions of these species in the action area, the factors responsible for those conditions, and the relationship of the action area to the survival and recovery of the species; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed federal action and the effects of any interrelated or interdependent activities on the species; and (4) the Cumulative Effects, which evaluates the effects of future, non-federal activities, that are reasonably certain to occur in the action area, on the species.

Impacts to Individuals – As discussed in the Effects of the Action, potential effects of the action include effects to piping plover, red knot, and seabeach amaranth during their respective breeding, growing, and migration periods over the 50-year project life. Effects generally include disturbance from construction activities, habitat modification and loss, reduction in foraging base, recreational disturbance, increases in predation, and plant competition. The potential for effects would be during the period these species are present during their migration or breeding seasons as in the case of red knot and piping plover, and during the growing season for seabeach amaranth. Seabeach amaranth seed banks which are stored in the berm habitat have a longer period of effects as the species is present year round in the system. The proposed plover TOY restriction (April 1 to September 1) and delayed buffer establishment will be only partially protective of direct effects for piping plover, especially in areas immediately adjacent to the breeding concentration sites. This TOY restriction is also not fully protective of red knot and seabeach amaranth whose migration period and growing seasons extend beyond September 1. Avoidance and minimization measures for construction activities that are specific to red knots are not fully protective of the species (e.g., they do not cover the entire migration period or do not apply to all areas in which red knots may be located) or are unable to be evaluated due to lack of details provided. The other impacts related to habitat modification and loss, degradation of foraging resources, increases in recreation, increases in predation, and plant competition will be chronic effects over the 50-year project and create conditions resulting in potential potential reductions in annual or daily survival rates, reproductive rates, and site fidelity.

Impacts to Populations – As we have concluded that individual piping plover, red knot, and seabeach amaranth are likely to experience some reductions in their annual or lifetime reproductive success and abundance, we need to assess the aggregated consequences of these anticipated reductions in fitness (i.e., reproductive success and long-term viability) of the exposed individuals on the Rockaway Peninsula populations of these species. .

Individuals of piping plover, red knot, and seabeach amaranth will be affected. As the project is only at a 15 to 30 percent design level, it is difficult to predict how the proposed project will function and the total degree of impacts that it will cause, and, therefore, whether the effects are expected to measurably decrease the fitness of these populations. The effects of construction will introduce disturbance, permanently or temporarily transform their habitat, and present chronic issues related to red knot and piping plover habitat and prey resources. In addition, the proposed project will contribute to, or compound, other issues such as recreational disturbance and predation that affect these species. Overall, the proposed project would impact a significant proportion of the Rockaway Peninsula piping plover breeding population and introduce

disturbance to red knots at their migratory stopover site.

Impacts to Species –We have concluded that populations of red knot, piping plover, and seabeach amaranth are likely to experience effects that may contribute to reductions in their fitness. It is difficult for the Service to predict the scale that the harmful effects associated with the proposed project will have on the RND of each species as a whole. To understand the consequences of population-level effects at the species level, we need to factor in the RND needs of the species. As discussed in the Status of the Species, these species need naturally functioning habitats with access to suitable nesting, foraging, and growing habitats, and minimal human disturbance and predation pressure to achieve reproductive success. This project will not contribute to those needs. In the case of piping plover, the species as a whole displays an increasing population trend but has still not met the recovery criteria established in USFWS (1996a). Both red knot and seabeach amaranth are displaying negative population trends across their ranges, and the proposed project places additional obstacles on them to reach population sustainability.

XI. CONCLUSION

We considered the current overall status of piping plover (improving), red knot (declining), and seabeach amaranth (declining) and the conditions of the species within the action area. We then assessed the effects of the proposed action and the potential for cumulative effects in the action area on individuals, populations, and the species as a whole. These types of effects of the proposed action are currently considered primary factors influencing the status of the species. While they may compound those factors, as stated above, we do not anticipate any reductions in the overall RND of these species. It is the Service's Opinion that the proposed project, is not likely to jeopardize the continued existence of the species covered in this Opinion. Since there are no Critical Habitat designations, none will be affected by the proposed project.

Piping Plover:

We based our conclusion on piping plover based on the following: The plover breeding sites in the project area represent 4 out of 60-80 active plover breeding areas on Long Island and an even smaller percentage on a NY-NJ Recovery Unit basis. As a result, the proposed project is not reasonably expected, directly or indirectly, to diminish the species' numbers, reproduction, or distribution so that the likelihood of survival and recovery in the wild is appreciably reduced.

Red Knot:

The number of red knots in the project area based on the best available information suggests a small proportion of the overall migrating population of the rufa subspecies in New York and along the western Atlantic. Red knot abundance in the project and action areas is also a smaller proportion of the red knots known to use the Jamaica Bay and Rockaway Peninsula, based on the best available information. As a result, the proposed project is not reasonably expected, directly or indirectly, to diminish the species' numbers, reproduction, or distribution so that the likelihood of survival and recovery in the wild is appreciably reduced.

Seabeach Amaranth:

While there are significant seabeach amaranth populations in the project and action areas, these would be protected to a large degree by the proposed avoidance and minimization measures, such as commitments to work with landowners on public outreach and avoidance and transplantation of plants that may be destroyed during construction activities, will reduce some of the effects of the project. As a result, the proposed project is not reasonably expected, directly or indirectly, to diminish the species' numbers, reproduction, or distribution so that the likelihood of survival and recovery in the wild is appreciably reduced.

XII. INCIDENTAL TAKE STATEMENT

Section 9 of the Act and the federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in the death or injury to listed species by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of carrying out an otherwise lawful activity. Under the terms of sections 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to, and not intended as part of, the agency action is not considered a prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps and become binding conditions of any grant or permit issued to the (applicant), as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement (50 CFR §402.14(i)(3)).

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally-listed endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of state law or regulation or in the course of any violation of a state criminal trespass law.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (MBTA; 16 U.S.C. 703-712), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

XIII. AMOUNT OR EXTENT OF TAKE ANTICIPATED

The level of take of red knots and piping plovers utilizing the project and action areas can be anticipated by the Project because:

1. Red knots are known to migrate through the project and action areas. Piping plovers are known to breed and migrate in the project and action areas.

2. A reduction of the invertebrate prey base base (up to 2 years following initial construction and each renourishment cycle) will occur due to sand placement which would affect the red knot's ability to forage and store enough fat reserves for migration back to the breeding grounds for multiple wintering seasons. Such an effect could result in reduced fitness. The reduction in prey resources would affect adult and chick piping plovers ability to obtain food necessary for growth, reproduction, and migration.

3. Human disturbance are expected for the duration of construction (initial and renourishment) activities and as a result of recreation which would make the project and action areas less desirable to piping plovers and red knots, and which may cause increased energy expenditure as birds move away from construction activities.

4. The project would reduce habitat variability through the creation of an engineered beach consisting of hard and soft structures, making piping plover and red knot susceptible to predation from mammalian or avian predators.

The amount of incidental take discussed below is based on the information and evaluations presented in the **Effects of the Action.** Where information is unavailable to assist us in quantifying take, we have determined, based on best professional judgement, the levels of incidental take.

A. Piping Plover and Red Knot

1. Incidental Take from Direct Effects of the Initial Construction Activities

The Service anticipates incidental take of two piping plovers in the form of harm from direct effects from construction activities for piping plovers that occur outside of the concentration areas during initial construction and each renourishment cycle. These individuals may be either foraging outside of the concentration area or migrants and subject to the effects of construction activities.

The Service also anticipates the incidental take of 2 pairs (4 individuals) within the plover concentration area during initial construction and each renourishment event from lack of a protective buffer zone and construction activities occurring immediately adjacent to the concentration area.

The Service anticipates incidental take of 2 individual red knots in the form of harm from construction activities, depending on the time of year, sequencing and type of construction activity in the action area for initial construction and each renourishment over the life of the project.

2. Incidental Take Due to Habitat Loss, Degradation, or Modification

Over the 50-year project, the Service anticipates incidental take of three pairs of piping plovers, due to the quantitative and qualitative loss of habitat from these activities, which significantly impairs essential behavioral patterns, including breeding, feeding, or sheltering.

Incidental take in the form of harm of 3 red knots is expected to occur over the 50-year life of the project on the Atlantic ocean and bayside shorelines as a result of the loss of habitat, which significantly impairs essential behavioral patterns, including migrating, feeding, or sheltering.

3. Incidental Take Due to Reductions in Infauna in the Intertidal Zone and Subaerial Beaches

Incidental take due to effects of reductions in foraging resources is anticipated due to elevated mortality of unfledged plover chicks due from lower quality foraging habitat. We anticipate these effects will lead to the incidental take of three piping plover chicks during initial construction and each renourishment cycle, and for the following nesting season after initial construction and after each nourishment. Lowered prey availability for red knots is anticipated to result in reduced fitness of red knots, therefore, we also anticipate the non-lethal incidental take of 3 red knots during initial construction and each renourishment cycle.

4. Incidental Take Due to Enhancement of Predator Habitat and Populations

Incidental take due to predation is anticipated. The BA did not describe the effects of the proposed project on predation of plovers or propose any conservation measures that they would undertake to address enhancement of predator habitat or increases in predator abundance other than the use of predator exclosures. Overall, the Service anticipates that incidental take of piping plovers in the form of the loss of one nest and the death of three plover chicks every year over the life of the project for a total of 150 chicks and 50 nests.

The Service anticipates up to 2 red knots will be taken each year over the life of the project due to these effects.

5. Incidental Take Due to Recreation and ORV Activities

The Service anticipates incidental take in the form of harm as a result of delayed establishment of nests, nest abandonment, and mortality of chicks due to the adverse effects associated with recreation and ORV use. Specifically, we believe that incidental take of piping plover is anticipated from the abandonment of one nest each year over the life of the project for a total of 50 nests over the life of the project and the death of one chick every 5 years for a total of 10 chicks over the life of the project. Incidental take to red knots is anticipated due to lost foraging opportunities amounting to 2 red knots each year over the life of the project

If, during the course of the action, the levels of incidental take are exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

TABLE 3.—Amount and type of anticipated incidental take.

Species	Amount of Take Anticipated (either in habitat or individuals)	Life Stage When Take is Anticipated	Type of Take	Take is Anticipated as a Result of	Total over 50-year Project Life
Piping Plover	27 pairs over 50 yrs	Adults	Harm	Reduction in foraging; Disturbance to breeding activities; Disturbance from construction activities; Habitat modification affecting nest site; recreational disturbance; predation	27 pairs
Piping Plover	24 Individuals over 50 yrs	Adults	Harm	Disturbance from construction activities	24 individuals
Piping Plover	2 nests/yr	Eggs	Harm	predation; recreation and ORV use	100 nests
Piping Plover	3 chicks/ nourishment cycle, 2-yr benthic recovery; 3 chicks/yr; 1 chick/5 yrs	Chicks	Harm	Reduction in foraging; predation; recreation and ORV use	238 chicks
				Total Incidental Take of Piping Plovers	27 pairs plus 24 individuals, 100 nests, and 238 chicks/50 yrs
Red		Adults or	Harm	Reduction in foraging area and	263 red

Knot		First-year birds		quality; Disturbance from construction activities	knots
				Total Incidental Take of Red Knot	263 red knots

XIV. EFFECT OF THE TAKE

A. Piping Plover and Red Knot

The Service has determined that the level of take anticipated, as described above, from the proposed action is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

XV. REASONABLE AND PRUDENT MEASURES

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take would represent new information requiring review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs.

A comprehensive report describing the actions taken to implement the RPMs and terms and conditions associated with this incidental take statement shall be submitted to the Service's Long Island Field Office by January 15 of the year following completion of all required surveys.

In order to determine if the amount of take due to harm from indirect impacts on habitat is approached or exceeded, the Corps shall ensure the implementation of the terms and conditions outlined below.

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of piping plover and red knot:

1. Reduce adverse effects to piping plover and red knot from construction and maintenance of composite seawall/dune, dune grass planting, sand fence installation, artificial beach, groin construction, and HFFRRF and NNBF projects;

2. Monitor pre-, concurrent, and post-habitat conditions in the action area;

3. Monitor implementation of avoidance and minimization measures and report to our office. (50 CFR 402.14[i][3]) requires federal agency or applicant to report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.);

4. Ensure that all project engineers, contractors, and construction staff are fully informed of and compliant with all conservation measures contained in the project description, RPMs, and terms and conditions; and

5. Ensure that NYCDPR, state, and Service field staff have continued access to all portions of the project area necessary to carry out the endangered species management over the life of the project.

XVI. TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary and apply to the piping plover and red knot.

1. **Terms and Conditions for Reasonable and Prudent Measure 1** (Reduce adverse effects from construction and maintenance of composite seawall/dune, dune grass planting, sand fence installation, artificial beach, groin construction, and HFFRRF and NNBF projects):

   1.1 The Corps shall provide maps and drawings to the Service, showing the extent of the work zones and all access routes for the first element of construction at least 30 days prior to initial construction. Subsequent construction phase work zones and access route maps will also be provided 30 days prior to construction.

   1.2 The Corps shall remove any construction material or equipment staged or stored within delineated breeding areas between Beach 19th Street and Beach 67th Street (or other known breeding areas based on LICWS data and areas where plovers exhibit territorial, courtship, nesting, and brood-rearing activities) by April 1 of any given year over the life of the project and pre-migration staging areas.

1.3 For the construction phase and each renourishment or other activity involving construction, maintenance, or surveying in the project and action areas (Far Rockaway Beach, Rockaway Beach, Jacob Riis and Fort Tilden Parks) piping plover breeding areas (not nests) will be fenced from April 1 to September of each year. The 500 m buffer for breeding adults and 1,000 m from chick rearing areas will be maintained between these areas and Corps' construction and renourishment activities to ensure no project related activities occur in the buffer zone. How these buffers are marked is at the discretion of the Corps for purposes of carrying out the construction, renourishment, and maintenance activities.

1.4 If construction occurs during the piping plover season, the Corps shall establish no construction activity zones from Beach 14th Street to Beach 74th Street (this includes a 500-m buffer for protection of breeding adults early in the season), and 500 m on either side of the western end of the western taper by April 1 of any given year. To protect plover chicks, this buffer shall be increased to 1,000 m one week before the first nest is scheduled to hatch.

Should pre-and during-project monitoring (discussed below) establish plover presence extending either west of Beach 67th Street or east of Beach 169th Street, then the Corps shall extend the buffer area from the new location of the plover breeding area to maintain the 500-m buffer.

1.5 If construction on the Oceanside occurs during the red knot migration season (April 1 through November 30), the Corps shall undertake pre-construction and concurrent construction surveys (discussed below). A minimum 500-m buffer shall be used to protect the species from direct disturbance. For the bayside Mid-Rockaway Arverne and Edgemere HFFRRFs, the Corps shall monitor construction activities from May 1 through November 30 and implement a 500-m buffer around red knots observed for at least fifteen minutes.

1.6 The Corps shall conduct renourishment, repair, construction and maintenance of the composite seawall, walkover, vehicle access points, groins, and other structures using a 500-m buffer until one week before the first nest hatches. A 500-m buffer should be used from migrating, staging, or other nonbreeding plovers after September 1, and from red knots at all times. Exposed composite seawall or groin rocks above spring hide tide must be covered between Beach 9th Street and Beach 82nd Street prior to April 1 of any given year over the life of the project.

1.7 No woody vegetation will be planted on the dune, only herbaceous native plants will be used. The vegetation planting density will be maintained at 24 inches on-center over the life of the project. Plantings will be made in a random manner and not rows with uniform spacing. Planting will not occur from April 1 to September 1 in order to protect breeding plovers whose breeding areas may

encompass the dune area. Planting may occur after the last day of chick fledging.

1.8 The beach placement areas shall be finished to the same backshore and foreshore slopes as the surrounding natural or design beach profiles depending on location. The area shall be graded at a gentle uniform slope with no piles, ridges, or holes left in the final graded beach placement materials.

1.9 If there are no breeding or chick foraging activities by July 15 in either of the two plover breeding areas or within the buffer zones, then work may proceed in those areas provided a 500-m buffer is maintained to protect nonbreeding plovers and red knots, and post fledge plovers.

1.10 The Corps shall work with the NYCDPR and the NPS to ensure that all suitable piping plover breeding habitat with a recent history (last five years) of plover breeding is protected by April 1 of each year to address the adverse effects associated with the expected increase in recreation.

2. **Terms and Conditions for Reasonable and Prudent Measures 2 and 3 - MONITORING** (50 CFR 402.14[i][3] requires federal agency or applicant to report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.)

2.1 "As take is expected each year of the 50-year project, pre-, concurrent, and post construction monitoring plan will be undertaken. The following measures will be incorporated into the Piping Plover Avoidance and Minimization Measures contained in Section II (C)(1) of the Rockaway Opinion. These will be undertaken by a qualified biologist who is selected by the Corps and meets the qualifications provided below.

Estimates of piping plover annual pair counts will be made using the males within pairs. Males for pair counts and productivity estimates are used because when pairs separate, the males often keep their territory when they partner with a new female. Additionally, males are the primary territory holders and defenders (Hermanns et al. 2018).

The monitoring surveys outlined in Section II(C)(1) for piping plover will be undertaken during the pre-construction phase of the project for one season prior to construction, implemented during the construction phase of the project and then for two years post construction. This cycle of monitoring will be applied to each renourishment phase as follows: one year prior to renourishment, during renourishment, and two seasons post renourishment for the life of the project.

For red knots one count will be made, at roughly ten day intervals, on or within 3 days of the dates below:

Spring: April 5, April 15, April 25, May 5, May 15, May 25, June 5, June 15.

Fall: July 15, July 25, August 5, August 15, August 25, September 5, September 15, September 25, October 5, October 15, October 25.

Winter: November 5, November 15, November 25.

The person(s) conducting the survey must demonstrate the qualifications given below.

Qualifications:

1. A minimum Bachelor of Science degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences;
2. Skilled in identification of North Atlantic shorebird species, specifically Piping Plover. At least one year of full-time, or equivalent part-time technical experience in observing piping plover and red knot.

2.2 The Corps shall document the topography, area, and habitat characteristics of the 3.5 ac of dune/ephemeral pool habitat present south of Beach 19th Street to determine whether it meets the Corps' project design profile. If so, construction in the dune and ephemeral pool habitats shall be avoided. Heavy equipment shall avoid the ephemeral pool areas to prevent any compaction of the sediment and crushing of the invertebrate fauna that are the prey base of these species. If habitat loss is unavoidable, then the Corps shall develop a restoration and implementation plan, in coordination with the Service, 3 months prior to initial construction.

2.3 As part of the Corps Inspection of Completed Works Program and the local sponsor's OMRR&R responsibilities, the Corps shall annually monitor the beach placement areas, beach profiles, composite seawalls, and new/modified groins to identify any erosion hotspots or areas where the project is not performing as intended to better inform any possible needed changes to the renourishment cycles. Any sandfill used for associated remedial actions shall be same sand grain size, percent composition, and sorting coefficient as the existing, naturally-occurring substrate in the project area.

2.4 The Corps will implement the following early successional beach habitat restoration plan for the berm habitat between Beach 9th Street and Beach 82nd Street. In order to avoid dense vegetation which would impede piping plover chick movement and degrade nesting habitat, 10 percent vegetation coverage will be the target vegetation density with a threshold action of 17 percent coverage for planning purposes between Beach 9th Street and Beach 82nd Street, so as to keep this in an early successional habitat stage.

All clearing and other site preparation activities will take place outside the breeding season (April 1 to September 1).

2.5 The Corps will develop a remedial action plan if erosion associated with hard structures (e.g., groins and rock sills) occurs between Beach 49th Street to 82nd Street, and at Jacob Riis and Fort Tilden Parks that may impact plover habitat, and throughout the ocean and bayside shoreline for red knots. Project induced erosion will be addressed at the earliest possible time but no later than the next scheduled renourishment cycle.

2.6 Monitoring of wrack and wrack invertebrates in the intertidal zone, and berm will be undertaken by a qualified biologist (biologist must have a 4 year biological sciences degree, with experience in invertebrate biology and ecology, study design. The information collected during this monitoring program will be used to adaptively manage the operation and maintenance phases of the project to further avoid and minimize take.

The following provides the basis for a wrack monitoring plan:

The sampling methodology modified from Ruiz-Delgado (2015), Kluft and Ginsberg (2009), and Dugan et al (2003) includes:

1) Select specific monitoring sites- Establish a monitoring area within plover breeding areas to include zones between the primary dune and low tide line between Beach 9th Street and Beach 82nd Street; and within Jacob Riis and Fort Tilden Units of the GNRA. Reference sites along the Rockaway Peninsula will be identified by the Corps. Reference sites will serve as controls, so they should not experience anthropomorphic activities that affect wrack deposition and persistence on the beach nor be affected by the beach nourishment of hard shoreline stabilization structures (i.e., beach raking, groins, etc).

2) Establish sample areas- areas should be 100 m in length (alongshore);

3) Establish transects- within each sample area, select five random points to establish transects (transects will run perpendicular to the shore);

4) Each Spring (approximately Mar 21-June 20) and Summer (approx. June 21 - September 21) season three replicates will be collected. Samples will be collected at two tidal levels: the level at which wrack is stranded during the highest spring tide and located above the current high tide line and another one at which wrack is deposited during the last high tide and located at the current driftline (hereafter upper and lower level, respectively).

The sampling points are to be randomly designated along each tidal level in covered and uncovered wrack areas during low spring tides. The along-shore distance of the sampling area will be 100 m, while the across-shore distance will be at 1 m above and below wrack bands (defined as the wrack-covered line parallel to the tide line). For each tidal level and sampling date, six random samples will be collected in each microhabitat (i.e., wrack patches and bare sand) for a total of 72 samples per habitat and tidal level. Wrack- associated fauna and burrowing fauna underneath the wrack patches will be collected in wrack-covered areas: algal wrack at the surface and 20 cm of sediment will be sampled with a 15-20cm diameter core. Samples will also be taken in the nearby bare sand,with the same core to a depth of 20 cm, to measure the abundance of invertebrates in areas not covered by wrack. Samples will be sieved (at 1 mm) and preserved for species identification.

5) To quantify the overall amount of wrack within each sampling area, any wrack debris along a profile will be recorded for dimensions (length*width*depth), percent species composition, and an ordinal rating of wrack consistency (1-5), and the mean density/meter ((l*w*d)/meter2 of beach) will be estimated. Since the clump will be measured at its largest length and width, and will overestimate clump cover, an elliptical surface area, estimated using the standard formula (length/2*width/2*PI), will be calculated for more accurate analysis. These surface area estimates (m2 wrack/meter of beach) for each transect will be used to generate overall % cover for each area (after Dugan et al., 2003).

6) Additional environmental variables will be measured within wrack samples including: transect percent cover, relative wrack age (categorized qualitatively as fresh, decaying, or old) and percent composition of vegetation observed, temperature and humidity at the wrack/sand interface, and sand temperature at 10 cm depth beneath wrack."

2.7 The following monitoring plan will be implemented by a qualified monitor(s) that is selected by the Corps, meeting the qualifications provided in RPM/TAC 2.10 to address the impacts of the dune, berm, composite seawall, and groin construction on plover and red knot biology and ecology. The monitoring program will evaluate red knot and plover population and behavioral responses to habitat changes in the action area, such as avoiding existing foraging, roosting, or breeding areas, as a whole, and any shifts in the species' distribution relative to these project features.

- Measure piping plover habitat use in the project area. To evaluate habitat use within the project area, the Corps will delineate the following habitats within the

Project Area from Beach 17th Street to Beach 82nd Street: composite dune crest, composite dune slope, constructed berm, and unaltered sand dune complex between Beach 17th Street and Beach 19th Street. The Corps will record and compare the number of pairs that use these identified habitats for breeding activities (including nest site selection and brood-rearing).

Nest site locations will be collected using a GPS device. To obtain information on changes in brood rearing areas the following will be undertaken: To monitor brood movements, broods will be searched for every 1-3 days during adult surveys or nest searching. When located, their locations will be obtained by offsetting an observer location with a distance from a rangefinder and a bearing from a compass. When the broods are located behavior data will also be collected. For five minutes, record forage rate (peck, pull, probe) continuously, and behavioral state (forage, sit, run, walk, chase, flee, preen, encounter with another individual) and habitat (moist sand, moist vegetation, dry sand, dry vegetation, and wrack) every ten seconds (Altmann 1974).

2.8 By April 1 of each year, the Corps shall monitor and ensure that the subaerial extent (from spring hide tide to the base of the dune) of the proposed and extended groins are covered following initial construction and then during the maintenance phases of the project to minimize habitat fragmentation and ensure plover chicks are able to traverse nesting and foraging areas. (A monitoring component to evaluate species habitat use relative to the new groins shall be made part of the biological monitoring plan requirements).

2.9 Between Beach 16th Street and Beach 82nd Street, the Corps shall reduce the potential of plover chicks or eggs from falling or getting trapped in crevices of the composite seawall and shall reduce potential of garbage collecting in crevices thus attracting predators.

2.10 To reduce the anticipated level of take due to increases in disturbances from recreational activities, the Corps will, in coordination with the NYCDPR and NPS, ensure the full implementation of the Service's "Guidelines for Managing Piping Plovers on Recreational Beach in Order to Avoid Take Under the Endangered Species Act" in the project area, including working with the NYCDPR and the NPS to ensure implementation and enforcement of plover management activities over the life of the project. The Corps will also coordinate these with the non-federal sponsor, NYSDEC.

2.11 The Corps will work with the NYCDPR and the NPS, in coordination with Service, in developing a predator management plan for the action area where predators of piping plovers are identified, management objectives designed and ensure implementation, and ensure results are documented. The Corps will also coordinate these with the non-federal sponsor, NYSDEC.

The predator management plan will incorporate results of monitoring described in Section II(C)(1) of the Opinion and include biological triggers (specific reduction in adult, nest or chick abundance, frequency of predator visitation to plover nests or the breeding area, etc). Additional information to assist in making informed decisions and to maintain a decision making framework about predator management will include the following:

1. Predator species abundance to be determine through transect surveys established from Beach 9th Street to Beach 82nd Street;
2. Duration of presence at the breeding site;
3. Record of frequency of visits for that observation period (i.e.: first, second, etc. occurrence);
4. Record of location; and
5. Record of predator behavior (resting, stooping, vocalizations, prey catch [species -adult, juvenile, chick,] etc.) and piping plover/red knot response (i.e. flight (noting direction), no reaction, vocalization, combination of responses, time to return to nest (when possible).

Local landowners will be consulted and may participate with the Corps in these activities, but it is the Corps' responsibility to ensure their implementation and reporting requirements as given in the Incidental Take Statement."

2.12 As the project involves nighttime construction activities and no night time monitoring is proposed, all construction personnel and the Service will be provided a daily report at the end of each day providing the location of all breeding activities, including territories, courtship areas, nest building areas, nest sites and chick rearing areas. All lights will be directed away from these areas as practicable to allow for safe construction.

2.13 The Corps shall undertake monitoring of physical beach parameters that requires the use of "sleds" or other beach equipment outside of the plover breeding season (April 1 to September 1) or not within 500 m of breeding adults or 1,000 m of chicks. When undertaking this work, a 500-m buffer should be used from migrating, staging, or other nonbreeding plovers whenever encountered. The 500-m buffer shall be applied to red knots from April 1 through November 30 on both the ocean- and bay-side action areas.

2.14 Report the extent of direct incidental take of piping plover and red knot to the Service within 30 days of completing construction activities related to the composite seawall and dune, new groins or groin extensions, beachfill, renourishment, HFFRRFs, or NNBFs. Through the Endangered Species Management Program, document annually the extent of observed indirect incidental take of piping plovers from recreational activities and beach management practices. In the event of take, a system of notification shall be implemented following the guidelines:

(a) Exercise care in handling any specimens of dead piping plover adults, young, or non-viable eggs and adult red knot to preserve biological material in the best possible state. In conjunction with the preservation of any specimens, the finder is responsible for ensuring that evidence intrinsic to determining the cause of death of the specimen is not unnecessarily disturbed. Finding dead or non-viable specimens does not imply enforcement proceedings pursuant to the Act. Reporting dead specimens is required for the Service to determine if take is reached or exceeded and to ensure that the terms and conditions are appropriate and effective.

(b) Upon locating a dead piping plover or red knot, initial notification shall be made to the following Service's Law Enforcement office:

Resident Agent in Charge
USFWS
Office of Law Enforcement
70 East Sunrise Highway, Suite 419
Valley Stream, NY 11581
516-825-3950

and

USFWS
Long Island Field Office
340 Smith Road
Shirley, NY 11967
631-286-0485

(c) The Corps will submit a post-construction compliance report prepared by a qualified biologist selected by the Corps (see required qualifications provided above) to the Long Island Field Office by December 1 of each year for the life of the project. This report will detail (i) dates that construction occurred; (ii) pertinent information concerning the success of the project in meeting conservation measures and reasonable and prudent measures/terms and conditions; (iii) an explanation of failure to meet such measures, if any; (iv) known project effects on listed species, if any; (v) occurrences of incidental take of listed species, if any; (vi) documentation of employee environmental education; and (vii) other pertinent information such as the development of adaptive management alternatives to address modification that may be necessary based on the monitoring efforts that are part of the project description and reasonable and prudent measures/terms and conditions.

All data collected will be provided in an Excel spreadsheet. Monitoring results will be submitted (datasheets, maps, database) on standard electronic media (e.g., CD, DVD) to the Long Island Field Office by November 1 of each year in which monitoring is completed.

Supporting credentials of all monitors (resume, references from supervisors of field work, transcripts of course work, reprints of published papers, etc.) will accompany the annual reports submitted to the Service.

3. **Terms and Conditions for Reasonable and Prudent Measure 4** (Ensure construction contractors informed of all conservation measures)

3.1. All on-site personnel are required to watch a Service-provided CD or digital video regarding plover biology and protection. This will be administered by the District.

All qualified shorebird monitors will be required to participate in a mandatory piping plover and seabeach amaranth training session provided by the Service prior to April 1 (provided and conducted by the Service or an approved Service representative). Any individuals without this training will not be permitted on site. All costs of this training will be the responsibility of the Corps or the contractor."

4. Terms and Conditions for Reasonable and Prudent Measure 5 (Ensure that NYCDPR, state, and Service field staff have continued access to all portions of the project area necessary to carry out the endangered species management over the life of the project)

4.1 The Corps shall ensure the NYCDPR, the NYSDEC, the Service, and the NPS have continued access to all portions of the project area necessary to carry out endangered species management over the life of the project.

XVII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Corps can decide under which programs they seek to implement these receommendations.

A. Piping Plover

1. The Corps should identify areas on Long Island within their Civil Works program where natural process can form bay to overwash habitat and promote

optimal plover habitat formation. The focus should be on areas outside of sites that already provide opportunities for these types of habitat development.

2. The Corps should identify mechanisms to contribute to plover protection measures, either by providing equipment, personnel, or funds, to local land managers within areas affected by their Civil Works projects.

3. The Corps should work with the Service, state, local municipalities, and nongovernmental organizations to develop an outreach program to promote the recovery of piping plover.

B. Red Knot

1. The Corps should avoid dredging submerged and emergent shoals to preserve beach dynamics and shorebird habitat on the bayside.

2. The Corps should avoid or reduce damage to wrack during project construction by requiring that vehicles drive above or below the primary wrackline.

3. The Corps should coordinate with the NYCDPR to protect wrack by ceasing or reducing wrack removal during beach-cleaning activities.

4. The Corps should incorporate provisions prohibiting introduction of (and requiring removal of existing) invasive plant species that degrade beach and dune habitats.

5. The Corps should coordinate with the NPS and the NYCDPR to place symbolic fencing around or otherwise protect roosting and staging areas during the time of year when red knots are present.

6. The Corps should coordinate with the NYCDPR to reduce disturbance by prohibiting dogs on the beach during the time of year when red knots are present.

C. Seabeach Amaranth

1. Both the NYCDPR and the NPS currently conduct surveys and erect symbolic fencing and signage to protect seabeach amaranth. Additionally, these agencies manage several state-listed shorebirds, including the common tern, least tern, and black skimmer along the ocean beach shoreline within the action area. In order to avoid duplicative efforts and minimize the potential to disturb nesting shorebirds during seabeach amaranth surveys, the Corps should coordinate with the NYCDPR and the NPS prior to implementing any surveys or installation of fencing within the action area.

XVIII. REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

XIX. CONSULTATION HISTORY

The history of the consultation request includes any informal consultation, prior formal consultations on the action, documentation of the date consultation was initiated, a chronology of subsequent requests for additional data, extensions, and other applicable past or current actions (USFWS and National Marine Fisheries Service 1998).

August 8, 2017	The Corps requests via electronic correspondence the Service's point(s) of contact for the endangered species consultation.
August 9, 2017	The Service responds to the Corps' request for points of contact.
July 10, 2018	The Corps transmits the Draft BA via electronic correspondence to the Service.
July 16, 2018	The Service provides initial comments on the BA to the Corps via electronic correspondence.
August 6, 2018	The Corps transmits the Revised Draft BA to the Service via electronic correspondence.
September 25, 2018	The Service provides additional comments/questions on the revised BA.
September 27, 2018	The Corps responds via electronic correspondence to the Service's September 25th questions and requests the Service's concurrence with a not likely to adversely affect (NLTAA) determination.
September 27, 2018	The Service responds via electronic correspondence to the Corps to the Corps' NLTAA concurrence request. The Service provides a justification for formal consultation for the piping plover, seabeach amaranth, and red knot.
September 27, 2018	The Corps transmits a letter to the Service requesting initiation of formal consultation for the piping plover and seabeach amaranth and concurrence with their NLTAA determination for the red knot.
October 15, 2018	Letter from the Service to the Corps acknowledging receipt of the Corps' September 27, 2018, initiation of formal consultation.
October 24, 2018	Electronic correspondence from the Service to the Corps requesting a description of the measures proposed to protect federally listed species (no-work buffers and TOY restrictions).
October 24, 2018	The Corps, via electronic correspondence, provides a description of endangered species protection measures.

October 25, 2018	The Service, via electronic correspondence to the Corps, requests clarification on proposed avoidance and minimization measures and a justification for the Corps' likely to adversely affect (LTAA) determination for the red knot.
November 1, 2018	The Corps, via electronic correspondence to the Service, transmits their LTAA determination for the red knot.
November 20, 2018	The Corps, via electronic correspondence, responds to the Service's inquiries regarding proposed improvements to the groins at Jacob Riis Park.
December 3, 2018	The Corps, via electronic correspondence, identifies remedial actions and monitoring for downdrift erosion.
December 10, 2018	The Corps, via electronic correspondence, responds to the Service's inquiries regarding the preservation/restoration of interdunal system south of Beach 19th Street.
December 11, 2018	The Corps, via electronic correspondence, responds to the Service's inquiries regarding downdrift erosion between Beach 49th Street and Beach 60th Street.
December 12, 2018	The Corps, via electronic correspondence, responds to the Service's inquiries regarding the project life and duration of impacts.
December 13, 2018	The Corps, via electronic correspondence, responds to the Service's inquiries regarding shoreline alignment/post-construction monitoring.
December 14, 2018	The Corps, via electronic correspondence, responds to the Service inquiries regarding design of nature-based features.
December 17, 2018	The Corps, via electronic correspondence, responds to the Service's inquiries regarding design of nature-based features.
December 20, 2018	The Service, via electronic correspondence, provides draft Avoidance and Minimization Measures for the Corps' consideration.
December 21, 2018	The Corps, via electronic correspondence, responds to the Service's draft Avoidance and Minimization Measures.
February 7, 2019	The Service, via electronic correspondence to the Corps, requests information on thresholds for remedial actions.
February 20, 2019	The Corps, via electronic correspondence, responds to the Service regarding the thresholds for remedial actions.

February 21, 2019	The Corps, via electronic correspondence, responds to the Service's inquiries regarding TOY restrictions for red knots.
February 27, 2019	The Service, via electronic correspondence to the Corps, transmits the Draft RPMs and Terms and Conditions.
March 1, 2019	The Corps, via electronic correspondence, provides their comments on the Draft RPMs and Terms and Conditions to the Service.
March 7, 2019	The Service, via electronic correspondence to the Corps, responds to the Corps' comments on the Draft RPMs and Terms and Conditions.
March 13, 2019	The Corps, via electronic correspondence, provided additional comments on the Draft RPMs and Terms and Conditions to the Service.
March 19, 2019	The Service and Corps, via several electronic correspondences, coordinated on the development of a beach management plan; the sequence of construction activities; specifics of piping plover monitoring; and NPS' input on the Reasonable and Prudent Measures.
March 20, 2019	The Service, via electronic correspondence to the Corps, provided a list of tasks/deliverables for each agency to complete as part of this consultation. The Service and Corps also coordinated on proposed beach/berm widths and vegetation management.
March 26, 2019	The Corps, via electronic correspondence, provided a breakdown of the daily schedule of construction activities.
April 26, 2019	The Corps, via written correspondence dated April 25, 2019, provided comments on the biological opinion's reasonable and prudent measures and terms and conditions.
June 25, 2019	The Service issues an amended biological opinion in response to the Corps'comments.

XX. LITERATURE CITED

Alegria-Arzaburu, A.R., I. Mariño-Tapia, R. Silva, and A. Pedrozo-Acuña. 2013. Post-Nourishment Beach Scarp Morphodynamics. *Journal of Coastal Research* Special Issue 65.

Anders, F.J., and S.P. Leatherman. 1987. Disturbance of Beach Sediment by Off-Road Vehicles. *Environmental Geology and Water Science*s 9:183–189.

Andersson, M., J. Wallander, and D. Isaksson. 2009. Predator Perches: A Visual Search Perspective. *Functional Ecology* 23:373–379.

Bent, A.C. 1929. Life Histories of North American Shorebirds. *U.S. Natural Museum Bulletin* 146:232–246.

Bilkovic, D.M., and M.M. Mitchell. 2013. Ecological Trade Offs of Stabilized Saltmarshes as a Shoreline Protection Strategy: Effects of Artificial Structures on Macrobenthic Assemblages. *Ecological Engineering* 61:469–481.

Bilkovic, D.M., M. Mitchell, P. Mason, and K. Duhring. 2016. The Role of Living Shorelines as Estuarine Habitat Conservation Strategies. Special Issue (Conserving Coastal and Estuarine Habitats) in *Coastal Management Journal* 44:161–174.

Bosch, J., C. Foley, L. Lipinski, C. McCarthy, J. McNamara, A. Naimaster, A. Raphael, A. Yang, and A. Baldwin. 2006. Constructed Wetlands for Shoreline Erosion Control: Field Assessment and Data Management. Final Report. Baltimore, Maryland: Maryland Department of the Environment, Wetlands and Waterways Program. 76 pp.

Burger, J. 1991. Foraging Behavior and the Effect of Human Disturbance on the Piping Plovers (*Charadrius melodus*). *Journal of Coastal Research* 7:39–52.

Cairns, W.E. 1977. Breeding Biology of Piping Plovers in Southern Nova Scotia. M.S. Thesis. Dalhousie University, Halifax, Nova Scotia. 115 pp.

Climate Change Science Program (also referenced as CCSP). 2009. Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. J.G. Titus, coordinating lead author. Environmental Protection Agency, Washington, D.C.

Cohen, J.B. 2005. Factors Limiting Piping Plover Nesting Pair Density and Reproductive Output on Long Island, New York. Ph.D. Dissertation. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 251 pp.

Cohen, J.B., E.H. Wunker, and J.D. Fraser. 2008. Substrate and Vegetation Selection by Nesting Piping Plovers. *The Wilson Journal of Ornithology* 120(2):404–407.

Cohen, J.B., L.M. Houghton, and J.D. Fraser. 2009. Nesting Density and Reproductive Success of Piping Plovers in Response to Storm- and Human- Created Habitat Changes. *Wildlife Monographs* 173:1–24.

Colwell, M.A., S.J. Hurley, J.N. Hall, and S.J. Dinsmore. 2007. Age-Related Survival and Behavior of Snowy Plover Chicks. *The Condor* 109:638–647.

Coutu, S.D., J.D. Fraser, J.L. McConnaughey, and J.P. Loegering. 1990. Piping Plover Distribution and Reproductive Success on Cape Hatteras National Seashore. Unpublished Report submitted to the National Park Service. 67 pp.

Cross, R.R. 1990. Monitoring Management and Research of the Piping Plover at Chincoteague National Wildlife Refuge. Unpublished Report. Virginia Department of Game and Inland Fisheries, Richmond, Virginia. 68 pp.

Defeo, O., A. McLachlan, D.S. Schoeman, T. Schlacher, J.E. Dugan, A. Jones, M. Lastra, and F. Scapini. 2009. Threats to Sandy Beach Ecosystems: A Review. *Estuarine, Coastal, and Shelf Science* 81(1):1–12.

DeRose-Wilson, A.L., K.L. Hunt, J.D. Monk, D.H. Catlin, S.M. Karpanty, and J.D. Fraser. 2018. Piping Plover Chick Survival Negatively Correlated with Beach Recreation. *Journal of Wildlife Management* 82(8):1608–1616.

Douglas, B.C., M. Kearney, and S. Leatherman. 2001. Sea-Level Rise: History and Consequences. Academic Press, Inc., New York, New York.

Dugan, J.E., D.M. Hubbard, M.D. McCrary, and M.O. Pierson. 2003. The Response of Macrofauna Communities and Shorebirds to Macrophyte Wrack Subsidies on Exposed Sandy Beaches of Southern California. *Estuarine, Coastal, and Shelf Science* 58:25–40.

Dugan, J.E., and D.M. Hubbard. 2010. Ecological Responses to Coastal Armoring on Exposed Sandy Beaches. *Shore & Beach* 74(1):10–16.

Dugan J.E., L. Airoldi, M.G. Chapman, S.J. Walker, and T. Schlacher. 2011. *In* E. Wolanski and D. McLusky, eds. Estuarine and Coastal Structures: Environmental Effects, a Focus on Shore and Nearshore Structures. Treatise on Estuarine and Coastal Science. Academic Press, pp. 17–41.

Duhring, K.A. 2008. A Comparison of Structural and Nonstructural Methods for Erosion Control and Providing Habitat in Virginia Saltmarshes. Proceedings of the 2006 Living Shoreline Summit (Williamsburg, Virginia), Gloucester Point, Virginia: Coastal Resources Commission (CRC) Publication No. 08-164, pp. 41–47.

eBird.org. 2018. eBird: An online database of bird distribution and abundance [web application]. Cornell Lab of Ornithology, Ithaca, New York. Available online at: <http://www.ebird.org/>.

Elias-Gerken, S.P. 1994. Piping Plover Habitat Suitability on Central Long Island, New York Barrier Islands. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 247 pp.

Elias, S.P., J.D. Fraser, and P.A. Buckley. 2000. Piping Plover Brood Foraging Ecology on New York Barrier Islands. *Journal Wildlife Management* 64(2):346–354.

Flemming, S.P., R.D. Chiasson, P.C. Smith, P.J. Austin-Smith, and R.P. Bancroft. 1988. Piping Plover Status in Nova Scotia Related to its Reproductive and Behavioral Responses to Human Disturbance. *Journal of Field Ornithology* 59(4):1–330.

Galbraith, H., R. Jones, R. Park, J. Clough, S. Herrod-Julius, B. Harrington, and G. Page. 2002. Global Climate Change and Sea-Level Rise: Potential Losses of Intertidal Habitat for Shorebirds. *Waterbirds* 25:173–183.

Goldin, M.R. 1993. Effects of Human Disturbance and Off-Road Vehicles on Piping Plover Reproductive Success and Behavior at Breezy Point, Gateway National Recreation Area, New York. M.S. Thesis. University of Massachusetts, Department of Forestry and Wildlife Management.

Gomez-Serrano, A.M., and P. Lopez-Lopez. 2014. Nest Site Selection by Kentish Plover Suggests a Trade-Off between Nest-Crypsis and Predator Detection Strategies. PLOS One 9(9):1–9.

Hoopes, E.M. 1993. Relationship Between Human Recreation and Piping Plover Foraging Ecology and Chick Survival. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 106 pp.

Hoopes, E.M., C.R. Griffin, and S.M. Melvin. 1992. Atlantic Coast Piping Plover Winter Distribution Survey. Unpublished Report submitted to the USFWS, Sudbury, Massachusetts. 6 pp.

Hopkinson, C.S., A.E. Lugo, M. Alber, A.P. Covich, and S.J. Van Bloem. 2008. Forecasting Effects of Sea-Level Rise and Windstorms on Coastal and Inland Ecosystems. *Frontiers in Ecology and Environment* 6:255–263.

Hubbard, D.M., and J.E. Dugan. 2003. Shorebird Use of An Exposed Sandy Beach in Southern California. *Estuarine, Coastal, and Shelf Science* 58:41–54.

Intergovernmental Panel on Climate Change [IPCC]. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Cambridge University Press, Cambridge, United Kingdom, and New York, New York.

Karpanty, S.M., J. Cohen, J.D. Fraser, and J. Berkson. 2011. Sufficiency of Horseshoe Crab Eggs for Red Knots During Spring Migration Stopover in Delaware Bay, United States of America. *Journal of Wildlife Management* 75(5):984–994.

Kluft, J.M., and H.S. Ginsburg. 2009. The Effect of Off-Road Vehicles on Barrier Beach Invertebrates at Cape Cod and Fire Island National Seashores. Technical Report NPS/NER/NRTR—2009/138. Boston, Massachusetts.

Koivula, K., and A. Ronka. 1998. Habitat Deterioration and Efficiency of Antipredator Strategy in a Meadow-Breeding Wader, Temminck's Stint (*Calidris temminckii*). *Oecologia* 116:348–355.

Loegering, J.P. 1992. Piping Plover Breeding Biology, Foraging Ecology, and Behavior on Assateague Island National Seashore, Maryland. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 247 pp.

Loegering, J.P., and J.D. Fraser. 1995. Factors Affecting Piping Plover Chick Survival in Different Brood-Rearing Habitats. *Journal of Wildlife Management* 59(4):646–655.

MacIvor, L.H. 1990. Population Dynamics, Breeding Ecology, and Management of Piping Plovers on Outer Cape Cod, Massachusetts. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 100 pp.

Massachusetts Barrier Beach Task Force. 1994. Guidelines for Barrier Beach Management in Massachusetts. Massachusetts Coastal Zone Management Program, Boston, Massachusetts. 265 pp.

Murdock, N. 1993. Endangered and Threatened Wildlife and Plants: *Amaranthus pumilus* (Seabeach Amaranth) Determined to be Threatened. U.S. Department of the Interior, Fish and Wildlife Service, *Federal Register* 58(65):18035–18042.

New York City Department of Parks and Recreation [NYCDPR]. 2017. Rockaway Beach Endangered Species Nesting Area. 2017 Final Report. Wildlife Unit. 31 pp.

Nicholls, J.L. 1989. Distribution and Other Ecological Aspects of Piping Plovers (*Charadrius melodus*) Wintering Along the Atlantic and Gulf Coasts. M.S. Thesis. Auburn University, Auburn, Alabama. 150 pp.

Niles, L.J., H.P. Sitters, A.D. Dey, P.W. Atkinson, A.J. Baker, K.A. Bennett, R. Carmona, K.E. Clark, N.A. Clark, and C. Espoza. 2008. Status of the Red Knot (*Calidris canutus rufa*) in the Western Hemisphere. *Studies in Avian Biology* 36:1–185.

Patterson, M.E. 1988. Piping Plover Breeding Biology and Reproductive Success in Assateague Island. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 131 pp.

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D3
Essential Fish Habitat Assessment for Federally-Managed Fisheries Species

December 2018

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Purpose and Objective of the Essential Fish Habitat Assessment 1
1.2 Project Background 3
1.3 Project Area Description 3
2 PROPOSED FEDERAL ACTION 4
2.1 Study Objectives 4
2.2 Recommended Plan Description 5
2.3 Recommended Plan: Atlantic Shorefront 5
2.4 Recommended Plan: Jamaica Bay 11
2.4.1 Cedarhurst-Lawrence 11
2.4.2 Mid-Rockaway - Edgemere Area 13
2.4.3 Mid-Rockaway - Arverne Area 16
2.4.4 Mid-Rockaway - Hammels Area 20
2.5 Project Elements 22
2.5.1 The Atlantic Shorefront Beachfill 23
2.5.2 Atlantic Shorefront: Construction of New Groins and Groin Extensions 24
2.5.3 Sand Removal from Offshore Borrow Area 25
2.6 Reasonably Foreseeable Future Actions 26
3 EFH DESIGNATIONS AND LIFE HISTORIES OF MANAGED FISH SPECIES 27
3.1 New England Species 30
3.1.1 Atlantic salmon (*Salmo salar*) 30
3.1.2 pollock (*Pollachius virens*) 30
3.1.3 clearnose skate (*Raja eglanteria*) 30
3.1.4 Atlantic cod (*Gadus morhua*) 30
3.1.5 red hake (*Urophysic chuss*) 31
3.1.6 winter flounder (*Pleutonectes americanus*) 31
3.1.7 windowpane flounder (*Scopthalmus aquosus*) 31
3.1.8 Atlantic herring (*Clupea harengus*) 32
3.1.9 monkfish (*Lophius americanus*) 32
3.1.10 little skate (*Leucoraja erinacea*) 32
3.1.11 winter skate (*Leucoraja ocellata*) 33
3.1.12 yellowtail Flounder (*Limanda ferruginea*) 33
3.2 Mid-Atlantic Species 33
3.2.1 bluefish (*Pomatomus saltatrix*) 33
3.2.2 long finned squid (*Loligo pealei*) 33

3.2.3 Atlantic butterfish (*Peprilus triacanthus*) 34
3.2.4 Atlantic mackerel (*Scomber scrombrus*) 34
3.2.5 summer flounder (Paralichthys denntatus) 34
3.2.6 scup (*Stenotomus chrysops*) 34
3.2.7 black sea bass (*Centropristus striata*) 35
3.2.8 spiny dogfish (*Squalus acanthias*) 35
3.3 Coastal Migratory Pelagic Species 35
3.3.1 king mackerel (*Scomberomorus cavalla*) 36
3.3.2 spanish mackerel (*Scomberomorus maculates*) 36
3.3.3 cobia (*Rachycentron canadum*) 36
3.4 Highly Migratory Species 36
3.4.1 sand tiger shark (*Odontaspis taurus*) 36
3.4.2 dusky shark (*Charcharinus obscurus*) 36
3.4.3 sandbar shark (*Charcharinus plumbeus*) 36
3.4.4 white shark (*Carcharodon carcharias*) 36
3.4.5 smoothhound shark (Atlantic Complex) (*Mustelus mustelus*) 37
3.4.6 skipjack tuna (*Katsuwonus pelamis*) 37
3.4.7 bluefin tuna (*Thunnus thynnus*) 37
4 EFFECTS ON EFH SPECIES IN THE PROJECT AREA 38
4.1 Impingement and/or Entrainment 38
4.1.1 Atlantic Shorefront 38
4.1.2 Jamaica Bay 38
4.2 Burial and Sedimentation 39
4.2.1 Atlantic Shorefront 39
4.2.2 Jamaica Bay 39
4.3 Habitat Loss and Fragmentation 40
4.3.1 Atlantic Shorefront 40
4.3.2 Jamaica Bay 41
4.4 Hydroacoustics 43
4.4.1 Atlantic Shorefront 43
4.4.2 Jamaica Bay 43
5 POTENTIAL DIRECT/INDIRECT IMPACTS, CUMULATIVE, AND MITIGATION 44
5.1 Direct Impacts 44
5.1.1 Atlantic Shorefront 44
5.1.2 Jamaica Bay 44
5.2 Indirect Impacts 45
5.2.1 Atlantic Shorefront 45

5.2.2 Jamaica Bay 46
5.3 Cumulative Impacts 47
5.4 Mitigation 47
5.4.1 Restoration / Creation of Low and High Marsh Habitats 48
5.4.2 Creation of Rock Sill Features 48
5.4.3 Evaluation of Planned Wetland Analysis 48
6 EFH CONSERVATION MEASURES AND CONCLUSION 50
7 REFERENCES 51

LIST OF TABLES

Table 1: Cedarhurst-Lawrence Outlet Table 11
Table 2: Edgemere Outlet Table 14
Table 3: Arverne Outlet Table 18
Table 4: Hammels Outlet Table 20
Table 5: Initial Construction Beachfill Quantities 24
Table 6: Summary of Groin Lengths 25
Table 7: 10' x 10' EFH Designated Coordinates 27
Table 8: Designated EFH Species and Life Stages – Atlantic Shorefront 28
Table 9: Designated EFH Species and Life Stages – Jamaica Bay 29
Table 10: Permanent Habitat Impacts - Acreage 42
Table 11: Temporary Habitat Impacts – Acreage 42
Table 12: Restoration, Creation & Enhancement – Acreage 43
Table 13: EPW Functional Assessment – FCU Losses 49
Table 14: EPW Functional Assessment – FCU Gains 49

LIST OF FIGURES

Figure 1 Project Area Location 2
Figure 2a: Atlantic Ocean Shorefront Component of Recommended Plan (1 of 4) 7
Figure 2b: Atlantic Ocean Shorefront Component of Recommended Plan (2 of 4) 8
Figure 2c: Atlantic Ocean Shorefront Component of Recommended Plan (3 of 4) 9
Figure 2d: Atlantic Ocean Shorefront Component of Recommended Plan (4 of 4) 10
Figure 3: Cedarhurst-Lawrence HFFRRF Project Plan 12
Figure 4: Mid Rockaway – Edgemere Area HFFRRF Project Plan 15
Figure 5: Mid Rockaway – Arverne Area HFFRRF Project Plan 19
Figure 6: Mid Rockaway – Hammels Area HFFRRF Project Plan 21
Figure 7: Composite Seawall Beach 19th St. to Beach 126th St 23
Figure 8: Composite Seawall Beach 126th St. to Beach 149th St. 23
Figure 9: Location of the East Rockaway Borrow Area 26

LIST OF APPENDICES

Appendix A. EFH Assessment Worksheets

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

General Reevaluation Report and Environmental Impact Statement

Appendix I Environmental Impacts

1 INTRODUCTION

1.1 Purpose and Objective of the Essential Fish Habitat Assessment

The regional fisheries management councils, with assistance from National Marine Fisheries Service (NMFS), are required under the 1996 amendments to Magnuson-Stevens Fishery Management and Conservation Act to delineate Essential Fish Habitat (EFH) for all managed species, minimize to the extent practicable adverse effects on EFH caused by fishing, and identify other actions to encourage the conservation and enhancement of EFH.

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (NMFS 2016a). In addition, the presence of adequate prey species is one of the biological properties that can define EFH. The regulations further clarify EFH by defining "waters" to include aquatic areas that are used by fish (either currently or historically) and their associated physical, chemical, and biological properties; "substrate" to include sediment, hard bottom, and structures underlying the water; areas used for "spawning, breeding, feeding, and growth to maturity" to cover a species' full life-cycle; and "prey species" as being a food source for one or more designated fish species (NMFS 2016b).

Pursuant to Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act, Federal agencies are required to consult with the NMFS regarding any action they authorize, fund, or undertake that may adversely affect EFH. For assessment purposes, an adverse effect has been defined in the Act as follows: "Any impact which reduces the quality and/or quantity of EFH. Adverse effects may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species fecundity), site specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions."

The objective of this EFH assessment is to describe the potential adverse effects to designated EFH for federally-managed fisheries species within the project site. It will also describe the conservation measures proposed to avoid, minimize or otherwise offset potential adverse effects to designated EFH resulting from the recommended plan.

Figure 1 Project Area Location

1.2 Project Background

Rockaway, New York, has an extensive history of property damage and economic loss as a result of coastal flooding and erosion associated with frequent storms. Significant beach erosion and sand loss has reduced the width of the protective beach front and has exposed properties to a high risk of damage from ocean flooding and wave attack, and existing groins and jetties along the island have deteriorated and are becoming less effective at reducing sand loss along the shoreline and providing wave protection. Non-shorefront flooding in Rockaway is attributed to storm surges in Jamaica Bay inundating the bay shorelines of Rockaway (Back Bay Flooding) and storm surges that overtop the high elevations located near the Rockaway beachfront flowing across the peninsula to meet the surge into Jamaica Bay (Cross Shore Flooding).

The Reformulation Study for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay was authorized by the House of Representatives, dated 27 September 1997, as stated within the Congressional Record for the US House of Representatives. It states, in part:

> *"With the funds provided for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York project, the conferees direct the Corps of Engineers to initiate a reevaluation report to identify more cost-effective measures of providing storm damage protection for the project. In conducting the reevaluation, the Corps should include consideration of using dredged material from maintenance dredging of East Rockaway Inlet and should also investigate the potential for ecosystem restoration within the project area."*

Public Law 113-2 (29Jan13), The Disaster Relief Appropriations Act of 2013 (the Act), was enacted in part to "improve and streamline disaster assistance for Hurricane Sandy, and for other purposes". The Act directed the Corps of Engineers to:

> *"…reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy" (PL 113-2).*

In partial fulfillment of the requirements detailed within the Act, the Corps produced a report assessing "authorized Corps projects for reducing flooding and storm risks in the affected area that have been constructed or are under construction". The East Rockaway Inlet to Rockaway Inlet, NY project met the definition in the Act as a constructed project. In accordance with the Act, the Corps is proceeding with an Integrated Hurricane Sandy General Reevaluation Report (HSGRR) and Environmental Impact Statement (EIS) to address resiliency, efficiency, risks, environmental compliance, and long-term sustainability within the study area.

1.3 Project Area Description

The communities located on the Rockaway peninsula from west to east include Breezy Point, Roxbury, Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammel, Arverne, Edgemere and Far Rockaway. The former Fort Tilden Military Reservation and the Jacob Riis Park (part of the Gateway National Recreation Area) are located in the western half of the peninsula between Breezy Point and Neponsit. The characteristics of nearly all of the communities on the Rockaway peninsula

are similar. Ground elevations rarely exceed 10 feet, except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from 5 feet, increasing to 10 feet further south toward the Atlantic coast. An estimated 7,900 residential and commercial structures on the peninsula fall within the FEMA regulated 100-year floodplain.

During Hurricane Sandy, tidal waters and waves directly impacted the Atlantic Ocean shoreline. Tidal waters amassed in Jamaica Bay by entering through Rockaway Inlet and by overtopping and flowing across the Rockaway Peninsula. Effective coastal storm risk management for communities within the study area requires reductions in risk from two sources of coastal storm damages: inundation, wave attack with overtopping along the Atlantic Ocean shorefront of the Rockaway peninsula and flood waters amassing within Jamaica Bay via the Rockaway Inlet.

The study area (Figure 1), consisting of the Atlantic Coast of New York City between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York is vulnerably located within the Federal Emergency Management Agency (FEMA) regulated 100-year floodplain. The shorefront area, which is a peninsula approximately 10 miles in length, generally referred to as Rockaway, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, New York City, and a section at the eastern end, known as Head-of-Bay, lies in Nassau County. More than 850,000 residents, 48,000 residential and commercial structures, and scores of critical infrastructure features such as hospitals, nursing homes, wastewater treatment facilities, subway, railroad, and schools are within the study area

The project area consists of mosaic of native as well as highly modified habitats as a result of human development. Upland areas in the vicinity of the Project have been committed to residential, commercial and recreational development. Near shore and upper beach areas in the project area are heavily utilized for beach recreation. Numerous stone groins currently exist in the project area. The shoreline has been stabilized since the 1880s with beach fill, groins, bulkheads, and a stone jetty at Rockaway Inlet.

2 PROPOSED FEDERAL ACTION

The Recommended Plan is a component of the USACE response to the unprecedented destruction and economic damage to communities within the study area caused by Hurricane Sandy. The recommendations herein include a systems-based approach for coastal storm risk management that provides a plan for the entire area, which has been formulated with two planning reaches to identify the most efficient solution for each reach. Project partners include the New York State Department of Environmental Conservation, the New York City (NYC) Mayor's Office of Recovery and Resiliency, the NYC Department of Parks and Recreation, the NYC Department of Environmental Protection, and the National Park Service.

2.1 Study Objectives

Five principal planning objectives have been identified for the study, based upon a collaborative planning approach. These planning objectives are intended to be achieved throughout the study period, which is from 2020 – 2070:

1. Reduce vulnerability to storm surge impacts;
2. Reduce future flood risk in ways that will support the long-term sustainability of the

coastal ecosystem and communities;

3. Reduce the economic costs and risks associated with large-scale flood and storm events;
4. Improve community resiliency, including infrastructure and service recovery from storm effects
5. Enhance natural storm surge buffers and improve coastal resilience.

2.2 Recommended Plan Description

The Coastal Storm Risk Management (CSRM) Recommended Plan for the area from East Rockaway Inlet to Rockaway Inlet and the lands within and surrounding Jamaica Bay New York consists of the following components, which are generally described for 2 Planning Reaches: 1) A reinforced dune and Berm Construction, in conjunction with groins in select locations along the Atlantic Ocean Shoreline; 2) High Frequency Flood Risk Reduction Features (HRFRRF) features in locations surrounding Jamaica Bay. In general, these features are intended to provide a design height of +6 ft NAVD through various methods to reduce frequent flooding. As HRFRRF features are further developed, additional NEPA documentation and resource agency coordination would be provided, as necessary. This Recommended Plan description includes the maximum footprint for the plan; however, the footprint may be reduced in scope based on public and agency comments as well as new information.

2.3 Recommended Plan: Atlantic Shorefront

The general approach to developing CSRM along Rockaway Beach (between Beach 9th Street and Beach 169th Street, which the east and west tapers are included) was to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective renourishment approach prior to the evaluation of alternatives for coastal storm risk management. The most cost-effective erosion control alternative is beach restoration with increased erosion control. This constitutes of a beach berm width of 60ft at an elevation of +8ft NAVD88 constructed by a beach fill quantity of 1.6 million CY for the initial placement and with a 4-year 1,021,000 CY renourishment cycle, as needed, for the life of the project (50 years). In addition, a screening analysis was performed to evaluate the level of risk reduction provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with the beach restoration with increased erosion control to optimize CSRM at Rockaway Beach. A composite seawall was selected as the best coastal storm risk management alternative. The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding. The Recommended Plan spans from Beach 20th Street to Beach 149th Street (Reach 3 through Reach 6b) and combines Beach Restoration and Erosion Control and two tapered beach sections at both the east and west end of the project (Beach 9-19, and Beach 150-Beach 169, respectively), which are described below. In summary, the Recommended Plan has the following features:

- A composite seawall with a structure crest elevation of +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet;
- A beach berm elevation of +8 ft NAVD and a depth of closure of -25 ft NAVD;

- A total beach fill quantity of 1.6 million cy for the initial placement, including tolerance, overfill and advanced nourishment with a 4-year renourishment cycle of 1,021,00 cy, resulting in a minimum berm width of 60 feet;
- Extension of 5 existing groins; and
- Construction of 13 new groins.

The east beachfill taper is approximately 3,000 ft in shorefront length from Beach 19th Street east to Beach 9th Street. The taper comprises of approximately 1,000 ft of dune and beach taper including reinforced dune feature and approximately 2,000 ft of dune and beach fill without reinforced dune feature. In addition to the tapering of berm width, the dune elevation also tapers from an elevation of +18 ft NAVD at 19th Street down to approximately +12 ft NAVD at Beach 9th Street which will be tied into the existing grade. The west beachfill taper is approximately 5,000 ft in shorefront length from Beach 149th Street west to Beach 169th street fronting Riis Park. The beachfill taper will be beach fill only with a berm width tapered from the design width at 149th Street to the existing width and height at 169th Street. In addition to the beachfill taper, a tapered groin system comprised of three (3) rock groins is included for this section.

Figures 2a through 2d show the Atlantic Ocean Shorefront component of the Recommended Plan.

Figure 2a: Atlantic Ocean Shorefront Component of Recommended Plan (1 of 4)

Figure 2b: Atlantic Ocean Shorefront Component of Recommended Plan (2 of 4)

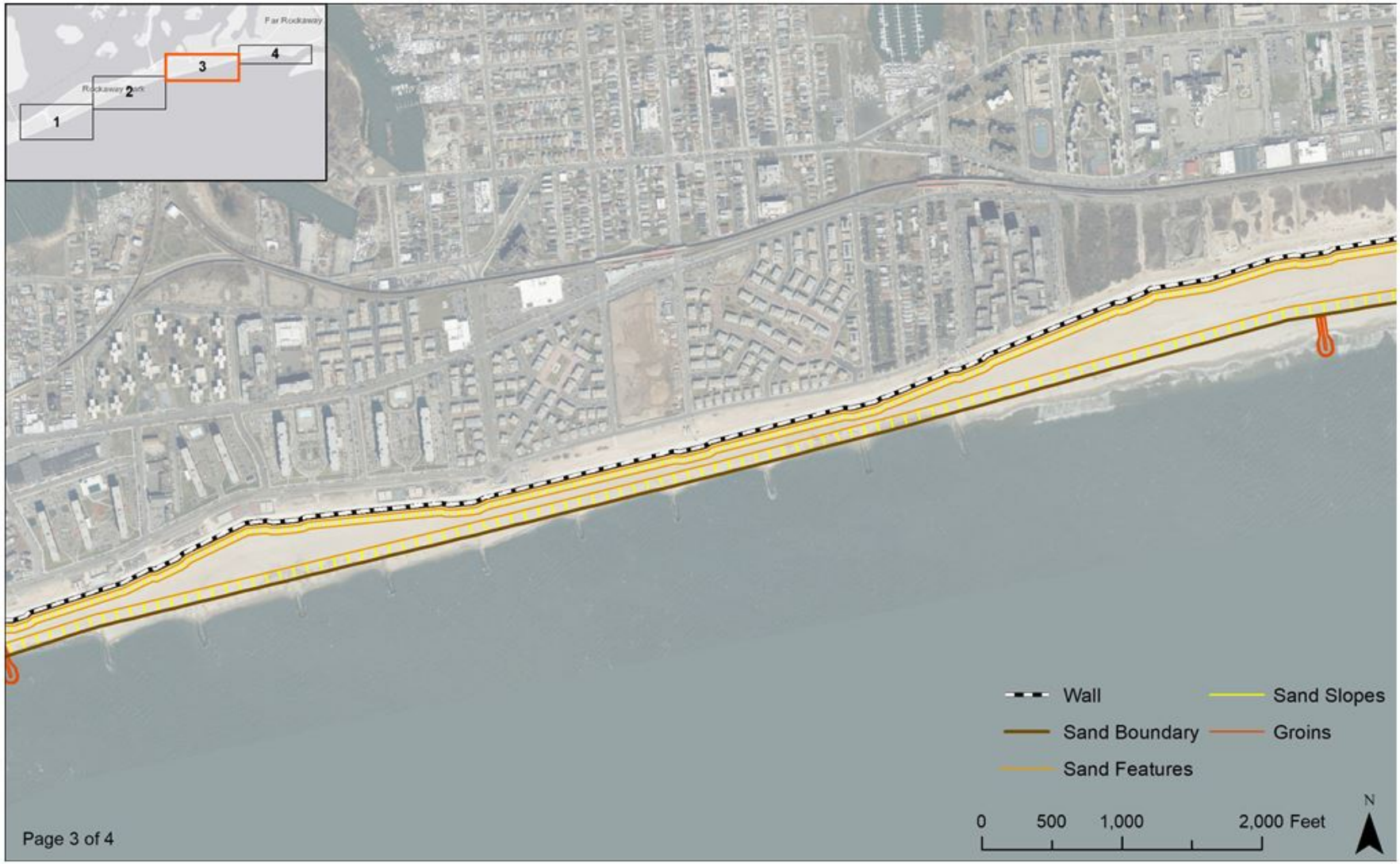


Figure 2c: Atlantic Ocean Shorefront Component of Recommended Plan (3 of 4)

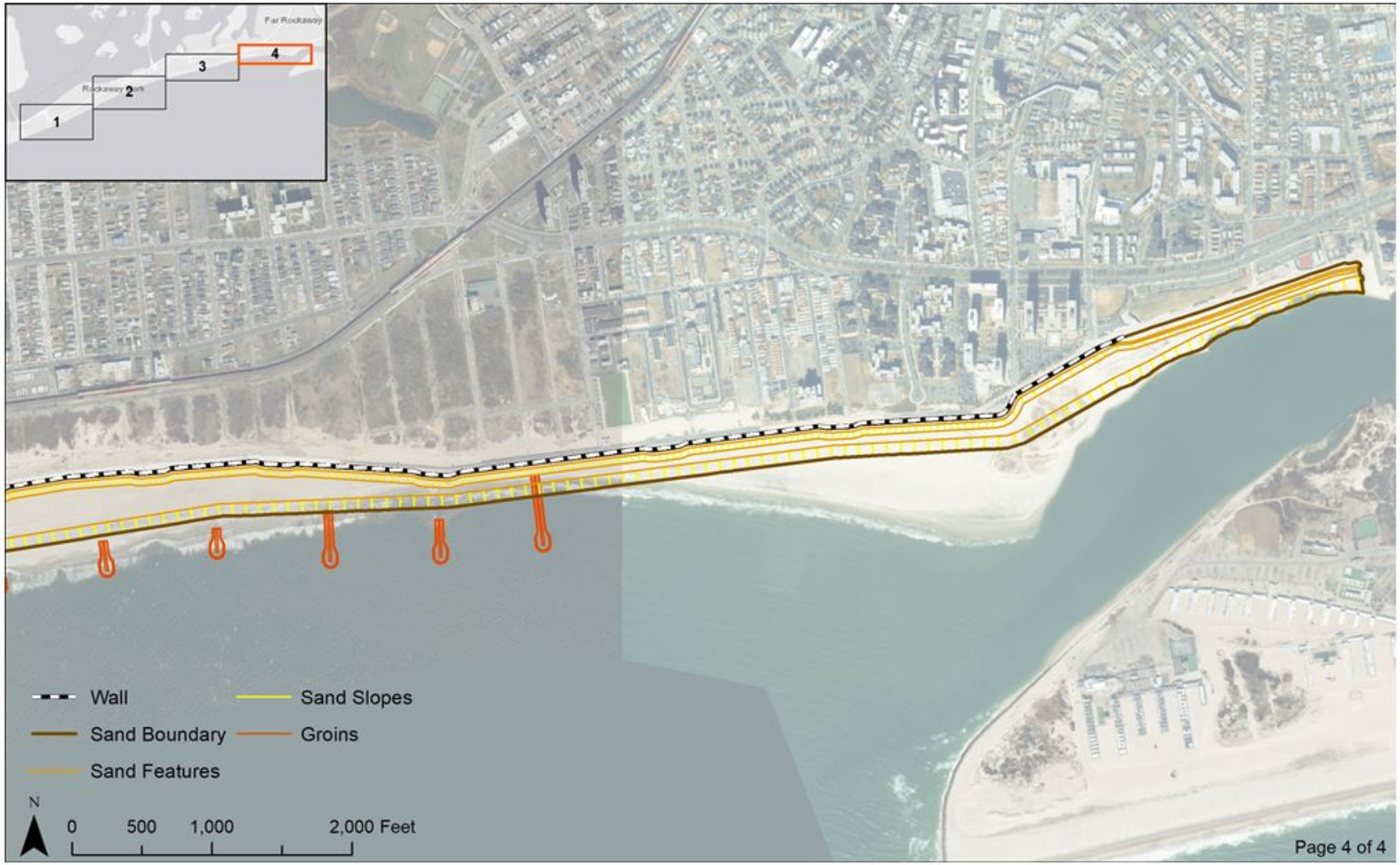


Figure 2d: Atlantic Ocean Shorefront Component of Recommended Plan (4 of 4)

2.4 Recommended Plan: Jamaica Bay

2.4.1 Cedarhurst-Lawrence

The Cedarhurst-Lawrence project (Figure 3) begins on the east side of the channel near the driveway to Lawrence High School. It consists of approximately 1000 feet of deep bulkhead that follows the existing bulkhead line around the southern end of the channel at Johnny Jack Park, and continues north along the west side before being connected to high-ground behind the Five Towns Mini Golf & Batting Facility with a 23 foot segment of medium floodwall. The project is located in Nassau County and crosses the border between the Village of Cedarhurst and the town of Hempstead. Project design elevations have preliminarily been established based on expected wave exposure are set at an elevation of +10.0ft NAVD88.

There are three existing outfalls in the area where the bulkhead will be raised. Each of the outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The outlet pipes will be replaced if the design phase indicates it is necessary. Drainage along the landward side of the bulkhead will be provided by a small ditch or drainage collection pipe, with inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station capacity is estimated to be approximately 40 cubic feet per second (cfs), which will be refined during the design phase.

Table 1: Cedarhurst-Lawrence Outlet Table

Drainage Area	Outfall Size	Outfall Location
Drainage Basin L1	TBD	Existing Outfall
Drainage Basin L1	TBD	Existing/New Culvert (500 feet from Peninsula Boulevard).
Drainage Basin L1	TBD	Existing/New Culvert (500 feet from Peninsula Boulevard).
Drainage Basin L1	5'x3'	Outfall L-1, Approximately 250 feet from Peninsula Boulevard

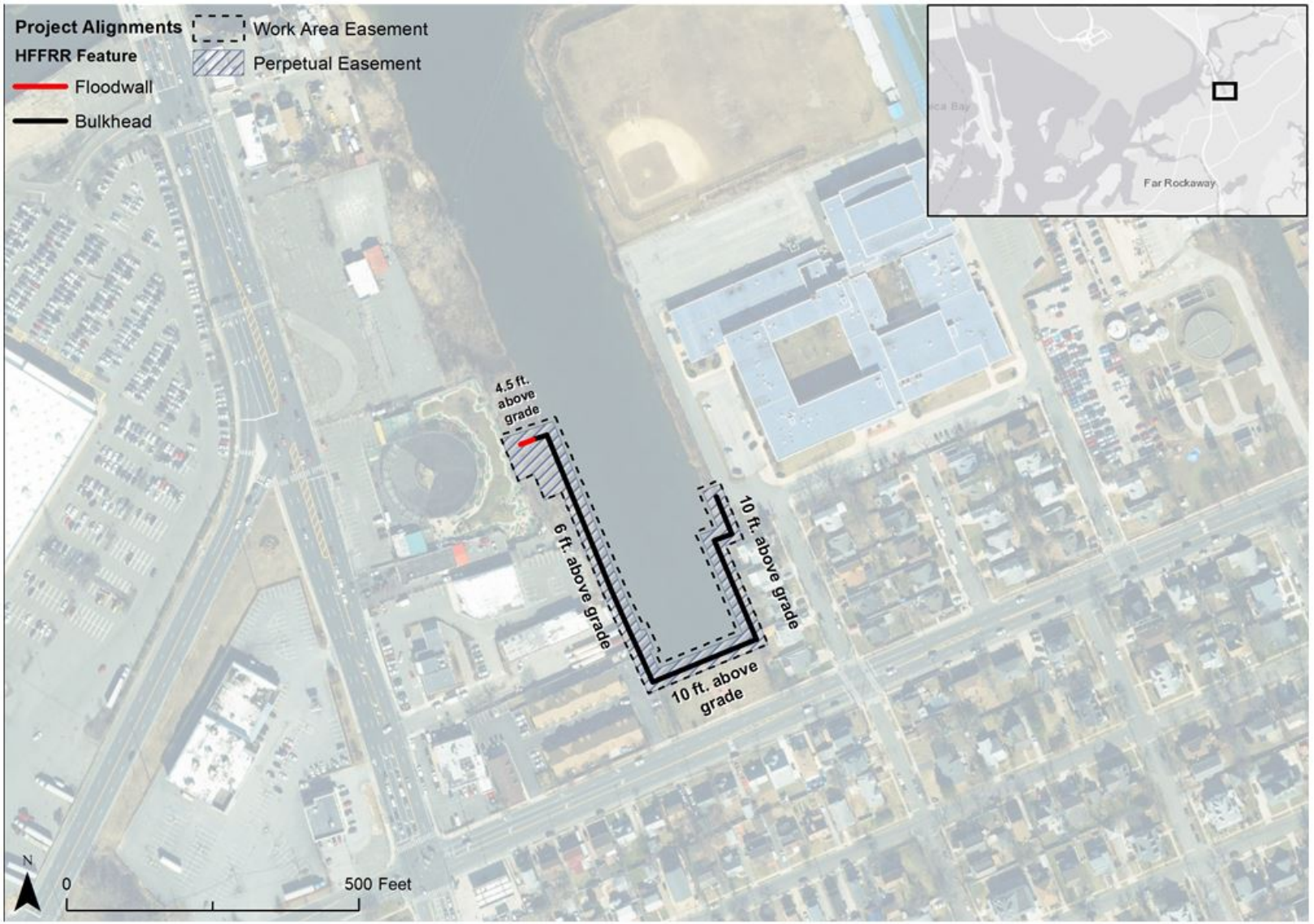


Figure 3: Cedarhurst-Lawrence HFFRRF Project Plan

2.4.2 Mid-Rockaway - Edgemere Area

The eastern end of the project area (Figure 4) begins at high ground near the intersection of Beach Channel Drive and Beach 35th Street. The project moves north and then west following parallel to Beach 35th Street before jogging to the north and crossing the abandoned portion of Beach 38th Street and continuing west. The project turns north and runs along the peninsula between Beach 43rd Street and the coastal edge. This approximately 3,200 foot section of hybrid berm has been maintained as far landward as possible and weaves in and out between the properties. The hybrid berm is strategically used at these locations to minimize and avoid impacts to existing healthy wetland habitats. This area has also been identified as a good candidate for the use of Natural and Nature Based Features (NNBFs). The NNBF design includes placement of a stone toe protection and rock sill structure just off the existing shoreline to attenuate wave action and allow tidal marsh to establish between the rock sill and the berm. In some locations the eroded/degraded shoreline (subtidal) will be regraded to allow for the development of low marsh (smooth cordgrass) to provide productive nursery habitats behind the sill structures. The shore slope behind the structure will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for establishment of a high tidal marsh, designated as scrub shrub areas in the figure. In addition, the graded habitat behind the structure will be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems. On the north east of the Edgemere peninsula the project then transitions into 200 feet of shallow bulkhead, which continues north along existing water front properties and bulkheads. Approximately 200' of medium floodwall then cuts west across, at the tip of the Edgemere peninsula. A road ramp on Beach 43rd Street has been included to maintain both pedestrian, and vehicle access to the coastal edge at north end of Beach 43rd street. The floodwall continues in southwest direction along the coastline after which it transitions into a 750 foot section of high berm. The berm continues west from Beach 43rd Street before turning south just to the east of the unpaved extension of Beach 44th Street. The project then transitions into a 660 foot section of high floodwall which continues southwest staying as far landwards as possible to avoid an existing restoration project. Near the intersection of Norton Avenue and Beach 46th Street, north of Norton Avenue, the floodwall transitions back into a low berm which runs parallel to Norton Avenue southwest and then turns northwest along Conch Place. The area waterward of this berm has also been identified as a good location for the use of NNBFs and to restore high marsh habitat. Project design elevations vary and have preliminarily been established based on expected wave exposure. Project elevations range between +8.0ft and +9.5t NAVD88.

The Edgemere interior drainage basin has two subbasins, E1 and E2 covering approximately 194 acres and 274 acres, respectively. The Edgemere drainage basin is almost fully developed and predominantly residential, except for a stretch of undeveloped, grassy area along the southern part of E1 and southwestern part of E2. Subbasin E1 was estimated to require 9 outlets, including 2 existing outlets. Subbasin E2 was estimated to require 6 outlets, including 1 existing outlet (See Edgemere Outlet Table). Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage

outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations are desired in the Edgemere Area. Due to the length of the area and difficulties in draining all of the area to a single site, drainage subbasin E1 is proposed to have two pump stations one pump station would be located near Norton Avenue and Beach 49th Street and the other near Beach 43rd Street and Hough Place with a combined capacity of about 210 cfs. Subbasin E2 is proposed to have one pump station located near Beach 38th Street with an estimated capacity of 120 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

Table 2: Edgemere Outlet Table

Drainage Basin	Outfall Size	Outfall Location
Drainage Basin E1	TBD	Existing Outfall ROC-648
Drainage Basin E1	5'x3'	Outfall E1-1 located on Norton Avenue between Beach 47th and 48th Streets.
Drainage Basin E1	5'x3'	Outfall E1-2 located on Norton Avenue between Beach 46th and 45th Streets.
Drainage Basin E1	5'x3'	Outfall E1-3 located on Beach 45th Street north of Hough Place.
Drainage Basin E1	5'x3'	Outfall E1-4 located on the north end of Beach 45th Street.
Drainage Basin E1	5'x3'	Outfall E1-5 located 550 feet north of Hough Place.
Drainage Basin E1	5'x3'	Outfall E1-6 located 500 feet north of Hough Place.
Drainage Basin E1	TBD	Existing Outfall ROC-637
Drainage Basin E1	5'x3'	Outfall E1-7 located north of Beach 40th Street.
Drainage Basin E2	TBD	Existing Outfall ROC-638
Drainage Basin E2	5'x3'	Outfall E2-1 located 50 feet east of Beach 37th Street.
Drainage Basin E2	5'x3'	Outfall E2-2 located 50 feet east of Beach 37th Street.
Drainage Basin E2	5'x3'	Outfall E2-3 located 50 feet east of Beach 36th Street.
Drainage Basin E2	5'x3'	Outfall E2-4 located 50 feet east of Beach 36th Street.
Drainage Basin E2	5'x3'	Outfall E2-5 located between Beach 36th Street and Beach 35th Street.

Figure 4: Mid Rockaway – Edgemere Area HFFRRF Project Plan

2.4.3 Mid-Rockaway - Arverne Area

This area of the project (Figure 5) begins at high ground to the north of Almeda Avenue and Beach 58th Street. An approximately 1,100 foot section of low berm runs south along Beach 58th Street. The berm has been maintained as far landward as possible to avoid healthy habitat. This segment has been identified as a candidate for the use of NNBFs. Much of the area is identified as existing quality wetlands, but a portion of fill area has been identified where intermediate marsh (Salt meadow Hay) will be restored. The project then transitions to an approximately 1,200 foot long medium floodwall which, for feasibility level analysis, is purposefully sited along property boundaries at the southern end of the channel to minimize impacts to the existing waterfront businesses. A road ramp has been included to maintain access to the marina. At the southwest corner of the channel the project transitions to run along the coastal edge north for approximately 1,700 feet. This segment transitions between revetments and bulkheads to match the existing coastline conditions and uses. The portion between Thursby Avenue and Elizabeth Road has been aligned such that it can be integrated into the planned NYC DPR Thursby Basin Park project. Just north of De Costa Avenue, the project transitions to low berm for approximately 1,600 feet and runs west along De Costa Avenue and around the edges of healthy habitat while also creating an area for stormwater storage and a pump station just north of Beach Street. At the corner of De Costa Avenue and Beach 65th Street the low berm transitions into a hybrid berm to minimize habitat impacts. The hybrid berm continues west and then north for 300 feet to the corner of Beach 65th Street and Bayfield Avenue. The project then transitions to a 2,400 foot long shallow bulkhead which travels west along the line of existing bulkheads where they exist and parallel with Bayfield Avenue in areas without existing bulkhead. The bulkhead section ends just west of the corner of Bayfield Avenue and Beach 72nd Street. The area west of Beach 69th Street and the eastern end of De Costa Ave has been identified as a good candidate for NNBF. Based on existing elevations and profiles, a combination of either fill or excavation is used to provide the appropriate elevations shoreward of the rock sills to maximize healthy subtidal habitats, with restoring a transition area for low to high intertidal marsh. Eroded shorelines were replaced with low intertidal (smooth cordgrass) habitats, and transition to either intermediate (salt meadow hay) and/or high marsh (scrub-shrub) habitats. From the end of the bulkhead section the project continues south with a 120 foot section of medium floodwall connecting the bulkhead to a 1,080 foot section of high berm. The berm runs south along Beach 72nd Street and turns west at Hillmeyer Avenue and continues west past the corner of Barbados Drive and Hillmeyer Avenue, where it turns north and transitions to a flood wall to minimize the features footprint. The berm section has been positioned close to the roads to minimize impacts on habitat. The berm section transitions into a high floodwall which goes west and then runs parallel to the coast southwest for 440 feet, ending at a bulkhead section just west of the end of Hillmeyer Avenue. The Brant Point area includes the creation of wetlands between the berm and the rock sills that are placed just off the coastal edge. The rock sill will protect the shoreline where eroded areas will be restored to low marsh habitats protecting the existing high quality habitats shoreward. The areas behind the existing wetlands areas will be graded to provide a transition area to high marsh and then uplands where practical. The existing uplands areas will be replanted as necessary to provide for a high quality maritime forest habitat, with appropriate tree species. South of Hillmeyer Avenue the alignment follows the bulkheaded coastal edge. The project proposes a high frequency flood risk reduction bulkhead feature that follows an existing bulkhead along the coastal edge for approximately 270 feet ending just south of Almeda Avenue. From this point a low floodwall runs parallel with the coastal edge southeast for 700 feet then transitions into a deep

bulkhead. This section of bulkhead continues southeast along the line of existing bulkhead for approximately 540 feet to the end of Thursby Avenue. The project continues as a low floodwall for approximately 1,400 feet, traveling east along Thursby Avenue and then south, parallel with Beach 72nd Street turning west and running along Amstel Boulevard, ending just past Beach 74th street. Two road ramps and one vehicular gate are included to maintain access to the waterfront. The final segment is approximately 250 feet of medium floodwall which runs along the coastal edge and connect the low floodwall to high ground in the west. Project design elevations vary and have preliminarily been established based on the expected wave exposure. Project elevations range between +8.0ft and +11.5t.

The Arverne drainage basin has three subbasins A1, A2, and A3, covering 76 acres, 139 acres, and 209 acres, respectively. The Arverne drainage basin is almost fully developed and predominantly residential, with a few, scattered undeveloped areas. Subbasin A1 was estimated to require 8 outfalls, including 5 existing outfalls. Subbasin A2 was estimated to require 3 outlets. Subbasin A3 was estimated to require 5 outlets, including 3 existing outlets. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts (See Arverne Outlet Table). Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that three pump stations are desired in the Arverne Area. Drainage Subbasin A1 is proposed to have a pump station located adjacent to DE Costa Avenue near Beach 72nd with a capacity of about 70cfs. Subbasin A2 is proposed to have one pump station located on DE Costa Avenue near Beach 63rd Street with an estimated capacity of 180 cfs. Subbasin A3 is proposed to have one pump station located south of Thursby Avenue with an estimated capacity of 300 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlet will be refined during the project design phase.

Table 3: Arverne Outlet Table

Drainage Basin	Outfall Size	Outfall Location
Drainage Basin A1	TBD	Existing Outfall ROC-633
Drainage Basin A1	TBD	Existing Outfall ROC-634
Drainage Basin A1	TBD	Existing Outfall ROC-40062
Drainage Basin A1	5'x3'	Outfall A1-1 located at the end of Hillmyer Avenue.
Drainage Basin A1	5'x3'	Outfall A1-2 located adjacent to Hillmyer Avenue and Barbadoes Avenue.
Drainage Basin A1	TBD	Existing Outfall ROC-658
Drainage Basin A1	5'x3'	Outfall A1-3
Drainage Basin A1	TBD	Existing Outfall ROC-659
Drainage Basin A2	5'x3'	Outfall A2-1 located on Bayfield Avenue 150 feet west of Beach 65th Street.
Drainage Basin A2	5'x3'	Outfall A2-2 located at the east end of DE Costa Avenue.
Drainage Basin A2	5'x3'	Outfall A2-3 located at the east end of Burchell Road.
Drainage Basin A3	TBD	Existing Outfall. Located at the east end of Thursby Avenue.
Drainage Basin A3	TBD'	Existing Outfall ROC-636
Drainage Basin A3	5'x3'	Outfall A3-1 located 250 north of Beach Channel Drive on 58 Street.
Drainage Basin A3	TBD	Existing Outfall ROC-635
Drainage Basin A3	5'x3'	Outfall A3-2 located 50 north of Beach Channel Drive on 58 Street.

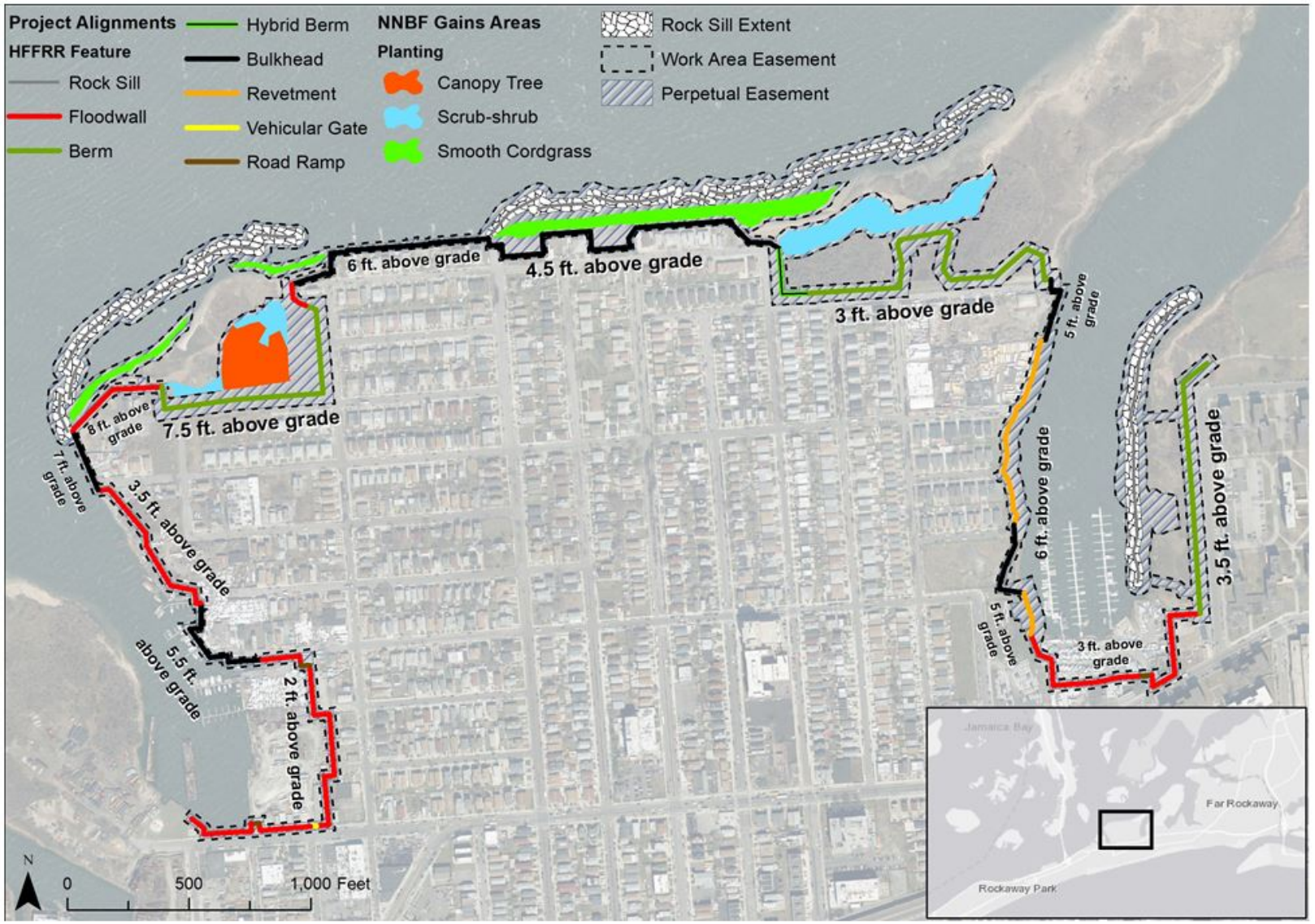


Figure 5: Mid Rockaway – Arverne Area HFFRRF Project Plan

2.4.4 Mid-Rockaway - Hammels Area

Two separate segments compose the Hammels area of the Mid-Rockaway project (Figure 6). The east segment begins approximately 320 feet west of the intersection of Beach 75th Street and Beach Channel Drive. It is composed of approximately 1,400 feet of low floodwall, running west along the north side of Beach Channel Drive, and parallel with the Rockaway Line elevated subway track. Three road ramps have been included to maintain access to the water front properties. The west segment consists of 1,400 feet of low floodwall beginning to the west of the MTA facility Hamels Wye adjacent to the Rockaway Line. The project heads west and south in a stair-step fashion avoiding impacts on existing structures, ending on the north side of Beach Channel Drive just west of Beach 87th Street. Three road ramps have been included to maintain access to the waterfront. Project design elevations have preliminarily been established based on the expected wave exposure, which is expected to be low, and are set at +8.0ft NAVD88.

The Hammels drainage basin includes two subbasins, H1 and H2, approximately 105 acres and 139 acres respectively. The Hammels drainage basin is almost fully developed, except for a few scattered grassy areas and is predominantly residential, with some commercial development. Subbasin H1 was estimated to require 3 outlets, including 2 existing outlets. Subbasin H2 was estimated to require 3 outlets, including 1 existing outlet. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system (See Hammels Outlet Table). The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 ft. wide by 3 ft. high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets. When the drainage outlets are blocked by a storm tide the ditch or pipes will direct runoff towards a pump station. The preliminary pump station analysis indicates that two pump stations are desired in the Hammels Area. Drainage subbasin H1 is proposed to have a pump station located at the southern end of Hammels near Beach 87th Street with a capacity of about 100cfs. Subbasin H2 is also proposed to have one pump station which is located at the northern end of Hammels near Beach Channel Drive with an estimated capacity of 180 cfs. It should be noted that each pump station will include additional gravity capacity that will operate when the pump station is not in operations mode. The capacity of each pump station and drainage outlets will be refined during the project design phase.

Table 4: Hammels Outlet Table

Drainage Area	Outfall Size	Outfall Location
Drainage Basin H1	TBD	Existing Outfall ROC-656
Drainage Basin H1	5'x3'	Outfall H1-1, Approximately 70 feet east of Beach 85th Street
Drainage Basin H1	TBD	Existing Outfall ROC-657
Drainage Basin H2	5'x3'	Outfall H2-1, Approximately 350 feet west of Beach 80th Street
Drainage Basin H2	5'x3'	Outfall H2-2, Approximately 100 feet east of Beach 79th Street
Drainage Basin H2	TBD	Existing Outfall ROC-653

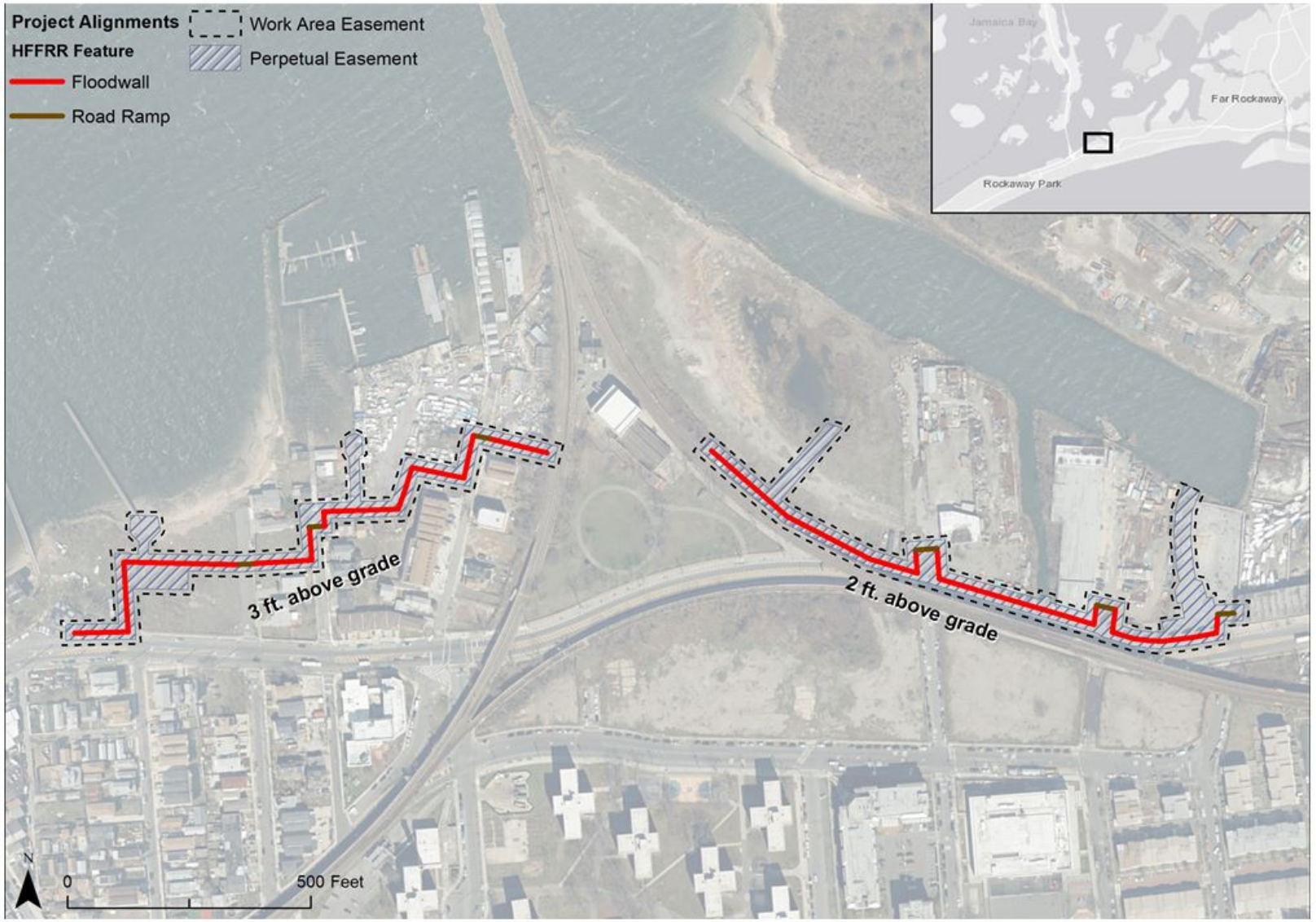


Figure 6: Mid Rockaway – Hammels Area HFFRRF Project Plan

2.5 Project Elements

Structural and non-structural management measures, including NNBFs, were developed to address one or more of the planning objectives for the project. Management measures were developed in consultation with the non-federal sponsor (NYSDEC), state and local agencies, and non-governmental entities. Measures were evaluated for compatibility with local conditions and relative effectiveness in meeting planning objectives. Effective measures were combined to create CSRM alternatives for two geographically discrete reaches: the Atlantic Ocean shorefront and Jamaica Bay. Integrating CSRM alternatives for the two reaches provides the most economically efficient system-wide solution for the vulnerable communities within the study area. It is important to note that any comprehensive approach to CSRM in the study area must include an Atlantic Ocean shorefront component because overtopping of the Rockaway peninsula is a source of flood waters into Jamaica Bay. Efficient CSRM solutions were formulated specifically to address conditions at the Atlantic Ocean shorefront. The best solution for the Atlantic Shorefront reach was included as a component of the alternative plans for the Jamaica Bay reach.

The Atlantic Ocean shorefront reach is subject to wave attack, wave run up, and over topping along the Rockaway peninsula. The general approach to developing CSRM along this reach was to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective renourishment approach prior to the evaluation of alternatives for coastal storm risk management. The most cost-effective erosion control alternative is beach restoration with increased erosion control (See Figures 2a through 2d). This erosion control alternative had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life. A screening analysis was performed to evaluate the level of risk reduction provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with beach restoration with increased erosion control to optimize CSRM at the Atlantic Ocean shorefront.

Beach fill for the Atlantic Shoreline component of the proposed project is available from an offshore borrow area containing approximately 17 million cy of suitable beach fill material, which exceeds the required initial fill and all periodic renourishment fill operations. The borrow area is located approximately two miles offshore (south) of the Rockaway peninsula.

Other factors such as prior projects at Rockaway Beach, project constraints, stakeholder concerns, and engineering judgment were also applied in the evaluation and selection. A composite seawall was selected as the best coastal storm risk management alternative. The composite seawall protects against erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding (Figures 7 and 8). The structure crest elevation is +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet. The armor stone in horizontally composite structures significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls to be used in the design if the face of the wall is completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding 1-layer of armor stone and extending the concrete cap up to the elevation of the armor stone.

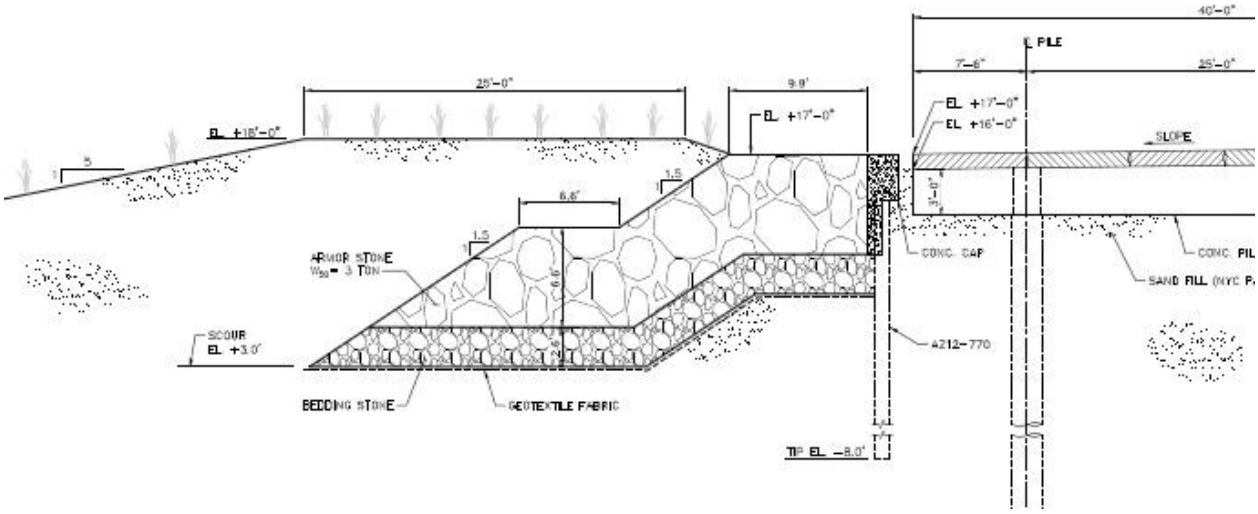


Figure 7: Composite Seawall Beach 19th St. to Beach 126th St

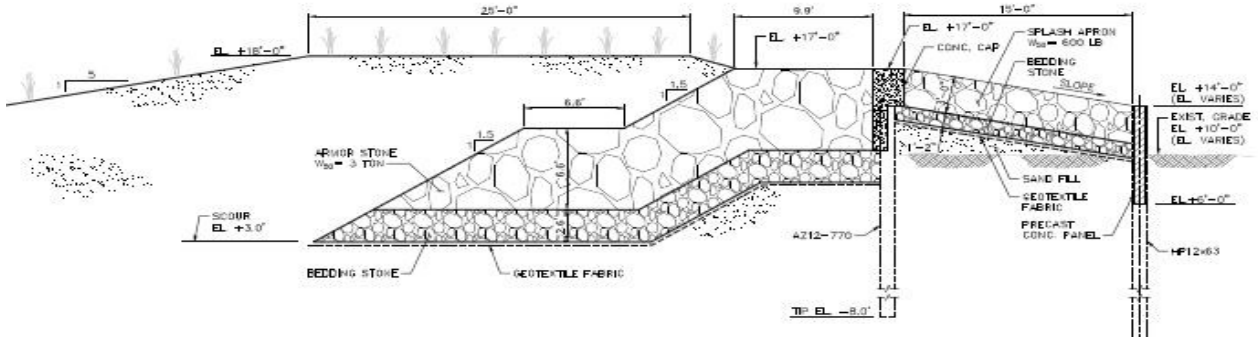


Figure 8: Composite Seawall Beach 126th St. to Beach 149th St.

2.5.1 The Atlantic Shorefront Beachfill

The selected storm damage reduction plan including changes from the authorized project, comprises approximately 152,000 If of dune and beach fill and generally extends from the eastern end of the barrier island at Beach 19th street to the western boundary of Breezy Point. This component of the Project includes the following: 1) a dune with a top elevation of +18 ft above NAVD88, a top width of 25 ft, and landward and seaward slopes of 1V:5H that will extend along the entire footprint (1V:3H on landward slope fronting the boardwalk).

All beachfill quantities include an overfill factor of 11% based on the compatibility analysis for the borrow areas. In addition, the initial construction quantities include an additional 15% for construction tolerance. It is noted that the advance fill and renourishment quantities do not include tolerance since the purpose of the advance fill and renourishment is to place a specific volume of sediment to offset anticipated losses between renourishment operations, rather than build a specific template. Beachfill quantities required for initial construction of each alternative are estimated based

on the expected shoreline position in June of 2018. It is impossible to predict the exact shoreline position in June 2018 since the wave conditions vary from year to year and affect shoreline change rates. The shoreline position in June of 2018 was estimated based on a 2.5 year GENESIS-T simulation representative of typical wave conditions.

Table 5: Initial Construction Beachfill Quantities

Reach	Reach Length (ft)	Recommended Plan Fill Quantity (CY)
West Taper		306,000
Reach 3	10,320	356,000
Reach 4	5,380	294,000
Reach 5	10,650	321,000
Reach 6a	3,730	250,000
Reach 6b	2,000	20,000
East Taper		49,000
Total		**1,596,000**

2.5.2 Atlantic Shorefront: Construction of New Groins and Groin Extensions

Three types of groin measures are considered in the alternative analysis: new groin construction, groin extension, and groin shortening. The exact dimensions and stone sizes of the existing groins at Rockaway is not available. Therefore, it is assumed that the existing groins in Reaches 5 and 6 are similar to the proposed new groin designs. Generally, a groin is comprised of three sections: 1) horizontal shore section (HSS) extending along the design berm; (2) an intermediate sloping section (ISS) extending from the berm to the design shoreline, and (3) an outer sloping section (OS) that extends from the shoreline to offshore. The head section (HD) is part of the OS and is typically constructed at a flatter slope than the trunk of the groin and may require larger stone due to the exposure to breaking waves.

The spacing between groins in this study is based on the existing spacing in Reach 5 (720 ft) and Reach 6a (780 ft). The required lengths of the new groins is based on the GENESIS-T model simulations.

The Project requires the immediate construction of a 12 new groins in reach 3 and 4 (between 92nd Street to 121st Street) and an additional groin in reach 6a (34th street). The 5 groin extension are located in Reach 6a (between 37th Street – 49th Street). The extension of the groin lengths vary and range from 75 ft to 200 ft. Groin widths will be 13 ft. See Table 6.

Table 6: Summary of Groin Lengths

Reach	Number	Street	HSS (ft)	ISS (ft)	OS (ft)	Total (ft)	Notes:
6a	1	34th St	90	108	328	526	New
6a	2	37th St	90	108	328	526	Extension
6a	3	40th St	90	108	328	526	Extension
6a	4	43rd St	90	108	228	426	Extension
6a	5	46th St	90	108	228	426	Extension
6a	6	49th St	90	108	228	426	Extension
4	1	92nd St	90	108	128	326	New
4	2	95th St	90	108	128	326	New
4	3	98th St	90	108	128	326	New
4	4	101st St	90	108	128	326	New
4	5	104th St	90	108	128	326	New
4	6	106th St	90	108	128	326	New
4	7	108th St	90	108	128	326	New
3	8	110th St	90	108	153	351	New
3	9	113th St	90	108	178	376	New
3	10	115th St	90	108	178	376	New
3	11	118th St	90	108	178	376	New
3	12	121st St	90	108	128	326	New

2.5.3 Sand Removal from Offshore Borrow Area

An offshore borrow area which is 2.6 miles long and 1.1 miles wide, located approximately 2 miles south of East Rockaway (Figure 9) between 35 feet mean low water and about 60 feet mean low water, has been identified as a potential source of sand material for beach fill and dune construction activities. The borrow area contains approximately 17,000,000 CY of suitable beach fill material.

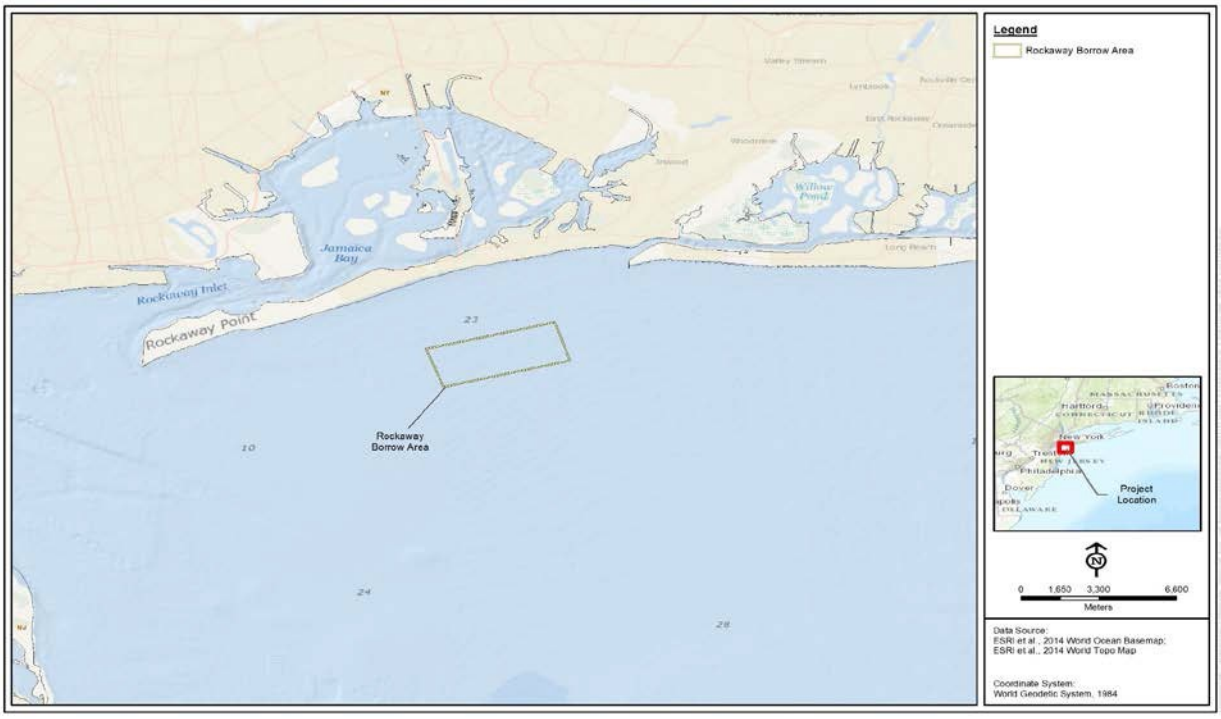


Figure 9: Location of the East Rockaway Borrow Area

2.6 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions of the Project include beach renourishments and maintenance of beach access locations. Renourishments will be conducted every 4-years or as needed over the 50-year life of the Project. During each renourishment, approximately 1,100,000 CY of sand will be added to the beach from the borrow area located approximately 2 miles offshore to the south of East Rockaway. Inlet maintenance dredging (115,000 cy/yr) is included in the 1.1 million cy of material needed for the renourishment.

3 EFH DESIGNATIONS AND LIFE HISTORIES OF MANAGED FISH SPECIES

The species and life stages that have designated EFH in the project area were determined using the *Guide to Essential Fish Habitat Designations in the Northeastern United States* found on the NMFS website[1] (NMFS 2016b), as well as publicly available GIS data. The 10' x 10' squares of latitude and longitude within which the project area falls were selected and Tables 7 through 9 were generated. Table 7 details the 10' x 10' square coordinates and is followed by a short but detailed description of the selected squares, including landmarks along the coastline. Tables 8 and 9 list the designated EFH species for the project area, specific to the Atlantic Shoreline and Jamaica Bay project reaches as described above. The notation "X" indicates that EFH has been designated within the 10' x 10' square for a given species and life stage.

Table 7: 10' x 10' EFH Designated Coordinates

Cell	Coordinates			
	North	East	South	West
Square 1	40º 40.0' N	73º 50.0' W	40º 30.0' N	74° 00.0' W
Square 2	40º 40.0' N	73º 40.0' W	40º 30.1' N	73º 50.0' W

Square 1 Description: Atlantic Ocean waters within the square within the Hudson River estuary affecting the following: western Rockaway Beach, western Jamaica Bay, Rockaway Inlet, Barren I., Coney I. except for Norton Pt., Paerdegat Basin, Mill Basin, southwest of Howard Beach, Ruffle Bar, and many smaller islands.

Square 2 Description: Atlantic Ocean waters within the square within Great South Bay estuary affecting the following: Western Long Beach, NY., Hewlett, NY., Woodmere, NY., Cedarhurst, NY., Lawrence, NY., Inwood, NY., Far Rockaway, NY., East Rockaway Inlet, eastern Jamaica Bay, Brosewere Bay, Grassy Bay, Head of Bay, Grass Hassock Channel, eastern Rockaway Beach, Atlantic Beach, Howard Beach, J. F. K. International Airport, Springfield, NY., and Rosedale, NY., along with many smaller islands.

[1] https://www.habitat.noaa.gov/protection/efh/newInv/index.html

Table 8: Designated EFH Species and Life Stages – Atlantic Shorefront

	EFH	Species	Eggs	Larvae	Juveniles	Adults
1	NE	Atlantic salmon (*Salmo salar*)				X
2	NE	pollock (*Pollachius virens*)			X	
3	NE	Atlantic Cod (*Gadus morhua*)				X
4	NE	red hake (*Urophycis chuss*)	X	X	X	X
5	NE	winter flounder (*Pleuronectes americanus*)	X	X	X	X
6	NE	windowpane flounder (*Scopthalmus aquosus*)	X	X	X	X
7	NE	Atlantic herring (*Clupea harengus*)			X	X
8	NE	monkfish (*Lophius americanus*)	X	X		x
9	NE	little skate (*Leucoraja erinacea*)			X	
10	NE	winter skate (*Leucoraja ocellata*)			X	X
11	MA	bluefish (*Pomatomus saltatrix*)			X	X
12	MA	long finned squid (*Loligo pealei*)	X			
13	MA	Atlantic butterfish (*Peprilus triacanthus*)				X
14	MA	Atlantic mackerel (*Scomber scombrus*)			X	X
15	MA	summer flounder (*Paralicthys dentatus*)		X	X	X
16	MA	scup (*Stenotomus chrysops*)	X	X	X	X
17	MA	black sea bass (*Centropristus striata*)			X	X
18	CMPS	king mackerel (*Scomberomorus cavalla*)	X	X	X	X
19	CMPS	Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X
20	CMPS	cobia (*Rachycentron canadum*)	X	X	X	X
21	HMS	sand tiger shark (*Odontaspis taurus*)		X		
22	HMS	Bluefin tuna (*Thunnus thynnus*)			X	
23	HMS	dusky shark (*Charcharinus obscurus*)		X		
24	HMS	sandbar shark (*Charcharinus plumbeus*)			X	X
25	HMS	white shark (*Carcharodon carcharias*)		X	X	X
26	HMS	Skipjack tuna (*Katsuwonus pelamis*)				X
27	HMS	Smoothhound Shark (Atlantic Stock)		X	X	X

NE= New England Species;

MA = Mid-Atlantic Species;

CMPS = Coastal Migratory Pelagic Species;

HMS = Highly Migratory Species

Table 9: Designated EFH Species and Life Stages – Jamaica Bay

	EFH	Species	Eggs	Larvae	Juveniles	Adults
1	NE	Atlantic salmon (*Salmo salar*)				X
2	NE	pollock (*Pollachius virens*)			X	
3	NE	clearnose skate (Raja eglanteria)			X	X
4	NE	red hake (*Urophycis chuss*)	X	X	X	X
5	NE	winter flounder (*Pleuronectes americanus*)	X	X	X	X
6	NE	windowpane flounder (*Scopthalmus aquosus*)	X	X	X	X
7	NE	Atlantic herring (*Clupea harengus*)		X	X	X
8	NE	monkfish (*Lophius americanus*)	X	X		
9	NE	Little skate (*Leucoraja erinacea*)				X
10	NE	Winter skate (*Leucoraja ocellata*)			X	X
11	NE	Yellowtail flounder (Limanda ferruginea)				X
11	MA	bluefish (*Pomatomus saltatrix*)			X	X
12	MA	long finned squid (*Loligo pealei*)	X			
13	MA	Atlantic butterfish (*Peprilus triacanthus*)			X	X
14	MA	Atlantic mackerel (*Scomber scombrus*)			X	X
15	MA	summer flounder (*Paralicthys dentatus*)			X	X
16	MA	scup (*Stenotomus chrysops*)			X	X
17	MA	black sea bass (*Centropristus striata*)			X	X
18	MA	spiny dogfish (*Squalus acanthias*)			X	X
19	CMPS	king mackerel (*Scomberomorus cavalla*)	X	X	X	X
20	CMPS	Spanish mackerel (*Scomberomorus maculatus*)	X	X	X	X
21	CMPS	cobia (*Rachycentron canadum*)	X	X	X	X
22	HMS	sand tiger shark (*Odontaspis taurus*)		X		
23	HMS	white shark (*Carcharodon carcharias*)		X		
24	HMS	smoothhound Shark (Atlantic Complex) (*Mustelus mustelus*)		X	X	X
25	HMS	sandbar shark (*Charcharinus plumbeus*)				X

NE= New England Species;

MA = Mid-Atlantic Species;

CMPS = Coastal Migratory Pelagic Species;

HMS = Highly Migratory Species

As shown on Tables 8 and 9, the project site has been identified as EFH for 27 species of fish for the Atlantic Shoreline project reach, and 25 species of fish for the Jamaica Bay project reach, respectively. The life stages of the Highly Migratory Species are broken down into neonates, juveniles, and adults. There are no 'egg' designations and neonates correspond to the "larvae" heading.

The following text provides a description of general habitat parameters of all identified designated EFH species and the applicable life stages specific to the EFH assessment. The habitat parameters were obtained from the *Guide to Essential Habitat Descriptions* and where necessary, supplemented by the *EFH Tables* (NMFS 2016c). If more than one geographic region was given in a description, the habitat parameters for the geographic region associated with the project area were used.

3.1 New England Species

3.1.1 Atlantic salmon (*Salmo salar*)

Eastern portions of the Atlantic Ocean along Long Island are designated as EFH habitat for salmon adults in the seawater salinity zone, mixing water/brackish salinity zone, and the tidal freshwater salinity zone. The habitat parameters for the applicable life stages are as follows.

Adults: Generally, the following conditions exist where Atlantic salmon adults are found migrating to the spawning grounds: streams with water temperatures below 22.8°C and dissolved oxygen above 5 parts-per-million (ppm). Oceanic adult Atlantic salmon are primarily pelagic and range from the waters of the continental shelf off southern New England north throughout the Gulf of Maine.

3.1.2 pollock (*Pollachius virens*)

The project site, for both planning reaches, is designated as EFH for pollock juveniles. The habitat parameters for the applicable life stages are as follows.

Juveniles: Generally, the following conditions exist where most pollock juveniles are found: water temperatures below 18°C, water depths between 0 and 250 meters, and salinities greater than 29 and 32%.

3.1.3 clearnose skate (*Raja eglanteria*)

The project site is designated as EFH for clearnose skate juveniles and adults within the Jamaica Bay planning reach. The habitat parameters for the applicable life stages are as follows.

Juveniles: Bottom habitats with a sandy or gravelly substrate or mud, generally found from the shore to depths of 137 meters, with the highest abundance from 73-91 meters. Most juveniles are found between in water with temperatures of 4-15°C.

Adults: bottom habitats with a sandy or gravelly substrate or mud within the same range as the juveniles.

3.1.4 Atlantic cod (*Gadus morhua*)

The project site is designated as EFH for Atlantic Cod adults in the Atlantic Shoreline project reach. The habitat parameters for the applicable life stage is as follows:

Adult: Bottom habitats with a substrate of rocks, pebbles, or gravel. Generally, the following conditions exist where cod adults are found: water temperatures below 10° C, depths from 10 - 150 meters, and a wide range of oceanic salinities.

3.1.5 red hake (*Urophysic chuss*)

The project site is designated as EFH for red hake eggs, larvae, juveniles, and adults for both planning reaches. The habitat parameters for the applicable life stages are as follows.

Eggs: Generally, the following conditions exist where hake eggs are found: sea surface water temperatures below 10°C along the inner continental shelf with salinities less than 25%. Red hake eggs are most often observed during the months from May to November, with peaks in June and July.

Larvae: Generally, the following conditions exist where red hake larvae are found: sea surface water temperatures below 19°C, water depths less than 200 meters, and salinities greater than 0.5%. Red hake larvae are most often observed from May through December, with peaks in September and October.

Juveniles: Generally, the following conditions exist where red hake juveniles are found: water temperatures below 16°C, water depths less than 100 meters, and a salinity range from 31 to 33%.

Adults: Bottom habitats in depressions with a substrate of sand and mud. Generally, the following conditions exist where red hake adults are found: water temperatures below 12° C, depths from 10 - 130 meters, and a salinity range from 33 – 34%.

3.1.6 winter flounder (*Pleutonectes americanus*)

The project site is designated as EFH for winter flounder eggs, larvae, juveniles, and adults in both planning reaches. The habitat parameters for the applicable life stages are as follows.

Eggs: Generally, the following conditions exist where winter flounder eggs are found: water temperatures less than 10°C, salinities between 10 to 30%, and water depths less than 5 meters. Winter flounder eggs are often observed from February to June.

Larvae: Generally, the following conditions exist where winter flounder larvae are found: sea surface water temperatures less than 15°C, salinities between 4 and 30‰, and water depths less than 6 meters. Winter flounder larvae are often observed from March to July.

Juveniles: Generally, the following conditions exist where winter flounder young-of-the-year are found: water temperatures below 28°C, water depths from 0.1 to 10 meters, and salinities between 5 and 33‰. Generally, the following conditions exist where juvenile winter flounder are found: water temperatures below 25°C, water depths from 1 to 50 meters, and salinities between 10 and 30%.

Adults: Generally, the following conditions exist where winter flounder adults are found: water temperatures below 25°C, water depths from 1 to 100 meters, and salinities between 15 and 33%.

3.1.7 windowpane flounder (*Scopthalmus aquosus*)

The project site is designated as EFH for windowpane flounder eggs, larvae, juveniles, and adults in both planning reaches. The habitat parameters for the applicable life stages are as follows.

Eggs: Generally, the following conditions exist where windowpane flounder eggs are found: sea surface water temperatures less than 20°C and water depths less than 70 meters. Windowpane flounder eggs are often observed from February to November with peaks in May and October.

Larvae: Generally, the following conditions exist where windowpane flounder larvae are found: sea surface water temperatures less than 20°C and water depths less than 70 meters. Windowpane flounder larvae are often observed from February to November with peaks in May and October.

Juveniles: Generally, the following conditions exist where windowpane flounder juveniles are found: water temperatures below 25°C, water depths from 1 to 100 meters, and salinities between 5.5 and 36%.

Adults: Generally, the following conditions exist where windowpane flounder adults are found: water temperatures below 26.8°C, water depths from 1 to 75 meters, and salinities between 5.5 and 36%.

3.1.8 Atlantic herring (*Clupea harengus*)

The project site is designated as EFH for Atlantic herring larvae, juveniles and adults in the Jamaica Bay planning reach, and juveniles and adults in the Atlantic Shorefront planning reach. The habitat parameters for the applicable life stages are as follows.

Larvae: Generally, the following conditions exist where Atlantic herring larvae are found: sea surface temperatures below 16° C, water depths from 50 - 90 meters, and salinities around 32‰. Atlantic herring larvae are observed between August and April, with peaks from September through November.

Juveniles: Generally, the following conditions exist where Atlantic herring juveniles are found: water temperatures below 10°C, water depths from 15 to 135 meters, and a salinity range from 26 to 32%.

Adults: Generally, the following conditions exist where Atlantic herring adults are found: water temperatures below 10°C, water depths from 20 to 130 meters, and salinities above 28%.

3.1.9 monkfish (*Lophius americanus*)

The project site is designated as EFH for monkfish eggs and larvae in both planning reaches, and adults in the Atlantic Shorefront planning reach. The habitat parameters for the applicable life stages are as follows.

Eggs: Generally, the following conditions exist where monkfish egg veils are found: sea surface water temperatures below 18°C and water depths from 15 to 1000 meters. Monkfish egg veils are most often observed during the months from March to September.

Larvae: Generally, the following conditions exist where monkfish larvae are found: water temperatures 15°C and water depths from 25 to 1000 meters. Monkfish larvae are most often observed during the months from March to September.

Adults: Bottom habitats with substrates of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud. Generally, the following conditions exist where monkfish adults are found: water temperatures below 15° C, depths from 25 - 200 meters, and a salinity range from 29.9 - 36.7‰.

3.1.10 little skate (*Leucoraja erinacea*)

The project site is designated as EFH for little skate juveniles in the Atlantic Shorefront, and adults in the Jamaica Bay planning reaches. The habitat parameters for the applicable life stages are as follows.

Juveniles: Bottom habitats with a sandy or gravelly substrate or mud, generally found from the shore to depths of 137 meters, with the highest abundance from 73-91 meters. Most juveniles are found between in water with temperatures of 4-15°C.

Adults: bottom habitats with a sandy or gravelly substrate or mud within the same range as the juveniles.

3.1.11 winter skate (*Leucoraja ocellata*)

The project site is designated as EFH for winter skate juveniles and adults in both planning reaches. The habitat parameters for the applicable life stages are as follows.

Juveniles: Sand and gravel or mud shoreline to about 400 meters and are most abundant at depths less than 111 meters. The temperature range for these skates is from - 1.2 - 21 °C, with most found from 4-16 °C, depending on the season.

Adults: Sand and gravel or mud substrate found from shoreline to 371 meters, but are most abundant at less than 111 meters. The temperature range is also very similar, with a range from –1.2 - 20 °C, with most found in water with temperatures ranging from 5-15 °C.

3.1.12 yellowtail Flounder (*Limanda ferruginea*)

The project site is designated as EFH for yellowtail flounder adults in the Jamaica Bay planning reach. The habitat parameters for the applicable life stages are as follows

Adult: Bottom habitats with a substrate of sand or sand and mud. Generally, the following conditions exist where yellowtail flounder adults are found: water temperatures below 15° C, depths from 20 - 50 meters, and a salinity range from 32.4 - 33.5‰.

3.2 Mid-Atlantic Species

3.2.1 bluefish (*Pomatomus saltatrix*)

The project site is designated as EFH for bluefish juveniles and adults in both planning reaches. The habitat parameters for the applicable life stages are as follows.

Juveniles: Generally juvenile bluefish occur in estuaries from May through October. Typical conditions for juveniles are: water temperatures between 19°C and 24°C and salinities between 23 and 36%.

Adults: Adult bluefish are found in Mid-Atlantic estuaries from April through October. Typical conditions for adults are: water temperatures from 14°C to 16°C and salinities greater than 25%.

3.2.2 long finned squid (*Loligo pealei*)

The project site is designated as EFH for long-finned squid eggs in both planning reaches. The habitat parameters for the applicable life stages are as follows.

Eggs: EFH for long finned squid eggs occurs in inshore and offshore bottom habitats from Georges Bank southward to Cape Hatteras, generally where bottom water temperatures are between 10°C and 23°C, salinities are between 30 and 32 ppt, and depth is less than 50 meters. Eggs have also been collected in bottom trawls in deeper water at various places on the continental shelf. Like most loliginid squids, their egg masses or "mops" are demersal and anchored to the substrates on which

they are laid, which include a variety of hard bottom types (e.g., shells, lobster pots, piers, fish traps, boulders, and rocks), submerged aquatic vegetation (e.g., *Fucus* sp.), sand, and mud.

3.2.3 Atlantic butterfish (*Peprilus triacanthus*)

The project site is designated as EFH for Atlantic butterfish juveniles, and adults for the Jamaica Bay planning reach, and only adults in Atlantic Shorefront planning reach. The habitat parameters for the applicable life stages are as follows.

Juveniles: Generally, juvenile butterfish occur in water depths between 10 and 365 meters, water temperatures between 3°C and 28°C, and a salinity range of 3 to 37%.

Adults: Generally, adult butterfish occur in water depths between 10 and 365 meters, water temperatures between 3°C and 28°C, and a salinity range of 4 to 26%.

3.2.4 Atlantic mackerel (*Scomber scrombrus*)

The project site is designated as EFH for Atlantic mackerel juveniles and adults for both planning reaches. The habitat parameters for the applicable life stages are as follows.

Juveniles: Generally, juvenile Atlantic mackerel occur in water depths between the shore and 320 meters, water temperatures between 4°C and 22°C, and salinities less than 25%.

Adults: Generally, adult Atlantic mackerel occur in water depths between the shore and 380 meters, water temperatures between 4°C and 16°C, and salinities less than 25%.

3.2.5 summer flounder (Paralichthys denntatus)

The project site is designated as EFH for summer flounder larvae, juveniles, and adults in the Atlantic Shorefront planning reach, and only juveniles and adults in the Jamaica Bay planning reach. The habitat parameters for the applicable life stages are as follows.

Larvae: In general, summer flounder larvae are most abundant nearshore at water depths between 10 and 70 meters, in water temperatures between 9°C and 12°C, and salinities between 23 to 33‰. They are most frequently found from September to February.

Juveniles: In general, juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in water temperatures greater than 11°C, water depths from 0.5 to 5 meters, and salinities ranging from 10 to 30%.

Adults: Generally, summer flounder occur in water depths between the shore and 25 meters. Seasonally, they inhabit shallow coastal and estuarine waters during warmer months and move offshore on the outer Continental Shelf at depths of 150 meters in colder months.

3.2.6 scup (*Stenotomus chrysops*)

The project site is designated as EFH for scup eggs, larvae, juveniles, and adults in the Atlantic Shorefront planning reach, and only juvenile and adults in the Jamaica Bay planning reach. The habitat parameters for the applicable life stages are as follows.

Eggs: In general, scup eggs are found from May through August, in water temperatures between 13°C and 23°C, water depths less than 30 meters, and salinities less than 15%.

Larvae: In general, scup larvae are most abundant nearshore from May through September, in water temperatures between 13°C and 23°C, water depths less than 20 meters, and salinities less than 15%.

Juveniles: In general, juvenile scup during the summer and spring are found in estuaries and bays, in association with various sands, mud, mussel, and eelgrass bed type substrates, between the shore and water depths of 38 meters. Typical conditions are: water temperatures less than 7°C and salinities less than 15%.

Adults: Generally, adult scup are found in water temperatures less than 7°C, water depths between 2 and 185 meters, and salinities less than 15%. Seasonally, wintering adults (November through April) are usually offshore.

3.2.7 black sea bass (*Centropristus striata*)

The project site is designated as EFH for black sea bass juveniles and adults for both planning reaches. The habitat parameters for the applicable life stages are as follows.

Juveniles: Juvenile black sea bass are usually found in association with rough bottom, shellfish and eelgrass beds, and man-made structures in sandy-shelly areas. Typical conditions are: water temperatures less than 6°C, water depths between 1 and 38 meters, and salinities less than 18%.

Adults: Structured habitats (natural and man-made), sand and shell are usually the substrate preference of adult black sea bass. Typical conditions are: water temperatures less than 6°C, water depths between 20 and 50 meters, and salinities less than 20%.

3.2.8 spiny dogfish (*Squalus acanthias*)

The project site is designated as EFH for spiny dogfish juveniles (i.e., sub-female) and adult male in the Atlantic Shorefront planning reach. The habitat parameters for the applicable life stages are as follows

Female Sub-Adults (36-79 cm): Pelagic and epibenthic habitats throughout the region. Sub-adult females are found over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7 to 15°C. Sub-adult females are widely distributed throughout the region in the winter and spring when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15°C.

Male Adults (≥60 cm): Pelagic and epibenthic habitats throughout the region. Adult males are found over a wide depth range in full salinity seawater (32-35 ppt) where bottom temperatures range from 7 to 15°C. They are widely distributed throughout the region in the winter and spring when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15°C.

3.3 Coastal Migratory Pelagic Species

The project site is designated as EFH for coastal migratory pelagic eggs, larvae, juveniles, and adults for the three species listed below for both planning reaches. These species are found in sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward. In addition, all coastal inlets and state-designated nursery habitats are of particular importance to these coastal migratory pelagics.

3.3.1 king mackerel (*Scomberomorus cavalla*)

In general, king mackerel are found in water temperatures less than 20°C and salinities less than 30%.

3.3.2 spanish mackerel (*Scomberomorus maculates*)

In general, Spanish mackerel are found in water temperatures less than 20°C and salinities less than 30%.

3.3.3 cobia (*Rachycentron canadum*)

In addition to the general habitat of the coastal migratory pelagics, Cobia are also found in high salinity bays, estuaries, and seagrass habitat. Typical conditions are: water temperatures less than 20°C and salinities less than 25%.

3.4 Highly Migratory Species

3.4.1 sand tiger shark (*Odontaspis taurus*)

The project site is designated as EFH for sand tiger shark neonates in both planning reaches. The habitat parameters for the applicable life stages are as follows.

Neonates/early juveniles: Neonates/early juveniles are found in shallow coastal waters to the 25-meter isobath.

3.4.2 dusky shark (*Charcharinus obscurus*)

The project site is designated as EFH for dusky shark neonates in the Atlantic Shorefront planning reach. The habitat parameters for the applicable life stages are as follows.

Neonate/early juveniles: Neonates/early juveniles are found in shallow coastal waters, inlets, and estuaries to the 25-meter isobath.

3.4.3 sandbar shark (*Charcharinus plumbeus*)

The project site is designated as EFH for sandbar shark juveniles and adults in the Atlantic Shorefront planning reach, and only adults in the Jamaica Bay planning reach. The habitat parameters for the applicable life stages are as follows.

Neonates/early juveniles: Neonates/early juveniles are found in shallow coastal areas to the 25-meter isobath. Typical conditions are: salinities greater than 22% and water temperatures greater than 21°C.

Late juveniles/subadults: Late juveniles/subadults are found offshore.

Adults: Adults are found in shallow coastal areas from the coast to the 50-meter isobath.

3.4.4 white shark (*Carcharodon carcharias*)

The project site is designated as EFH for white shark neonates, juveniles and adults in the Atlantic Shorefront planning reach, and only adults in the Jamaica Bay planning reach. The habitat parameters for the applicable life stages are as follows.

It is a migratory species, spending winters in southern waters and summers in northern waters. Sandbar sharks are found near shore at depths of 65.6 to 213.3 feet. In the northern hemisphere, mating occurs from May to June. Average length of gestation range from eight (8) to 12 months and is dependent on geological location. Litter size ranges from six (6) to 13 pups. In the western Atlantic, pups are born from June to August. Sandbar shark diet consists of bottom fish, shellfish, skates, stingrays, squid, shrimp, crabs, mollusks, and other smaller sharks (Florida Museum of Natural History, 2016).

3.4.5 smoothhound shark (Atlantic Complex) (*Mustelus mustelus*)

The project site is designated as EFH for smoothhound shark neonates, juveniles and adults in the both planning reaches. NMFS does not provide information pertaining to suitable habitat characteristics that support these life stages.

3.4.6 skipjack tuna (*Katsuwonus pelamis*)

The project site is designated as EFH for skipjack tuna adults in the Atlantic Shorefront planning reach. Its habitat is the pelagic surface waters. It is an extremely fast, ever moving species.

3.4.7 bluefin tuna (*Thunnus thynnus*)

The project site is designated as EFH for bluefin tuna juveniles in the Atlantic Shorefront planning reach. Their habitat is primarily surface water, also found in inshore and pelagic waters.

4 EFFECTS ON EFH SPECIES IN THE PROJECT AREA

The identified EFH species (Tables 8 and 9 shown above) potentially could occur in either or both of the planning reaches (i.e., Atlantic Shorefront and Jamaica Bay) at different times of the year. To support the evaluation of effect on these species, a separate EFH Assessment Worksheet has been prepared for each planning reach and are included as Appendix A. It is recognized that there are temporary impacts that could result to different life stages of the identified species due to the proposed construction given their potential presence in the project area. However, it is noted that the project is anticipated to have a long-term benefit on EFH designated fisheries through the proposed actions.

Effects on EFH designated species through the Recommended Plan, including both planning reaches, can be grouped into four distinct impact categories: impingement and/or entrainment, burial and sedimentation, habitat loss and alteration, and hydroacoustics. Each are discussed below specific to the two planning reaches. This is section is followed by a summary of identified direct, indirect, and cumulative effects on the EFH designated species. In addition, a comprehensive survey of the proposed mitigation is also provided.

4.1 Impingement and/or Entrainment

4.1.1 Atlantic Shorefront

The potential for impingement and/or entrainment of eggs and larvae is only specific to the dredging of sand within the proposed borrow area. As discussed below for habitat fragmentation, dredging of sand in shoals will focus on flatter areas surrounding the prominent shoals. Initial analysis completed by USACE has removed prominent shoal habitat from consideration for sand dredging. This was accomplished by avoiding sites with prominent shoal habitat such as the “Seaside Lumps” and “Fish Heaven”, which are considered important sport and commercial fishing grounds (Long and Figley 1984).

It is recognized that the dredging activities could have adverse effects on EFH due to the entrainment of early life stages. The EFH designated species most likely to suffer mortality from dredging are juvenile winter flounder and windowpane flounder. Mortality of young-of-the-year (YOY) juvenile windowpane and winter flounder would be highest in the spring, just after they settle to the bottom and metamorphose. However, mortalities of small flounder would be minimized if dredging was restricted to the fall (October-December), after they are larger and start to move into deeper water (Pereira et al. 1999) and would be less plentiful on shallow borrow areas. Dredging and in water construction activities in the fall would also minimize any possible impacts on pelagic fish eggs and larvae produced by EFH- designated species since most of them spawn in the spring.

The USACE anticipates that construction activities will occur in the fall and winter. These dates align to minimize impacts to EFH, while also being protective of terrestrial species protected under jurisdiction of U.S. Fish and Wildlife Service.

4.1.2 Jamaica Bay

There will be no impacts associated with impingement and entrainment for proposed features of the Jamaica Bay planning reach.

4.2 Burial and Sedimentation

4.2.1 Atlantic Shorefront

The dredging of sand can lead to increased suspended sediment levels, and which could smoother (i.e., bury) immobile benthic organisms or juvenile demersal fish (i.e., flounder). As noted above, USACE anticipates a construction window (i.e., fall or winter) that would minimize impacts on pelagic fish eggs and larvae. The temporary impacts by removal and/or burial of a benthic community could have adverse effects on benthic food-prey organisms present in the borrow area. However, the impacts to EFH designed fish species is expected to be minimal as the borrow area is a relatively small when compared to the overall area of the larger Atlantic Shoreline. In addition, the borrow area is anticipated to be recolonize by benthic communities following dredging operations within 2 years. Finally, it is recognized that the suspended sediment can also impact foraging or migratory species; however, these larger, motile species are expected to alter behavior to avoid the construction area and utilize adjacent, more suitable habitats.

The near-shore beaches where sand will be placed, and groins constructed or enlarged, will also be susceptible to short-term increased suspended sediments as well as burial of existing habitats. It is recognized that EFH can be adversely impacted temporarily through water quality impacts such as increased turbidity and decreased dissolved oxygen content within and proximate to the construction work areas. These impacts would subside upon cessation of construction activities. Construction activities in the near shore environment will employ Best Management Practices (BMPs) to minimize construction impacts within open waters (i.e., construction scheduling). Similar to the discussion for dredging impacts, sand placement and groin construction could also bury benthic habitats and have indirect effects on EFH designated fish species. However, it is noted these impacts will be temporary and short term.

Finally, it is noted that an objective of the project is to protect these beach and near-shore habitats from future coastal storms while at the same time minimizing required maintenance and thereby reducing long-term cumulative impacts.

4.2.2 Jamaica Bay

It is recognized that benthic habitat can vary within the Jamaica Bay planning reach. Submerged aquatic vegetation beds have not been identified within the project area. In general, the intertidal and subtidal areas are flat, featureless sediment-dominated habitats devoid of vegetation or habitat structure. While lacking habitat structure, these large sediment areas support valuable habitat for numerous benthic invertebrates (e.g., worms, clams). These species in turn serve as prey species for fish, crabs, birds, and other faunal life.

Resuspension of sediments within Jamaica Bay planning reach due to in-water activities (i.e., bulkhead construction, rock sills) will have variable impacts on fish depending on species and life stage. To directly address this, construction activities in the near shore environment will employ BMPs to minimize construction impacts within open waters, and which will subside upon cessation of construction activities. For example, construction occurring at low tide and in-the-dry will minimize and/or avoid significant resuspension of sediment. It is also anticipated that during construction activities, if present, larger more motile fish species will modify their behavior and relocate to other more suitable habitats with no significant impact to the population or individual.

It is recognized that lethal levels of water column solids vary widely among species; one study found that the tolerance of adult fish for suspended sediment ranged from 580 milligrams per liter (mg/L) to 24,500 mg/L (Shrek et al. 1975 as cited in NMFS 2003). Common impacts to fish are the abrasion of gill membranes (resulting in inability to collect oxygen), impairment of feeding, reduction in dissolved oxygen, and fatal impacts to early life stages.

Larval stage fish also have wide suspended sediment tolerance ranges; however, the reported data is generally thought to represent tolerance levels for only relatively short exposure periods (e.g., less than 24 hours) (Morgan and Levings 1989). The project is not anticipated to have prolonged suspended solids for extended periods (i.e., less than 24 hours). Beyond that timeframe, mortality can occur at concentrations as low as 1,300 mg/L (Morgan et al. 1983). Kiorboe et al. 1981, (as cited in Clarke and Wilber 2000) indicate that hatching of striped bass can be delayed if daily sediment concentrations reach 100 mg/L. Wilbur and Clarke, 2001 (as cited in NMFS 2003), indicate that hatching is delayed for striped bass and white perch at concentrations of 800 and 100 mg/L, respectively. In a 2003 biological opinion, NMFS indicated that total suspended solids concentrations below 100 mg/L are not likely to affect eggs and larvae, at least over short durations (NMFS 2003).

Consistent with the discussion for dredging impacts, rock sill construction and potentially near shoreline construction (i.e., bulkheads) could bury benthic habitats and have indirect effects on EFH designated fish species. It is noted these impacts to benthic habitats will be temporary and short term as these areas will be quickly recolonized. There could be burial of eggs or larvae that result in mortality, but the anticipated construction schedule is intended to minimize or avoid these impacts. Finally, from a long-term perspective, the overall project is intended to enhance benthic habitat and in-water habitat complexity through incorporation of NNBFs as part of the HRFRRF. These will provide enhanced habitats for benthic communities, as well as the identified EFH fish species. A further discussion of ecological benefits associated with NNBFs is provided below.

4.3 Habitat Loss and Fragmentation

4.3.1 Atlantic Shorefront

It is anticipated that there will be alterations of the benthic and open water habitats associated with the borrow site. One major concern with respect to physical changes involves the potential loss of prominent offshore sandy shoal habitat within borrow sites due to sand dredging for the beach replenishment. It is generally regarded that prominent offshore shoals are areas that are attractive to fish, including the federally managed species, and are frequently targeted by recreational and commercial fishermen. Despite this, there is little specific information to determine whether shoals of this type have any enhanced value for fish. However, it is reasonable to expect that the increased habitat complexity at the shoals and adjacent bottom would be more attractive to fish than the flat featureless bottom that characterizes much of the mid-Atlantic coastal region (U.S. Fish and Wildlife Service 1999a). Since dredging of sand in shoals may result in a significant habitat alteration, it is proposed that these areas be avoided or the flatter areas surrounding the prominent shoals be mined. Initial analysis has removed prominent shoal habitat from consideration.

Other physical alterations to EFH within the borrow area involve substrate modifications. An example would be the conversion of a soft sandy bottom into a hard clay bottom through the removal of overlying sand strata. This could result in a significant change in the benthic community composition after recolonization, or it could provide unsuitable habitat required for surf clam recruitment or spawning of some finfish species. This could be avoided by correlating vibracore

strata data with sand thickness to restrict dredging depths to avoid exposing a different substrate. Based on vibracore data, dredging depths would be considered to minimize the exposure of dissimilar substrates.

The removal of sand also leaves a depression or hole (borrow pit) in the sea floor that can persist for years. The rate at which borrow pits fill up will depend on the amount of sediment that is available and the direction and strength of currents in the area. Borrow pits can modify the habitat for benthic, bottom-feeding fishes since they are deeper than the surrounding sea floor and act as traps for fine grained sediments. Accumulation of mud can cause a change in benthic community structure that favors certain species of fish. Also, if circulation of bottom water in the pits is reduced, DO can fall to low enough levels (<2-3 ppm) that fish will avoid them all together. High organic contents of mud accumulating in pits could also cause oxygen depletion.

In terms of the near shore environment, it is recognized that construction of groins will alter the existing habitat. Constructed groins will create in water habitat areas suitable for recruitment and protection for numerous fish species. Beneficial impacts to the fish community would include the increase in food source, spawning beds, and shelter in the project area. Construction of groins would also provide living spaces for the food resource on which fish species rely. In addition to creating living spaces and increasing food availability of the project area, the proposed would potentially provide shelter for fish from wave attacks during large coastal storm events.

It is noted that recent literature has shown direct adverse effects of shoreline armoring on mobile upper shore invertebrates (Dugan et al 2008, Dugan 2011). Specific to this project, the upper shore is heavily utilized and historically disturbed by continuous recreational activities. As such, research of natural shorelines may not be comparable to this heavily urbanized beach. It is recognized that while certain benthic invertebrate populations may be displaced by the proposed in water features (i.e., groins), it is expected that the habitat complexity will support a diverse assemblage of benthic species that would continue to function as prey for both aquatic and terrestrial wildlife that utilize this shoreline.

4.3.2 Jamaica Bay

The recommended project will have both permanent and temporary impacts to shoreline habitats within the Jamaica Bay planning area and are summarized in Tables 10 and 11. These will result from construction of the HFFRRFs, and specific to EFH designated species focus on in-water activities (i.e., bulkhead construction, rock sill placement).

To account for these impacts, a series of NNBFs were developed as part of the proposed HFFRRFs to not only control erosion and help manage coastal storm risk, but also to provide opportunities for habitat restoration and enhancement which would offset unavoidable permanent impacts to Federal and state regulated areas and species. Table 12 presents proposed restoration / creation, as well as enhancement efforts associated with the NNBFs. While the project will result in unavoidable impacts to 3.74 acres of federal and state regulated waters and wetlands[2], the project includes 7.65 acres of wetland restoration or creation, and 0.472 acres of wetland enhancement, and restoration of 1.35 acres.

[2] Conservatively assumed to include the following habitat types: beach/shoreline, freshwater wetlands, intertidal wetlands, mudflats, and subtidal bottom.

While the project area includes EFH designated species in all life stages, the scope of the in-water activities is expected to only have minor, short-term impacts. These short-term impacts are directly tied to the objective to enhance ecological functioning of these shorelines, and with direct benefits to EFH designated species. The restored wetlands, and constructed sills will have direct benefits to spawning, nursery, foraging, and shelter habitats that are critical to supporting the identified EFH designated species.

Table 10: Permanent Habitat Impacts - Acreage

Habitat Type	CL	MRE	MRA	MRH	TOTAL
Beach / Unvegetated Shoreline	0.000	0.036	0.773	0.000	0.809
Freshwater Wetland	0.000	0.000	0.000	0.056	0.056
Intertidal Wetlands	0.108	0.875	1.675	0.115	2.817
Mudflats	0.046	0.000	0.015	0.000	0.061
Subtidal Bottom	0.000	0.000	0.000	0.000	0.000
Maritime Forest	0.318	0.000	1.487	0.000	1.806
Upland Ruderal	0.000	0.000	0.000	0.000	0.000
Urban	0.000	0.000	0.000	0.000	0.000
Total	**0.472**	**0.910**	**3.950**	**0.171**	**5.549**
Total Waters/Wetlands	**0.154**	**0.910**	**2.463**	**0.171**	**3.743**

CL: Cedarhurst-Lawrence MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area MRH: Mid-Rockaway Hammels Area

Table 11: Temporary Habitat Impacts – Acreage

Habitat Type	CL	MRE	MRA	MRH	TOTAL
Beach / Unvegetated Shoreline	0.000	0.000	0.273	0.114	0.388
Freshwater Wetland	0.000	0.000	0.000	0.000	0.000
Intertidal Wetlands	0.005	0.051	0.013	0.000	0.069
Mudflats	0.440	0.000	1.917	0.015	2.371
Subtidal Bottom	0.058	3.985	7.191	0.000	11.234
Maritime Forest	0.000	0.000	0.000	0.000	0.000
Upland Ruderal	0.218	8.457	6.746	0.922	16.970
Urban	0.018	1.726	4.641	3.038	9.617
Total	**0.739**	**14.219**	**20.781**	**4.089**	**40.648**
Total Waters/Wetlands	**0.503**	**4.036**	**9.394**	**0.129**	**14.062**

CL: Cedarhurst-Lawrence MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area MRH: Mid-Rockaway Hammels Area

Table 12: Restoration, Creation & Enhancement – Acreage

Habitat Type	Restoration / Creation		Enhancement	
	Mid-Rockaway Edgemere Area	Mid-Rockaway Arverne Area	Mid-Rockaway Edgemere Area	Mid-Rockaway Arverne Area
Intertidal Wetland	3.042	4.606	0.468	0.000
Maritime Forest	0.000	1.348	0.000	0.000

4.4 Hydroacoustics

4.4.1 Atlantic Shorefront

Ambient noise levels will be temporarily impacted as a result of in-water construction associated with dredging, sand placement, and groin construction. Intense sound can result in mortality, injury, and/or behavioral response. Generally, sounds in exceedance of 206 dB re 1 µPa (sound, expressed in decibels relative to one (1) micro-Pascal) are considered to be fatal to most fish species. This level of sound is rare and often associated with sheet pile construction, impact hammer, and no sound attenuating devices (e.g., bubble curtains). Other potential effects include rupture of the swim bladder (the bubble of air in the abdominal cavity of most fish species that is involved in maintenance of buoyancy), barotraumas, and oscillations of the swim bladder (leading to nearby organ damage). In other words, an animal that has had physical or physiological damage may be less likely than an animal without damage to avoid a predator or find food. Sounds above RMS 150 dB are often associated with behavioral impacts. These impacts could range from a fish altering its course of travel to avoiding an area during construction.

The type of construction proposed is not anticipated to cause sound levels that could result in mortality or injury. However, it is assumed that constructional activities could have behavioral impacts due to hydroacoustics. These impacts would be focused on fish changing a course of travel and avoiding a construction area, with limited to no impact on the survival of that individual or sustainability of the population.

4.4.2 Jamaica Bay

The potential impacts within the Jamaica Bay planning reach with respect to hydroacoustics are consistent with those discussed above for the Atlantic Shorefront. The type of construction proposed is not anticipated to cause sound levels that could result in mortality or injury. However, it is assumed that constructional activities could have behavioral impacts due to hydroacoustics. These impacts would be focused on fish changing a course of travel and avoiding a construction area, with limited to no impact on the survival of that individual or sustainability of the population.

5 POTENTIAL DIRECT/INDIRECT IMPACTS, CUMULATIVE, AND MITIGATION

The proposed activity would have immediate, short-term, direct and indirect impacts on EFH for some of the designated fish species and life history stages that occur in the immediate vicinity of the project areas. Dredging and placement activities in the project area are not expected to have any significant or long-term lasting effects on the "spawning, breeding, feeding, or growth to maturity" of the designated EFH species that occupy the both planning reaches. In fact, the Recommended Action is intended to have long term benefits to EFH by creating additional nearshore habitat structure and preserving or restoring native shoreline habitats. This section identifies the direct and indirect impacts that could result from the proposed project and makes recommendations for minimizing these impacts.

5.1 Direct Impacts

5.1.1 Atlantic Shorefront

Due to the mobility of larger fish, direct impacts from dredging and near shore construction activities (i.e., sand placement, and groin construction) would be limited to eggs, larvae, small fish, and benthic invertebrates or shellfish which would be removed, buried, or displaced. Specifically, dredging activities could have direct impacts to eggs, larvae, and potential juvenile EFH due to impingement or entrainment. The EFH designated species most likely to suffer mortality from dredging are juvenile winter flounder and windowpane flounder. These impacts will be minimized through construction scheduling (i.e., late fall or early winter). In addition, borrow pits left behind after dredging ceases would eventually provide good spawning habitat for winter flounder since the sand that would accumulate in them would provide substrate for eggs. In terms of benthic invertebrates and less mobile shellfish, it is assumed there will be direct impacts due to burial from suspended solids within the water column. Given the limited footprint size of in-water work, and ability of species to quickly recolonize disturbed habitats, these direct impacts are assumed to be minor, and short-term.

Minor short-term direct impact on benthic feeding fish species (e.g., windowpane, summer and winter flounder) would also be experienced due to temporary displacement during dredging or construction of groins (potentially due to water quality, hydroacoustics, burial, or habitat disturbance). It is anticipated that the substrates will return to pre-construction conditions as discussed above. As such, impacts to benthic communities are considered short-term because benthic invertebrate species are expected to fully recolonize the disturbed areas. While some areas will be permanently buried due to groin construction, this footprint is relatively small and will provide additional habitat structure important to EFH along this reach of shoreline. Finally, impacts from both dredging and nearshore or in water construction are considered minor and short-term because benthic feeding fish species are expected to avoid construction areas and feed in the surrounding area as result of water quality or hydroacoustics; and therefore, would not be adversely affected by the temporary localized reduction in available benthic food sources.

5.1.2 Jamaica Bay

Direct impacts due burial or sedimentation are possible as a result of in-water construction (i.e., bulkheads, rock sills). Construction activities in the near shore environment will employ BMPs (i.e.,

silt curtains, construction schedule) to minimize construction impacts within open waters. Rock sill construction could have direct effect on early life stages of EFH, as well as benthic habitats due to permanent burial of subtidal habitats. There could be burial of eggs or larvae that result in mortality, but construction BMPs will be intended to minimize or avoid these impacts can be employed. In addition, the small footprint relative to the overall habitats within Jamaica Bay will not affect the long-term sustainability of an EFH designated species. In fact, from a long-term perspective, the overall project of the project is intended to enhance in-water habitat complexity through incorporation of NNBFs as part of the HRFRRF. These will provide enhanced habitats for benthic communities, as well as the identified EFH fish species.

There would also be direct impacts to wetlands, mudflats, and other habitats that support multiple life stages of the identified EFH species. However, while there are direct impacts associated with the overall HFFRRFs, the NNBFs have been incorporated to offset these impacts and provide enhanced ecological functioning along these shorelines.

There would also be short-term direct impacts to larger foraging, transient, or migratory fish species within the project area as a result of water quality or hydroacoustics. However, it is assumed that these larger, mobile species will alter their behavior to avoid construction areas and utilize the surrounding area with no long-term impact to an individual or population.

5.2 Indirect Impacts

5.2.1 Atlantic Shorefront

As a result of dredging, placement of the material, and nearshore and in water construction activities, the most immediate, indirect effect on EFH areas would be the loss of benthic invertebrate prey species within the construction footprint of the proposed project. Small motile and sedentary epifaunal species (*e.g.*, small crabs, snails, tube- dwelling amphipods), and all infaunal species (*e.g.*, polychaetes), would be most vulnerable to suction dredging and burial from construction activities. However, impacts would be short term as infaunal organisms are likely to recolonize the area from nearby communities and re-establish to a similar community.

The EFH designated species most vulnerable to the loss of prey organisms are winter flounder, windowpane flounder, scup, and black sea bass. Winter flounder are obligate bottom feeders, preying primarily on infaunal polychaetes and tube-dwelling amphipods. The removal of benthic prey organisms will affect them more directly than any other EFH species. Windowpane flounder have larger mouths than winter flounder and feed primarily on small crustaceans (*i.e.*, mysid and decapod shrimp) and fish larvae. These are motile prey organisms that live in the water column or near the bottom and could, to some extent, avoid being removed by the dredge. Scup and black sea bass feed on a variety of benthic infaunal and epifaunal organisms that would be affected by dredging. The immediate impact of prey removal would be negligible since bottom feeding EFH species would re- locate to nearby areas with intact benthic food resources. It would also be a temporary condition, lasting only as long as it takes for benthic organisms to re-colonize the dredged area.

Studies performed in the Lower Bay of New York Harbor have shown that benthic community structure is disrupted by dredging but can reach a new equilibrium fairly rapidly. Cerrato and Scheier (1984) found that the borrow pits on the West Bank of the Ambrose Channel had distinctly different habitats from a nearby undredged control site. The benthic fauna at the control site was more diverse (*i.e.*, more species) and, in general, more stable (less susceptible to seasonal shifts in species composition and abundance)

through time, whereas there were fewer species in the borrow pits, but some of them were very abundant. In a related study, Conover *et al.* (1985) found that fish, including some EFH-designated species, were actually more abundant in borrow pits. Of the EFH designated species, butterfish (mostly juveniles) were more abundant in the borrow pits, as were winter flounder (in the fall). Red hake were more abundant in one of the borrow pits and the largest catches of windowpane flounder were made in one of the pits in the spring. Summer flounder were generally more abundant in the borrow pits as well.

In addition, Conover *et al.* (1985) also examined the stomach contents of winter flounder in the three sampling sites and related them to benthic populations identified by Cerrato and Scheier (1984). The results indicated that, despite changes in the species composition of benthic communities after dredging, the feeding success of winter flounder in the pits was not affected. Winter flounder, like many other bottom-feeding species, are selective feeders that adapt their diets to whatever prey species are readily available. These results suggest that the feeding success of other bottom-feeding EFH species is also likely to not be affected by changes in benthic community structure caused by dredging.

The degree to which water quality is degraded, or temperature and salinity changes in borrow pits depends on the depth of the pit, the circulation of water through the pit, and the amount of fine sediment and organic matter that accumulates in the pit. Conover *et al.* (1985) determined that summer water temperatures tended to be lower in borrow pits and salinities consistently higher (generally by 1-3 ppt, but by 7.3 ppt in January). More importantly, DO concentrations measured between June and November did not vary between sites.

Bottom currents along the project area shore are strong, thus it is likely that DO levels near the bottom of borrow pits in the project area would not be reduced. There is, in fact, so much sand that is transported west along the outer New York coast that any hole created by dredging would likely fill in naturally within a very short time. If fine sediments accumulate in them, the benthic invertebrate community will change from a sand-dominated to a mud-dominated fauna. However, as long as water quality is not degraded, there would be no adverse impact on EFH. In fact, if summer water temperatures in borrow pits are lower than on adjacent shoal areas, EFH might be improved.

5.2.2 Jamaica Bay

Consistent with conclusions for the Atlantic Shorefront planning reach, indirect effects on EFH areas would be the loss of benthic invertebrate as well as shellfish prey species due to burial or temporary habitat disturbance. During and immediately after construction, EFH species are expected to alter their behavior and utilize adjacent, more suitable habitats within Jamaica Bay. The expected footprint that will result in burial (i.e., rock sills) is relatively small. Temporarily disturbed habitats are expected to quickly recover. Finally, the rock sills and other portions of the NNBFs are expected to provide enhanced ecological services to EFH species by protecting shoreline habitats as well as in-water habitat structure.

There also could be indirect effects as a result of impacts to shoreline habitats, with emphasis on wetlands. Tidal wetlands are essential to healthy fisheries, and provide an essential food, refuge, and nursery habitats for many EFH designated species. While the project will result in habitat disturbances that could have short term indirect impacts on the EFH species that utilize them, the long-term benefits of the project through construction of NNBFs are expected to offset these short-term impacts. The restored wetlands, and constructed sills will have direct benefits to spawning, nursery, foraging, and shelter habitats that are critical to supporting the identified EFH designated species.

5.3 Cumulative Impacts

Given the growth capacity of EFH-designated fish populations within the project area, the expected recolonization rates of benthic prey species, the ecological benefits associated with NNBFs as well as groin construction, there would be no expected cumulative effects. The overall objective of the project is to provide coastal protection, resiliency of these shoreline habitats, as well as enhanced ecological services where possible.

In summary, the cumulative impacts on EFH are not considered significant consistent with previous consultations with NMFS. Like the benthic environment, the impacts to EFH are temporary in nature and do not result in a permanent loss in EFH. Impacts to benthic communities are considered short-term and minor because benthic invertebrate species are expected to recolonize quickly. Infaunal organisms are likely to recolonize the area from nearby communities and re-establish to a similar community within a 2 - 6.5 month period (USACE 2001). Impacts to fish community assemblages are considered minor (USACE 2001), given the large extent of the Atlantic Ocean and Jamaica Bay compared to the project construction footprint, and recolonization rates of benthic communities. Only short-term adverse impacts would occur because of short-term changes to water quality during construction, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates.

The borrow sites proposed for this project do not contain prominent shoal habitat features, wrecks and reefs, or any known hard bottom features that could be permanently lost due to the impacts from dredging. These types of habitat were avoided through careful site selection and coordination with fishery resource agencies. Some minor and temporary impacts would result in a loss of food source in the affected areas with each periodic nourishment. This impact would affect demersal or bottom-feeding EFH species such as summer flounder and windowpane. Cumulative losses of EFH can be avoided by not dredging deep holes, and leaving similar sandy substrate (with 3 feet of sand or more) for recruitment.

Steps taken to minimize impacts during construction are generally standardized across the District's projects. Dredging windows are employed when necessary, dredging is conducted in a manner to avoid creating deep pits, dredging locations within borrow areas are rotated when possible to reduce impacts, buffer areas are established around cultural targets within borrow areas, and borrow areas are chosen to minimize impacts to shellfish and fisheries resources. With the inclusion of these measures in all projects, cumulative impacts for the Recommended Plan are expected to be minimized to the greatest extent possible.

5.4 Mitigation

As noted throughout this report, a series of NNBFs were developed as part of the proposed HFFRRFs to not only control erosion and help manage coastal storm risk, but also to provide opportunities for habitat restoration and enhancement which would offset unavoidable permanent impacts to Federal and state regulated areas. Specifically, these NNBFs provide the following ecological benefits and were incorporated in the feasibility design to also recognize future federal, state, and city permitting requirements:

5.4.1 Restoration / Creation of Low and High Marsh Habitats

For purposes of habitat accounting and recognizing the difficulty in differentiating between low and high marsh habitats during mapping, these habitats have been categorized as "intertidal wetlands". Specifically, these NNBF efforts target the following:

- Restoration of low marsh habitat in existing mudflat areas proximate to highly erosional shorelines; and
- Restoration and/or creation of high marsh habitat in adjacent uplands that are dominated by common reed (*Phragmites australis*) and other invasive species.

5.4.2 Creation of Rock Sill Features

Creation of rock sill features provides protection for the subtidal and intertidal habitats, as well as provide a hard bottom habitat for increased ecological production. These features provide additional opportunities for shellfish habitat creation.

5.4.3 Evaluation of Planned Wetland Analysis

Evaluation of Planned Wetlands (Bartoldus et al. 1994) was also used to characterize the functional impacts and benefits within intertidal wetlands associated with each HFFRRF. The assessment results provide estimates of current resource value loss, and the potential increase in resource value through implementation of NNBFs. EPW provides a quantitative measure for capacity of an intertidal wetland to perform the following five functions:

- Shoreline bank erosion control – capacity to provide erosion control and dissipate erosive forces at the shoreline bank
- Sediment stabilization – capacity to stabilize and retain previously deposited sediments
- Water quality – capacity to retain and process dissolved or particulate materials to the benefit of downstream surface water quality
- Fish (tidal) – degree to which a wetland habitat meets the food/cover, reproductive, and water quality requirements for fish
- Wildlife – presence of characteristics that distinguish a wetland as unique, rare, or valuable.

Within each function, numerous elements (i.e., physical, chemical, and biological characteristics) are evaluated in order to identify a wetland's capacity to perform a given function. Element scores (unitless numbers ranging from 0.0 to 1.0, where 1.0 represents the optimal score) were assessed for the existing condition and proposed NNBFs. The scores were combined to produce a Functional Capacity Index (FCI) value from 0.0 to 1.0, which provides a relative index of a reference site's capacity to perform a given function. Total acreage of proposed intertidal wetland restoration, creation, or enhancement at the site is then multiplied by the FCI value to produce a wetland functional capacity unit (FCU), which represents the site's capacity to perform each wetland function (Bartoldus *et al.* 1994). Although no specific values are given to maritime or coastal buffer habitats with EPW, the wetland numbers are enhanced by having the adjacent buffer.

A summary of the analysis and the numerical results of the EPW functional assessment is provided in Tables 13 and 14. In summary, Table 13 shows that the project will result in the loss of 8.59 FCU's across the five functions. However, Table 14 shows that the NNBFs will result in the gain

of 34.51 FCUs across the five functions. Similar to the acreage metric evaluation, the EPW functional assessment shows significant gains to the shoreline ecosystem through the incorporation of NNBFs.

Table 13: EPW Functional Assessment – FCU Losses

Function	CL	MRE	MRA	MRH	TOTAL
Shoreline Bank Erosion	0.000	-0.420	-1.014	0.000	-1.456
Sediment Stabilization	-0.108	-0.643	-1.255	-0.129	-2.168
Water Quality	-0.100	-0.776	-1.415	-0.101	-2.43
Fish (tidal)	-0.075	-0.444	-0.890	-0.065	-1.498
Wildlife	-0.048	-0.365	-0.558	-0.045	-1.038
Total	**-0.330**	**-2.648**	**-5.132**	**-0.340**	**-8.589**

CL: Cedarhurst-Lawrence
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

Table 14: EPW Functional Assessment – FCU Gains

Function	CL	MRE	MRA	MRH	TOTAL
Shoreline Bank Erosion	0.000	3.542	4.606	0.000	8.148
Sediment Stabilization	0.000	3.513	4.606	0.000	8.119
Water Quality	0.000	3.443	4.606	0.000	8.049
Fish (tidal)	0.000	2.470	3.224	0.000	5.694
Wildlife	0.000	1.965	2.533	0.000	4.498
Total	**0.000**	**14.933**	**19.574**	**0.000**	**34.507**

CL: Cedarhurst-Lawrence
MRE: Mid-Rockaway Edgemere Area
MRA: Mid-Rockaway Arverne Area
MRH: Mid-Rockaway Hammels Area

6 EFH CONSERVATION MEASURES AND CONCLUSION

The District plans to continue coordination with NMFS on appropriate EFH conservation and mitigation measures for the project. Currently, the District's best management practices, including seasonal restrictions (i.e. no-dredge windows on Atlantic Shorefront between September and 1 March), natural resource protective state and city mandated Special Conditions under their Clean Water Act (CWA) and Coastal Zone Management Act (CZMA) jurisdictions, as well as USFWS recommendations to ensure protection of species under their jurisdiction, will likely offer significant protections for potentially-affected EFH managed species.

To summarize potential impacts; a minor increase in turbidity and sedimentation would be generated by the proposed construction activities. If EFH species eggs and larvae are present during construction, they could be affected. During the construction period, adult and juvenile fish would leave the area of construction and move to nearby suitable locations outside the area of disturbance. Also, for a short period of time after construction, there would be a reduction in benthic organisms immediately adjacent to the in-water construction footprint; however, this area would be recolonized quickly. These impacts would occur over comparatively small, discrete areas and would not adversely impact local water flow and circulation. Therefore, implementation of the Recommended Plan may adversely affect EFH, but likely would result in minimal adverse effects as the resulting changes to EFH and its ecological functions would be relatively small and insignificant. In addition, it is anticipated that ecosystem restoration efforts as part of this Recommended Plan would result in long-term, net benefits to managed species (all life stages), associated species, and EFH. In summary, the District concludes that the federal project will not cause significant adverse effects to EFH or EFH species. The finding of no significance adverse effects to EFH or EFH species was concurred upon by NMFS on December 4, 2018 (concurrence in Appendix I – Pertinent Correspondence).

7 REFERENCES

Bartoldus, C.C., E.W. Garbisch, and M.L. Kraus. 1994. Evaluation for Planned Wetlands (EPW). Environmental Concern Inc., St. Michaels, MD.

Cerrato, R. M., and F. T. Scheier. 1984. The effect of borrow on the distribution and abundance of benthic fauna in the lower Bay of New York Harbor. State University of New York at Stony Brook, Marine Sciences Research Center, Special Report 59, Ref. 85-6, 1-315. (Compagno 1984)

Clarke, D. G., and Wilber, D. H. 2000. "Assessment of potential impacts of dredging operations due to sediment resuspension," DOER Technical Notes Collection (ERDC TN-DOER-E9), United States Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/dots/doer.

Conover, D., R. M. Cerrato, and H. J. Bokuniewicz. 1985. Effect of borrow pits on the abundance and distribution of fishes in the Lower Bay of New York Harbor. State University of New York at Stony Brook, Marine Sciences Research Center, Special Report 64, Ref. 85-20, 1-68.

Dugan JE, Airoldi L, Chapman MG, Walker SJ, and Schlacher T (2011) Estuarine and Coastal Structures: Environmental Effects, A Focus on Shore and Nearshore Structures. In: Wolanski E and McLusky DS (eds.) Treatise on Estuarine and Coastal Science, Vol 8, pp. 17–41. Waltham: Academic Press.

Dugan, J.E., Hubbard, D.M., 2006. Ecological responses to coastal armoring on exposed sandy beaches. Shore and Beach 74 (1), 10–16

Kiorboe, T., Frantsen, E., Jensen, C., and Nohr, O. 1981. "Effects of suspended-sediment on development and hatching of herring (Clupea harengus) eggs," Estuarine, Coastal and Shelf Science 13, 107-111.

Long and Figley, 1984 Long, D. and W. Figley. 1984. New Jersey's Recreational and Commercial Ocean Fishing Grounds. New Jersey Department of Environmental Protection - Division of Fish, Game and Wildlife – Marine Fisheries Administration – Bureau of Marine Fisheries.

Morgan, J. D., and Levings, C. D. 1989. "Effects of suspended sediments on eggs and larvae of lingcod, Pacific herring, and surf smelt," Canadian Technical Report Fisheries and Aquatic Sciences 1729:I-VII; 1-31.

National Marine Fisheries Service (NMFS). 2003. Endangered Species Act Biological Opinion for the National Pollutant Discharge Permit of the Washington Aqueduct F/NER/2003/00600

NMFS, Northeast Regional Office, Habitat Conservation Division. Essential Fish Habitat. http://www.greateratlantic.fisheries.noaa.gov/hcd/webintro.html. Accessed April 21, 2016a (on-line).

NMFS, Habitat Protection Division. Essential Fish Habitat Regulatory Guideline. http://www.habitat.noaa.gov/pdf/efhregulatoryguidelines.pdf. Accessed April 21, 2016b (on-line).

NMFS, Northeast Regional Office, Habitat Conservation Division. Guide To Essential Fish Habitat Descriptions. http://www.greateratlantic.fisheries.noaa.gov/hcd/list.htm. Accessed April 21, 2016c (on-line).

Pereira, J.J., Goldberg, R., Ziskowski, J.J., Berrien, P.L., Morse, W.W., Johnson, D.L. 1999. Essential Fish Habitat Source Document: Winter Flounder, Pseudopleuronectes americanus, Life History and Habitat Characteristics. http://www.nefsc.noaa.gov/nefsc/publications/tm/tm138/. Accessed October 18, 2005.

USACE (2001). The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury Park to Manasquan Section Beach Erosion Control Project. Final Report. U.S. Army Engineer District, New York and U.S. Army Engineer Research and Development Center, Waterways Experiment Station

USFWS, Coastal Ecosystems Program. Significant Habitats and Habitat Complexes of the New York Bight Region. 1999.

APPENDIX A. EFH ASSESSMENT WORKSHEETS

NOAA FISHERIES
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
Essential Fish Habitat (EFH) Consultation Guidance
EFH ASSESSMENT WORKSHEET

Introduction:

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) mandates that federal agencies conduct an essential fish habitat (EFH) consultation with NOAA Fisheries regarding any of their actions authorized, funded, or undertaken that may adversely affect EFH. An adverse effect means any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

This worksheet has been designed to assist in determining whether a consultation is necessary and in preparing EFH assessments. This worksheet should be used as your EFH assessment or as a guideline for the development of your EFH assessment. At a minimum, all the information required to complete this worksheet should be included in your EFH assessment. If the answers in the worksheet do not fully evaluate the adverse effects to EFH, we may request additional information in order to complete the consultation.

An expanded EFH assessment may be required for more complex projects in order to fully characterize the effects of the project and the avoidance and minimization of impacts to EFH. While the EFH worksheet may be used for larger projects, the format may not be sufficient to incorporate the extent of detail required, and a separate EFH assessment may be developed. However, regardless of format, the analysis outlined in this worksheet should be included for an expanded EFH assessment, along with additional information that may be necessary. This additional information includes:

- the results of on-site inspections to evaluate the habitat and site-specific effects
- the views of recognized experts on the habitat or the species that may be affected
- a review of pertinent literature and related information
- an analysis of alternatives to the action that could avoid or minimize the adverse effects on EFH.

Your analysis of adverse effects to EFH under the MSA should focus on impacts to the habitat for all life stages of species with designated EFH, rather than individual responses of fish species. Fish habitat includes the substrate and benthic resources (e.g., submerged aquatic vegetation, shellfish beds, salt marsh wetlands), as well as the water column and prey species.

Consultation with us may also be necessary if a proposed action results in adverse impacts to other NOAA-trust resources. Part 6 of the worksheet is designed to help assess the effects of the action on other NOAA-trust resources. This helps maintain efficiency in our interagency coordination process. In addition, further consultation may be required if a proposed action impacts marine mammals or threatened and endangered species for which we are responsible. Staff from our Greater Atlantic Regional Fisheries Office, Protected Resources Division should be contacted regarding potential impacts to marine mammals or threatened and endangered species.

Instructions for Use:

Federal agencies must submit an EFH assessment to NOAA Fisheries as part of the EFH consultation. Your EFH assessment must include:

1) A description of the proposed action.
2) An analysis of the potential adverse effects of the action on EFH, and the managed species.
3) The federal agency's conclusions regarding the effects of the action on EFH.
4) Proposed mitigation if applicable.

In order for this worksheet to be considered as your EFH assessment, you must answer the questions in this worksheet fully and with as much detail as available. Give brief explanations for each answer.

Federal action agencies or the non-federal designated lead agency should submit the completed worksheet to NOAA Fisheries Greater Atlantic Regional Fisheries Office, Habitat Conservation Division (HCD) with the public notice or project application. Include project plans showing existing and proposed conditions, all waters of the U.S. on the project site, with mean low water (MLW), mean high water (MHW), high tide line (HTL), and water depths clearly marked and sensitive habitats mapped, including special aquatic sites (submerged aquatic vegetation, saltmarsh, mudflats, riffles and pools, coral reefs, and sanctuaries and refuges), hard bottom habitat areas and shellfish beds, as well as any available site photographs.

For most consultations, NOAA Fisheries has 30 days to provide EFH conservation recommendations once we receive a complete EFH assessment. Submitting all necessary information at once minimizes delays in review and keeps review timelines consistent. Delays in providing a complete EFH assessment can result in our consultation review period extending beyond the public comment period for a particular project.

The information contained on the HCD Consultation website will assist you in completing this worksheet.

EFH ASSESSMENT WORKSHEET FOR FEDERAL AGENCIES (modified 3/2016)

PROJECT NAME: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study (hereafter Project)

DATE: 07/25/2018

PROJECT NO.:

LOCATION (Water body, county, physical address):

Specific to the Atlantic Shoreline project reach of the Project

PREPARER: U.S. Army Corps of Engineers, New York District

Step 1: Use to generate the list of designated EFH for federally-managed species life stages for the geographic area of interest. Use this list as part of the initial screening process to determine if EFH for those species occurs in the vicinity of the proposed action. The list can be included as an attachment to the worksheet. Make a preliminary determination on the need to conduct an EFH consultation.

1. INITIAL CONSIDERATIONS

EFH Designations	Yes	No
Is the action located in or adjacent to EFH designated for eggs? **List the species:** Red hake, winter flounder, windowpane flounder, monkfish, long finned squid, scup, king mackerel, Spanish mackerel, cobia. See Tables 8 & 9 in attached EFH Assessment Report. Table is inclusive of scientific nomenclature.	✓	
Is the action located in or adjacent to EFH designated for larvae? **List the species:** Red hake, winter flounder, windowpane flounder, monkfish, summer flounder, scup, king mackerel, Spanish mackerel, cobia. In addition, sand tiger shark, dusky shark, white shark, and smoothhound shark (Atlantic stock). [The life stages of the Highly Migratory Species are broken down into neonates, juveniles, and adults. There are no 'egg' designations and neonates are assumed to correspond to the “larvae” heading.] See Tables 8 & 9 in attached EFH Assessment Report. Table is inclusive of scientific nomenclature.	✓	
Is the action located in or adjacent to EFH designated for juveniles? **List the species:** Pollock, red hake, winter flounder, windowpane flounder, Atlantic herring, little skate, winter skate, bluefish, Atlantic mackerel, summer founlder, scup, black sea bass, king mackerel, Spanish mackerel, cobia, bluefin tuna, sanbar shark, white shark, and smoothhound shark (Atlantic Stock). See Tables 8 & 9 in attached EFH Assessment Report. Table is inclusive of scientific nomenclature.	✓	

Is the action located in or adjacent to EFH designated for adults or spawning adults? List the species: Atlantic salmon, Atlantic cod, red hake, winter flounder, windowpane flounder, Atlantic herring, monkfish, winter skate, bluefish, Atlantic butterfish, Atlantic mackerel, summer flounder, scup, black sea bass, king mackerel, Spanish mackerel, cobia, sandbar shark, white shark, skipjack tuna, and smoothhound shark (Atlantic Stock). See Tables 8 & 9 in attached EFH Assessment Report. Table is inclusive of scientific nomenclature.	✓	

If you answered 'no' to all questions above, then an EFH consultation is not required - go to Section 5.

If you answered 'yes' to any of the above questions, proceed to Section 2 and complete the remainder of the worksheet.

<u>Step 2</u>: In order to assess impacts, it is critical to know the habitat characteristics of the site before the activity is undertaken. Use existing information, to the extent possible, in answering these questions. Identify the sources of the information provided and provide as much description as available. These should not be yes or no answers. Please note that there may be circumstances in which new information must be collected to appropriately characterize the site and assess impacts. Project plans that show the location and extent of sensitive habitats, as well as water depths, the HTL, MHW and MLW should be provided.

2. SITE CHARACTERISTICS

Site Characteristics	Description
Is the site intertidal, sub-tidal, or water column?	Their are two components to this phase of the project: 1. Borrow source for sand will occur is sub-tidal waters. 2. Sand placement and groin construction will occur in intertidal waters.
What are the sediment characteristics?	1. Borrow source area is sand. Valuable sandy shoal habitat will be avoided and flatter areas focused on. 2. Beach and near-shore area is best characterized as sand.
Is there submerged aquatic vegetation (SAV) at or adjacent to project site? If so describe the SAV species and spatial extent.	No in response to both project areas. The near-shore area is heavily disturbed due to historic and current recreational use of the beach areas.
Are there wetlands present on or adjacent to the site? If so, describe the spatial extent and vegetation types.	No. Wetlands are not mapped, and have not been identified in the field, within the Atlantic Shorefront area of the project.

Is there shellfish present at or adjacent to the project site? If so, please describe the spatial extent and species present.	With regards to the borrow area, there could be surf clams and other shellfish present. This is addressed in greater depth in Sections 4 and 5 of the attached EFH Assessment Report.
Are there mudflats present at or adjacent to the project site? If so please describe the spatial extent.	No.
Is there rocky or cobble bottom habitat present at or adjacent to the project site? If so, please describe the spatial extent.	No.
Is Habitat Area of Particular Concern (HAPC) designated at or near the site? If so for which species, what type habitat type, size, characteristics?	No.
What is the typical salinity, depth and water temperature regime/range?	1. Borrow source. Unknown. 2. Beach and near shore. Ocean salinity is generally 32 parts per thousand within three miles of Long Island. Temperature ranges from 37 to 77 degrees Fahrenheit throughout the year. Depths range in this near shore environment, but are generally pretty shallow.
What is the normal frequency of site disturbance, both natural and man-made?	1. For the borrow source area, these areas are typically not recently disturbed from a physical perspective. It is recognized that commercial or recreational fishing may occur in the area. 2. For the beach and near-shore area, these areas are continually disturbed as a result of recreational activities and human utilization of the shoreline.
What is the area of proposed impact (work footprint & far afield)?	The project area is described in Section 2 of the attached EFH Assessment Report. Maps of the project area are included.

Step 3: This section is used to describe the anticipated impacts from the proposed action on the physical/chemical/biological environment at the project site and areas adjacent to the site that may be affected.

3. DESCRIPTION OF IMPACTS

Impacts	Y	N	Description
Nature and duration of activity(s). Clearly describe the activities proposed and the duration of any disturbances.			The USACE anticipates that construction activities will occur from 2 September through 31 March. These dates align with potential protective areas for sensitive fish species such as the winter flounder, and also are protective of terrestrial species protected under jurisdiction of U.S. Fish and Wildlife Service. While the activities are further described in the attached EFH Assessment Report, the following activities will occur: 1. Dredging of sand from the borrow area. 2. Placement of sand and construction of buried seawall along the Atlantic Shoreline project reach. 3. Construction of 13 new groins and extension of 5 existing groins along the Atlantic Shoreline project reach. Construction of the groins is intended to reduce the long-term maintenance (i.e., sand placement) within the project area.
Will the benthic community be disturbed? If no, why not? If yes, describe in detail how the benthos will be impacted.	✓		The benthic communities will be disturbed in both project areas (i.e., borrow site and near shore areas). It is recognized that there would be an indirect effect on identified EFH species due to the temporary loss of benthic food prey items. However, these effects on the benthic food-prey organisms is considered to be temporary as as benthic studies have demonstrated recolonization following dredging operations within 2 to 2.5 years. Impacts to fish community assemblages are considered minor given the large extent of the Atlantic Ocean compared to the project construction footprint, and recolonization rates of benthic communities. In addition, construction of groins could also provide living spaces for benthic communities on which fish species rely. In addition to potentially creating living spaces and increasing food availability of the project area, the proposed would potentially provide shelter for fish from wave attacks during large coastal storm events.
Will SAV be impacted? If no, why not? If yes, describe in detail how the SAV will be impacted. Consider both direct and indirect impacts. Provide details of any SAV survey conducted at the site.		✓	No.
Will salt marsh habitat be impacted? If no, why not? If yes, describe in detail how wetlands will be impacted. What is the aerial extent of the impacts? Are the effects temporary or permanent?		✓	No.

Will mudflat habitat be impacted? If no, why not? If yes, describe in detail how mudflats will be impacted. What is the aerial extent of the impacts? Are the effects temporary or permanent?		✓	No.
Will shellfish habitat be impacted? If so, provide in detail how the shellfish habitat will be impacted. What is the aerial extent of the impact? Provide details of any shellfish survey conducted at the site.	✓		Yes. It is recognized that shellfish such as surf clams could temporarily impacted as result of the sand mining, or construction in the near shore environment. Specific to the borrow source, USACE will evaluate potential steps to restrict dredging depths to exposure of a different hardened substrate that would be unsuitable to shellfish. Impacted areas are expected to be recolonized quickly given the limited extent of in-water construction footprint. Finally, impacts to shellfish as considered minor given the large extent of the Atlantic Ocean compared to the project construction footprint, and recolonization rates of shellfish and benthic communities. Finally, construction of groins could also provide living spaces for shellfish (i.e., mussels).
Will hard bottom (rocky, cobble, gravel) habitat be impacted at the site? If so, provide in detail how the hard bottom will be impacted. What is the aerial extent of the impact?		✓	
Will sediments be altered and/or sedimentation rates change? If no, why not? If yes, describe how.	✓		The project is being undertaken as a coastal storm risk management project, and is specifically designed be protective from coastal flooding and wave climates. It is expected that the placement of sand and construction of groins will alter near shore sediment transport. However, these changes are assumed to provide benefits to the near shore ecosystem by protecting these beaches from future coastal storms while also minimizing long-term maintenance requirements that could have cumulative effects.
Will turbidity increase? If no, why not? If yes, describe the causes, the extent of the effects, and the duration.	✓		Construction activities under the Recommended Plan would employ Best Management Practices (BMPs) to reduce construction impacts with emphasis on turbidity. It is recognized that sand mining as well as near shore construction will cause a short-term increase in turbidity. However, grain size of material is anticipated to be coarse and not create as much turbidity as fine grain sands. If eggs and larvae are present during construction, they could be affected. However defined construction windows should minimize this impact. In addition, during the construction period, it is assumed that adult and juvenile fish would leave the area of construction and move to nearby suitable locations outside the area of disturbance.

Will water depth change? What are the current and proposed depths?	✓		The water depths will change within the borrow area. The depth of sand mining is unknown at this time. As discussed in the attached EFH Assessment Report, special consideration will be taken to maintain a consistent substrate in these borrow areas to minimize impacts to benthic and shellfish communities.
Will contaminants be released into sediments or water column? If yes, describe the nature of the contaminants and the extent of the effects.		✓	
Will tidal flow, currents, or wave patterns be altered? If no, why not? If yes, describe in detail how.	✓		The project is being undertaken as a coastal storm risk management project, and is specifically designed be protective from coastal flooding and wave climates. Similar to discussion relative to sediment transport, it is expected that the placement of sand and construction of groins will provide benefits to the near shore ecosystem by protecting these beaches from future coastal storms while also minimizing long-term maintenance requirements that could have cumulative effects.
Will water quality be altered? If no, why not? If yes, describe in detail how. If the effects are temporary, describe the duration of the impact.	✓		Water quality will be temporarily impacted as a result of in-water construction associated with sand mining, sand placement, and groin construction. Water quality impacts are assumed to primarily focus on turbidity and suspended sediments. Construction activities under the Recommended Plan would employ BMPs to reduce construction impacts with emphasis on turbidity. If eggs and larvae are present during construction, they could be affected. However defined construction windows should minimize this impact. In addition, during the construction period, it is assumed that adult and juvenile fish would leave the area of construction and move to nearby suitable locations outside the area of disturbance.
Will ambient noise levels change? If no, why not? If yes, describe in detail how. If the effects are temporary, describe the duration and degree of impact.	✓		Ambient noise levels will be temporarily impacted as a result of in-water construction associated with sand mining, sand placement, and groin construction. The type of construction proposed is not anticipated to cause sound levels that could result in mortality or injury. However, it is assumed that they could have behavioral impacts. These primarily would be focused on fish changing a course of travel and avoiding a construction area, with limited to no impact on the survival of that individual or sustainability of the population.
Does the action have the potential to impact prey species of federally managed fish with EFH designations?	✓		As discussed above, there will be temporary impacts to the benthic communities in both the borrow area as well as near shore environment. As such, it is recognized that there would be an indirect effect on identified EFH and EFH designated species due to the temporary loss of benthic food prey items. However, these effects on the benthic food-prey organisms is considered to be temporary as as benthic studies have demonstrated recolonization following dredging operations occurs within 2 to 2.5 years. Impacts to fish community assemblages are considered minor given the large extent of the Atlantic Ocean compared to the project construction footprint, and recolonization rates of benthic communities. In addition, construction of groins could also provide living spaces for benthic communities on which fish species rely. In addition to potentially creating living spaces and increasing food availability of the project area, the proposed would potentially provide shelter for fish from wave attacks during large coastal storms.

Step 4: This section is used to evaluate the consequences of the proposed action on the functions and values of EFH as well as the vulnerability of the EFH species and their life stages. Identify which species (from the list generated in Step 1) will be adversely impacted from the action. Assessment of EFH impacts should be based upon the site characteristics identified in Step 2 and the nature of the impacts described within Step 3. should be used during this assessment to determine the ecological parameters/ preferences associated with each species listed and the potential impact to those parameters.

4. EFH ASSESSMENT

Functions and Values	Y	N	Describe habitat type, species and life stages to be adversely impacted
Will functions and values of EFH be impacted for:			
Spawning **If yes, describe in detail how, and for which species. Describe how adverse effects will be avoided and minimized.**	✓		Unlike any of the other EFH-designated species, winter flounder deposit their eggs on the bottom in nearshore waters in depths of 1 to 15 feet on mud, sand, and gravel substrates along the Atlantic coast of New York during the winter (peak spawning in February and March) (Pereira et al. 1999). There is a high probability that dredging on borrow areas in the winter would cause the mortality of winter flounder eggs. As such, USACE will try an restrict dredging to the fall or early winter, and risk of removing winter flounder eggs would be eliminated or minimized.
Nursery **If yes, describe in detail how and for which species. Describe how adverse effects will be avoided and minimized.**			The project is not anticipated to adversely affect nursery habitat that supports identified EFH designated species. It is recognized that larvae and juveniles could be present within the work area. However, it is recognized that scheduling will be considered to minimize adverse effects as discussed in the attached EFH Assessment Report. In addition, these highly motile species are expected to avoid the construction area and seek more suitable habitat in near proximity.
Forage **If yes, describe in detail how and for which species. Describe how adverse effects will be avoided and minimized.**	✓		As discussed above, there will be temporary impacts to the benthic communities in both the borrow area as well as near shore environment. As such, it is recognized that there would be an indirect effect on identified EFH species due to the temporary loss of benthic food prey items. However, these effects on the benthic food-prey organisms is considered to be temporary as as benthic studies have demonstrated recolonization following dredging operations occurs within 2 to 2.5 years. It is also recognized that foraging or transient migratory fish will alter their behavior as a result of construction activities. However, it is assumed that these highly motile fish will find suitable habitat in near proximity and not have an adverse impact on either the individual or population.
Shelter **If yes, describe in detail how and for which species. Describe how adverse effects will be avoided and minimized.**			The project will not result in impacts to any habitat that provides shelter to EFH species. In fact, the construction of groins will provide additional near-shore habitat that fish could utilize for shelter or additional foraging.

Will impacts be temporary or permanent? Please box and describe the duration of the impacts.			
Will compensatory mitigation be used? If no, why not? Describe plans for mitigation and how this will offset impacts to EFH. Include a conceptual compensatory mitigation plan, if applicable.	☐	✓	Mitigation for the overall project is described in Section 5 of the attached EFH Assessment Report to account for both temporary and permanent impacts to federal and state regulated waters and wetlands. In addition, BMPs will be employed as necessary to avoid and/or minimize impacts to sensitive species of concern. Overall, the objective of the Atlantic Shoreline component of this project is to provide coastal storm protection, but also to minimize long-term maintenance of these beaches that could have cumulative effects on EFH designated species.

<u>Step 5</u>: This section provides the federal agency's determination on the degree of impact to EFH from the proposed action. The EFH determination also dictates the type of EFH consultation that will be required with NOAA Fisheries.

Please note: if information provided in the worksheet is insufficient to allow NOAA Fisheries to complete the EFH consultation additional information will be requested.

5. DETERMINATION OF IMPACT

Federal Agency's EFH Determination		
Overall degree of adverse effects on EFH (not including compensatory mitigation) will be: (check the appropriate statement)	☐	**There is no adverse effect on EFH or no EFH is designated at the project site. EFH Consultation is not required.**
	✓	**The adverse effect on EFH is not substantial. This means that the adverse effects are either no more than minimal, temporary, or that they can be alleviated with minor project modifications or conservation recommendations. This is a request for an abbreviated EFH consultation.**
	☐	**The adverse effect on EFH is substantial. This is a request for an expanded EFH consultation.**

Step 6: Consultation with NOAA Fisheries may also be required if the proposed action results in adverse impacts to other NOAA-trust resources, such as anadromous fish, shellfish, crustaceans, or their habitats as part of the Fish and Wildlife Coordination Act Some examples of other NOAA-trust resources are listed below. Inquiries regarding potential impacts to marine mammals or threatened/endangered species should be directed to NOAA Fisheries' Protected Resources Division.

6. OTHER NOAA-TRUST RESOURCES IMPACT ASSESSMENT

Species known to occur at site (list others that may apply)	Describe habitat impact type (i.e., physical, chemical, or biological disruption of spawning and/or egg development habitat, juvenile nursery and/or adult feeding or migration habitat). Please note, impacts to federally listed species of fish, sea turtles, and marine mammals must be coordinated with the GARFO Protected Resources Division.
alewife	Anadromous species such as alewife (Alosa pseudoharengus), blueback herring (Alosa aestivalis), American shad (Alosa sapidissima), and striped bass transit the inlet of the project area to reach spawning and nursery habitat in the freshwater portions of the system. Alewife and blueback herring, collectively known as river herring, spend most of their adult life at sea, but return to freshwater areas to spawn in the spring. They would be present in the project area as transients, and are likely to alter their behavior to avoid the construction area.
American eel	American eel (Anguilla rostrata) spawn in the Sargasso Sea, transit inlets as elvers and move into estuarine and freshwater habitats within coastal embayments. They inhabit these areas until they return to the sea through those inlets as adults. Given they would likely be adults within the project area, it is expected that these species will modify behavior to avoid the project area.
American shad	See discusion for alewife above.
Atlantic menhaden	Could be present within the project area, but would likely alter behavior to avoid the construction area.
blue crab	Will likely alter behavior to avoid the construction area. Construction of groins could provide long-term benefits to the species.
blue mussel	See discussion above for impacts to benthic and shellfish communities. Localized foot print could have temporary impacts, but project should provide long-term benefits to benthic communities including the blue mussel.
blueback herring	See alewife above.

Eastern oyster	N/A
horseshoe crab	The project is not expected to occur during breeding season. Individuals will avoid the construction area. Overall, the project could have long-term benefits to the species by further protection of near shore beach habitats.
quahog	See discussion above for impacts to benthic and shellfish communities.
soft-shell clams	See discussion above for impacts to benthic and shellfish communities. Construction of groins could provide long-term benefits to the species.
striped bass	Expected to avoid the construction area as adults or juveniles. No adverse impacts.
other species:	

Useful Links

National Wetland Inventory Maps

EPA's National Estuaries Program

Northeast Regional Ocean Council (NROC) Data

Mid-Atlantic Regional Council on the Ocean (MARCO) Data

Maine

Eelgrass maps

Maine Office of GIS Data Catalog

Casco Bay Estuary Partnership

Maine GIS Stream Habitat Viewer

New Hampshire

New Hampshire's Statewide GIS Clearinghouse, NH GRANIT

New Hampshire Coastal Viewer

Massachusetts

Eelgrass maps

MADMF Recommended Time of Year Restrictions Document

Massachusetts Bays National Estuary Program

Buzzards Bay National Estuary Program

Massachusetts Division of Marine Fisheries

Massachusetts Office of Coastal Zone Management

Rhode Island

Eelgrass maps

Narraganset Bay

Rhode Island Division of Marine Fisheries

Rhode Island Coastal Resources Management Council

CT DEEP Office of Long Island Sound Programs and Fisheries

CT Bureau of Aquaculture Shellfish

Maps CT River Watershed Council

New York

Eelgrass report

Peconic Estuary Program

NY/NJ Harbor Estuary

New Jersey

Submerged Aquatic Vegetation mapping

Barnegat Bay Partnership

Delaware

Partnership for the Delaware Estuary

Center for Delaware Inland Bays

Maryland

Submerged Aquatic Vegetation mapping

MERLIN

Virginia

Submerged Aquatic Vegetation mapping

NOAA FISHERIES
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
Essential Fish Habitat (EFH) Consultation Guidance
EFH ASSESSMENT WORKSHEET

Introduction:

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) mandates that federal agencies conduct an essential fish habitat (EFH) consultation with NOAA Fisheries regarding any of their actions authorized, funded, or undertaken that may adversely affect EFH. An adverse effect means any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

This worksheet has been designed to assist in determining whether a consultation is necessary and in preparing EFH assessments. This worksheet should be used as your EFH assessment or as a guideline for the development of your EFH assessment. At a minimum, all the information required to complete this worksheet should be included in your EFH assessment. If the answers in the worksheet do not fully evaluate the adverse effects to EFH, we may request additional information in order to complete the consultation.

An expanded EFH assessment may be required for more complex projects in order to fully characterize the effects of the project and the avoidance and minimization of impacts to EFH. While the EFH worksheet may be used for larger projects, the format may not be sufficient to incorporate the extent of detail required, and a separate EFH assessment may be developed. However, regardless of format, the analysis outlined in this worksheet should be included for an expanded EFH assessment, along with additional information that may be necessary. This additional information includes:

- the results of on-site inspections to evaluate the habitat and site-specific effects
- the views of recognized experts on the habitat or the species that may be affected
- a review of pertinent literature and related information
- an analysis of alternatives to the action that could avoid or minimize the adverse effects on EFH.

Your analysis of adverse effects to EFH under the MSA should focus on impacts to the habitat for all life stages of species with designated EFH, rather than individual responses of fish species. Fish habitat includes the substrate and benthic resources (e.g., submerged aquatic vegetation, shellfish beds, salt marsh wetlands), as well as the water column and prey species.

Consultation with us may also be necessary if a proposed action results in adverse impacts to other NOAA-trust resources. Part 6 of the worksheet is designed to help assess the effects of the action on other NOAA-trust resources. This helps maintain efficiency in our interagency coordination process. In addition, further consultation may be required if a proposed action impacts marine mammals or threatened and endangered species for which we are responsible. Staff from our Greater Atlantic Regional Fisheries Office, Protected Resources Division should be contacted regarding potential impacts to marine mammals or threatened and endangered species.

Instructions for Use:

Federal agencies must submit an EFH assessment to NOAA Fisheries as part of the EFH consultation. Your EFH assessment must include:

1) A description of the proposed action.
2) An analysis of the potential adverse effects of the action on EFH, and the managed species.
3) The federal agency's conclusions regarding the effects of the action on EFH.
4) Proposed mitigation if applicable.

In order for this worksheet to be considered as your EFH assessment, you must answer the questions in this worksheet fully and with as much detail as available. Give brief explanations for each answer.

Federal action agencies or the non-federal designated lead agency should submit the completed worksheet to NOAA Fisheries Greater Atlantic Regional Fisheries Office, Habitat Conservation Division (HCD) with the public notice or project application. Include project plans showing existing and proposed conditions, all waters of the U.S. on the project site, with mean low water (MLW), mean high water (MHW), high tide line (HTL), and water depths clearly marked and sensitive habitats mapped, including special aquatic sites (submerged aquatic vegetation, saltmarsh, mudflats, riffles and pools, coral reefs, and sanctuaries and refuges), hard bottom habitat areas and shellfish beds, as well as any available site photographs.

For most consultations, NOAA Fisheries has 30 days to provide EFH conservation recommendations once we receive a complete EFH assessment. Submitting all necessary information at once minimizes delays in review and keeps review timelines consistent. Delays in providing a complete EFH assessment can result in our consultation review period extending beyond the public comment period for a particular project.

The information contained on the HCD Consultation website will assist you in completing this worksheet.

EFH ASSESSMENT WORKSHEET FOR FEDERAL AGENCIES (modified 3/2016)

PROJECT NAME: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study (hereafter Project)

DATE: 07/25/2018

PROJECT NO.:

LOCATION (Water body, county, physical address):

Specific to the Jamaica Bay portion of the Project

PREPARER: U.S. Army Corps of Engineers, New York District

Step 1: Use to generate the list of designated EFH for federally-managed species life stages for the geographic area of interest. Use this list as part of the initial screening process to determine if EFH for those species occurs in the vicinity of the proposed action. The list can be included as an attachment to the worksheet. Make a preliminary determination on the need to conduct an EFH consultation.

1. INITIAL CONSIDERATIONS

EFH Designations	Yes	No
Is the action located in or adjacent to EFH designated for eggs? **List the species:** Red hake, winter flounder, windowpane flounder, monkfish, long finned squid, king mackerel, Spanish mackerel, cobia. See Tables 8 & 9 in attached EFH Assessment Report. Table is inclusive of scientific nomenclature.	✓	
Is the action located in or adjacent to EFH designated for larvae? **List the species:** Red hake, winter flounder, windowpane flounder, Atlantic herring, monkfish, king mackerel, Spanish mackerel, cobia. In addition, sand tiger shark, white shark, and smoothhound shark (Atlantic stock). [The life stages of the Highly Migratory Species are broken down into neonates, juveniles, and adults. There are no 'egg' designations and neonates are assumed to correspond to the “larvae” heading.] See Tables 8 & 9 in attached EFH Assessment Report. Table is inclusive of scientific nomenclature.	✓	
Is the action located in or adjacent to EFH designated for juveniles? **List the species:** Pollock, clearnose skate, red hake, winter flounder, windowpane flounder, Atlantic herring, winter skate, bluefish, Atlantic butterfish, Atlantic mackerel, summer flounder, scup, black sea bass, spiny dogfish, king mackerel, Spanish mackerel, cobia, sandbar shark, and smoothhound shark (Atlantic Stock). See Tables 8 & 9 in attached EFH Assessment Report. Table is inclusive of scientific nomenclature.	✓	

Is the action located in or adjacent to EFH designated for adults or spawning adults? List the species: Atlantic salmon, Clearnose skate, red hake, winter flounder, windowpane flounder, Atlantic herring, little skate, winter skate, yellowtail flounder, bluefish, Atlantic butterfish, Atlantic mackerel, summer flounder, scup, black sea bass, spiny dogfish, king mackerel, Spanish mackerel, cobia, sandbar shark, and smoothhound shark (Atlantic Stock). See Tables 8 & 9 in attached EFH Assessment Report. Table is inclusive of scientific nomenclature.	✓	

If you answered 'no' to all questions above, then an EFH consultation is not required - go to Section 5.

If you answered 'yes' to any of the above questions, proceed to Section 2 and complete the remainder of the worksheet.

Step 2: In order to assess impacts, it is critical to know the habitat characteristics of the site before the activity is undertaken. Use existing information, to the extent possible, in answering these questions. Identify the sources of the information provided and provide as much description as available. These should not be yes or no answers. Please note that there may be circumstances in which new information must be collected to appropriately characterize the site and assess impacts. Project plans that show the location and extent of sensitive habitats, as well as water depths, the HTL, MHW and MLW should be provided.

2. SITE CHARACTERISTICS

Site Characteristics	Description
Is the site intertidal, sub-tidal, or water column?	The project will occur in both intertidal and sub-tidal areas. The shoreline protection features will be in the intertidal zone, where the rock sills are assumed to occur within the sub-tidal area.
What are the sediment characteristics?	The shoreline and near shore environment within the Jamaica Bay project area is best characterized as fine silts and sands. The shoreline is heavily disturbed in some areas and characteristically has a rocky, cobble substrate.
Is there submerged aquatic vegetation (SAV) at or adjacent to project site? If so describe the SAV species and spatial extent.	No.
Are there wetlands present on or adjacent to the site? If so, describe the spatial extent and vegetation types.	Yes. The project will have temporary impacts to 0.07 acres of intertidal wetlands that will be restored in-kind and in-place. The project will have permanent impacts to 2.82 acres of intertidal wetlands.

Is there shellfish present at or adjacent to the project site? If so, please describe the spatial extent and species present.	Yes. Shellfish are expected to occur within the project area, and likely have temporary impacts to these communities. Impacts are likely focused on burial, physical disturbance, and/or water quality (i.e., turbidity).
Are there mudflats present at or adjacent to the project site? If so please describe the spatial extent.	Yes. The project will have permanent impacts to 0.06 acres, and temporary impacts to 2.37 acres of mudflats. Temporary impacts are primarily the result of construction (temporary) easements associated with construction of shoreline features.
Is there rocky or cobble bottom habitat present at or adjacent to the project site? If so, please describe the spatial extent.	Yes. In the most highly disturbed shorelines there is a rocky or cobble hard bottom habitat along the shoreline.
Is Habitat Area of Particular Concern (HAPC) designated at or near the site? If so for which species, what type habitat type, size, characteristics?	No.
What is the typical salinity, depth and water temperature regime/range?	It is recognized that temperatures and salinity will vary throughout the Jamaica Bay portion of the project. Data was reviewed for the USGS station 01311875 at Rockaway Inlet near Floyd Bennett Field. Temperatures range from 30 to 75 Fahrenheit throughout the year. Salinities range from approximately 28 to 30 parts per thousand.
What is the normal frequency of site disturbance, both natural and man-made?	These shorelines are heavily used and are continually disturbed by both anthropogenic disturbances, as well as waves associated with large storm events.
What is the area of proposed impact (work footprint & far afield)?	The project area is described in the attached EFH Assessment Report. Maps of the project area are included.

Step 3: This section is used to describe the anticipated impacts from the proposed action on the physical/chemical/biological environment at the project site and areas adjacent to the site that may be affected.

3. DESCRIPTION OF IMPACTS

Impacts	Y	N	Description
Nature and duration of activity(s). Clearly describe the activities proposed and the duration of any disturbances.			While the activities are further described in the attached EFH Assessment Report, the following activities will occur: 1. Construction of hardened shoreline features such as bulkheads, floodwalls, or revetments. These primarily occur in locations where they already exist. 2. Construction of NNBFs that include rock sills and wetland restoration along the intertidal, and subtidal zones.
Will the benthic community be disturbed? If no, why not? If yes, describe in detail how the benthos will be impacted.	✓		The benthic communities will be temporarily disturbed in the project areas. This could result from temporary in water work associated with bulkhead construction, or construction of rock sills in the subtidal zone. It is recognized that there would be an indirect effect on identified EFH species due to the temporary loss of benthic food prey items. However, these effects on the benthic food-prey organisms is considered to be temporary as as benthic studies have demonstrated recolonization following dredging operations occurs within 2 to 2.5 years. Impacts to fish community assemblages are considered minor, given the large extent of Jamaica Bay compared to the project construction footprint, and recolonization rates of benthic communities. In addition, construction of rock sills will provide living spaces for shellfish and benthic communities on which fish species rely. USACE will evaluate further opportunities to include oyster and mussel restoration as part of these rock sills. In addition to potentially creating living spaces and increasing food availability of the project area, the proposed would potentially provide shelter for fish from wave attacks during large coastal storm events.
Will SAV be impacted? If no, why not? If yes, describe in detail how the SAV will be impacted. Consider both direct and indirect impacts. Provide details of any SAV survey conducted at the site.		✓	No.
Will salt marsh habitat be impacted? If no, why not? If yes, describe in detail how wetlands will be impacted. What is the aerial extent of the impacts? Are the effects temporary or permanent?	✓		Yes. The project will have temporary impacts to 0.07 acres of intertidal wetlands that will be restored in-kind and in-place. The project will have permanent impacts to 2.82 acres of intertidal wetlands. These impacts will result from construction of the proposed High Frequency Flood Risk Reduction Features (HRFRRF). It should be noted that the NNBFs that are included in this project will restore and/or create 7.65 acres of new intertidal wetlands, and an additional 0.47 acres of wetland enhancement. In addition, long-term additional wetland areas are expected to be restored as a result of rock sills. Utilizing the Evaluation of Planned Wetlands, the project will have a net benefit on ecological services provided by intertidal wetlands. This specifically includes a function identified specific to tidal fish communities. A comprehensive description of mitigation is included in Section 5 of the attached EFH Assessment Report.

Will mudflat habitat be impacted? If no, why not? If yes, describe in detail how mudflats will be impacted. What is the aerial extent of the impacts? Are the effects temporary or permanent?	✓		Yes. The project will have permanent impacts to 0.06 acres, and temporary impacts to 2.37 acres of mudflats. These impacts will result from construction of the proposed HRFRRF. Temporary impacts are primarily the result of construction (temporary) easements associated with construction of shoreline features. These features will be restored to pre-existing elevation; restoring in-place and in-kind.
Will shellfish habitat be impacted? If so, provide in detail how the shellfish habitat will be impacted. What is the aerial extent of the impact? Provide details of any shellfish survey conducted at the site.	✓		Yes. It is recognized that shellfish could temporarily impacted as result of in-water construction activities associated with the HRFRRFs. Impacted areas are expected to be recolonized quickly given the limited extent of in-water construction footprint, and past results that have showed quick recolonization of disturbed intertidal areas. Overall, it is expected that with the inclusion of the NNBFs, the project will have a net-benefit on the shellfish, and overall ecological functioning, of these shorelines.
Will hard bottom (rocky, cobble, gravel) habitat be impacted at the site? If so, provide in detail how the hard bottom will be impacted. What is the aerial extent of the impact?	✓		Yes. It is recognized that some of the most heavily disturbed shorelines have this habitat. However, due to continual disturbance in these areas, the project is expected to have little to no impact on this habitat type.
Will sediments be altered and/or sedimentation rates change? If no, why not? If yes, describe how.	✓		The project is being undertaken as a coastal storm risk management project, and is specifically designed be protective from coastal flooding and wave climates. It is expected that the construction of rock sills will alter sediment transport. However, it is expected these features will promote sediment accretion and stabilize eroding shorelines. It is also recognized that hardened shorelines can have long-term impacts on bathymetry through exaggerated erosion. However, the proposed features will be constructed in areas where a hardened shoreline already exists and likely not result in significant long-term impacts beyond the existing site conditions.
Will turbidity increase? If no, why not? If yes, describe the causes, the extent of the effects, and the duration.	✓		Construction activities under the Recommended Plan would employ Best Management Practices (BMPs) to reduce construction impacts with emphasis on turbidity. It is recognized that near shore construction will cause a short-term increase in turbidity. However, grain size of material is anticipated to be coarse and not create as much turbidity as fine grain sands. If eggs and larvae are present during construction, they could be affected. However defined construction windows should minimize this impact. In addition, during the construction period, it is assumed that adult and juvenile fish would leave the area of construction and move to nearby suitable locations outside the area of disturbance.

Will water depth change? What are the current and proposed depths?		✓	Not expected. Some sediment accretion is expected behind the rock sills, but this will promote the sustainability of existing intertidal wetlands.
Will contaminants be released into sediments or water column? If yes, describe the nature of the contaminants and the extent of the effects.		✓	
Will tidal flow, currents, or wave patterns be altered? If no, why not? If yes, describe in detail how.	✓		The project is being undertaken as a coastal storm risk management project, and is specifically designed be protective from coastal flooding and wave climates. Similar to discussion relative to sediment transport, it is expected that the construction of rock sills will provide benefits to the near shore ecosystem by protecting these eroding shorelines from future coastal storms.
Will water quality be altered? If no, why not? If yes, describe in detail how. If the effects are temporary, describe the duration of the impact.	✓		Water quality will be temporarily impacted as a result of in-water construction associated with in water construction of the HRFRRFs. Water quality impacts are assumed to primarily focus on turbidity and suspended sediments. Construction activities under the Recommended Plan would employ BMPs to reduce construction impacts with emphasis on turbidity. If eggs and larvae are present during construction, they could be affected. However defined construction windows should minimize this impact. In addition, during the construction period, it is assumed that adult and juvenile fish would leave the area of construction and move to nearby suitable locations outside the area of disturbance. With the restoration of intertidal wetlands, and potential oyster and mussel restoration as part of the rock sills, the project could have a long term benefit on water quality.
Will ambient noise levels change? If no, why not? If yes, describe in detail how. If the effects are temporary, describe the duration and degree of impact.	✓		Ambient noise levels will be temporarily impacted as a result of in-water construction associated with the HRFRRFs. The type of construction proposed is not anticipated to cause sound levels that could result in mortality or injury. However, it is assumed that they could have behavioral impacts. These primarily would be focused on fish changing a course of travel and avoiding a construction area, with limited to no impact on the survival of that individual or sustainability of the population.
Does the action have the potential to impact prey species of federally managed fish with EFH designations?	✓		As discussed above, there will be temporary impacts to the benthic communities in the near shore environment. As such, it is recognized that there would be an indirect effect on identified EFH species due to the temporary loss of benthic food prey items. However, these effects on the benthic food-prey organisms is considered to be temporary as as benthic studies have demonstrated recolonization following dredging operations occurs within 2 to 2.5 years. Overall, the project will have a net benefit on EFH through the inclusions of NNBFs that strategically target wetland restoration as well as in water habitat structures.

Step 4: This section is used to evaluate the consequences of the proposed action on the functions and values of EFH as well as the vulnerability of the EFH species and their life stages. Identify which species (from the list generated in Step 1) will be adversely impacted from the action. Assessment of EFH impacts should be based upon the site characteristics identified in Step 2 and the nature of the impacts described within Step 3. should be used during this assessment to determine the ecological parameters/ preferences associated with each species listed and the potential impact to those parameters.

4. EFH ASSESSMENT

Functions and Values	Y	N	Describe habitat type, species and life stages to be adversely impacted
Will functions and values of EFH be impacted for:			
Spawning **If yes, describe in detail how, and for which species. Describe how adverse effects will be avoided and minimized.**	✓		A number of identified EFH-designated species spawn in estuarine and coastal waters, and likely could occur in Jamaica Bay. The range of spawning times is specific to species, and varies through the year based upon list provided. While many of the listed species have buoyant eggs, it is noted that winter flounder deposit their eggs on the bottom in nearshore waters in depths of 1 to 15 feet on mud, sand, and gravel substrates along the Atlantic coast of New York during the winter (peak spawning in February and March) (Pereira et al. 1999). For other species with eggs listed as a critical life history stage protected under EFH, the impacts with proposed construction is anticipated to be minor and short term. Overall, the project will have a positive long-term impact on these species by enhancing existing spawning habitats and providing additional protection through in water habitat.
Nursery **If yes, describe in detail how and for which species. Describe how adverse effects will be avoided and minimized.**			It is recognized that the project will have temporary impacts to coastal wetlands, and near shore environments. There could be temporary impacts to nursery habitats. However, the NNBFs that have been included in the design will provide a net positive long-term benefit to ecological functioning. These features will provide enhanced nursery habitat to EFH designated fish by restoring intertidal wetlands, as well as providing additional protection and in water habitat structure through construction of rock sills.
Forage **If yes, describe in detail how and for which species. Describe how adverse effects will be avoided and minimized.**	✓		As discussed above, there will be temporary impacts to the benthic communities and forage fish due to proposed in water construction. As such, it is recognized that there would be an indirect effect on identified EFH species due to the temporary loss of food prey items. However, these effects on the benthic food-prey organisms is considered to be temporary as as benthic studies have demonstrated recolonization following dredging operations occurs within 2 to 2.5 years. Forage fish are anticipated to return almost immediately following construction. It is also recognized that foraging fish will alter their behavior as a result of construction activities. However, it is assumed that these highly motile fish will find suitable habitat in near proximity and not have an adverse impact on either the individual or population.
Shelter **If yes, describe in detail how and for which species. Describe how adverse effects will be avoided and minimized.**			The project will not result in impacts to any habitat that provides shelter to EFH species. In fact, the construction of in water rock sills and intertidal wetlands will provide additional near-shore habitat that fish could utilize for shelter or additional foraging.

Will impacts be temporary or permanent? Please box and describe the duration of the impacts.			
Will compensatory mitigation be used? If no, why not? Describe plans for mitigation and how this will offset impacts to EFH. Include a conceptual compensatory mitigation plan, if applicable.		✓	Mitigation for the overall project is described in Section 5 of the attached EFH Assessment Report to account for both temporary and permanent impacts to federal and state regulated waters and wetlands. In addition, BMPs will be employed as necessary to avoid and/or minimize impacts to sensitive species of concern. Overall, the inclusion of NNBFs as part of the project design was intended to offset any unavoidable impacts to sensitive habitat, while also providing enhanced resiliency of these shoreline ecosystems.

<u>Step 5</u>: This section provides the federal agency's determination on the degree of impact to EFH from the proposed action. The EFH determination also dictates the type of EFH consultation that will be required with NOAA Fisheries.

Please note: if information provided in the worksheet is insufficient to allow NOAA Fisheries to complete the EFH consultation additional information will be requested.

5. DETERMINATION OF IMPACT

Federal Agency's EFH Determination		
Overall degree of adverse effects on EFH (not including compensatory mitigation) will be: (check the appropriate statement)		**There is no adverse effect on EFH or no EFH is designated at the project site. EFH Consultation is not required.**
	✓	**The adverse effect on EFH is not substantial. This means that the adverse effects are either no more than minimal, temporary, or that they can be alleviated with minor project modifications or conservation recommendations. This is a request for an abbreviated EFH consultation.**
		The adverse effect on EFH is substantial. This is a request for an expanded EFH consultation.

Step 6: Consultation with NOAA Fisheries may also be required if the proposed action results in adverse impacts to other NOAA-trust resources, such as anadromous fish, shellfish, crustaceans, or their habitats as part of the Fish and Wildlife Coordination Act Some examples of other NOAA-trust resources are listed below. Inquiries regarding potential impacts to marine mammals or threatened/endangered species should be directed to NOAA Fisheries' Protected Resources Division.

6. OTHER NOAA-TRUST RESOURCES IMPACT ASSESSMENT

Species known to occur at site (list others that may apply)	Describe habitat impact type (i.e., physical, chemical, or biological disruption of spawning and/or egg development habitat, juvenile nursery and/or adult feeding or migration habitat). Please note, impacts to federally listed species of fish, sea turtles, and marine mammals must be coordinated with the GARFO Protected Resources Division.
alewife	Anadromous species such as alewife (Alosa pseudoharengus), blueback herring (Alosa aestivalis), American shad (Alosa sapidissima), and striped bass transit the inlet of the project area to reach spawning and nursery habitat in the freshwater portions of the system. Alewife and blueback herring, collectively known as river herring, spend most of their adult life at sea, but return to freshwater areas to spawn in the spring. They would be present in the project area as transients, and are likely to alter their behavior to avoid the construction area.
American eel	American eel (Anguilla rostrata) spawn in the Sargasso Sea, transit inlets as elvers and move into estuarine and freshwater habitats within coastal embayments. They inhabit these areas until they return to the sea through those inlets as adults. Given they would likely be adults within the project area, it is expected that these species will modify behavior to avoid the project area.
American shad	See discusion for alewife above.
Atlantic menhaden	Could be present within the project area, but would likely alter behavior to avoid the construction area.
blue crab	Will likely alter behavior to avoid the construction area. Construction of rock sills could provide long-term benefits to the species.
blue mussel	See discussion above for impacts to benthic and shellfish communities. Localized foot print could have temporary impacts, but project should provide long-term benefits to benthic communities including the blue mussel.
blueback herring	See alewife above.

Eastern oyster	See discussion above for impacts to benthic and shellfish communities. Localized foot print could have temporary impacts, but project should provide long-term benefits to benthic communities including the oyster populations. In fact, USACE will explore opportunities for oyster restoration as part of the rock sills.
horseshoe crab	The project is not expected to occur during breeding season. Individuals will avoid the construction area. Overall, the project could have long-term benefits to the species by further protection of near shore beach habitats.
quahog	See discussion above for impacts to benthic and shellfish communities.
soft-shell clams	See discussion above for impacts to benthic and shellfish communities. Construction of rock sills could provide long-term benefits to the species.
striped bass	Expected to avoid the construction area as adults or juveniles. No adverse impacts.
other species:	

Useful Links

National Wetland Inventory Maps

EPA's National Estuaries Program

Northeast Regional Ocean Council (NROC) Data

Mid-Atlantic Regional Council on the Ocean (MARCO) Data

Maine

Eelgrass maps

Maine Office of GIS Data Catalog

Casco Bay Estuary Partnership

Maine GIS Stream Habitat Viewer

New Hampshire

New Hampshire's Statewide GIS Clearinghouse, NH GRANIT

New Hampshire Coastal Viewer

Massachusetts

Eelgrass maps

MADMF Recommended Time of Year Restrictions Document

Massachusetts Bays National Estuary Program

Buzzards Bay National Estuary Program

Massachusetts Division of Marine Fisheries

Massachusetts Office of Coastal Zone Management

Rhode Island

Eelgrass maps

Narraganset Bay

Rhode Island Division of Marine Fisheries

Rhode Island Coastal Resources Management Council

CT DEEP Office of Long Island Sound Programs and Fisheries

CT Bureau of Aquaculture Shellfish

Maps CT River Watershed Council

New York

Eelgrass report

Peconic Estuary Program

NY/NJ Harbor Estuary

New Jersey

Submerged Aquatic Vegetation mapping

Barnegat Bay Partnership

Delaware

Partnership for the Delaware Estuary

Center for Delaware Inland Bays

Maryland

Submerged Aquatic Vegetation mapping

MERLIN

Virginia

Submerged Aquatic Vegetation mapping

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

OCT 31 2018

Peter Weppler, Chief
Environmental Analysis Branch
Planning Division
New York District
U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278-0900

RE: Draft Final Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement, Essential Fish Habitat Assessment
Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Dear Mr. Weppler:

We have reviewed the Draft Final Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (DEIS) and essential fish habitat (EFH) assessment for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study. The project area includes the Atlantic coast of New York City between East Rockaway Inlet and Rockaway Inlet, areas within Jamaica Bay, and an offshore borrow area.

The report addresses the reevaluation of solutions to flooding attributed to storm surges in Jamaica Bay that inundate the bay shorelines of Rockaway (back bay flooding) and that overtop the Rockaway beachfront and flow across the peninsula to meet the surge into Jamaica Bay (cross shore flooding). The Recommended Plan (RP) has been formulated with two planning reaches, including 1) a reinforced dune and berm construction on the Atlantic shorefront and 2) high frequency flood risk reduction features (HFFRRF) in locations surrounding Jamaica Bay.

The Atlantic shorefront planning reach includes Rockaway Beach between Beach 9th Street and Beach 169th Street and an offshore borrow area in the Atlantic Ocean. The RP includes beach renourishment and construction of a 60 ft. wide beach berm for the length of the reach resulting in approximately 259 acres of dune and beach fill, as well as beach renourishment on a four year cycle for the 50-year life of the project. An approximately 33,000 lf composite seawall, extension of five existing groins and construction of 13 new groins are also proposed. The sand material for beach fill and berm construction will be dredged from an existing, 1830-acre offshore borrow area, two miles south of East Rockaway in waters depths of 35 – 60 ft.

The HFFRRF planning reach consists of flood control subreaches in Cedarhurst-Lawrence, Motts Basin North, Mid-Rockaway – Edgemere, Mid-Rockaway – Arverne, and Mid-Rockaway – Hammels. The RP for all of these subreaches includes construction of 11 acres of rock sills and 5,250 lf of bulkhead, modification of existing and construction of new stormwater outfalls and

culverts, and installation of pump stations. The rock sills are components of natural and nature-based features (NNBFs) proposed for the Mid-Rockaway – Edgemere and Mid-Rockaway – Arverne subreaches, Tidal marsh habitats with upland buffers will be created, restored or enhanced shoreward of the sills and will be designed to allow their shoreward migration with rising sea levels.

Magnuson Stevens Fisheries Management and Conservation Act (MSA)
The project area has been designated as EFH for a number of federally managed species including Atlantic butterfish (*Peprilus triacanthus*), Atlantic mackerel (*Scomber scombrus*), Atlantic sea herring (*Clupea harengus*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus saltatrix*), clearnose skate (*Raja eglanteria*), cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), little skate (*Leucoraja erinacea*), long-finned inshore squid (*Loligo pealei*), monkfish (*Lophius americanus*), red hake (*Urophycis chuss*), scup (*Stenotomus chrysops*), Spanish mackerel (*Scomberomorus maculates*), summer flounder (*Paralichthys dentatus*), whiting (*Merluccius bilinearis*), windowpane flounder (*Scophthalmus aquosus*), winter flounder (*Pseudopleuronectes americanus*), winter skate (*Leucoraja ocellata*) and others.

The project area is also EFH for several highly migratory species including blue shark (*Prionace glauca*), dusky shark (*Carcharhinus obscurus*), sandbar shark (*Carcharhinus plumbeus*), and sand tiger shark (*Odontaspis taurus*). Sand tiger and dusky sharks have also been designated as Species of Concern by NOAA. Species of Concern are those about which we have concerns regarding their status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act (ESA). The goal of designating a species as a Species of Concern is to promote proactive conservation efforts for these species in order to preclude the need to list them in the future.

The MSA requires federal agencies to consult with us on projects such as this that may affect EFH adversely. This process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments, lists the required contents of EFH assessments, and generally outlines each agency's obligations in this consultation procedure.

The EFH final rule published in the Federal Register on January 17, 2002 defines an adverse effect as "any impact which reduces the quality and/or quantity of EFH" and further states that:

> An adverse effect may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystems components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

We have reviewed the EFH assessment for this project. The assessment adequately evaluates many of the impacts of the project on EFH in the Atlantic shorefront and Jamaica Bay project reaches, and we agree with your conclusions on those impacts. However, some information, such as a full evaluation of impacts of dredging on the borrow area, was not provided. We understand that at this stage of the planning process, site specific information and design details are not yet

available; as a result additional coordination and consultation will take place during the Preconstruction, Engineering and Design Phase of the project so our EFH conservation recommendations provided in this letter can be refined.

The Atlantic shorefront project plan includes seawall and groin construction, dredging and beach renourishment that will result in 259 acres of dune and beach fill with subsequent renourishment efforts every four years. The NNBF rock sills constructed as part of the Jamaica Bay HFFRRF project have been designed to control erosion, help manage coastal storm risk, and provide opportunities for habitat restoration and enhancement. Construction of the sills will result in a habitat conversion of 11 acres of unconsolidated bottom to hard structure in two sub-reaches. Tidal marshes will be created, restored, or enhanced shoreward of the sills in eroded and/or degraded subtidal and intertidal habitats, and will be designed to allow their shoreward migration with rising sea levels. Construction of the NNBFs will create a mix of low and high marsh habitat and upland buffers that will have a positive effect on EFH, federally managed species and NOAA trust resources.

In the DEIS it states that as HFFRRF features are further developed, additional NEPA documentation and resource agency coordination would be provided, as necessary. We agree with this process. Also, impacts to EFH for longfin inshore squid in the borrow area were not fully evaluated because you were not aware of new research examining squid spawning in the area offshore of Long Island. We will continue to coordinate with your office to further evaluate impacts to EFH of longfin inshore squid in the borrow area, including providing additional EFH conservation recommendations as necessary.

Aquatic Resources

Longfin Inshore Squid

Longfin inshore squid spawn throughout the New York Bight; early life stages are found in coastal waters and throughout Jamaica Bay. Egg masses are demersal and are typically attached to low-relief structure (e.g. rocks, small boulders) on sandy or muddy substrate in water depths less than 50 feet (Jacobson 2005). Recent research indicates that spawning may be concentrated in coastal waters off of the Rockaway peninsula (D. Stevenson, personal communication, 2018), which could result in increased vulnerability to EFH of longfin inshore squid to dredging operations. Our office is currently investigating the locations of highest egg mass concentration, seasonal occurrence, and egg mass residence time to better define EFH, in order to evaluate dredging impacts to the species in the Atlantic shorefront borrow area.

Shellfish

Surf clam (*Spisula solidissima*), razor clam (*Ensis directus*), and tellin (*Tellina agillis*) occur in the vicinity of the offshore borrow area. Shellfish also occur in the Jamaica Bay portion of the project area, including hard clam (*Mercenaria mercenaria*), soft shell clam (*Mya arenaria*), blue mussel (*Mytilus edulis*), oyster (*Crassostrea virginica*), blue crab (*Callinectes sapidus*), and horseshoe crab (*Limulus polyphemus*).

Coen and Grizzle (2007) discuss the ecological value of shellfish habitat to a variety of managed species (e.g. American lobster, American eel, and winter flounder) and have suggested its designation as EFH for federally managed species. Clams are a prey species for a number of

federally managed fish including skates, bluefish, summer flounder and windowpane; siphons of hard clams provide a food source for winter flounder and scup (Steimle et al. 2000). Infaunal species such as clams filter significant volumes of water, effectively retaining organic nutrients from the water column (Nakamura and Kerciku 2000; Forster and Zettler 2004).

Horseshoe crabs may use multiple habitats along the shoreline of the Jamaica Bay reach, including subtidal bottoms, intertidal mudflats, and sandy beaches (Botton et al. 2006). Their eggs are a key seasonal food resource for a number of fish species including summer flounder and winter flounder (Botton and Shuster 2003); as a prey species, horseshoe crabs are considered EFH for those fishes.

Winter flounder

Winter flounder transit inlets such as East Rockaway Inlet to reach spawning areas within mid-Atlantic estuaries when water temperatures begin to decline in the fall. Tagging studies show that most return repeatedly to the same spawning grounds (Lobell 1939, Saila 1961, Grove 1982 in Collette and Klein-MacPhee 2002). Winter flounder typically spawn in the winter and early spring, although the exact timing is temperature dependent and thus varies with latitude (Able and Fahay 1998), however movement into these spawning areas may occur earlier, generally from mid- to late November through December. Winter flounder have demersal eggs that sink and remain on the bottom until they hatch. After hatching, the larvae are initially planktonic, but following metamorphosis they assume an epibenthic existence. Winter flounder larvae are negatively buoyant (Pereira et al. 1999) and are typically more abundant near the bottom (Able and Fahay 1998). These life stages are less mobile and thus more likely to be affected adversely by any impact to benthic habitat. As adults often spawn in shallow water within estuaries such as Jamaica Bay, they are especially vulnerable to benthic impacts associated with construction of the NNBFs in the Jamaica Bay HFFRRF reach.

Anadromous Fishes

Anadromous fishes such as river herring (alewife *Alosa pseudoharengus* and blueback herring *Alosa aestivalis*) use inlets such as East Rockaway Inlet as a migratory pathway to nursery and forage habitat within the estuary beyond the inlet. Alewife and blueback herring spend most of their adult life at sea, but return to freshwater areas to spawn in the spring. Both species are believed to be repeat spawners, generally returning to their natal rivers (Collette and Klein-MacPhee 2002). Because landing statistics and the number of fish observed on annual spawning runs indicate a drastic decline in alewife and blueback herring populations throughout the mid-Atlantic since the mid-1960's (ASMFC 2007), they have been designated as Species of Concern by NOAA.

Increases in turbidity due to the resuspension of sediments into the water column during renourishment can degrade water quality, lower dissolved oxygen levels, and potentially release chemical contaminants bound to the fine-grained estuarine/marine sediments, and can impede river herring migration (Auld and Schubel 1978; Breitburg 1988; Newcombe and MacDonald 1991; Burton 1993; Nelson and Wheeler 1997). Noise from beach renourishment activities may also result in adverse effects. Our concerns about noise effects come from an increased awareness that high-intensity sounds have the potential to harm both terrestrial and aquatic vertebrates (Fletcher and Busnel 1978; Kryter 1984; Popper 2003; Popper et al. 2004).

Buckel and Conover (1997) in Fahay et al. (1999) reported that diet items of juvenile bluefish include *Alosa* species such alewife and blueback herring. Juvenile *Alosa* species have also been identified as prey species for windowpane flounder and summer flounder in Steimle et al. (2000). As a result, activities that adversely affect the spawning success and the quality for the nursery habitat of these anadromous fish can adversely affect the EFH for juvenile bluefish, windowpane and summer flounder by reducing the availability of prey items.

Wetlands

Jamaica Bay is regionally significant for shellfish and marine, estuarine, and anadromous fishes, as well as for its significant migratory and wintering waterfowl concentrations. The wetlands and uplands in the bay are important as fish nursery areas and foraging areas for shorebirds and waterbirds. Wetlands in the project area perform many important ecological functions including water storage, nutrient cycling and primary production, sediment retention, water filtration or purification, and groundwater recharge. The estuary is subject to severe anthropogenic impacts, and has incurred a loss of 63% of wetlands between 1951 and 2003. During this time period, the rate of marsh loss increased from 17 acres lost per year during 1951 – 1974 to 33 acres lost per year during 1989 – 2003 (NPS 2007). Vegetated wetlands are also considered to be special aquatic sites under the Clean Water Act. Because of their ecological value, impacts on these special aquatic sites should be avoided and minimized; wetlands should be created, restored, or enhanced where feasible.

Tidal wetlands provide nursery habitat for many species of fish, including winter flounder and summer flounder. Summer flounder larvae migrate inshore into estuarine nursery areas, settling to the bottom of tidal marsh creeks to transform to their juvenile stage. These juveniles will then make extensive use of the creeks, preying on creek fauna such as Atlantic silversides and mummichogs. Juvenile summer flounder may also be found in salt marsh cord grass habitat during flood tides. Juveniles utilize the marsh edges for shelter, burying themselves in the muddy substrates. Keefe and Able (1992) in Packer et al. (1999) found that summer flounder juveniles that inhabit tidal marsh creeks exhibit the fastest growth. Larval and juvenile black sea bass also concentrate and feed extensively and shelter within these habitats. As a consequence, growth rates are high and predation rates are low, which makes these habitats effective nursery areas. Juvenile black sea bass are also known to inhabit the mouths of tidal marsh creeks as well as shallow shoals and tidal marsh edge habitat. Within these habitats, young-of-year black sea bass display high site fidelity; they may be territorial and move very little (Musick and Mercer 1977; Werme 1981; Able and Hales 1997). Black sea bass have been observed defending small areas of nursery habitat rather than fleeing to other suitable areas (Able and Fahay 1998).

An unimpeded marsh edge is important to estuarine and tidal marsh community dynamics, both to allow tidal flushing and concomitant transport of plankton, nekton, nutrients and sediment as well as to enable access to edge habitat by estuarine biota, including federally managed species, diadromous fishes, and other important prey for federally managed species. Marshes and marsh edge habitat can therefore be considered EFH for summer flounder, black sea bass, and other species.

Atlantic Shorefront

Beach Nourishment and Dredging

The dredging of sand for beach nourishment has the potential to impact both the EFH of a particular species as well as the organisms themselves in a variety of ways. Dredging can result in the impingement of eggs and larvae in the dredge plant and create undesirable suspended sediment levels in the water column. As stated above, increased suspended sediment levels can reduce dissolved oxygen, mask pheromones used by migratory fishes, and smother immobile benthic organisms and newly-settled juvenile demersal fish (Auld and Schubel 1978; Breitburg 1988; Newcombe and MacDonald 1991; Burton 1993; Nelson and Wheeler 1997). Sustained water column turbulence can reduce the feeding success of sight-feeding fish such as winter flounder and summer flounder.

Dredging can remove the substrate used by federally managed species as spawning, refuge and forage habitat. Benthic organisms that are food sources for federally managed species may also be removed during dredging. These impacts may be temporary if the substrate returns to preconstruction condition and the benthic community recovers with the same or similar organisms. The impacts may be permanent if the substrate is altered in a way that reduces its suitability as habitat, and if the benthic community is altered in a way that reduces its suitability as forage.

Overall, the dredging and placement of sand along the coastline will have some adverse effects on EFH and federally managed species due to the entrainment of early life stages in the dredge, alteration or loss of benthic habitat and forage species, and altered forage patterns and success due to increased, noise, turbidity and sedimentation. We agree that some effects will be temporary and others can be minimized using some of the management practices mentioned in the EFH assessment, such as dredging in the fall to avoid sensitive life stages of certain species, not dredging deep holes and leaving similar substrate in place to allow for recruitment.

Dredging in the borrow area can also affect EFH adversely through impacts to prey species. The EFH final rule states that the loss of prey may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat; the definition of EFH includes waters and substrate necessary to fish for feeding. Steimle et al. (2000) reported that winter flounder diets include the siphons of surf clams (*Spisula solidissima*). As a result, activities that adversely affect surf clams can adversely affect the EFH for winter flounder by reducing the availability of prey items

According to the DEIS, the offshore borrow area provides habitat for Atlantic surf clams; however surveys conducted by the USACE in 2003 and by the NYSDEC in 2012 indicate that the borrow area itself contains very low to no localized populations of surf clams. To ensure that impacts to surf clams are minimized, the borrow areas should be surveyed prior to each dredging cycle and areas of high densities should be avoided. Copies of the shellfish survey results should also be provided to us prior to any dredging in the borrow area.

The Mid-Atlantic Fisheries Management Council (MAFMC) has developed a policy statement on sand mining and beach nourishment activities that may affect federally managed species under their purview including summer flounder, scup, black sea bass, monkfish and butterfish.

These policies are intended to articulate the MAFMC's position on various development activities and facilitate the protection and restoration of fisheries habitat and ecosystem function. The MAFMC's policies on beach nourishment are:

1. Avoid sand mining in areas containing sensitive fish habitats (e.g., spawning and feeding sites, hard bottom, cobble/gravel substrate, shellfish beds).

2. Avoid mining sand from sandy ridges, lumps, shoals, and rises that are named on maps. The naming of these is often the result of the area being an important fishing ground.

3. Existing sand borrow sites should be used to the extent possible. Mining sand from new areas introduces additional impacts.

4. Conduct beach nourishment during the winter and early spring, when productivity for benthic infauna is at a minimum.

5. Seasonal restrictions and spatial buffers on sand mining should be used to limit negative impacts during fish spawning, egg development, young-of-year development, and migration periods, and to avoid secondary impacts to sensitive habitat areas such as SAV.

6. Preserve, enhance, or create beach dune and native dune vegetation in order to provide natural beach habitat and reduce the need for nourishment.

7. Each beach nourishment activity should be treated as a new activity (i.e., subject to review and comment), including those identified under a programmatic environmental assessment or environmental impact statement.

8. Bathymetric and biological monitoring should be conducted before and after beach nourishment to assess recovery in beach borrow and nourishment areas.

9. The effect of noise from mining operations on the feeding, reproduction, and migratory behavior of marine mammals and finfish should be assessed.

10. The cost effectiveness and efficacy of investments in traditional beach nourishment projects should be evaluated and consider alternative investments such as non-structural response and relocation of vulnerable infrastructure given projections of sea level rise and extreme weather events.

Sand Placement Effects on Fishes

Beach renourishment activities produce turbidity and sound impacts; fish may move away from those impacts in open water but cannot avoid them in inlets and channels. Fish that transit through inlets and channels on spawning migrations are therefore vulnerable to these impacts. As discussed earlier, winter flounder and river herring ingress through inlets to access estuarine spawning habitats. Winter flounder migrate into mid-Atlantic estuaries from mid-November through December. River herring enter these same estuaries on their spawning migrations from early March through May. Because project plans include beach renourishment along Rockaway

Beach at East Rockaway Inlet, sequencing of beach nourishment activities may be necessary in order to avoid impacts to ingressing winter flounder and river herring. This may include seasonal in-water work restrictions for winter flounder from November 15 through December 31 and from March 1 to May 31 for river herring. Any in-water work undertaken at the inlet at other times of the year should be designed with 50% of the inlet unobstructed to allow ingress and egress of fish past the work site.

Jamaica Bay HFFRRF

Impacts of NNBF Construction on EFH

The Jamaica Bay HFFRRF project plan proposing construction of NNBFs in the Edgemere and Arverne subreaches will result in permanent impacts to shallow water and tidal wetland habitat, including EFH for winter flounder. Rock sills are proposed for two subreaches of the Jamaica Bay HFFRRF, including four sections in Edgemere totaling approximately 3100 lf and three sections in Arverne totaling approximately 4800 lf, with a combined footprint of 11 acres. Tidal marshes will be created, restored, or enhanced shoreward of the proposed rock sills and will be designed to allow their shoreward migration with rising sea levels. We appreciate the Corps' use of NNBFs in this project and encourage their use in future projects when practicable.

The construction of the NNBFs, including rock sills and tidal wetlands, will result in a permanent loss of winter flounder EFH associated within the footprints of the sills and in areas shoreward of the sills due to natural sediment accretion and tidal wetlands creation. Seasonal in-water work restrictions from January 1 to May 31 will minimize impacts to winter flounder early life stages and their EFH during the construction activities and the NNBF features will provide habitat for other aquatic resources.

Impacts to Prey Species

Construction of the NNBFs may impede access by horseshoe crabs to spawning beaches. Horseshoe crab eggs are an important seasonal food source for summer flounder and winter flounder. Seasonal in-water work restrictions in areas suitable for horseshoe crab spawning from April 15 to July 15 minimize adverse effects to this prey species. Shellfish are also prey species for a number of federally managed fish including bluefish, scup, skates, summer flounder, windowpane and winter flounder. Site design and placement of the NNBFs should include an evaluation of shellfish resources in the project area; NNBFs should not be placed in areas of moderate to high densities of shellfish.

Tidal flushing and access to tidal marsh fringe habitat are important to maintain estuarine and marsh community dynamics; impediments to marsh edge habitat may therefore impact EFH for federally managed species, including winter flounder and summer flounder. Seven rock sills, approximately 350 lf to 2000 lf, are proposed in the Edgemere and Arverne subreaches. The individual sills as proposed appear to be of solid construction, with gaps between each sill but no gaps (vents/windows) within the sills. Vents/windows provide a number of benefits, including facilitating transport of plankton, nekton, sediment and nutrients into aquatic food webs that include federally managed species, diadromous fishes, and other important prey for federally managed species. These openings should generally be 10-15 feet in width, as measured from the bottom, and spaced evenly across the sill (e.g., one every 100 feet). Rock sills without

vents/windows placed at regular intervals can severely restrict biological functions and impact the marsh community. Additionally, though rare, displacement of sills either as a whole or as individual elements is a concern in highly dynamic environments.

All living shorelines must be properly maintained, which may require periodic repair of sills/reefs. A long-term maintenance plan should be developed for the proposed NNBFs, including plans to address the potential migration of hardened materials/structures. As we continue to coordinate on this project and plans are developed, information on incorporation of vents/windows and dropdowns into the sill design, overall wetland design, invasive species management, and monitoring, maintenance, and long-term stewardship of the NNBFs should be provided to us.

Essential Fish Habitat Conservation Recommendations

Pursuant to Section 305 (b) (4) (A) of the MSA, we offer the following EFH conservation recommendations to minimize adverse effects to EFH for summer flounder, bluefish, windowpane, little skate and other federally managed species:

Atlantic Shorefront

1. Coordinate with our office to determine impacts of dredging in the borrow area to longfin inshore squid EFH. If warranted, we will provide you with additional EFH conservation recommendations to address impacts to longfin inshore squid as information becomes available. We will work with you to incorporate conservation recommendations into the initial construction or subsequent maintenance dredging events.

2. Reinitiate consultation prior to each dredging event. Notification should be provided to our office prior to commencement of each dredging event and should include the location of the segment to be nourished, volume of sand to be dredged, depth of sand to be removed and the boundaries of the dredging within the borrow area.

3. Design and undertake dredging within the borrow areas in a manner that maintains geomorphic characteristics of the borrow area. Employ best management practices such as not dredging too deeply and leaving similar substrate in place to allow for benthic community recovery.

4. Incorporate MAFMC policies on sand mining and beach nourishment into the final design of this project and its long-term management plan as practicable.

5. Avoid areas of high surf clam densities within the borrow area. To ensure that impacts to surf clams are minimized, the borrow areas should be surveyed prior to each dredging cycle and areas of high densities should be avoided. Copies of the shellfish survey results should also be provided to us prior to any dredging in the borrow area.

6. Avoid turning on the intakes on the dredge plant until the dredge head is in the sediment and turn off before lifting out of the sediment to minimize larval entrainment in the dredge.

7. Provide annual reports to us on the acres of borrow area disturbed, dredging location, cubic yardage removed, depth of removal and post-dredging bathymetry of the borrow area.

8. Avoid beach renourishment activities in East Rockaway Inlet from November 15 to December 31 (winter flounder) and March 1 to May 31 (river herring) of each year to maintain access to estuarine and freshwater spawning habitats. At other times of the year, at least 50 % of the channel should remain unobstructed to allow ingress and egress of these species.

9. Use best management practices to minimize the release of suspended sediments during beach nourishment activities, including placing the material above the spring high tide line at low tide where possible and using turbidity barriers where feasible.

Jamaica Bay HFFRRF

10. Avoid construction of NNBFs below mean low water (MLW) from January 1 to May 31 of each year to minimize impacts to EFH for winter flounder. Work is permissible above MLW when the work area is exposed during low tide cycles.

11. Avoid construction of NNBFs from April 15 to July 15 of each year to protect horseshoe crab spawning habitat.

12. NNBFs should not be placed in areas of moderate to high shellfish density as practicable.

13. Incorporate vents/windows and dropdowns into rock sill design according to best management practices. Sills should be designed to optimize tidal flow and to ensure that horseshoe crabs do not get trapped behind them.

14. Provide design plans for tidal wetland creation/restoration and enhancement as well as monitoring, maintenance, adaptive management and long-term stewardship plans to us for review prior to construction.

15. Continue to coordinate with us during the Preconstruction, Engineering and Design Phase of the project.

Please note that Section 305 (b)(4)(B) of the MSA requires you to provide us with a detailed written response to these EFH conservation recommendations, including the measures adopted by you for avoiding, mitigating, or offsetting the impact of the project on EFH. In the case of a response that is inconsistent with our recommendations, Section 305 (b)(4)(B) of the MSA also indicates that you must explain your reasons for not following the recommendations. Included in such reasoning would be the scientific justification for any disagreements with us over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate or offset such effect pursuant to 50 CFR 600.920 (k). Please also note that a distinct and further EFH consultation must be reinitiated pursuant to 50 CRF 600.920 (j) if new information becomes available, or if the project is revised in such a manner that affects the basis for the above EFH conservation recommendations.

Endangered Species Act

Atlantic Large Whales

Federally endangered North Atlantic right and fin whales occur year round off the New York coast in the Atlantic Ocean. Right whales are most likely to occur in the offshore borrow areas between November and April and fin whales are most likely to occur between October and January. Right whales feed on copepods and could be foraging in the action area if suitable forage is present; right whales are also likely to occur in the action area while migrating along the Atlantic coast. Fin whale sightings off the eastern United States are centered along the 100m isobath, but fin whales are well spread out over shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1987; Hain et al. 1992). Fin whales feed on small schooling fish, squid, and crustaceans, including krill. Sperm and sei whales are limited to the offshore area beyond the continental shelf.

Sea Turtles

Four species of ESA listed threatened or endangered sea turtles under our jurisdiction are seasonally present off the New York coast in the Atlantic Ocean and could occur in the Rockaway Inlets and Jamaica Bay: the threatened Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead, the threatened North Atlantic DPS of green, and the endangered Kemp's ridley and leatherback sea turtles. Sea turtles typically occur along the Long Island coast from May to mid-November, with the highest concentration of sea turtles present from June through October.

Atlantic Sturgeon

Atlantic sturgeon are present off the New York coast in the Atlantic Ocean and could occur in the Rockaway Inlets and Jamaica Bay. The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPS of Atlantic sturgeon are endangered; the Gulf of Maine DPS is threatened. Adult and subadult Atlantic sturgeon originating from any of these DPSs could occur in the proposed project area. As young remain in their natal river/estuary until approximately age 2, and early life stages are not tolerant of saline waters, no eggs, larvae, or juvenile Atlantic sturgeon will occur within the waters off the New York coast in the Atlantic Ocean or in the Rockaway Inlets and Jamaica Bay.

Shortnose Sturgeon

Shortnose sturgeon are not expected to be present in waters south of Long Island.

As project details develop, we recommend you consider the following effects of the project on whales, sea turtles, and sturgeon:

- For any impacts to habitat or conditions that temporarily render affected water bodies unsuitable for the above-mentioned species, consider the use of timing restrictions for in water work.
- For activities that increase levels of suspended sediment, consider the use of silt management and/or soil erosion best practices (i.e., silt curtains and/or cofferdams).
- Consider the related effects to water quality after an outfall is built (i.e. , will the standards still be met, will the effluent volume change, and will there be any effects to the species).

- For pile driving or other activities that may affect underwater noise levels, consider the use of cushion blocks and other noise attenuating tools to avoid reaching noise levels that will cause injury or behavioral disturbance to sea turtles, and sturgeon - see the table below for more information regarding noise criteria for injury/behavioral disturbance in sturgeon or sea turtles.

Organism	**Injury**	**Behavioral Modification**
Sturgeon	206 dB re 1 µPaPeak and 187 dB cSEL	150 dB re 1 µPaRMS
Sea Turtles	180 dB re 1 µPaRMS	166 dB re 1 µPaRMS

Depending on the amount and duration of work that takes place in the water, listed species of whales, sea turtles, and sturgeon may occur within the vicinity of your proposed project. The Corps will be responsible for determining whether the proposed action may affect listed species. If you determine that the proposed action may affect a listed species, you should submit your determination of effects, along with justification and a request for concurrence to the attention of the Section 7 Coordinator, NMFS, Greater Atlantic Regional Fisheries Office, Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930 or nmfs.gar.esa.section7@noaa.gov. Please be aware that we have recently provided on our website guidance and tools to assist action agencies with their description of the action and analysis of effects to support their determination. See - http://www.greateratlantic.fisheries.noaa.gov/section7. After receiving a complete, accurate comprehensive request for consultation, in accordance to the guidance and instructions on our website, we would then be able to conduct a consultation under section 7 of the ESA. Should project plans change or new information become available that changes the basis for this determination, further coordination should be pursued. If you have any questions regarding these comments, please contact Edith Carson-Supino (978-282-8490; Edith.Carson-Supino@noaa.gov).

We look forward to our continued coordination with your office on this project as it moves forward. We can work with your staff to complete a programmatic consultation for the beach replenishment portion of the project to reduce the need for individual consultations. If you have any questions or need additional information, please do not hesitate to contact Ursula Howson at ursula.howson@noaa.gov or (732) 872-3116.

Sincerely,

Louis A. Chiarella,
Assistant Regional Administrator
for Habitat Conservation

cc:
ACOE – C. Alcoba, D. Mezey
PRD – D. Marrone, E. Carson-Supino
FWS – S. Sinkevich
EPA – D. Montella
NYSDEC – D. McReynolds
NEFMC – T. Nies
MAFMC – C. Moore
ASMFC – L. Havel

Literature Cited

Able, K.W. and M.P. Fahay. 1998. The First Year in the Life of Estuarine Fishes of the Middle Atlantic Bight. Rutgers University Press. New Brunswick, NJ

Able, K.W. and L.S. Hales Jr. 1997. Movements of juvenile black sea bass *Centropristis striata* (Linnaeus) in a southern New Jersey estuary. J. Exp. Mar. Biol. Ecol. 213:153-167.

Atlantic States Marine Fisheries Commission. 2007. Species Profile: shad and river herring: Atlantic states seek to improve knowledge of stock status and protect populations coast wide. www.asmfc.org. Washington, DC.

Auld, A.H. and J.R. Schubel. 1978. Effects of suspended sediments on fish eggs and larvae: a laboratory assessment. Estuar. Coast. Mar. Sci. 6:153-164.

Botton, M.L. And C. N. Shuster. 2003. Horseshoe crabs in a food web: Who eats whom? In C. N. Shuster, R. B. Barlow, and H. J. Brockmann (eds.), The American Horseshoe Crab. Harvard University Press, Cambridge, Massachusetts, pp. 133-153.

Botton, M.L., R.E. Loveland, J.T. Tanacredi, T. Itow. 2006. Horseshoe crabs (*Limulus polyphemus*) in an urban estuary (Jamaica Bay, New York) and the potential for ecological restoration. Estuaries Coasts, 29:820–830.

Breitburg, D.L. 1988. Effects of turbidity on prey consumption by striped bass larvae. Trans. Amer. Fish. Soc. 117: 72-77.

Buckel, J.A. and D.O. Conover. 1997. Movements, feeding periods, and daily ration of piscivorous young-of-the-year bluefish, *Pomatomus saltatrix*, in the Hudson River estuary. Fish. Bull. (U.S.) 95(4):665-679.

Burton, W.H. 1993. Effects of bucket dredging on water quality in the Delaware River and the potential for effects on fisheries resources. Prepared for: Delaware Basin Fish and Wildlife Management Cooperative, by Versar Inc, Columbia MD.

Coen LD, Grizzle RE. 2007. The importance of habitat created by molluscan shellfish to managed species along the Atlantic coast of the United States. Atlantic States Marine Fisheries Commission. Habitat Management Series #8.

Collette, B.B. and G. Klein-MacPhee. eds. 2002. Bigelow and Schroeder's fishes of the Gulf of Maine. Smithsonian Institution. Washington, D.C.

Fahay, M.P., P.L. Berrien, D.L. Johnson and W.W. Morse. 1999. Essential Fish Habitat Source Document: Bluefish *Pomatomus saltatrix* life history and habitat characteristics. U.S. Dep. Commer., NOAA Technical Memorandum NMFS-NE-144.

Fletcher, J. L. and R. G. Busnel. 1978. Effects of Noise on Wildlife. Academic Press, New York.

Forster S, Zettler ML. 2004. The capacity of the filter-feeding bivalve *Mya arenaria* L. to affect water transport in sandy beds. Marine Biology 144:1183–1189.

Grove, C.A. 1982. Population biology of the winter flounder, *Pseudopleuronectes americanus*, in a New England estuary. M.S. thesis, University of Rhode Island, Kingston, 95 pp.

Hain, J. H. W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The Fin Whale, *Balaenoptera physalus*, in Waters of the Northeastern United States Continental Shelf. Reports of the International Whaling Commission 42:653-669.

Jacobson, L. 2005. Essential fish habitat source document: Longfin inshore squid, Loligo pealeii, life history and habitat characteristics. NOAA Tech Memorandum NMFS- NE- 193. Woods Hole, MA. 52 p.

Keefe, M. and K.W. Able. 1992. Habitat quality in New Jersey estuaries: habitat-specific growth rates in juvenile summer flounder in vegetated habitats. Final Rep. for the New Jersey Dep. of Environmental Protection. Trenton, NJ. 26 p.

Kenney, R.D. and Winn, H.E. 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/slope areas. *Continental Shelf Research*, 7(2):107-114.

Kryter, K D. 1985. The Handbook of Hearing and the Effects of Noise (2nd ed.). Academic Press, Orlando, Florida.

Lobell, M.J. 1939. A biological survey of the salt waters of Long Island. Report on certain fishes: Winter flounder *(Pseudopleuronectes americanus)*. New York Conserv. Dept. 28th Ann. Rept. Suppl., Part I: 63-96.

Musick, J.A. and L.P. Mercer. 1977. Seasonal distribution of black sea bass, *Centropristis striata*, in the Middle Atlantic Bight with comments on the ecology and fisheries of the species. Trans. Am. Fish. Soc. 106:12-25.

Nakamura Y, Kerciku F. 2000. Effects of filter-feeding bivalves on the distribution of water quality and nutrient cycling in a eutrophic coastal lagoon. Journal of Marine Systems 26(2):209-221.

National Park Service (NPS). 2007. An update on the disappearing salt marshes of Jamaica Bay, New York. Gateway National Recreation Area, National Park Service, Dept. of the Interior. 78 p.

Nelson, D.A. and J.L. Wheeler. 1997. The influence of dredging-induced turbidity and associated contaminants upon hatching success and larval survival of winter flounder, *Pleuronectes americanus*, a laboratory study. Final report, Grant CWF #321-R, to Connecticut Department Environmental Protection, by National Marine Fisheries Service, Milford CT.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. N. Amer. J. Fish. Manag. 11:72-82.

Packer D.B., S. J. Griesbach, P.L. Berrien, C. A. Zetlin, C., D.L. Johnson D.L. and W.W. Morse. 1999. Essential fish habitat source document: summer flounder, *Paralichthys dentatus*, life history and habitat characteristics. NOAA Tech Memorandum NMFS- NE- 151. Woods Hole, MA. 88 p.

Pereira, J. J., R. Goldberg, J. J. Ziskowski, P.L. Berrien, W.W. Morse and D.L. Johnson. 1999. Essential Fish Habitat Source Document: Winter Flounder, *Pseudopleuronectes americanus*, life history and habitat characteristics. U.S. Dep. Commer., NOAA Technical Memorandum NMFS-NE-138.

Popper, A.N. 2003. Effects of anthropogenic sound on fishes. Fisheries 28:24-31.

Popper, A N., J. Fewtrell, M E. Smith, and R.D. McCauley. 2004. Anthropogenic sound: Effects on the behavior and physiology of fishes. MTS J. 37: 35-40.

Saila, S.B. 1961. The contribution of estuaries to the offshore winter flounder fishery in Rhode Island. Proc. Gulf. Carib. Fish. Inst. 14:95-109.

Steimle, F.W., R.A. Pikanowski, D.G. McMillan, C.A. Zetlin, S.J. Wilk. 2000. Demersal fish and American lobster diets in the Lower Hudson-Raritan Estuary. NOAA Technical Memorandum NMFS-NE-161. Woods Hole, MA. 106 p.

Stevenson, D. NOAA/ NMFS/ Greater Atlantic Regional Fisheries Office. Personal Communication, October 2, 2018.

Werme, C.E. 1981. Resource partitioning in a salt marsh fish community. PhD. Dissertation, Boston Univ., Boston, MA. 132 p.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Environmental Analysis Branch

November 16, 2018

Mr. Lou Chiarella,
Assistant Regional Administrator for Habitat Conservation
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
55 Great Republic Drive
Gloucester, Mass. 01930-2276

Attention: Karen Green, Field Supervisor, Sandy Hook Field Office, NJ
Ursula Howson, Biologist, Sandy Hook Field Office, NJ

Dear Mr. Chiarella:

The U.S. Army Corps of Engineers (USACE), New York District (District) is in receipt of National Marine Fisheries Service (NMFS) EFH Conservation Recommendations, dated October 31 2018 submitting recommendations on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Study.

Please find attached find our responses to your Conservation Recommendations. The District looks forward to working with your office throughout the Pre-Engineering and Design and Construction phases of this study and thank you for your continued assistance and input to this process which helps to advance the execution of this regionally-significant project.

If you require any additional information, please feel free to contact Ms. Daria Mazey Project Biologist/Planner at 917-790-8726.

Sincerely,

Peter Weppler
Chief, Environmental Analysis Branch

Enclosure
cc: NMFS, Green

Please be assured that a full evaluation of impacts within the borrow area was completed as part of this study. USACE has been working for many years to consolidate information to support consultation for this project. Two factors associated with the latest revisions to the HSGRR/EIS and attached EFH Assessment appear to have led to concerns regarding scope of the evaluation of the borrow area:

- In effort to consolidate the HSGRR/EIS, the previously provided *Borrow Area Study for the Atlantic Coast of Long Island, East Rockaway New York, Storm Damage Reduction Project* (Tetra Tech 2015) which was Appendix B2 in the 2016 Draft Report that NMFS previously reviewed was not provided as a separate appendix for the Revised Draft, but rather incorporated throughout the EIS and EFH Assessment. USACE has attached this information to NMFS as part of our response, and will include it on the public website for the project as supplementary information.
- To address a comment about addressing all portions of the study area equally, sections previously focused primarily on the borrow area, were subsumed within the discussion pertaining to Atlantic Shorefront Planning Reach. A discussion of the potential direct and indirect impacts within the borrow area are discussed as they pertain to four distinct impact categories (i.e., Sections 4.1 -4.4, and Sections 5.1-5.3). As such, a consolidated section pertaining specific to effects within the borrow area was not included, but this information is still captured in the analysis and the EIS.

As previously discussed, additional coordination is warranted during the Preconstruction, Engineering and Design Phase of the project. Based upon this additional coordination and potential data analysis specific to refined design details, USACE expects to continue to work with NMFS and include the appropriate references to existing and previous data collection as well as refine conservation recommendations as necessary.

From:	Ursula Howson - NOAA Federal
To:	Mazey, Daria S CIV USARMY CENAN (USA)
Cc:	Gallo, Jenine CIV CENAN CENAD (US); Alcoba, Catherine J CIV USARMY CENAN (US); Karen Greene - NOAA Federal
Subject:	[Non-DoD Source] EFH concurrence - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Study.
Date:	Tuesday, December 4, 2018 1:19:41 PM

Hello Daria,

Thank you for providing the requested information on the Rockaway borrow area as per our letter dated October 31, 2018. Regarding your letter dated November 16, 2018 responding to our EFH conservation recommendations (CRs), we concur with your comments and understand that additional coordination on those CRs will occur with us during the preconstruction, engineering and design phase of the project. We look forward to our continuing coordination with your office.

Thank you,
Ursula

--

Ursula Howson, PhD
NOAA/National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office
Habitat Conservation Division
James J. Howard Marine Sciences Laboratory
74 Magruder Rd.
Highlands, NJ 07732
732 872-3116 <tel:732%20872-3116> (office)
ursula.howson@noaa.gov <mailto:ursula.howson@noaa.gov>

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D4
Section 404(b)(1) Guidelines Evaluation

December 2018

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

General Reevaluation Report and Environmental Impact Statement

Section 404(b)(1) Guidelines Evaluation

1 INTRODUCTION

This attachment to Appendix D (Environmental Compliance) of the Hurricane Sandy General Re-evaluation Report/Environmental Impact Statement (GRR/EIS) presents a Section 404(b)(1) Guideline evaluation for the comprehensive evaluation of improvements to the Rockaway Atlantic Ocean Shoreline, and Jamaica Bay back bay shoreline elements of the project area. The evaluation is based on the regulations found at 40 CFR 230, Section 404(b)(1): Guidelines for Specification of Disposal Sites for Dredged or Fill Material. The regulations implement Sections 404(b) and 501(a) of the Clean Water Act, which govern the disposal of dredged and fill material inside the territorial sea baseline (§230.2(b)).

As stated in Section 230.10(a)(4):

> For actions subject to NEPA, where the Corps of Engineers is the permitting agency, the analysis of alternatives required for NEPA environmental documents, including supplemental Corps NEPA documents, will in most cases provide the information for the evaluation of alternatives under these Guidelines.

The integrated Draft Hurricane Sandy General Reevaluation Report/Environmental Impact Statement (GRR/EIS), to which this evaluation is an appendix, provides the documentation necessary to attest that the project is fully in compliance with the Section 404(b)(1) guidelines. The GRR/EIS provides a full project description and location, description of existing conditions, full alternatives analysis, and description of potential impacts as a result of the project and the project's construction.

The analysis provided within the GRR/EIS documents that the implementation of the Recommended Plan will not cause or contribute to significant degradation of the waters of the United States, as is demonstrated in the following sections.

The following Section 404(b)(1) evaluation is presented in a format consistent with typical evaluations in the New York area and addresses all required elements of the evaluation.

2 PROJECT DESCRIPTION

a. Location: The study area consists of the Atlantic Coast of New York City between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York. The Recommended Plan (RP) includes physical Coastal Storm Risk Management (CSRM) elements along the

oceanfront along Rockaway, and along the coastline of the Rockaway Inlet and Jamaica Bay. The study area is vulnerably located within the Federal Emergency Management Agency (FEMA) regulated 100-year floodplain. The shorefront area, which is a peninsula approximately 10 miles in length, generally referred to as Rockaway, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, New York City, and a section at the eastern end, known as Head-of-Bay, lies in Nassau County. More than 850,000 residents, 48,000 residential and commercial structures, and scores of critical infrastructure features such as hospitals, nursing homes, wastewater treatment facilities, subway, railroad, and schools are within the study area.

b. General Description: During Hurricane Sandy in October 2012, tidal waters and waves directly impacted the Atlantic Ocean shoreline. Tidal waters amassed in Jamaica Bay by entering through Rockaway Inlet and by overtopping and flowing across the Rockaway Peninsula. Effective coastal storm risk management for communities within the study area requires reductions in risk from two sources of coastal storm damages: inundation, wave attack with overtopping along the Atlantic Ocean shorefront of the Rockaway peninsula and flood waters amassing within Jamaica Bay via the Rockaway Inlet.

   The RP includes Atlantic Ocean shorefront protection (composite seawall, beach renourishment, groins) along the Atlantic Coast of the Rockaway peninsula and both structural and non-structural high frequency flooding risk reduction features (HFFRRFs) and Natural and Nature Based Features (NNBFs) along the Jamaica Bay coastline. No significant adverse impacts from construction or operation of the RP on environmental resources in the study area have been identified in the EIS. Short-term, direct, minor adverse impacts to aesthetics, noise, water quality, aquatic habitats and species, marine and terrestrial species, and recreation resources would occur during construction of the RP. These impacts would end upon completion of construction of the RP.

c. Authority and Purpose: The RP identification and analyses will be conducted by USACE under Section 1135 of the Water Resources Development Act of 1986, as amended. Under Section 1135, the USACE is authorized to review the need for modifications of existing projects for the purpose of providing measures to improve environmental quality and is authorized to address degradation of the environment caused by a past USACE project.

   For many years prior to Hurricane Sandy, study area CSRM efforts have emphasized Atlantic shoreline features with the State of New York as the local sponsor. In October 2012, coastal areas in vicinity to New York City were devastated by the impacts of Hurricane Sandy. Awareness of the need for an integrated approach to CSRM opportunities in Jamaica Bay and surrounding communities has increased since Hurricane Sandy. As a result of the devastation associated with Hurricane Sandy, the USACE has been tasked to address "coastal resiliency" and "long-term sustainability" in addition to the traditional USACE

planning report categories of "economics, risk, and environmental compliance" (USACE 2013).

Accordingly, USACE has prepared a Hurricane Sandy General Reevaluation Report/Environmental Impact Statement (GRR/EIS) examining coastal storm management (CSRM) problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area. The goal of the Draft GRR/EIS is to identify solutions that will reduce Atlantic Ocean shoreline and Jamaica Bay vulnerability to storm damage over time, in a way that is sustainable over the long-term, both for the natural coastal ecosystem and for communities.

Consistent with current USACE planning guidance, the study team identified and screened alternatives to address CSRM, and is presenting the RP. The RP identifies the overall project features, with the acknowledgement that the specific dimensions of the plan have not been finalized. These final design components will be undertaken after review of the GRR/EIS. The Revised Draft GRR/EIS will undergo public review, policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR). The USACE study team will respond to review comments, then present a recommended plan and develop a Final GRR/EIS.

d. General Description of Placement Material: Sand that is compatible to the existing Rockaway Atlantic Ocean shoreline will be pumped in from a proposed offshore borrow area, and rock sill is proposed for some elements of the Jamaica Bay component of the overall project.

e. Proposed Discharge Site: Under the RP, the dredged sand would be placed along the Rockaway Atlantic Ocean shoreline, and rock sill is proposed for some elements of the Jamaica Bay component of the overall project.

f. Disposal Method: Use of hydraulic dredging equipment for the initial construction and renourishment efforts, as well as for Jamaica Bay components of the overall project, is proposed.

3 FACTUAL DETERMINATIONS

a. Physical Substrate Determinations (Atlantic Coast/Jamaica Bay)

(1) The GRR Coastal Storm Risk Management plan for the area from East Rockaway Inlet to Rockaway Inlet and the lands within and surrounding Jamaica Bay New York consists of the following components, which are generally described for two Planning Reaches: 1) A reinforced dune and Berm Construction, in conjunction with groins in select locations along the Atlantic Ocean Shoreline; 2) a line of protection along Jamaica Bay and Rockaway Inlet comprised of CSRM features in locations surrounding Jamaica Bay (See GRR/EIS Section 6.2 for extensive plan details). If additional CSRM features are further developed, additional NEPA documentation and resource agency coordination would be provided, as necessary. This RP description includes the maximum footprint for the plan, however the footprint may be revised based on public and agency comments as well as new

information. Both elements (i.e., Atlantic Ocean Shoreline, Jamaica Bay/Back Bay shoreline) of the entire project are subject to evaluation under the 404(b)(1) jurisdiction.

The plan (summary provided here) along the Atlantic Ocean Shorefront consists of:

- A composite seawall with a structure crest elevation of +17 feet (NAVD88) – the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet;
- A beach berm elevation of +8 ft (NAVD88) and a depth of closure of -25 ft (NAVD88);
- A total beach fill quantity of 1.6 million cy for the initial placement, including tolerance, overfill and advanced nourishment with a 4-year renourishment cycle of 1,021,000 cy, resulting in a minimum berm width of 60 feet;
- Extension of 5 existing groins; and
  Construction of 13 new groins.
- The east beachfill taper is approximately 3,000 ft in shorefront length from Beach 19th Street east to Beach 9th Street. The taper comprises of approximately 1,000 ft of dune and beach taper including reinforced dune feature and approximately 2,000 ft of dune and beach fill without reinforced dune feature. In addition to the tapering of berm width, the dune elevation also tapers from an elevation of +18 ft (NAVD88) at 19th Street down to approximately +12 ft (NAVD88) at Beach 9th Street which will be tied into the existing grade. The west beachfill taper is approximately 5,000 ft in shorefront length from Beach 149th Street west to Beach 169th street fronting Riis Park. The beachfill taper will be beach fill only with a berm width tapered from the design width at 149th Street to the existing width and height at 169th Street. In addition to the beachfill taper, a tapered groin system comprised of three (3) rock groins is included for this section.

The plan along the Jamaica Bay/Back Bay consists of:

See RDGRR/EIS Section 6.2 for plan details, and summary.

(2) Sediment Type: Sediments similar to those present in the placement area will be utilized. No impacts are anticipated. (See "Borrow Source Investigation Appendix B," April 7, 2016; and "Draft Reformulation Study," March 26, 2015.)/ There will be no significant impact to sediment from implementation of the Jamaica Bay Recommended Plan features.

(3) Dredged Material Movement: Minor short-term movement and existing shore processes will continue/NA

(4) Physical Effects on Benthos: Minor short-term disruption at the Atlantic Ocean Shoreline, and habitat exchange due to rock sill placement at some segments of Jamaica Bay Shoreline. Creation of rock sill features provides protection for the subtidal and intertidal habitats, as well as provide a hard bottom habitat for increased

ecological production. These features provide additional opportunities for oyster and ribbed mussel habitat creation.

(5) Other Effects: None identified

(6) Action to Minimize Impacts: See Section 6.

b. Water Circulation, Fluctuations, and Salinity Determinations

(1) Water

a. Salinity: Proposed project is not expected to affect salinity because beach fill does not govern the overall water mass movements (tidal flow and river discharge) that control salinity.

b. Water Chemistry: No major impacts are expected.

c. Clarity: Temporary increase in turbidity will occur from sediment resuspension during placement of the material/ No significant effect from implementation of Jamaica Bay features.

d. Color: Minor temporary changes possible but no major short- or long-term impacts are expected/NA

e. Odor: No measurable impacts are expected/NA.

f. Taste: Not applicable/NA

g. Dissolved Gas Levels: Possible short-term variation may occur due to turbulence created by placement of the material on the beach/NA.

h. Nutrients: Temporary and localized nutrient increases may occur due to sediment resuspension during beach and rock fill activities. No long-term increase in nutrients and eutrophication will result from the Recommended Plan /NA.

i. Eutrophication: None identified/NA

j. Other: None identified

(2) Current Patterns and Circulation: No significant impacts identified

(3) Normal Water Level Fluctuations: No significant impacts identified/NA

(4) Salinity Gradients: No significant impacts expected/NA

(5) Actions to Minimize Impacts: Implement recommendations from National Marine Fisheries Service, USFWS and state and local regulatory agencies to maintain potential impacts at minor, less-than-significant adverse levels.

c. Suspended Particulate/Turbidity Determination

(1) Change at Disposal Site: Short-term, localized increases in suspended sediment/turbidity as a result of placement of fill material.

(2) Effects on Chemical and Physical Properties of the Water Column: Resuspension impacts should be minimal since particles will settle out fairly rapidly and no toxic

metals or organic compounds are anticipated to be encountered in the borrow area source material/NA.

(3) Effects on Biota: Short-term exposure due to localized sediment resuspension during placement of material. No long-term significant effects are projected/NA.

(4) Action to Minimize Impacts: Placement of material will be completed as early as possible to allow for optimum recruitment of benthic organisms within the placement area. Use of BMPs, per USFWS, NMFS and state and local regulatory agency recommendations will be utilized to minimize potential significant impacts/NA.

d. Contaminant Determination: No impacts identified.

e. Aquatic Ecosystems and Organisms Determination: Possible effects to those species that are in the immediate area of placement. No significant impacts are expected/NA.

f. Proposed Disposal Site Determination: Not applicable.

g. Determination of Cumulative Effects on the Aquatic Ecosystem: See EIS Section 7.25.

h. Determination of Secondary Effects on the Aquatic Ecosystem: None identified.

4 FINDINGS OF COMPLIANCE OR NONCOMPLIANCE

a. There are no practicable alternatives for the RP under the jurisdiction of Section 404(b)(1) Guidelines.

b. The RP does not appear to violate applicable state water quality standards or effluent standards.

c. The RP will not have significant adverse impacts on endangered species or their critical habitats. Formal coordination with the USFWS and NMFS under Section 7 of the Endangered Species Act of 1973 will be completed to ensure the safety of any transient species that may be present during construction.

d. The RP will not result in significant adverse impacts on human health or welfare, including municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife and special aquatic sites.

e. All appropriate steps to minimize adverse environmental impacts will be implemented during construction and operation of the RP.

f. No significant adaptations of the guidelines were made relative to this evaluation.

5 CONCLUSIONS

Based on the above, the RP is determined to be in compliance with the Section 404(b)(1) Guidelines, subject to appropriate and reasonable conditions, to be determined on a case-by-case basis, to protect the public interest.

US Army Corps of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D5
Coastal Zone Management Program
Federal Consistency Determination

December 2018

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

Final General Reevaluation Report and Environmental Impact Statement

New York (and New York City Local Waterfront Development Plan) Coastal Zone Management Program Federal Consistency Determination

As required under the Federal Coastal Zone Management Act, the USACE, New York District reviewed the Recommended Plan in relation to the applicable policies of the New York State Coastal Zone Management Program. A number of questions under Part C of the New York State Coastal Management Program (NYS CMP) Federal Consistency Assessment Form (New York State Department of State (NYSDOS), Division of Coastal Resources (DCR), 2003b) were answered in the affirmative; therefore, as stated under Part D, number two, it is necessary to analyze the Project in more detail with respect to its consistency with the *State Coastal Policies* (NYSDOS DCR, 2003c) of the NYS CMP, as well as New York City's *The New Waterfront Revitalization Program* (WRP) (New York City Department of City Planning, Consistency Assessment Form 2016). Following is a list of the State and city policies in question and a brief statement of how the Project is consistent with each of these policies. Policies that are not listed were answered in the negative with respect to this Project as proposed. New York State Department of State concurred with the Federal Consistency Determination on December 6, 2018, in coordination with the New York City Department of City Planning (Appendix I—Pertinent Correspondence).

1 DEVELOPMENT POLICIES

1.1 Policy 1

Restore, revitalize, and redevelop deteriorated and underutilized waterfront areas for commercial, industrial, cultural, recreational, and other compatible uses. (Question 1c)

The Project will restore deteriorated waterfront areas along the Atlantic shorefront and along the Jamaica Bay / Back Bay on Rockaway peninsula. The Project will protect the environment and human development around Jamaica Bay, as well as coastal resources of Kings, Queens, and Nassau counties, which will enhance existing and anticipated recreational uses in the future, namely the use of Rockaway Beach and the recently improved Rockaway Boardwalk. The Project will renourish the beachfront and improve existing groins, as well as offer flood protection to residents and enhance natural resources along the Jamaica Bay perimeter, to further reduce the type of damage to all waterfront areas (natural and residential areas), that occurred during Hurricane Sandy. Accordingly, the Project is consistent and compatible with the character of the area, will not adversely affect adjacent and upland views, will not cause further deterioration of the shoreline, and will reduce the extent of adverse impacts to the economic base of the community from potential future coastal storms similar to Hurricane Sandy.

1.2 Policy 2

Facilitate the siting of water-dependent uses and facilities on or adjacent to coastal waters. (Questions 1b and 3a)

The Project includes flood and erosion protection structures that will physically alter land along the shoreline and under coastal waters, and requires siting of water-dependent uses and facilities along the Atlantic Ocean shorefront and along the Jamaica Bay / Back Bay shoreline on the Rockaway peninsula. The Project will not preempt the reasonably foreseeable development of water-dependent uses. The Project is designed to add to the public use and enjoyment of the water's edge, as well as reducing the extent of damage to coastal resources that occurred during Hurricane Sandy. The guidelines for site choices listed under this policy apply to this Project as follows:

1. Competition for space: The Project will provide increased protection to water-dependent activities as well as to existing and reasonably foreseeable development or redevelopment located inland of the Atlantic Shoreline. There is no competing use for within the shoreline.
2. In-place facilities and services: Existing in-place facilities and service will be sufficient to support this Project.
3. Access to navigational channels: Shipping, fishing, and boating activities are not planned for the Project site. The Project will not prevent access to existing navigation channels
4. Compatibility with adjacent uses and protection of other coastal resources: The Project is compatible with adjacent properties and will enhance the surrounding community and environmental quality of Rockaway by protecting coastal resources from damaging coastal storms similar to Hurricane Sandy.
5. Preference to underutilized sites: Not applicable to the Project. However, the Project protects underutilized sites from coastal storm damage.
6. Providing for expansion: The Project does not prevent current or reasonably foreseeable future water-dependent uses. The CSRMUs are designed to provide 50-years of coastal storm protection with a minimal footprint such that long-term space needs and future demand for land are not limited.

2 FISH AND WILDLIFE POLICIES

2.1 Policy 7

Significant coastal fish and wildlife habitats will be protected, preserved, and where practical, restored so as to maintain their viability as habitats. (Question 2c)

The Project will affect and be located in the NYSDEC-designated Critical Environmental Area. The Project involves dredging and excavation, physical alteration of shore area through beach renourishment and construction of flood protection and environmental enhancement features and structures The Project will protect coastal habitat and reduce damage from coastal storms similar to Hurricane Sandy, which is in direct accord with this policy, as well as the direction of *The New*

Waterfront Revitalization Program regarding Special Natural Waterfront Areas (SWNA); the western portion of the Rockaway peninsula is a proposed SNWA as of October 30, 2013. Accordingly, the Project will increase the quality and quantity of the physical, biological, and chemical parameters along the Atlantic shorefronts of the Rockaway Peninsula and Jamaica Bay Back Bay shoreline.

This policy requires that a narrative for each significant habitat be provided to aid in consistency determination. As stated above, the Project area has been identified by NYSDEC as a CEA and by NYC as a proposed SWNA. Following is a narrative for the Project site, noting the five required items.

(1) The Project is located in Kings and Queens Counties, and will provide protection to coastal areas in these counties as well as southwestern Nassau County.

(2) The Jamaica Bay Ecological Restoration and Research Team reports (Tanacredi *et al*, 2002) observed many different types of vegetative, fish, bird, and other wildlife species. These species are discussed in the Revised Draft Integrated General Reevaluation Report and Environmental Impact Statement (GRR/EIS).

(3) Physical, biological, and chemical parameters that will be improved and/or increased by the Project include protection of coastal habitat and associated wildlife and habitat and erosion control.

(4) Dredging would be an activity to impact offshore coastal habitat, while beachfront renourishment, groins, and seawalls will require filling along the coastline and may impact nearshore benthic, fish and bird habitat. However, all work will utilize best management practices to limit impacts to offshore benthic and fish communities.

(5) The quantitative basis used to rate the habitat is provided in the GRR/EIS.

Fill placement along the Atlantic shoreline in the project area will create wider beaches and dunes to minimize breaching and overwashing and consequent damage to habitats and communities on the barrier island. There will be no change in existing tidal exchange patterns, only a continuation of the non-storm induced conditions. A comprehensive assessment of potential project impacts to threatened and endangered species and habitats was conducted and is presented in the GRR/EIS prepared for the project.

The proposed activities would be undertaken in a manner consistent with this policy.

2.2 Policy 8

Protect fish and wildlife resources in the coastal area from the introduction of hazardous wastes and other pollutants which bio-accumulate in the food chain or which cause significant sublethal or lethal effect on those resources.

The material that may be obtained from the offshore borrow areas, consists primarily of clean, coarse-grained sand. The material has been dredged in the past, and prior sampling of this material has indicated that the material is suitable for use as downdrift beach nourishment material. The material that would be dredged and used for beach nourishment on the down drift beaches would not contain hazardous wastes or other pollutants that would bioaccumulate in the food chain or cause significant sublethal or lethal effects on those resources. Sediment re-suspension is likely to cause temporary increases in turbidity; however, these increases would be limited in duration and

spatial extent and are not expected to significantly affect fish or aquatic wildlife in the project areas.

The proposed activities would not adversely affect fish and wildlife resources and would be undertaken in a manner consistent with this policy.

3 FLOODING AND EROSION HAZARDS POLICIES

3.1 Policy 11

Buildings and other structures will be sited in the coastal area so as to minimize damage to property and the endangering of human lives caused by flooding and erosion. (Questions 1a, 1b, and 2b)

The Project will result in physical changes to the Atlantic shorefront and the Back Bay of Jamaica Bay, Rockaway. The Project is also located in a federally-designated flood hazard area. However, the Project is designed to protect coastal resources in these areas through a layered approach consisting of a combination of seawalls, groins, floodwalls, bulkheads, nature-based non-structural features and beach renourishment. Sand obtained from the offshore borrow area would be pumped to the beach areas to restore the natural protective features of the barrier island. The nourishment of beaches and dunes with appropriate material is an allowable activity pursuant to the coastal erosion hazard area regulations contained in 6 NYCRR Part 505 (see also Policy 35), and is a non-structural erosion control measure preferred over structural measures by the State in its tidal wetlands, erosion hazards, and coastal management program statutes and regulations (see Policies 17, 35, and 44). Restoring the natural protective characteristics of the barrier island (resulting in the protection of the barrier island itself, the bay-system and the mainland of Long Island) would be consistent with and further promote Policy 12, which is to minimize damage to natural resources and property by protecting the naturally occurring protective characteristics and the associated physical processes. Therefore, the Project will minimize damage to property and reduce the risk to human lives caused by flooding and erosion from coastal storms similar to Hurricane Sandy.

3.2 Policy 12

Activities or development in the coastal area will be undertaken so as to minimize damage to natural resources and property from flooding and erosion by protecting natural protective features including beaches, dunes, barrier islands and bluffs. (Question 1b and 2b)

The Project will require physical alteration of onshore and offshore coastal area; is located in flood and erosion hazard areas; and will affect beaches, dunes, and barrier islands. However, the coastal resources this policy is intended to protect will be protected by the Project, which will reduce damage to these coastal resources from coastal storms similar to Hurricane Sandy.

Therefore, the project will be undertaken in a manner consistent with this policy.

3.3 Policy 13

The construction or reconstruction of erosion protection structures shall be undertaken only if they have a reasonable probability of controlling erosion for at least thirty years as

demonstrated in design and construction standards and/or assured maintenance or replacement programs. (Question 3c)

The Project requires construction of flood and erosion control structures (ex. seawalls, groins, beach renourishment) as well as the construction of nature-based non-structural features. The Atlantic shoreline features are designed to provide 50-years of protection from coastal storms similar to Hurricane Sandy. The Project includes procedures for scheduled maintenance to ensure the shoreline features remain effective over this time frame. Should the magnitude of coastal storms increase above conditions predicted for the next 50 years (see GRR/EIS for sea level change scenarios used to calculate the 50 year projection), USACE, New York District will assess how best to upgrade the shoreline features to provide increased protection from such coastal storm events. Stone structures in the coastal environment, such as the proposed groins, can continue to perform well past their intended design life. It is anticipated that the groins can provide rocky intertidal habitat enhancement and erosion protection past their 50-year service life. It should also be noted that features are adaptable and could be modified in the future to extend their service life.

3.4 Policy 14

Activities and development, including the construction or reconstruction of erosion protection structures, shall be undertaken so that there will be no measurable increase in erosion or flooding at the site of such activities or development, or at other locations. (Question 3c)

The Project requires construction of flood and erosion control structures (seawalls, groins, floodwalls, bulkheads beach renourishment), as well as the construction of nature-based non-structural features. The proposed measures are designed to address wave energy, event-based (i.e., short-term/storm-related) and gradual (long-term) shoreline erosion and impacts of coastal flooding, while not leading to increased erosion of the shoreline outside the project site. The design of these structures accounts for subsequent changes that will occur to littoral transport of sediment to adjacent shorelines; these design elements are described in the GRR/EIS Appendix A1A on the Engineering Modeling for the Atlantic Shorefront (Section 8). Accordingly, as required, construction and operation of the shoreline features will not increase erosion or flooding at the site or at other locations.

The proposed activities are consistent with this policy.

3.5 Policy 15

Mining, excavation or dredging in coastal waters shall not significantly interfere with the natural coastal processes which supply beach materials to land adjacent to such waters and shall be undertaken in a manner which will not cause an increase in erosion of such land. (Question 1h)

The Project will result in dredging from a borrow source located approximately 3-4 miles south of the Rockaway Atlantic shorefront. Dredging near this area for other borrow source material has occurred for several USACE-led beachfront renourishment projects; these prior dredging activities have not reduced the natural regenerative powers of the shoreland. Best management practices will be followed during all dredging activities and the proposed dredging depth in the

borrow areas will not reduce the flow of sediments to adjacent areas. Coastal processes along the shoreline sand placement areas will not be interfered with as only natural sands will be placed; no structures or shoreline hardening is proposed. The natural regenerative powers of the subject project shoreline have decreased such that renourishment, groins, and seawalls are necessary to limit further loss of shoreline sediment due to coastal storms and normal coastal hydrodynamics, and not due to excavation or dredging in coastal waters.

The proposed activities are consistent with this policy.

3.6 Policy 16

Public funds shall only be used for erosion protective structures where necessary to protect human life, and new development which requires a location within or adjacent to an erosion hazard area to be able to function, or existing development; and only where the public benefits outweigh the long term monetary and other costs including the potential for increasing erosion and adverse effects on natural protective features. (Question 3c)

The Project requires construction of flood and erosion control structures (seawalls, groins, floodwalls, bulkheads, and beach renourishment), as well as the construction of natural and nature-based non-structural features. The economic impacts associated with construction and operation of the shoreline features are significantly lower than the cost to repair damages reasonably anticipated to occur from coastal storms similar to Hurricane Sandy. Benefits to the human and natural environments outweigh the expenditures of public funds. Economic models are presented in the GRR/EIS.

The project is consistent with this policy.

3.7 Policy 17

Non-structural measures to minimize damage to natural resources and property from flooding and erosion shall be used whenever possible. (Question 2b)

The Project will affect and will be located in flood and erosion hazard areas. The shoreline features will provide flood and erosion control through beach renourishment, seawalls, floodwalls, bulkheads, groins and natural and nature-based non-structural features. The beach renourishment would be considered a non-structural measure. However, beach renourishment alone is not sufficient to minimize damage to nature resources and property from flooding and erosion that this policy seeks to ensure. The GRR/EIS includes the results of the analysis showing that non-structural measures alone are insufficient. Accordingly, as structural measures (ex. groins, seawall) are likely necessary to minimize damage to these coastal resources from coastal storms similar to Hurricane Sandy, non-structural measures are also included, where feasible, as applicable. The proposed activities are consistent to the maximum extent practicable with this policy.

4 PUBLIC ACCESS POLICIES

4.1 Policy 19

Protect, maintain, and increase the level and types of access to public water-related recreation resources and facilities. (Yes to Question 2h; no to Question 1d)

The Project will affect and will be located adjacent to State, County, and local parks. The CSRMUs will protect these resources from damage caused by coastal storms similar to Hurricane Sandy. The beach areas in the proposed project area support a variety of public recreational activities. A temporary reduction in off-season, public access to the work site during the construction season would occur. Buffer areas approximately 1,000 feet in length will be closed during construction activities for safety reasons. As beach placement activities are completed within each 1,000-foot compartment, the buffer is shifted accordingly. Public use of the beach area would be restored at that time. The shoreline features will reduce damage to the transportation systems, parking areas, and pedestrian walkways that occurred during Hurricane Sandy. Additionally, the Project will prevent a decrease in access to and use of recreational areas (e.g. Rockaway Beach and Jamaica Bay) due to flooding that would continue if the Project is not implemented.

The proposed activities would be undertaken in a manner consistent with this policy.

4.2 Policy 20

Access to the publicly-owned foreshore and to lands immediately adjacent to the foreshore or the water's edge that are publicly-owned shall be provided and it shall be provided in a manner compatible with adjoining uses. (Questions 1b and 2h; no to Question 1d)

The lands and waters adjacent to and at the sites of the proposed activities are publicly owned and accessible underwater lands and parklands that support a variety of public uses are present in the area (see also Policies 18 and 19). Based on the Policy 19 analysis above, the proposed activities would be undertaken in a manner consistent with and would advance this policy.

5 RECREATION POLICIES

5.1 Policy 21

Water-dependent and water-enhanced recreation will be encouraged and facilitated, and will be given priority over non-water-related used along the coast. (Question 3a)

The majority of lands and waters within the project area are publicly owned and currently support a variety of public water dependent uses such as fishing, boating and beaching. The project will protect and enhance these uses in the long term, with only staggered short term loss of use during construction, as described under Policy 19. The proposed project is consistent with and will advance this policy.

5.2 Policy 22

Development, when located adjacent to the shore, will provide for water-related recreation, whenever such use is compatible with reasonably anticipated demand for such

activities, and is compatible with the primary purpose of the development. (Questions 1a and 3a)

The project is not "development" per se, but is a coastal storm risk management measure. Water related recreation is a primary land use in the project area and will remain as such. The project will protect and enhance these water dependent recreational uses in the long term, with only staggered short term loss of use during construction, as described under Policy 19. The project will not restrict passive water- related recreational uses or diminish scenic views of the coastal shoreline. The beachfront renourishment along the Atlantic shoreline provides greater area for recreational activities. Additionally, the groins and seawall reduce damage to coastal resources (e.g. Jamaica Bay) caused by coastal storms similar to Hurricane Sandy. The proposed project is consistent with and will advance this policy.

6 HISTORIC AND SCENIC RESOURCES POLICIES

6.1 Policy 23

Protect, enhance and restore structures, districts, areas or sites that are of significance in the history, architecture, archaeology or culture of the state, its communities, or the nation. (Question 2i)

The Project will affect and be located adjacent to National and NYC historic resources. However, the Project will have a beneficial impact on these resources by protecting them from damage caused by coastal storms similar to Hurricane Sandy. USACE has closely coordinated the project design with the NY SHPO and Federally-recognized Native American Tribes (a record of coordination is provided in the GRR/EIS).

The project will protect cultural resources and is consistent with this policy.

7 WATER AND AIR RESOURCES POLICIES

7.1 Policy 30

Municipal, industrial, and commercial discharge of pollutants, including but not limited to, toxic and hazardous substances, into coastal waters will conform to state and national water quality standards. (Question 3d)

Although identified as a potentially relevant policy on the FCAF checklist, this policy is not directly applicable to the project as no pollutants will be discharged. The project is likely to result in sediment re-suspension and associated increases in turbidity during dredging in the borrow areas and during sand placement along the shoreline. These turbidity increases will be temporary and will not result in a violation of this policy.

7.2 Policy 35

Dredging and filling in coastal waters and disposal of dredged material will be undertaken in a manner that meets existing State permit requirements, and protects significant fish and wildlife habitats, scenic resources, natural protective features, important agricultural lands, and wetlands. (Questions 1b, 1h, and 1i)

No scenic resources or agricultural lands are located near the proposed project area; therefore, no such resources or lands will be affected by the proposed activities.

The proposed dredging of clean, relatively coarse-grained accumulated sand offshore borrow area approximately ¾ mile to three miles offshore, will not adversely affect significant coastal fish and wildlife habitats (see Policy 7), natural protective characteristics (see Policies 12, 14, 15, 17, and 18), or wetlands (see Policy 44).

The proposed dredging activities would take place in waters greater than 6 feet deep, and are therefore not required to meet the regulatory standards contained in the State's tidal wetlands land use regulations in 6 NYCRR Part 661. However, the use of the dredged material for beach nourishment in the areas adjacent to the Atlantic Ocean tidal wetland littoral zone would require a tidal wetlands permit (see Policy 44). The sand placement area is within state designated significant fish and wildlife habitats. The State tidal wetlands regulations in 6 NYCRR Part 661 indicate that the use of the dredge material for beach nourishment in an area adjacent to tidal wetlands is a generally compatible use; however, such a use is dependent on several character and resource values and the effects such nourishment and its associated dredged materials might have on intertidal wetlands and adjacent areas. The material to be dredged and used to nourish the beaches is compatible with the material currently on the beaches. The nourishment of beaches and dunes where necessary and appropriate is an activity that may be authorized pursuant to the coastal erosion hazard area regulations in 6 NYCRR Part 505 (see also Policy 12).

The project will be implemented in such a manner as to avoid adverse impacts to these habitats during construction to the extent practicable. Long term benefits to significant fish and wildlife habitats are anticipated as the placement of the beach fill would lead to larger and wider beach areas that could be used for breeding and nesting by shorebirds.

In addition, all required permits, such as a NYSDEC Tidal Wetlands Permit, Section 401 Water Quality Certificate, and Clean Water Act Section 404 analysis will be acquired and all permit conditions will be complied with. Consultation and coordination with State and Federal resource agencies (US Fish &Wildlife Service, NOAA Fisheries, National Park Service and State Natural Resource agencies) will be conducted and species specific seasonal restrictions and mitigation measures will be put in place. The proposed activities will be conducted in a manner consistent with this policy.

7.3 Policy 38

The quality and quantity of surface water and groundwater supplies will be conserved and protected, particularly where such waters constitute the primary or sole source of water supply. (Questions 1a and 3d)

Temporary increases in turbidity may occur during dredging and sand placement activities; however, these will be limited to construction periods and will be limited in spatial extent and duration. Best management practices will be implemented to minimize impacts. The Project will require State water quality permits or certifications. However, the Project will not encounter bedrock aquifers or surface water drinking water resources. Therefore, the Project will have no impact on surface water or groundwater supplies.

7.4 Policy 41

Land use or development in the coastal area will not cause national or state air quality standards to be violated. (Questions 1a and 3e)

The Project will require a large physical change to sites within the coastal area which will require the preparation of an EIS. These alterations are necessary for the construction of CSRMUs that will reduce damage to coastal resources caused by coastal storms similar to Hurricane Sandy. Construction of the Project will exceed the *de minimis* Air Quality Thresholds for nitrogen oxides (NOx), for which a full mitigation plan, per General Conformity Rule (GCR) of the Clean Air Act (CAA) is designed to reduce those thresholds back down to zero, as currently presented for authorization in the GRR/EIS.

7.5 Policy 43

Land use or development in the coastal area must not cause the generation of significant amounts of acid rain precursors: nitrates and sulfates. (Questions 1a and 3e)

The Project will require a large physical change to sites within the coastal area which will require the preparation of an EIS. These alterations are necessary for the construction of CSRMUs that will reduce damage to coastal resources caused by coastal storms similar to Hurricane Sandy. Construction of the Project will exceed the *de minimis* Air Quality Thresholds for nitrogen oxides (NOx), for which a full mitigation plan, per General Conformity Rule (GCR) of the Clean Air Act (CAA) is designed to reduce those thresholds back down to zero, as currently presented for authorization in the GRR/EIS.

8 WETLANDS POLICY

8.1 Policy 44

Preserve and protect tidal and freshwater wetlands and preserve the benefits derived from these areas. (Questions 1b and 2a)

As demonstrated above in the Policy 35 analysis, the proposed beach nourishment activities would take place in an area adjacent to the Atlantic Ocean littoral zone and an intertidal wetland area. The proposed beach nourishment activity is a generally compatible use according to the tidal wetlands land use regulations in 6 NYCRR Part 661. The beach nourishment activities will result in physical changes to the intertidal area that will adversely affect some invertebrates at the site of the beach nourishment activities for approximately 3 months while the projects are being undertaken (see Policy 35 analysis). However, these adverse effects would not be significant, would be temporary, and would not result in significant adverse effects nor significantly impair the benefits derived from the tidal wetland areas. The GRR/EIS provides detailed analyses of impacts to fish and wildlife habitat, and any mitigation that is required to compensate for significant (permanent, extensive, long term) losses. The proposed activities would be undertaken in a manner consistent with this policy.

9 NEW YORK CITY LOCAL WATERFRONT DEVELOPMENT PLAN

Policy 1.2

Encourage non-industrial development with uses and design features that enliven the waterfront and attract the public.

Restoration of the beach should enhance the recreational experience for beach goers and attract the public.

The proposed project is consistent with this policy.

Policy 2.2

Encourage a compatible relationship between working waterfront uses, upland development and natural resources within the Ecologically Sensitive Maritime and Industrial Area.

The *high frequency flooding risk reduction features* (HFFRRFs) on the bayside of the Rockaway peninsula utilize varying measures in order to be compatible between existing uses and conditions. For example, in areas that have active marinas or docks, either the alignment is pulled back behind the interactive waterfront uses, or a compatible bulkhead is proposed. In natural areas, a nature-based feature is proposed which incorporates tidal wetlands that slope up to an upland berm and integrate varying appropriate types of vegetation in order to help stabilize the features, provide habitat, and help attenuate wave actions. Rock sills are proposed at the toe of the wetlands in order to establish the necessary quiescent environment for wetland development and to attenuate wave action to protect the berm and upland habitat and the communities/infrastructure behind them.

The proposed project is consistent with this policy.

Policy 2.5

Incorporate consideration of climate change and sea level rise into the planning and design of waterfront industrial development and infrastructure, pursuant to WRP Policy 6.2.

Existing and future projected sea level rise was incorporated into the design for both the shorefront and bayside features. Please see attached worksheet and graphs pursuant to Policy 6.2 (attachment 2). Adaptive strategies (and the cost to adapt) has also been considered in the event that sea levels rise faster than the intermediate projection upon which the design is based.

The proposed project is consistent with this policy.

Policy 3.1

Support and encourage in-water recreational activities in suitable locations.

Beach restoration on the Atlantic Shorefront supports and encourages recreational uses of the beach. On the bayside, existing kayak launches, fishing spots, etc. have been noted and incorporated into the design of in-water NNBFs so that recreational activities are not negatively impacted. Fishing may improve due to the establishment of new foraging habitat, i.e. wetlands.

The proposed project is consistent with this policy.

Policy 4

Protect and restore the quality and function of ecological systems within the New York City coastal area.

Five areas of habitat restoration/enhancement are proposed as part of the Recommended Plan for Jamaica Bay, which will protect and restore the quality and function of ecological systems.

The design of the HFFRRFs has been refined to minimize impact to sensitive shoreline habitats, and primarily occur in mapped upland ruderal or urban habitats. Within these degraded habitats, the condition will primarily be restored as a temporary impact.

The project would have direct adverse impacts on native habitats that include beach and unvegetated shoreline, freshwater wetland, intertidal wetland, mudflats, subtidal bottom, and maritime forest. Specifically, as detailed in Section 6.5 Habitat Impacts and Mitigation Requirements of the Integrated General Reevaluation Report/Environmental Impact Statement (Integrated Report), the project will result in 14.1 acres of temporary impacts and 5.5 acres of permanent impacts to these habitats (See Section 6.5, Table 6-14 of the Integrated Report). Specific to federal and state regulated waters and wetlands, the project will temporarily impact 14.1 acres and permanently impact 3.7 acres (Table 6-13 of the Integrated Report). Temporary impacts assume that habitat will be replaced on-site and in-kind. The majority of temporary impacts to federal and state regulated waters and wetlands will occur in open water habitats (i.e., subtidal bottom, mudflat), or beach and unvegetated shorelines where subsequent planting will not be required and the time to full restoration of ecological services will be relatively quick compared to habitats that require development of native plant community.

To account for permanent impacts, *natural and nature-based features* (NNBFs) associated with the HFFRRFs will result in the restoration and/or creation of 7.6 acres of intertidal wetlands, enhancement to 0.5 acres of intertidal wetlands, and restoration of 1.3 acres of maritime forest (See Section 6.5, Table 6-15 of the Integrated Report). Overall, the Recommended Plan that includes NNBFs will attenuate waves, stabilize shorelines, and facilitate the restoration or enhancement of native shoreline habitats. As such, the long-term benefit realized by this plan will likely exceed the NNBF acreage noted above. For example, shore slopes behind the rock sill structures will be regraded to reduce risk of erosion further and create suitable elevation gradients and substrates for future establishment of tidal marsh plants. As such, the total restoration of intertidal marsh habitats will likely exceed the proposed planting area of 7.6 acres. The graded habitat behind the structure will also be designed to allow the shoreward migration of various habitats with rising sea levels, thereby extending the life of these important ecological systems. Finally, the rock sills will provide opportunities for shellfish habitat creation and will provide habitat complexity to near shore open water habitats (that is currently absent in project areas) which will support a diversity of both aquatic and terrestrial wildlife (discussed below), as well as improve near shore water quality.

A functional habitat assessment model for wetlands, EPW, also was used to characterize the functional impacts and benefits within intertidal wetlands associated with each HFFRRF. The assessment results estimate current resource value loss, and the potential increase in resource value through implementation of NNBFs. A summary of the analysis and the numerical results of the EPW functional assessment is provided in Section 6, Tables 6-12 and 6-13 of the Integrated Report. The project will result in the loss of 8.6 FCUs across the five functions. However, the

NNBFs will result in the gain of 34.5 FCUs across the five functions. Similar to the metric evaluation, the EPW functional assessment shows significant gains to the shoreline ecosystem through the incorporation of NNBFs.

The proposed project is consistent with this policy.

Policy 4.1

Protect and restore the ecological quality and component habitats and resources within the Special Natural Waterfront Areas.

Five areas and a gain of 34.5 functional habitat units, or a net gain of 3.9 acres of habitat, are proposed as part of the Recommended Plan, which will protect and restore the quality and function of ecological systems.

The proposed project is consistent with this policy.

Policy 4.3

Protect designated Significant Coastal Fish and Wildlife Habitats.

See NYSDOS Policy 7. Jamaica Bay up to the high tide line is a designated Significant Coastal Fish and Wildlife Habitat by Department of State. The project will result in a net gain of 3.9 acres of habitat, however, due to the degraded condition of much of the existing habitat which will be enhanced, this should result in a gain of 34.5 functional habitat units. Furthermore, the designs include erosion control features which should protect against future erosion of the shoreline which has been rapidly eroding.

The proposed project is consistent with this policy.

Policy 4.4

Identify, remediate and restore ecological functions within Recognized Ecological Complexes.

There are five areas proposed as part of the Recommended Plan where an opportunity to restore ecological functions has been identified, in conjunction with improving the natural resiliency to frequent coastal storms that these coastal ecosystems provide. (See Attachment A: Project Description) for more information on the proposed restoration.

The proposed project is consistent with this policy.

Policy 4.5

Protect and restore tidal and freshwater wetlands.

A total of 7.6 acres of tidal wetland restoration is proposed as part of this project. See above description for Policy 4 for more detail.

The proposed project is consistent with this policy.

Policy 4.6

In addition to wetlands, seek opportunities to create a mosaic of habitats with high ecological value and function that provide environmental and societal benefits. Restoration should strive to incorporate multiple habitat characteristics to achieve the greatest ecological benefit at a single location.

The NNBF designs do incorporate a mosaic of habitats. Please see Project Description for more information.

The proposed project is consistent with this policy.

Policy 4.7

Protect vulnerable plant, fish and wildlife species, and rare ecological communities. Design and develop land and water uses to maximize their integration or compatibility with the identified ecological community.

Wetland and maritime forest habitats are rare and vulnerable ecological communities in Jamaica Bay. As part of the Recommended Plan, the Corps proposes restoring and enhancing existing wetland and maritime forest habitats. The feature types for the *high frequency flooding risk reduction features* were chosen based on the ability of various measures to integrate in a compatible fashion with the existing habitat and waterfront uses/conditions.

The proposed project is consistent with this policy.

Policy 4.8

Maintain and protect living aquatic resources.

By using nature-based features, where feasible, the project will maintain and protect living aquatic resources.

The proposed project is consistent with this policy.

Policy 5

Protect and improve water quality in the New York City coastal area.

Currently, stormwater runoff enters the Bay untreated in many areas via sheetflow and outfalls into the Bay. By adding wetlands where stormwater runoff can be directed to, the water quality of the Bay should improve. This is due to wetland's ability to filter nutrients and pollutants and improve water quality.

The proposed project is consistent with this policy.

Policy 5.1

Manage direct or indirect discharges to waterbodies.

As described above, indirect discharges to Jamaica Bay include stormwater runoff and direct discharges exist at outfalls. This project will help to manage these discharges by including interior drainage upgrades (see Project Description for more information). These upgrades will capture

runoff that currently sheetflows into the bay and will direct that flow to the existing or new outfalls. Where there is sufficient space behind the proposed berms, floodwalls or bulkheads the runoff will be captured in vegetated swales. Where space is limited, the stormwater will be collected in pipe drains near the toe of the structure. At this time the new outfalls are not anticipated to connect directly to the existing drainage system. They are expected to discharge the sheetflow captured in the swales, toe drainage and stormwater that backs out of the existing drainage system during high tides. During the design phase opportunities to interconnect the systems to improve overall performance will be investigated. The existing outfalls will be repaired as needed and new flap gates to prevent backflow will be added. Standard construction stormwater BMPs would be implemented to protect water quality of surrounding water resources.

The proposed project is consistent with this policy.

Policy 5.2

Protect the quality of New York City's waters by managing activities that generate nonpoint source pollution.

The project will reduce the frequency and extant of flooding from storm tides and stormwater runoff, which wash nonpoint pollution back into the bay. Stormwater runoff, which is usually laden with contaminants in an urban paved environment, have the potential in some areas to be directed into the wetlands which the project is constructing, in order to filter runoff and improve water quality. Standard construction stormwater BMPs would be implemented to protect water quality of surrounding water resources.

The proposed project is consistent with this policy.

Policy 5.5

Protect and improve water quality through cost-effective grey-infrastructure and in-water ecological strategies.

The project floodwalls, berms and bulkheads will reduce the frequency and extant of flooding from storm tides and reduce the amount of contaminants washed back into the bay. This will contribute to protecting and improving water quality. In-water ecological strategies for improving water quality include wetlands, which this project is proposing.

The proposed project is consistent with this policy.

Policy 6

Minimize loss of life, structures, infrastructure, and natural resources caused by flooding and erosion, and increase resilience to future conditions created by climate change.

The project is designed to manage the risk of coastal erosion and flooding for the study area sea level rise due to future climate conditions was addressed in the project design.

The project is consistent with this policy.

Policy 6.1

Minimize losses from flooding and erosion by employing non-structural and structural management measures appropriate to the site, the use of the property to be protected, and the surrounding area.

Structural management measures are proposed as part of this project and are chosen in order to apply appropriate measures to the varying site conditions, the use of the properties and the surrounding areas. Where there is limited space or sensitive habitat, smaller footprint features like floodwalls and/or a smaller footprint hybrid berm are proposed. Where natural shorelines exist and bathymetry is appropriate, nature-based features for minimizing losses from flooding and erosion are proposed. Section 5 of the main General Reevaluation Report explains the rationale behind the selection of the Atlantic Shorefront design. The screening criteria for the HFFRRFs included that they 1) had to be incrementally justified by coastal storm risk management benefits which exceeded the costs, 2) are designed to complement a potential future storm surge barrier which is being further studied under the New York and New Jersey Harbor and Tributaries Study, and 3) they had to be standalone features which could withstand larger storms that would overtop them and would function as intended even if the storm surge barrier never gets built. The formulation, evaluation and screening of the HFFRRFs is discussed in detail in Section 5 of the main report.

With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins in Belle Harbor and Neponsit, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. The proposed project is consistent with this policy.

Policy 6.2

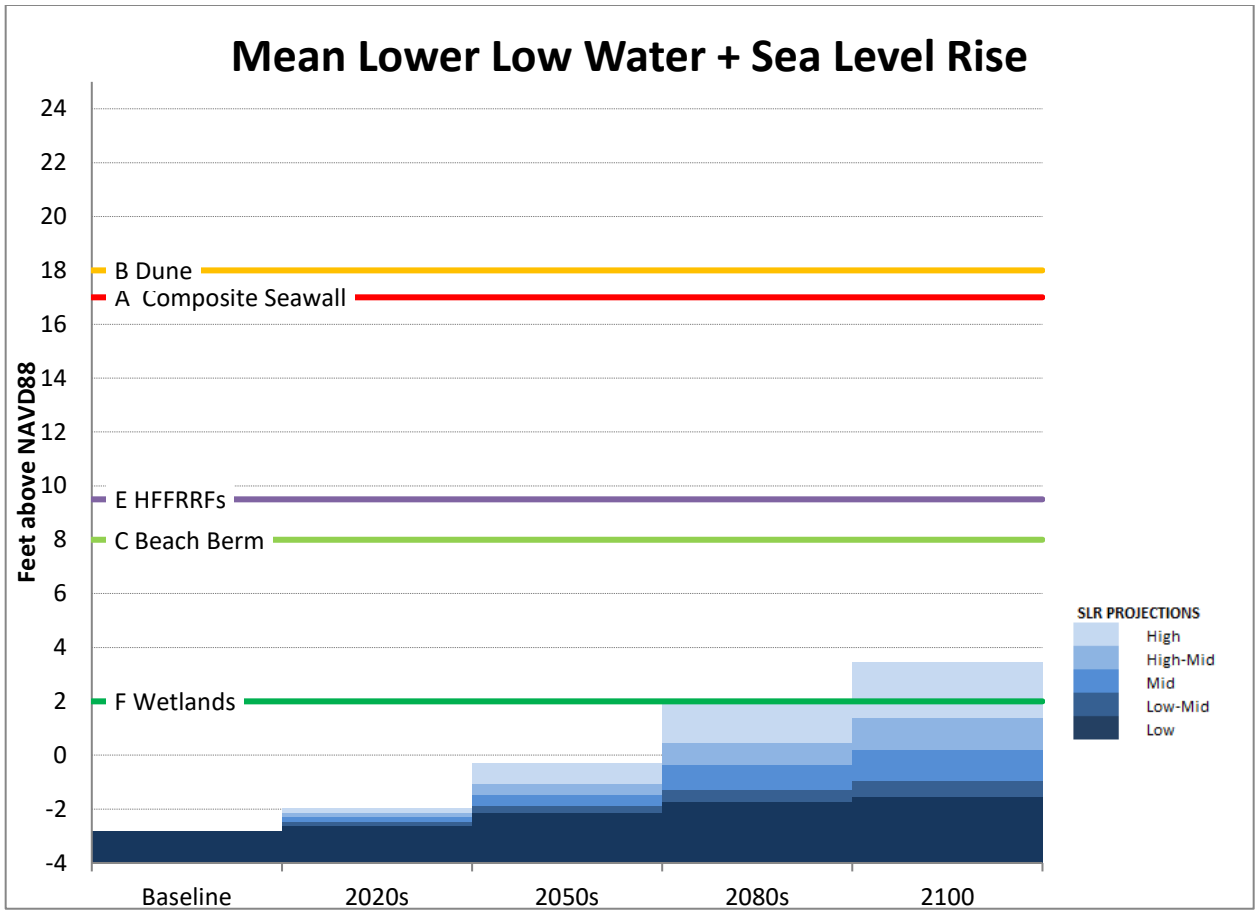
Integrate consideration of the latest New York City projections of climate change and sea level rise (as published in New York City Panel on Climate Change 2015 Report, Chapter 2: Sea Level Rise and Coastal Storms) into the planning and design of projects in the city's Coastal Zone.

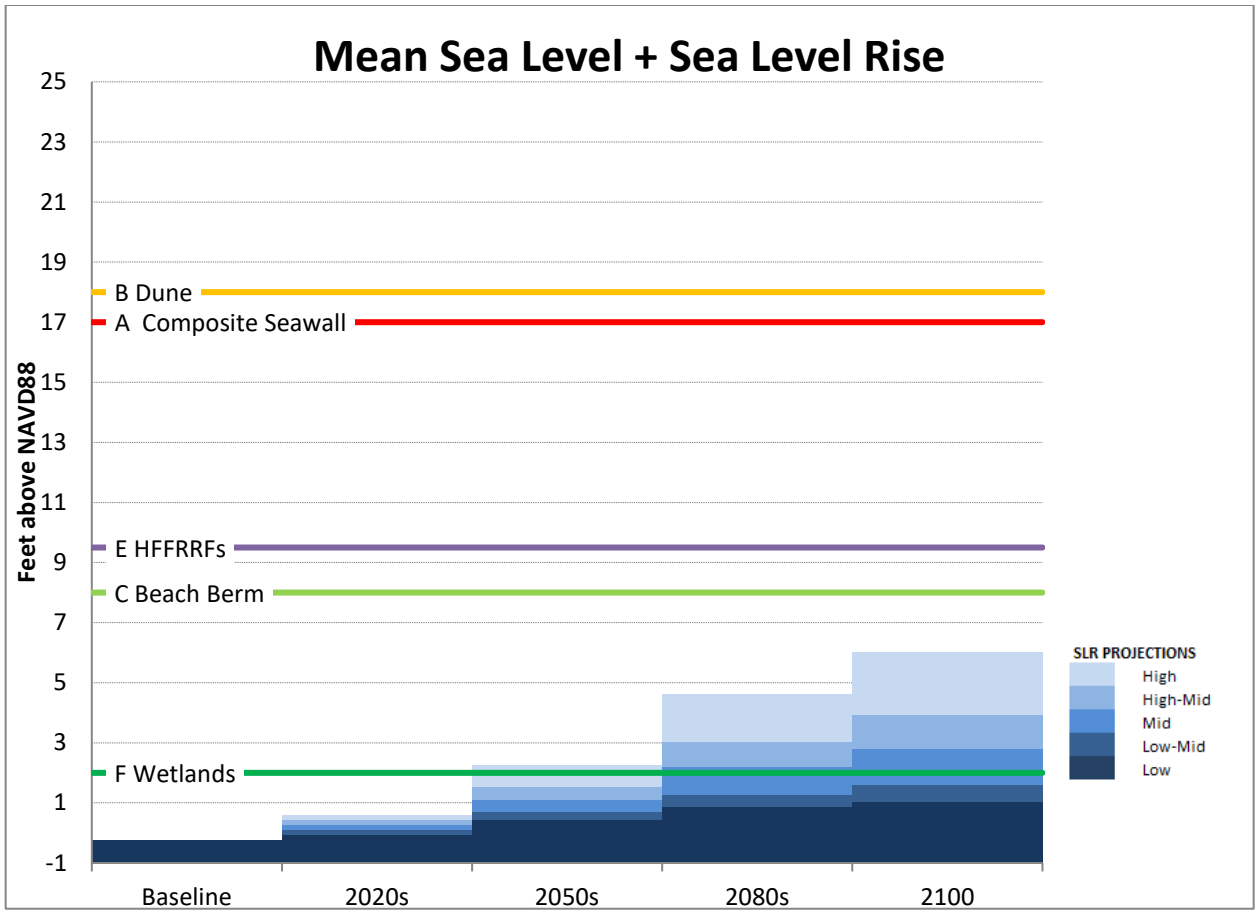
As stated in Policy 6, sea level rise due to future climate conditions was addressed in the proposed design. Hydraulic and hydrology modeling were conducted to review the interaction

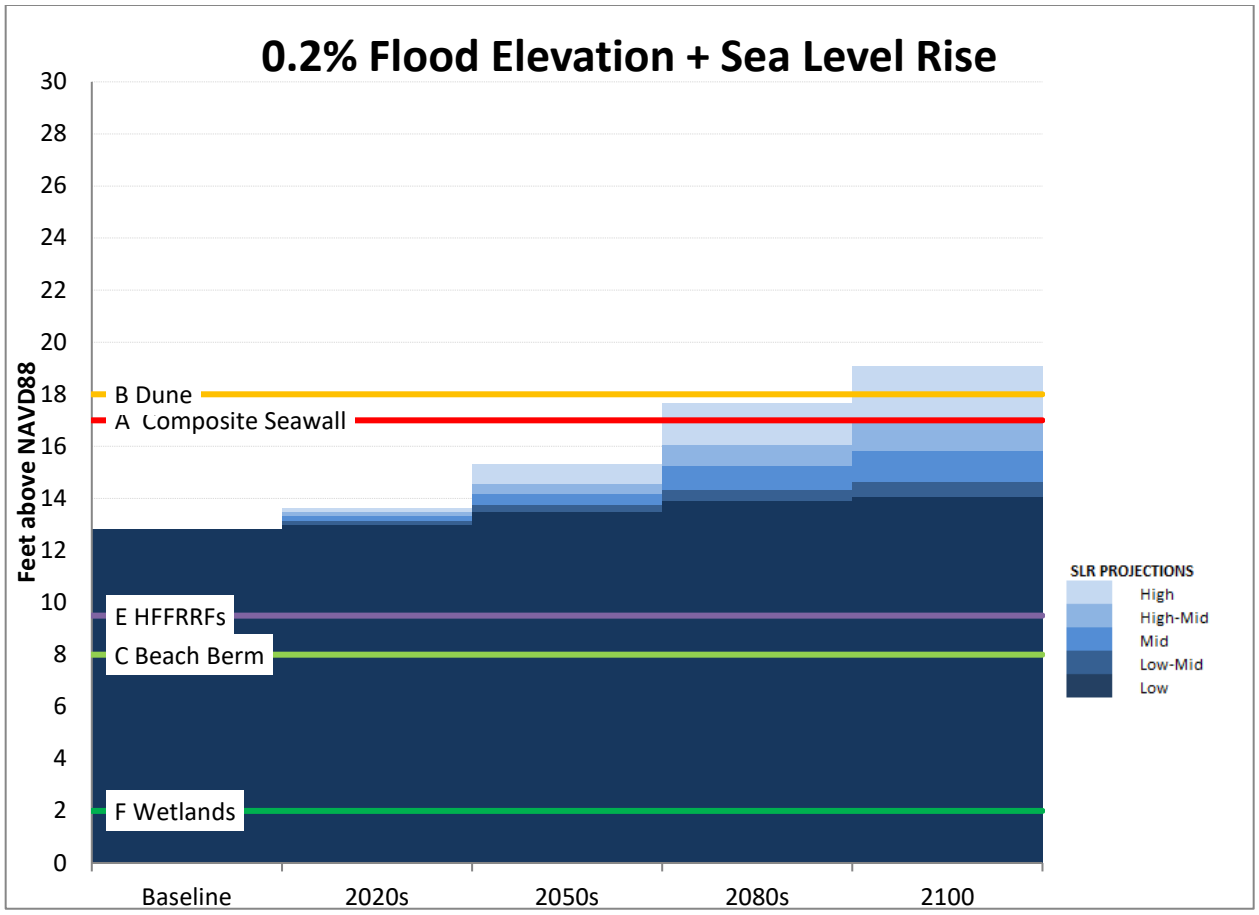
of typical and storm tidal conditions and included the effects of sea level rise. The sea level rise (SLR) projection for the study area site was estimated by using the USACE Sea Level Change Curve Calculator (version 2015.46). This Sea Level Change Curve Calculator is based on the most recent sea level curves published from the National Research Council (NRC) and Inter-Governmental Panel on Climate Change (IPCC). Adaptive measures for how the project features could be adapted if sea levels rise at a faster rate than the intermediate curves predict have been considered. The below graphs (from the attached Policy 6.2 worksheet, sub-attachment a) shows the various features (and their respective top elevations) as they compare with various sea level rise trends.

The groins and wetlands (both at +2 feet NAVD88 elevations, though you can only see wetlands on the below graphs), are compatible with being near the water level. Wetlands by definition are partially wet some or all of the time and as sea levels rise, given the proper sediment supply and available upland space, can even naturally accrete and migrate to adapt to rising water levels. Under the high sea level rise scenario, the groins would no longer be as effective and adding more or larger rocks to them would be an appropriate adaptive management strategy to maintain their full intended usefulness.

The project is intended to last 50 years from 2018-2068. Around the end of the project life is when the high sea level rise predictions would begin to decrease the effectiveness of the other coastal storm risk management features, such as the dune and composite seawall. Potential adaptive features, such as adding 1 foot to the seawall, are discussed in the Integrated Report. For the Jamaica Bay reach, the high frequency features are expected to be overtopped, with increasing frequency with sea level rise. The proposed storm surge barrier currently under consideration in the NYNJHAT study would provide an additional adaptive feature to the Bayside plan as the barrier could be operated more frequently if sea levels rise more rapidly than the intermediate curve projections. There is also a possibility that HFFRRF features could be retrofitted to a higher top elevation to adapt to future conditions. The nature-based features included in the design are expected to accrete naturally with sea level rise and are more inherently adaptable by nature. If sediment deficits in the Bay inhibit natural accretion, these could be artificially adapted by adding new sediment to raise their elevations. Adaptive capacity of the project is discussed further in both the main report (Section 6) and in the Engineering Appendices A1 and A2. Therefore, the project is consistent with this policy.


Mean Lower Low Water + Sea Level Rise
Feet above NAVD88
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
B Dune
A Composite Seawall
E HFFRRFs
C Beach Berm
F Wetlands
Baseline
2020s
2050s
2080s
2100
SLR PROJECTIONS
High
High-Mid
Mid
Low-Mid
Low


Mean Sea Level + Sea Level Rise
Feet above NAVD88
25
23
21
19
17
15
13
11
9
7
5
3
1
-1
B Dune
A Composite Seawall
E HFFRRFs
C Beach Berm
F Wetlands
Baseline
2020s
2050s
2080s
2100
SLR PROJECTIONS
High
High-Mid
Mid
Low-Mid
Low



Policy 6.3

Direct public funding for flood prevention or erosion control measures to those locations where the investment will yield significant public benefit.

This project is publically funded for coastal storm risk management and the overall project yields significant public benefit of 50.2 million dollars in net National Economic Development benefits.

The proposed project is consistent with this policy.

POLICY 8 PROVIDE PUBLIC ACCESS TO, FROM, AND ALONG NEW YORK CITY'S COASTAL WATERS

Public access for the entire beach side of the project will be provided at a minimum of every ¼ mile, but generally smaller distances between public access points are available. See the Public Access Plan (Appendix F) for more information.

The proposed project is consistent with this policy.

Policy 8.1

Preserve, protect, maintain, and enhance physical, visual and recreational access to the waterfront.

Along the Atlantic Shorefront, physical, visual and recreational access is provided for the waterfront. In the bayside Mid-Rockaway site, physical recreational access is not compatible with the successful establishment of wetland vegetation and effective erosion control, which is the intent of the feature. In areas where kayakers or fishing recreation are existing, these uses and access will be maintained. Visual recreational access in the form or bird-watching will be enhanced. The USACE will work with the New York State Department of Environmental Conservation and New York City during the Pre-Construction Engineering and Design (PED) Phase to identify potential compatible public access points on the Bayside, such as upland paths or point access, as long as they do not interfere with the intended function of the project. However, it is possible that additional features will require non-federal funds to implement. This will need to be worked out in the PED Phase.

The Recommended Plan is the result of a Feasibility Study and the design details presented are in line with typical feasibility design plans. The goal of a Feasibility Study is to recommend a feasible plan which meets the objectives laid out during the study and complies with the law and the policies of the USACE. The level of design and analysis performed during the Feasibility Study is geared towards reducing the amount of uncertainty about what the alternative(s) would cost to implement and what the potential impacts of the plan(s) may be in order for decision makers to feel comfortable with approving the Recommended Plan for implementation. Please note that additional design details will be worked out during the next phase—the PED Phase. During the Feasibility Study the focus has been on the evaluation of the various Coastal Storm Risk Management and erosion control alternatives. With the buried composite seawall / dune plus beach berm being the Recommended Plan for the Atlantic Shorefront reach. Detailed design and/or analyses of access points and on and off ramps and ADA compliance has not been included at this stage as that level of design is performed during the PED Phase. Beach access designs will be completed during the PED phase and will need to be completed on a site-specific basis to account for any geometric constraints. Changes in the alignment or section of the horizontal composite seawall may be needed at certain locations to accommodate beach access, but all of this is expected to be worked out during PED in coordination with the non-federal partners, New York State and New York City.

The proposed project is consistent with this policy.

Policy 8.2

Incorporate public access into new public and private development where compatible with proposed land use and coastal location.

The project incorporates public access in the public beach restoration. On the bayside, public access is incompatible with the objectives of the proposed nature-based features and will not be provided, except where existing recreational uses are already there and have been incorporated into the design. The USACE will work with the New York State Department of Environmental Conservation and New York City during the Pre-Construction Engineering and Design (PED) Phase to identify potential compatible public access points on the Bayside, such as upland paths or point access, as long as they do not interfere with the intended function of the project. However, it is possible that additional features will require non-federal funds to implement. This will need to be worked out in the PED Phase.

The proposed project is consistent with this policy.

Policy 8.3

Provide visual access to the waterfront where physically practical.

Visual access is provided where physically practical. The height of the features is dependent on the existing elevations in order to keep a consistent line of protection and avoid inducing flood impacts at any lower sites. In most cases the heights of the features do allow for visual access. During Plans and Specs, the Corps will work with New York City and NYDEC to identify any potentials to enhance visual access along the bayside, which may be included as betterments at the discretion and funding of the non-federal sponsors.

The proposed project is consistent with this policy.

Policy 8.4

Preserve and develop waterfront open space and recreation on publicly owned land at suitable locations.

The Atlantic Shorefront plan would restore and maintain a minimum beach berm width of 60 feet, which would develop waterfront open space and recreation on publicly owned land at suitable locations.

The proposed project is consistent with this policy.

Policy 8.5

Preserve the public interest in and use of lands and waters held in public trust by the State and City.

By restoring eroding beaches in the Rockaways, public interest in using the lands and waters held in public trust by the State, City, and NPS, will be preserved.

The proposed project is consistent with this policy.

Policy 9

Protect scenic resources that contribute to the visual quality of the New York City coastal area.

By restoring the eroding beach resources, the visual quality of the NYC coastal area will be protected. Furthermore, use of natural and nature-based features on the bayside will contribute to the visual quality of the NYC coastal area.

The proposed project is consistent with this policy.

Policy 9.1

Protect and improve visual quality associated with New York City's urban context and the historic and working waterfront.

By restoring the eroding beach resources, the visual quality of the NYC coastal area will be protected and improved. Furthermore, use of natural and nature-based features on the bayside will contribute to the visual quality of the NYC coastal area.

The proposed project is consistent with this policy.

Policy 9.2

Protect and enhance scenic values associated with natural resources.

By restoring the eroding beach resources, the visual quality of the NYC coastal area will be protected and improved. Furthermore, use of natural and nature-based features on the bayside will contribute to the visual quality of the NYC coastal area.

The proposed project is consistent with this policy.

10 POLICY 10

Protect, preserve, and enhance resources significant to the historical, archaeological, architectural, and cultural legacy of the New York City coastal area.

Policy 10.1

Retain and preserve historic resources, and enhance resources significant to the coastal culture of New York City.

The proposed plan would protect existing historic properties, City landmarks and other cultural resources located on or behind the Rockaway barrier island, which would include, but not be limited to, the Far Rockaway Bungalow Historic District, the Far Rockaway Coast Guard Station Historic District, the Gil Hodges Bridge, the Flight 587 Memorial, and Waterfront Tribute Park. The proposed plan would be adjacent to or encroach within the eastern boundary of Jacob Riis Park, which is listed on the National Register of Historic Places. The District is coordinating with the National Park Service to ensure that the placement of sand or the tapering of groins will not have an adverse effect on the property's contributing elements.

The proposed project is consistent with this policy.

Policy 10.2

Protect and preserve archaeological resources and artifacts.

The proposed plan would have an adverse effect on buried cultural resources, primarily buried land surfaces and archaeological sites related to the earliest occupation of the area, located along the project alignment. However, archaeological investigations would be completed in advance of construction to examine the proposed alignment and identify and evaluate archaeological sites and recover significant archaeological information if sites are identified. This work is memorialized in the project's Programmatic Agreement.

The proposed plan would protect potentially significant archaeological information associated with identified historic properties and City landmarks as well as buried land surfaces and archaeological sites associated with the earliest use of the barrier island that are located on the Rockaway peninsula behind the berm.

The proposed project is consistent with this policy.

Sub-Attachment a to Appendix D, Attachment 5 Coastal Zone Management Federal Consistency Determination

New York City Waterfront Revitalization Program – Policy 6.2 Flood Elevation Worksheet

NYC Waterfront Revitalization Program - Policy 6.2 Flood Elevation Workhsheet

COMPLETE INSTRUCTIONS ON HOW TO USE THIS WORKSHEET ARE PROVIDED IN THE "CLIMATE CHANGE ADAPTATION GUIDANCE" DOCUMENT AVAILABLE AT www.nyc.gov/wrp

Enter information about the project and site in highlighted cells in Tabs 1-3. HighTab 4 contains primary results. Tab 5, "Future Flood Level Projections" contains background computations. The remaining tabs contain additional results, to be used as relevant.Non-highlighted cells have been locked.

Background Information	
Project Name	East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Hurricane Sandy Reformulation Study
Location	Atlantic Coast of New York
Type(s)	☐ Residential, Commercial, Community Facility ☐ Parkland, Open Space, and Natural Areas ☑ Tidal Wetland Restoration ☑ Critical Infrastructure or Facility ☐ Industrial Uses ☐ Over-water Structures ☑ Shoreline Structures ☐ Transportation ☐ Wastewater Treatment/Drainage ☑ Coastal Protection
Description	The objective of the Recommended Plan is to manage the risk of coastal flooding from the Atlantic shorefront as well as the frequent flooding from smaller events in Jamaica Bay. The general approach to developing CSRM along Rockaway Beach (between Beach 9th Street and Beach 169th Street, which the east and west tapers are included) was to evaluate erosion control alternatives in combination with a single beach restoration plan to select the most cost effective renourishment approach prior to the evaluation of alternatives for coastal storm risk management. The most cost-effective erosion control alternative is beach restoration with increased erosion control. This constitutes of a beach berm width of 60ft at an elevation of +8ft NAVD88
Planned Completion date	

The New York City Waterfront Revitalization Program Climate Change Adaptation Guidance document was developed by the NYC Department of City Planning. It is a guidance document only and is not intended to serve as a substitute for actual regulations. The City disclaims any liability for errors that may be contained herein and shall not be responsible for any damages, consequential or actual, arising out of or in connection with the use of this information. The City reserves the right to update or correct information in this guidance document at any time and without notice.

For technical assistance on using this worksheet, email wrp@planning.nyc.gov, using the message subject "Policy 6.2 Worksheet Error."

Last update: June 7, 2017

Establish current tidal and flood heights.

	FT (NAVD88)	Feet	Datum	Source
MHHW	2.41	**2.41**	**NAVD88**	*Sandy Hook Gage*
1% flood height	9.91	**9.91**	**NAVD88**	*ADCIRC NACCS*
As relevant:				
0.2% flood height	12.80	12.80	**NAVD88**	*ADCIRC NACCS*
MHW	2.08	2.08	**NAVD88**	*Sandy Hook Gage*
MSL	-0.24	-0.24	**NAVD88**	*Sandy Hook Gage*
MLLW	-2.82	-2.82	**NAVD88**	*Sandy Hook Gage*

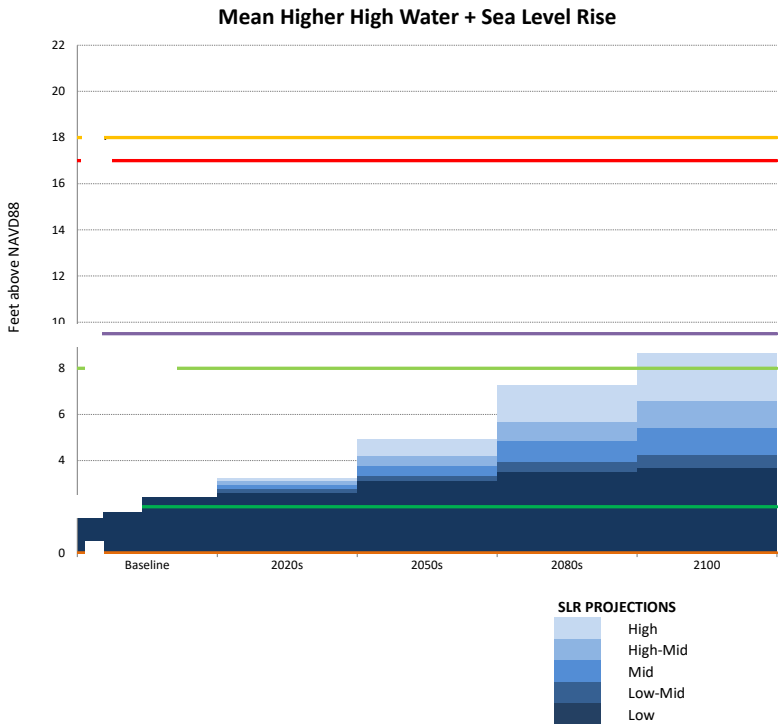
Data will be converted based on the following datums:

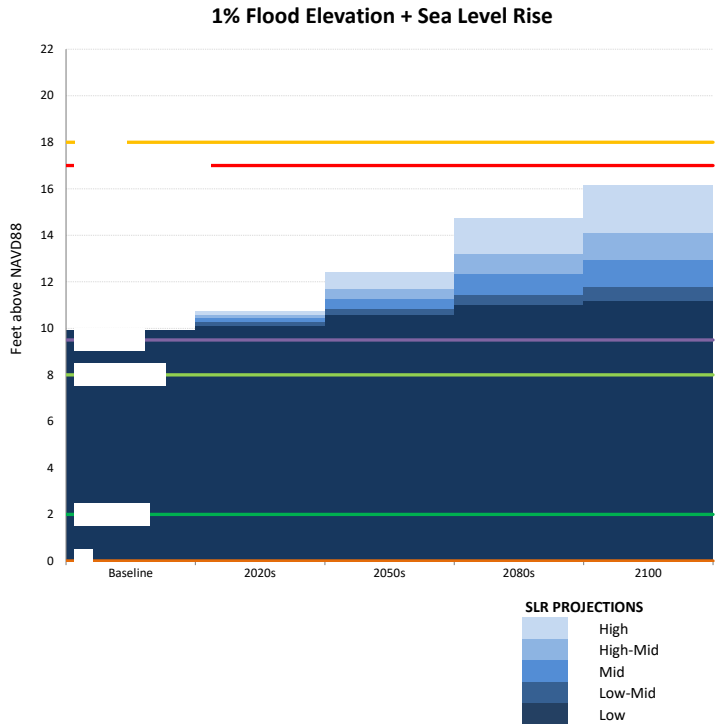
Datum	FT (NAVD88)
NAVD88	*0.00*
NGVD29	*-1.10*
Manhattan Datum	*1.65*
Bronx Datum	*1.51*
Brooklyn Datum (Sewer)	*0.61*
Brooklyn Datum (Highway)	*1.45*
Queens Datum	*1.63*
Richmond Datum	*2.09*
Station	Sandy Hook
MLLW	-2.82

Describe key physical features of the project.

Feature *(enter name)*	Feature Category	Lifespan	Elevation	Units	Datum	Ft	Ft Above NAVD88	Ft Above MHHW	Ft Above 1% flood height	Ft Above 0.2% flood height
A Composite Seawall	☐Vulnerable ☐Critical ☐Potentially Hazardous ☐Other	50	17.0	Feet	NAVD88	*17.0*	*17.0*	*14.6*	*7.1*	*4.2*
Description of Planned Uses and Materials										
B Dune	☐Vulnerable ☐Critical ☐Potentially Hazardous ☑Other	50	18.0	Feet	NAVD88	*18.0*	*18.0*	*15.6*	*8.1*	*5.2*
Description of Planned Uses and Materials										
C Beach Berm	☑Vulnerable ☐Critical ☐Potentially Hazardous ☐Other	50	8.0	Feet	NAVD88	*8.0*	*8.0*	*5.6*	*-1.9*	*-4.8*
Description of Planned Uses and Materials										
D Groins	☐Vulnerable ☐Critical ☐Potentially Hazardous ☑Other	50	2.0	Feet	NAVD88	*2.0*	*2.0*	*-0.4*	*-7.9*	*-10.8*
Description of Planned Uses and Materials										
E HFFRRFs	☐Vulnerable ☐Critical ☐Potentially Hazardous ☑Other	50	9.5	Feet	NAVD88	*9.5*	*9.5*	*7.1*	*-0.4*	*-3.3*
Description of Planned Uses and Materials										
F Wetlands	☐Vulnerable ☐Critical ☐Potentially Hazardous ☑Other	50	2.0	Feet	NAVD88	*2.0*	*2.0*	*-0.4*	*-7.9*	*-10.8*
Description of Planned Uses and Materials. Rocks for the rock sills, limited fill to grade to appropriate elevations and wetland vegetation. These features should be able to accrete naturally with sea level rise and are inherently adaptable when compared with gray infrastructure										
G	☐Vulnerable ☐Critical ☐Potentially Hazardous ☐Other			Feet	NAVD88					
Description of Planned Uses and Materials										
H	☐Vulnerable ☐Critical ☐Potentially Hazardous ☐Other			Feet	NAVD88					
Description of Planned Uses and Materials										

Assess project vulnerability over a range of sea level rise projections.





SLR (ft)

	Low	Low-Mid	Mid	High-Mid	High	
Baseline	0.00	0.00	0.00	0.00	0.00	**2014**
2020s	0.17	0.33	0.50	0.67	0.83	**2020s**
2050s	0.67	0.92	1.33	1.75	2.50	**2050s**
2080s	1.08	1.50	2.42	3.25	4.83	**2080s**
2100	1.25	1.83	3.00	4.17	6.25	**2100**

MHHW+SLR (ft above NAVD88)

	Low	Low-Mid	Mid	High-Mid	High	
Baseline	2.41	2.41	2.41	2.41	2.41	**Baseline**
2020s	2.58	2.74	2.91	3.08	3.24	**2020s**
2050s	3.08	3.33	3.74	4.16	4.91	**2050s**
2080s	3.49	3.91	4.83	5.66	7.24	**2080s**
2100	3.66	4.24	5.41	6.58	8.66	**2100**

1%+SLR (ft above NAVD88)

	Low	Low-Mid	Mid	High-Mid	High	
Baseline	9.91	9.91	9.91	9.91	9.91	**Baseline**
2020s	10.08	10.24	10.41	10.58	10.74	**2020s**
2050s	10.58	10.83	11.24	11.66	12.41	**2050s**
2080s	10.99	11.41	12.33	13.16	14.74	**2080s**
2100	11.16	11.74	12.91	14.08	16.16	**2100**

0.2%+SLR (ft above NAVD88)

	Low	Low-Mid	Mid	High-Mid	High
Baseline	12.80	12.80	12.80	12.80	12.80
2020s	12.97	13.13	13.30	13.47	13.63
2050s	13.47	13.72	14.13	14.55	15.30
2080s	13.88	14.30	15.22	16.05	17.63
2100	14.05	14.63	15.80	16.97	19.05

	0	1
A Composite Seawall	17	17
B Dune	18	18
C Beach Berm	8	8
D Groins	2	2
E HFFRRFs	9.5	9.5
F Wetlands	2	2
G	0	0
H	0	0

SLR (in)

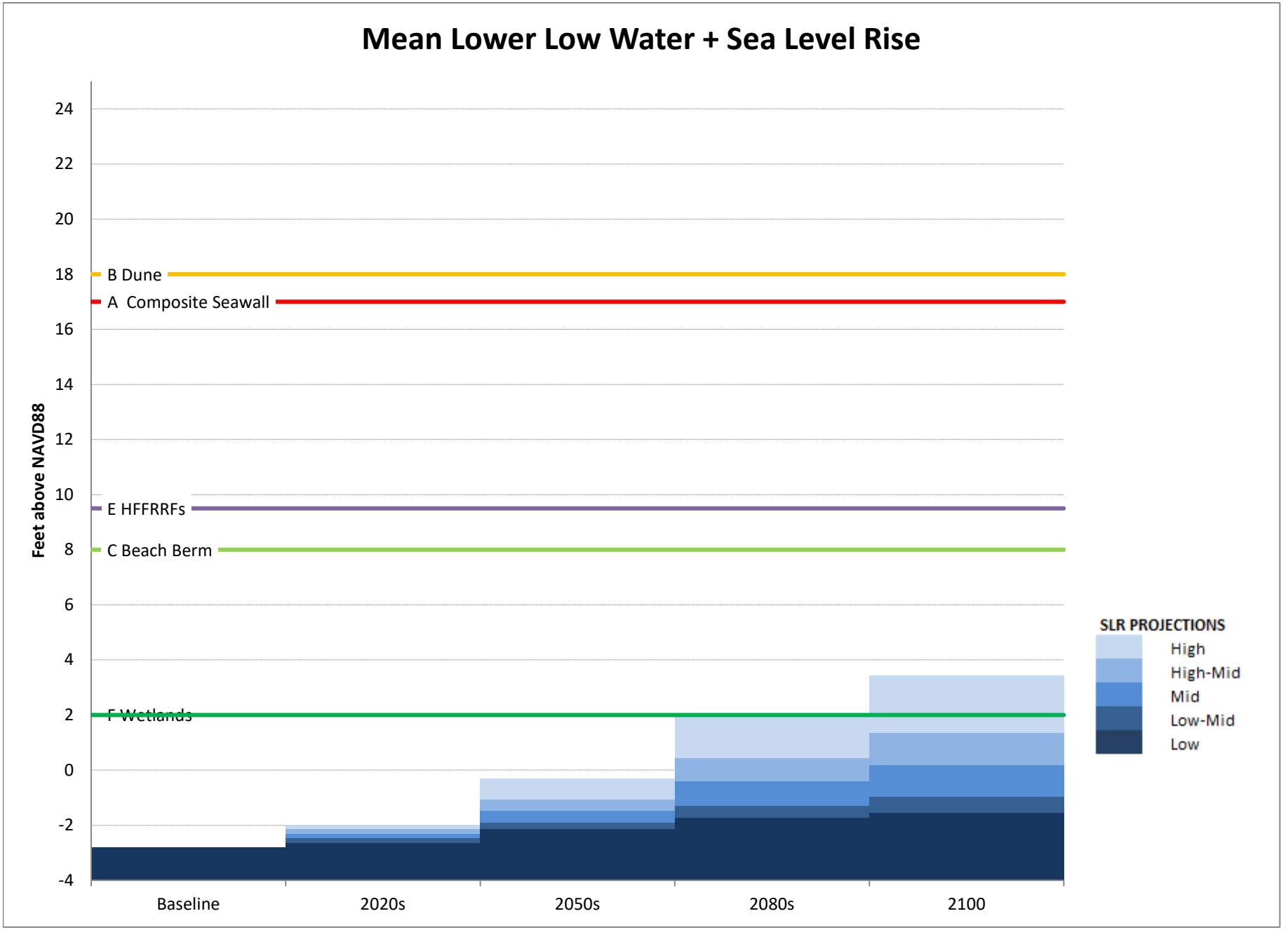
Low	Low-Mid	Mid	High-Mid	High
0	0	0	0	0
2	4	6	8	10
8	11	16	21	30
13	18	29	39	58
15	22	36	50	75

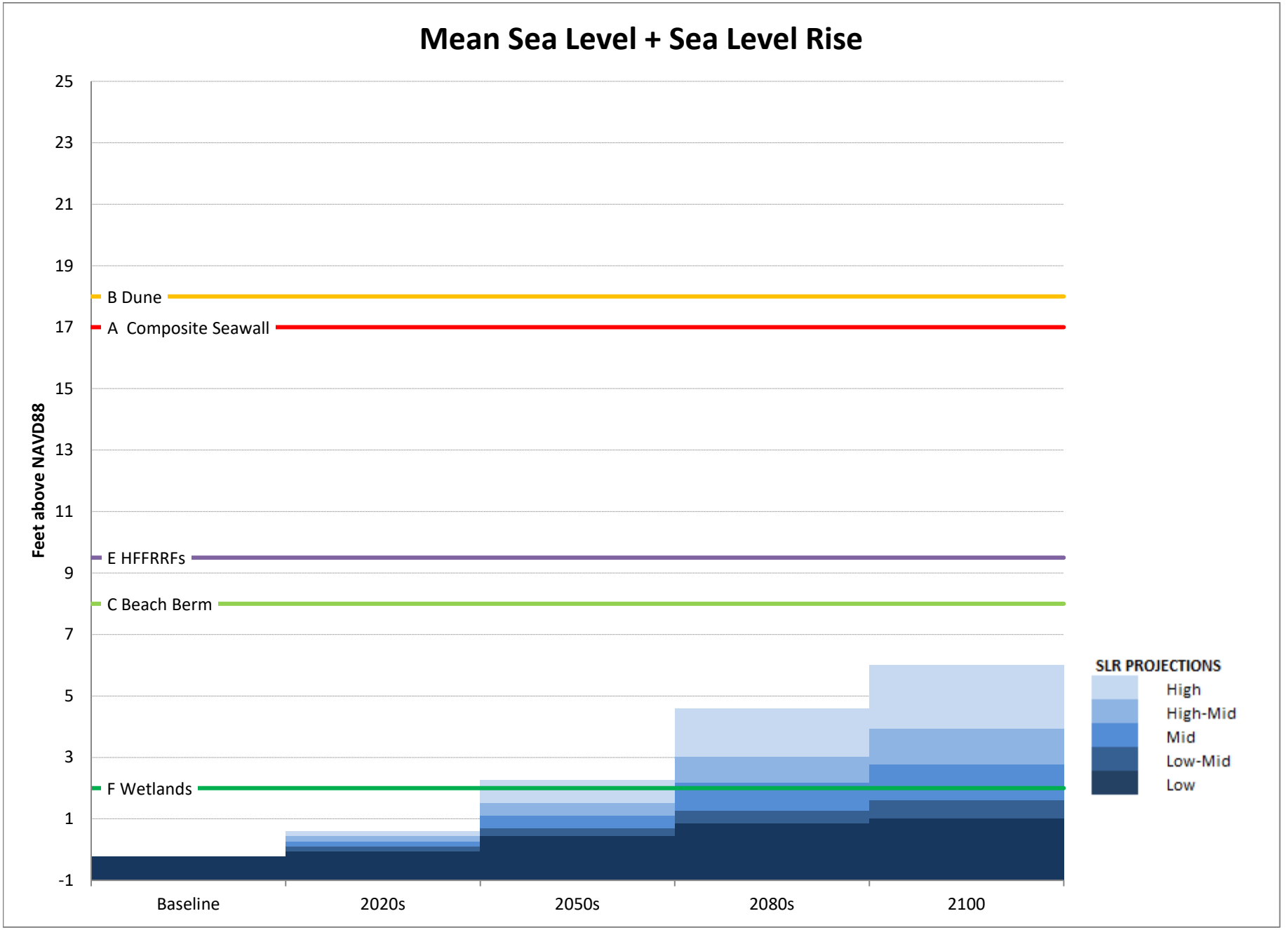
MLLW+SLR (ft above NAVD88)

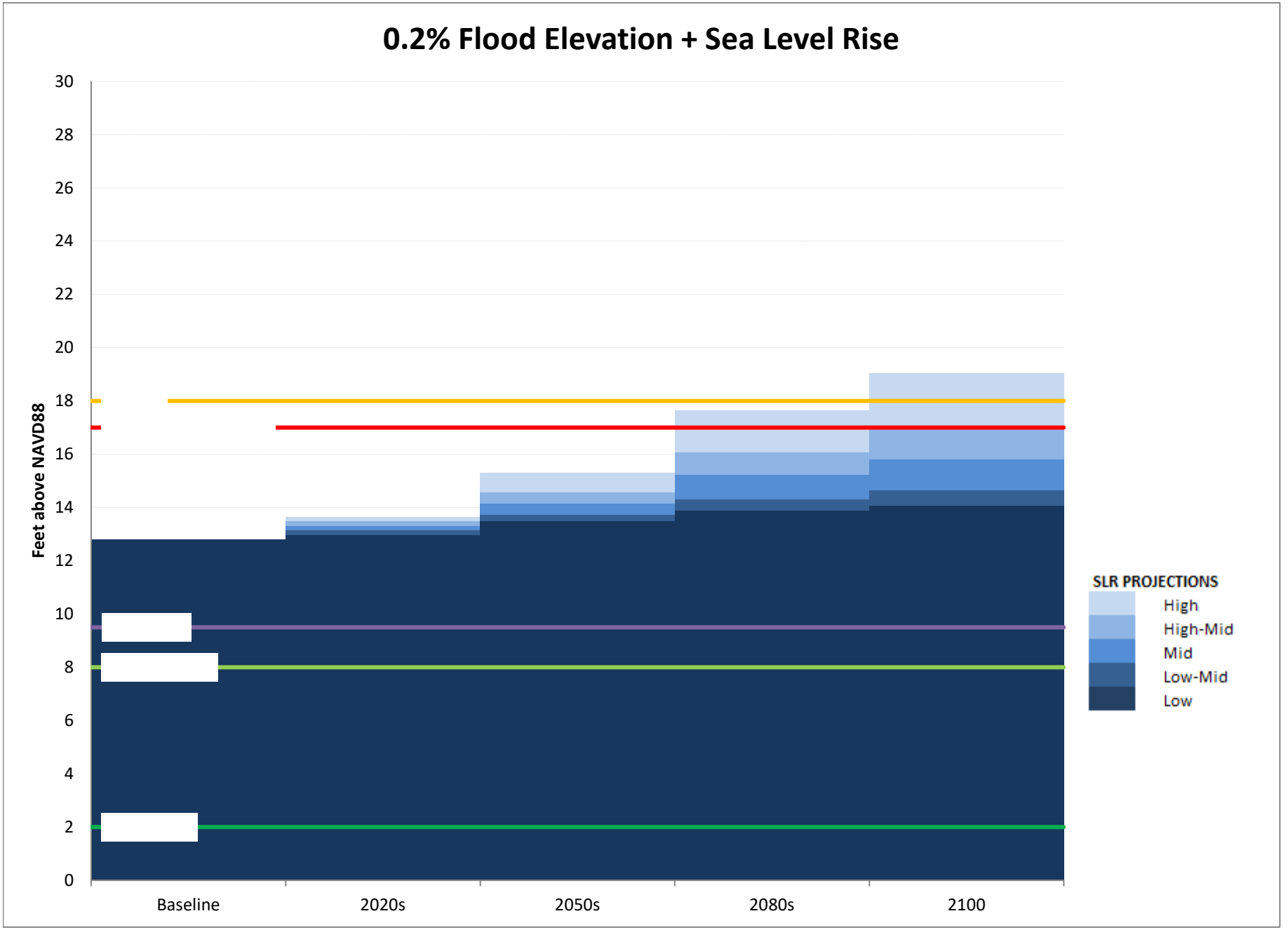
Low	Low-Mid	Mid	High-Mid	High
-2.82	-2.82	-2.82	-2.82	-2.82
-2.65	-2.49	-2.32	-2.15	-1.99
-2.15	-1.90	-1.49	-1.07	-0.32
-1.74	-1.32	-0.40	0.43	2.01
-1.57	-0.99	0.18	1.35	3.43

MSL+SLR (ft above NAVD88)

Low	Low-Mid	Mid	High-Mid	High
-0.24	-0.24	-0.24	-0.24	-0.24
-0.07	0.09	0.26	0.43	0.59
0.43	0.68	1.09	1.51	2.26
0.84	1.26	2.18	3.01	4.59
1.01	1.59	2.76	3.93	6.01


Mean Lower Low Water + Sea Level Rise
Feet above NAVD88
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
B Dune
A Composite Seawall
E HFFRRFs
C Beach Berm
F Wetlands
Baseline
2020s
2050s
2080s
2100
SLR PROJECTIONS
High
High-Mid
Mid
Low-Mid
Low


Mean Sea Level + Sea Level Rise
Feet above NAVD88
25
23
21
19
17
15
13
11
9
7
5
3
1
-1
B Dune
A Composite Seawall
E HFFRRFs
C Beach Berm
F Wetlands
Baseline
2020s
2050s
2080s
2100
SLR PROJECTIONS
High
High-Mid
Mid
Low-Mid
Low


0.2% Flood Elevation + Sea Level Rise
Feet above NAVD88
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Baseline
2020s
2050s
2080s
2100
SLR PROJECTIONS
High
High-Mid
Mid
Low-Mid
Low

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
THE NEW YORK STATE HISTORIC PRESERVATION OFFICE,
THE NATIONAL PARK SERVICE,
AND
THE NEW YORK CITY LANDMARKS PRESERVATION COMMISSION
REGARDING
ATLANTIC COAST OF NEW YORK
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
GENERAL RE-EVALUTION STUDY

WHEREAS, the US Army Corps of Engineers, New York District (District) is proposing to undertake measures to reduce coastal storm damages and minimize impact on the Rockaway Peninsula from East Rockaway Inlet to Rockaway Inlet along the Atlantic Ocean and the Jamaica Bay shorelines as well as locations within Jamaica Bay (Undertaking); and

WHEREAS, the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York Hurricane Sandy General Re-Evaluation Study was authorized by the House of Representatives dated 27 September 1997 and Public Law 113-2 (29 Jan 13), the Disaster Relief Appropriations Act of 2013 authorized Corps projects for reducing flood and storm risks in the Hurricane Sandy affected area that have been or are under construction, which includes the Project; and

WHEREAS, the New York State Department of Environmental Conservation is the non-federal sponsor and New York City, through the New York City Mayor's Office Recovery and Resiliency is the local sponsor to New York State; and

WHEREAS, the Undertaking consists of levee, buried seawall, new groin construction, extension and rehabilitation of existing groins, and beach renourishment along the Atlantic Ocean shoreline of the Rockaway Peninsula, as well as residual high frequency flood risk reduction features consisting of berms, floodwalls, and bulkheads along the southeast side of Jamaica Bay (Attachments A and B); and

WHEREAS, the Area(s) of Potential Effect include the offshore borrow sites, near shore sand placement, the alignments for all of the Project features, the viewsheds associated with affected historic properties, including those from the shore to the Atlantic Ocean (Attachments A and B); and

WHEREAS, the Jacob Riis Park Historic District, and the Far Rockaway Bungalow Historic District are located within the APE along the Rockaway Peninsula (Attachments A and B); and

WHEREAS, the high frequency flood risk reduction features and other Project alignments have the potential to be sensitive for archaeological resources (Attachments A and B); and

WHEREAS, pursuant to 36 CFR Part 800, the regulations implementing

Section 106 of the National Historic Preservation Act (NHPA) (54 U.S.C 306108), the District has determined that implementation of the Project will have the potential to have an adverse effect on the Jacob Riis Park Historic District and archaeological resources potentially located within the alignment and the high frequency flood risk reduction measures; and

WHEREAS, the National Park Service (NPS) manages and administers the Jacob Riis Historic District, which is located within the Gateway National Recreation Area; and

WHEREAS, the District is consulting with and will continue to consult with the NPS, Gateway National Recreation Area, New York State Historic Preservation Office (NYSHPO), the Shinnecock Indian Nation, the Stockbridge-Munsee Community, the Delaware Tribe of Indians, the Delaware Nation (all federally-recognized Tribes), the New York state-recognized Unkecheug Indian Nation, and the New York City Landmarks Preservation Commission (NYCLPC), to define efficient and cost effective processes for taking into consideration the effects of the P r o j e c t on historic properties; and

WHEREAS, the District will invite the NPS, NYSHPO, and the NYCLPC, to be signatories to this agreement; and

WHEREAS, the District has notified the Advisory Council on Historic Preservation (ACHP) of the potential for the Project to affect historic properties and that a programmatic agreement will be prepared; and

WHEREAS, the District has involved the general public through the National Environmental Policy Act (NEPA) process, which affords all persons, organizations, and government agencies the right to review and comment on proposed major federal actions that are evaluated by a NEPA document and participate in public meetings during the review of the feasibility report; and

NOW, THEREFORE, the District, NPS, NYCLPC and the NYSHPO agree that the Undertakings shall be implemented in accordance with the following stipulations in order to take into account the effects of the Undertakings on historic properties.

STIPULATIONS

I. BEACH FILL - BORROW AREA INVESTIGATIONS

A. A remote sensing (magnetometer and side scan sonar survey) of any borrow areas not previously surveyed will be conducted to identify any potential cultural resources. In addition, cores for any borrow areas not previously surveyed will be examined, if available, to determine the potential for the recovery of buried landsurfaces.

B. If a cultural resource(s), target(s), and/or anomaly(ies) are identified, the District will designate a buffer zone around each potential resource, as determined by the nature of the anomaly/return. Buffer zone(s) shall be clearly delineated on construction plans. No construction activities, including the removal of sand, anchoring, etc., that could potentially impact the wrecks will occur within the designated buffer zones.

C. If any targets and/or anomalies cannot be avoided, the District will consult with the NYSHPO to consider alternatives and determine the level of additional investigations (diving, documentation, additional reconnaissance diving, Phase II survey, etc.) are required.

D. The results of any investigations will be coordinated with the NYSHPO and other signatories and consulting parties.

E. If the anomalies/targets are determined to represent a historic property, the District in coordination with the NYSHPO will determine alternatives including avoidance, data recovery through underwater archaeological investigations, and documentation. The District will resolve adverse effects to historic properties in accordance with Stipulation IV below.

II. HIGH FREQUENCY FLOOD RISK REDUCTION FEATURES

A. The District will determine, in coordination and consultation with the NYSHPO, and the NYCLPC, what investigations are necessary to determine if the construction of any high frequency flood risk reduction features will have an adverse effect on historic properties. The District would carry out investigations, as necessary, to identify historic properties and determine the effect of the proposed features on identified features.

B. The District will document the results of any investigations and provide them for review to the NYSHPO, the federally-recognized Tribes, and the NYCLPC.

C. If a property is determined to be eligible for the National Register, the District will consult with the NYSHPO, federally-recognized Tribes and the NYCLPC to resolve the adverse effects in accordance with Stipulation IV below.

III. BURIED SEAWALL AND FLOODWALLS

A. The District will determine, in coordination and consultation with the NYSHPO, the NPS, and the NYCLPC what investigations are necessary to determine if the construction of buried seawalls, floodwalls, and other features that include subsurface disturbance will have an adverse effect on the built environment, including the beach, bulkhead, and/or groins that are contributing elements of the various historic districts, as well as on potentially sensitive areas for archaeological resources. These investigations may include, but not be limited to, construction monitoring and recordation and/or research, field investigations and analysis on the Rockaway Peninsula development to include the potential for deeply buried archaeological sites.

B. The District will document results of any investigations and provide them for review to the NYSHPO, NPS, the federally-recognized Tribes, and the NYCLPC.

C. If a property is determined to be eligible for the National Register, the District will consult with the NYSHPO, NPS, federally-recognized Tribes and the NYCLPC to resolve the adverse effects in accordance with Stipulation IV below.

IV. RESOLUTION OF ADVERSE EFFECTS

A. The District shall continue consultation with the NYSHPO, NPS, the federally-recognized Tribes, and the NYCLPC, and other consulting parties if identified, pursuant to 36 CFR Part 800.6 to avoid, minimize or mitigate adverse effects to historic properties.

B. The District shall notify the NYSHPO, NPS, the federally-recognized Tribes, and the NYCLPC, property owners and other consulting parties, if identified and provide documentation regarding the identification and evaluation of the historic properties. The District will work with the NYSHPO, other relevant signatories, etc. to determine how best to resolve any adverse effects and document the proposed resolution.

C. Once there is agreement on how the adverse effects will be resolved, the District shall prepare treatment plan that will identify the activities to be implemented that will resolve the adverse effects. The treatment plan will be provided for review and comment prior to implementation.

D. Should the District, NYSHPO, and the relevant signatories disagree on how the adverse effects will be resolved, the District shall seek to resolve such objection through consultation in accordance with procedures outlined in Stipulation X.C.

V. PUBLIC INVOLVEMENT AND OUTREACH

A. The District shall inform the public of the existence of this PA and the District's plan for meeting the stipulations of the PA. Copies of this agreement and relevant documentation prepared pursuant to the terms of this PA shall be made available for public inspection. Information regarding the specific locations of terrestrial and submerged archaeological sites, including potential wreck areas, will be withheld in accordance with the Freedom of Information Act and National Register Bulletin No. 29, if it appears that this information could jeopardize archaeological sites. Any comments received from the public related to the activities identified by this PA shall be taken into account by the District.

B. The District shall develop, in coordination with the NYSHPO, NPS, the federally-recognized Tribes, and the NYCLPC publically accessible information about the cultural resources and historic properties investigations for the Undertaking in the form of brief publication(s), exhibit(s), or website.

VI. CURATION

A. The District shall ensure that all collections resulting from the identification and evaluation of surveys, data recovery operations, or other investigations pursuant to this PA are maintained in accordance with 36 CFR Part 79 until the collection is turned over to the NPS, New York City, or other landowner/entity. Minimally, the District will ensure that analysis is complete and the final report(s) are produced and accepted by the NYSHPO prior to the turnover of collections to the appropriate entity.

B. The District shall be responsible for consulting with the NPS, New York City and other landowners regarding the curation of collections resulting from archaeological surveys,

data recovery operations, or other studies and activities pursuant to this agreement. The District shall coordinate the return of collections to non-federal landowners. If non-federal landowners wish to donate the collection, the District, in coordination with the NYSHPO, the NPS, the federally-recognized Tribes, and the NYCLPC to determine an appropriate entity to take control of the collection.

C. The District shall be responsible for the preparation of federally-owned collections and the associated records and non-federal collections donated for curation in accordance with the standards of the curation facility.

VII. UNANTICIPATED DISCOVERY

A. The following language shall be included in construction plans and specifications:

"When a previously identified cultural resource, including but not limited to archaeological sites, shipwrecks and the remains of ships and/or boats, standing structures, and properties of traditional religious and cultural significance to the federally-recognized Tribes are discovered during the execution of the Project, the individual(s) who made the discovery shall immediately secure the vicinity and make a reasonable effort to avoid or minimize harm to the resource, and notify the Project's Contracting Officer's Representative (COR) and the District. All activities shall cease within a minimum of 50 feet from the inadvertent discovery (50-foot radius 'no work' buffer) until authorized by the District and the Project COR.

B. If previously unidentified and unanticipated properties are discovered during Project activities, the District shall cease all work in the vicinity of the discovery until it can be evaluated in accordance with 36 CFR Part 800.13 "Post Review Discoveries". Upon notification of an unanticipated discovery, the District shall implement any additional reasonable measures to avoid or minimize effects to the resource. Any previously unidentified cultural resource will be treated as though it is eligible for the NRHP until such other determination may be made.

C. The District shall immediately notify the NYSHPO, the NPS, the federally-recognized Tribes, and the NYCLPC within 48 hours of the finding and request consultation to resolve potential adverse effects.

1. If the District, NYSHPO, the NPS, the federally-recognized Tribes, and the NYCLPC agree that the cultural resource is not eligible for the NRHP, then the suspension of work in the area of the discovery will end.

2. If the District, NYSHPO, the NPS, the federally-recognized Tribes, and the NYCLPC agree that the cultural resource is eligible for the NRHP, then the suspension of work will continue, and the District, in consultation with the NYSHPO, NPS, the federally-recognized Tribes and the NYCLPC, will determine the actions to avoid, minimize, or mitigate adverse effects to the historic property and will ensure that the appropriate actions are carried out.

3. If the District, the NYSHPO, the NPS, and the NYCLPC cannot agree on the appropriate course of action to address an unanticipated discovery or effects situation, then the District shall initiate the dispute resolution process set forth in Stipulation X.C below.

VIII. DISCOVERY OF HUMAN REMAINS

1. If any human remains and/or grave-associated artifacts are encountered during any of the investigations, including data recovery, the District will follow the NYSHPO Human Remains Discovery Protocol (2008; Attachment C) and, as appropriate, develop a treatment plan for human remains that is responsive to the ACHP's Policy Statement on Human Remains" (September 27, 1988), the Native American Graves Protection and Repatriation Act (PL 101-601) and , US Army Corps of Engineers, Policy Guidance Letter No. 57 (1998) Indian Sovereignty and Government-to-Government Relations with Indian Tribes.

2. The following language shall be included in the construction plans and specifications:

"When human remains, suspected human remains, or indications of a burial are discovered during the execution of a Project, the individual(s) who made the discovery shall immediately notify the local law enforcement, coroner/medical examiner, and the Project COR and the District, and make a reasonable effort to protect the remains from any harm. The human remains shall not be touched, moved or further disturbed. All activities shall cease within a minimum of 50 feet from the area of the find (50-foot radius 'no work' buffer) until authorized by the District."

IX. PROFESSIONAL QUALIFICATIONS AND STANDARDS

A. The District shall ensure that qualified professionals meeting the National Park Service professional qualifications for the appropriate discipline [National Park Service Professional Qualification Standards, Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (48 FR 44738-39)] are used to complete all identification and evaluation plans related to this undertaking, to include remote sensing surveys, underwater investigations, historic structure inventory and documentation.

B. All archaeological investigations carried out pursuant to this PA will be undertaken in accordance with the New York State Archaeological Council's Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State (1994) and Cultural Resources Standards Handbook (2000), the NYSHPO Archaeological Report Format Requirements (2005), and the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (36 CFR Part 68).

X. ADMINISTRATIVE TERMS

A. REPORTING

1. Each year following the execution of this PA until it expires or is terminated, the District shall provide the NYSHPO, NPS, the federally-recognized Tribes, all signatories, and interested parties a summary report detailing work undertaken pursuant to this PA. This report will include any scheduling changes, problems encountered, project work completed, PA activities completed, and any objections

and/or disputes received by the District in its efforts to carry out the terms of this PA.

2. Following authorization and appropriation, the District shall coordinate a meeting or equivalent with the signatories to be held annually on a mutually agreed upon date to evaluate the effectiveness of this PA and discuss activities carried out pursuant to this PA during the preceding year and activities scheduled for the upcoming year.

B. REVIEW PERIODS

1. The District shall ensure that all draft and final reports resulting from action pursuant to this PA will be provided to the NYSHPO, NPS, the federally-recognized Tribes, the NYCLPC, the Unkechaug Indian Nation, and to other interested parties, if identified.

2. The NYSHPO, ACHP, NPS, the federally-recognized Tribes, the NYCLPC, the Unkechaug Indian Nation, and any other interested party shall have 30 calendar days to review and/or object to determinations, evaluations, plans, reports and other documents submitted to them by the District.

3. Any comments and/or objections resulting from a review of any District determination, evaluations, plans, reports and other documents must be provided in writing to the District.

4. If comments, objections, etc., are not received within 30 calendar days, the District will assume concurrence with the subject determination, evaluation, plan, report or other document submitted.

C. DISPUTE RESOLUTION

1. Should any signatory object in writing to the District at any time to any actions proposed or the manner in which the terms of this PA are implemented, the District and the signatories shall attempt to resolve any disagreement arising from implementation of this PA.

2. If there is a determination that the disagreement cannot be resolved, the District shall forward all documentation relevant to the dispute to the ACHP and request the ACHP's recommendations or request the comments of the Council in accordance with 36 CFR Part 800.7(c).

3. The ACHP shall provide the District with its advice on the resolution of the objection within thirty (30) days of receiving adequate documentation. Any ACHP recommendations or comments provided in response will be considered in accordance with 36 CFR Part 800.7(c), with reference only to the subject of the dispute. The District shall respond to ACHP recommendations or comments indicating how the District has taken the ACHP recommendations or comments into account and complied with the ACHP recommendations or comments prior to proceeding with the Undertaking activities that are the subject to dispute. Responsibility to carry out all other actions under this PA that are not the subject of the dispute will remain unchanged.

4. If the ACHP does not provide its advice regarding the dispute within the thirty (30) calendar day time period, the District may make a final decision on the dispute and proceed accordingly. Prior to reaching such a final decision, the District shall prepare a written response that takes into account any timely comments regarding the dispute from the signatories to the PA, and provide them and the ACHP with a copy of such written response.

D. WITHDRAWAL AND TERMINATION

1. Any signatory may withdraw its participation in this PA by providing thirty (30) days advance written notification to all other signatories. In the event of withdrawal, any signatory to this PA may terminate it by providing 30 calendar days, written notice to the signatories. In the event of withdrawal, this PA will remain in effect for the remaining signatories.

2. This agreement may be terminated in accordance with 36 CFR Part 800, provided that the signatories consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. Any signatory requesting termination of this PA will provide thirty (30) days advance written notification to all other signatories.

3. In the event of termination, the District will comply with 36 CFR 800.4 through 800.6 with regard to individual undertakings covered by this Agreement.

E. DURATION AND SUNSET CLAUSE

1. This PA shall take effect upon execution by the District, the NYSHPO, and the signatories with the date of the final signature.

2. This PA will continue in full force and effect until the construction of the Project is complete and all terms of this PA are met, unless the Project is terminated or authorization is rescinded or a period of five years from execution of the PA has passed, at which time the agreement may be extended as written provided all signatories concur.

F.AMENDMENT

1. This PA may be amended upon agreement in writing by all signatories. Within thirty (30) days of a written request to the District, the District will facilitate consultation between the signatories regarding the proposed amendment.

2. Any amendments will be in writing and will be in effect on the date the amended PA is filed with the Council.

G. ANTI-DEFICIENCY ACT

All requirements set forth in this PA requiring expenditure of funds by the District are expressly subject to the availability of appropriations and the requirements of the Anti-Deficiency Act (31 U.S.C. 1341). No obligation undertaken by the District under the terms of this PA shall require or be interpreted to require a commitment to extend funds not appropriated for a particular purpose. If the District cannot perform any

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
THE NEW YORK STATE HISTORIC PRESERVATION OFFICE,
THE NATIONAL PARK SERVICE,
AND
THE NEW YORK CITY LANDMARKS PRESERVATION COMMISSION
REGARDING
ATLANTIC COAST OF NEW YORK
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
GENERAL RE-EVALUTION STUDY

Execution and implementation of this PA evidences that the District has satisfied its Section 106 responsibilities for all individual undertakings of the Project, and has afforded the NYSHPO and the ACHP an opportunity to comment on the undertaking and its effects on historic properties.

By:_____ Date: 20190711
Thomas D. Asbery
Colonel, U.S. Army
District Engineer

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
THE NEW YORK STATE HISTORIC PRESERVATION OFFICE,
THE NATIONAL PARK SERVICE,
AND
THE NEW YORK CITY LANDMARKS PRESERVATION COMMISSION
REGARDING
ATLANTIC COAST OF NEW YORK
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
GENERAL RE-EVALUTION STUDY

Execution and implementation of this PA evidences that the District has satisfied its Section 106 responsibilities for all individual undertakings of the Project, and has afforded the NYSHPO and the ACHP an opportunity to comment on the undertaking and its effects on historic properties.

By: R Daniel Mackay Date: 8/14/2019
R. Daniel Mackay
Deputy Commissioner
Division for Historic Preservation
New York Office of Parks, Recreation and Historic Preservation

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
THE NEW YORK STATE HISTORIC PRESERVATION OFFICE,
THE NATIONAL PARK SERVICE,
AND
THE NEW YORK CITY LANDMARKS PRESERVATION COMMISSION
REGARDING
ATLANTIC COAST OF NEW YORK
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
GENERAL RE-EVALUTION STUDY

Execution and implementation of this PA evidences that the District has satisfied its Section 106 responsibilities for all individual undertakings of the Project, and has afforded the NYSHPO and the ACHP an opportunity to comment on the undertaking and its effects on historic properties.

By:_____ Date:_____
Gina Santucci
Director of Environmental Review
New York City Landmarks Preservation Commission

APPENDIX A: CULTURAL RESOURCES

Historic Properties Case Report
Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens and Nassau Counties, New York

U.S. Army Corps of Engineers, New York District

Introduction

The Rockaway peninsula and southern Queens was one of the areas most devastated by Hurricane Sandy in 2012. There were 10 fatalities and more than 1,000 structures either substantially damaged or destroyed. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes along the Peninsula. Prior to Hurricane Sandy, the U.S. Army Corps of Engineers, New York District (District), was undertaking an effort to identify a long-term solution for the study area, which focused on the Atlantic Ocean shoreline. Prior to this reformulation, an existing, authorized project for the area was constructed in 1977 and renourished periodically through 2004, based upon a 1965 construction authorization. The current study was authorized by Public Law 113-2, The Disaster Relief Appropriations Act of 2013.

As a federal agency, the District has certain responsibilities to take into account the effects of their undertakings on historic properties that may be located within the Area of Potential Effect (APE) associated with the proposed undertaking. Present statutes and regulations governing these responsibilities include the National Historic Preservation Act of 1966 as amended (NHPA; 54 U.S.C 3001), the Advisory Council on Historic Preservation (ACHP) regulations implementing Section 106 of the NHPA (36 C.F.R. Part 800 *Protection of Historic Properties* August 2004) the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) and Executive Order 11593. Significant cultural resources include any material remains of human activity potentially eligible for inclusion on the National Register of Historic Places (National Register) and historic properties are those resources that are listed or been determined eligible for the National Register.

Description of the Undertaking

The East Rockaway Inlet to Rockaway Inlet and Jamaica Bay coastal storm risk management project is proposing to reduce the study area's vulnerability to coastal storms and improve community and coastal resiliency to the Rockaway Peninsula and southern Queens. The measures proposed by this study include the construction of a composite seawall buried along the beach, the construction of new and/or the extension of existing groins and sand fill along the Atlantic shoreline as well as four high-frequency flood risk reduction measures on Jamaica Bay in Cedarhurst-Lawrence, Hammels, Edgemere and Arverne, Queens and Nassau Counties, New York (Figure 1).

Figure 1: Recommended plan overview with Atlantic shoreline features and high-frequency flood risk reduction measures.

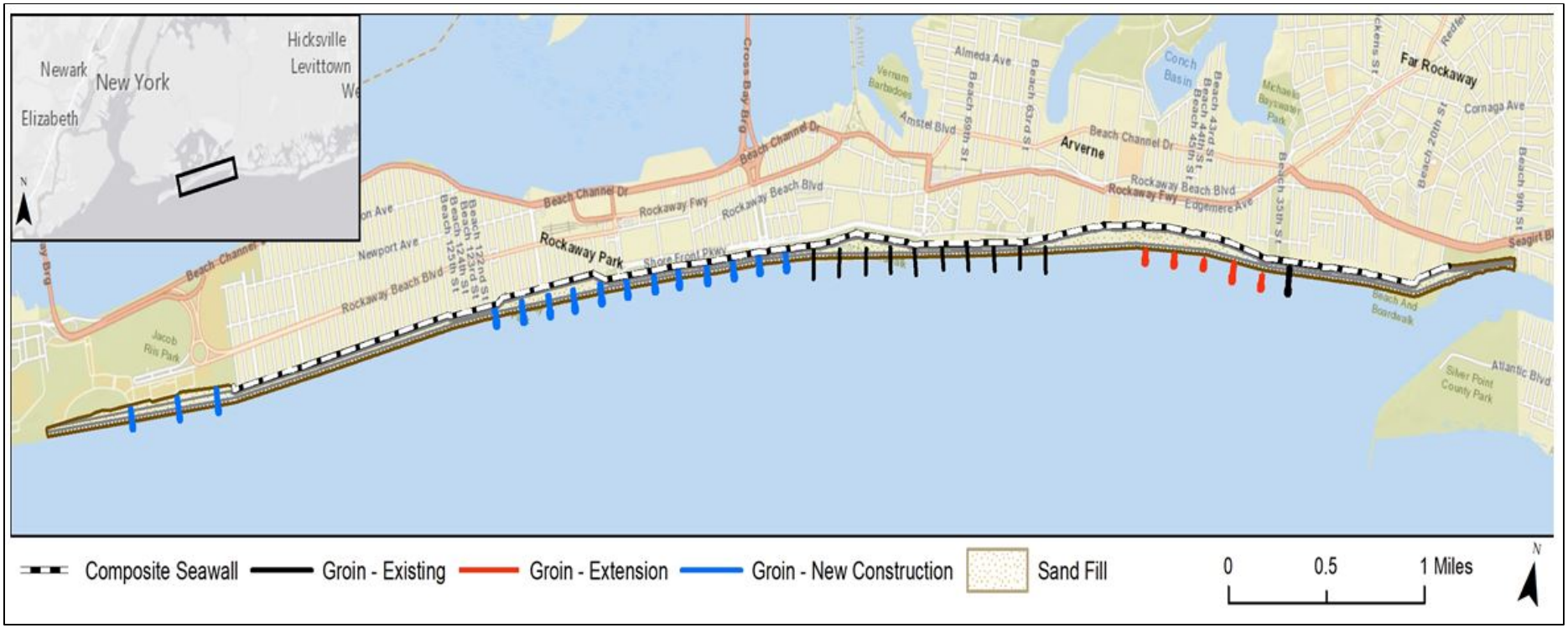


Figure 2: Atlantic Shorefront Component of the Recommended Plan

Figure 3: Groin rehabilitation and beach fill in Jacob Riis Park with the composite seawall just outside the park extending east along the Atlantic shoreline.

Figure 4: Groin Rehabilitation, beach fill and composite seawall along the Atlantic shoreline.

Figure 5: Composite seawall, beach fill and new groin construction (east) along the Atlantic shoreline.

Figure 6: New groin construction, beach fill and composite seawall along the Atlantic shoreline.

- Atlantic Shoreline Measures

These measures consist of a reinforced dune, also referred to as a composite seawall, approximately 60 feet wide and extending approximately 35,000 linear feet from Beach 9th to Beach 149th Street (Figures 2-6). The structure crest elevation of the seawall structure will be approximately +17 feet above NAVD 88. The dune height will be approximately +18 feet NAVD 88. The bottom of the reinforced dune will be approximately 15 feet below the dune crest. Beach fill will be placed along the reinforced dune and will be obtained from an offshore borrow area (see Figures 2-6). In addition, five existing groins will be extended and 13 new groins will be constructed (see Figures 4-6). Currently, three additional groin rehabilitations are proposed for Jacob Riis Park as well as the placement of sand fill (see Figure 3). Engineering analysis is being completed to determine if the rehabilitation of the Jacob Riis Park groins is necessary. The reinforced dune will not extend into Jacob Riis Park (see Figure 3).

- High-Frequency Flood Risk Reduction Measures

- Cedarhurst-Lawrence: Located in the channel adjacent to the Lawrence High School, this measure consists of 1,000 feet of bulkhead along the east, south and west sides where it will connect to high ground. A small extent of floodwall will be used to connect the bulkhead to the higher ground upland. The proposed elevation will be approximately 10 feet NAVD 88. The existing outfalls will be raised and a pump station will be constructed to receive stormwater when the outlets are blocked by storm surge or tide (Figure 7).

- Mid-Rockaway-Edgemere: This measure extends from Beach 35th to just beyond Beach 49th Street and will include a combination of a berm, hybrid berm, floodwall and bulkhead. Portions of the berm and hybrid berm will be fronted by scrub-shrub, salt meadow hay and smooth cordgrass natural features stabilized by a rock sill. It is anticipated that three pump stations and one road ramp will be needed. Proposed project elevations range from +8 to +9.5 feet NAVD 88 (Figure 8).

- Mid-Rockaway-Arverne: This measure extends from Almeda Avenue and Beach 58th Street all the way around Arvene's Jamaica Bay shoreline to Amstel Avenue just past Beach 74th Street. This alignment includes a berm, floodwall, revetment a bulkhead and hybrid berm. Natural features, including canopy tree, salt meadow hay, scrub-shrub, and smooth cordgrass, will be constructed in front of the floodwall, hybrid berm, and bulkhead, and protected by rock sill. Three pump stations, one flood gate and three road ramps will also be constructed (Figure 9).

- Mid-Rockaway – Hammels: This measure consists of two individual segments: an east segment of 1,400 linear feet of floodwall along Beach Channel Drive and a west segment of 1,400 linear feet from the Beach 84th Street to Beach Channel Drive. It

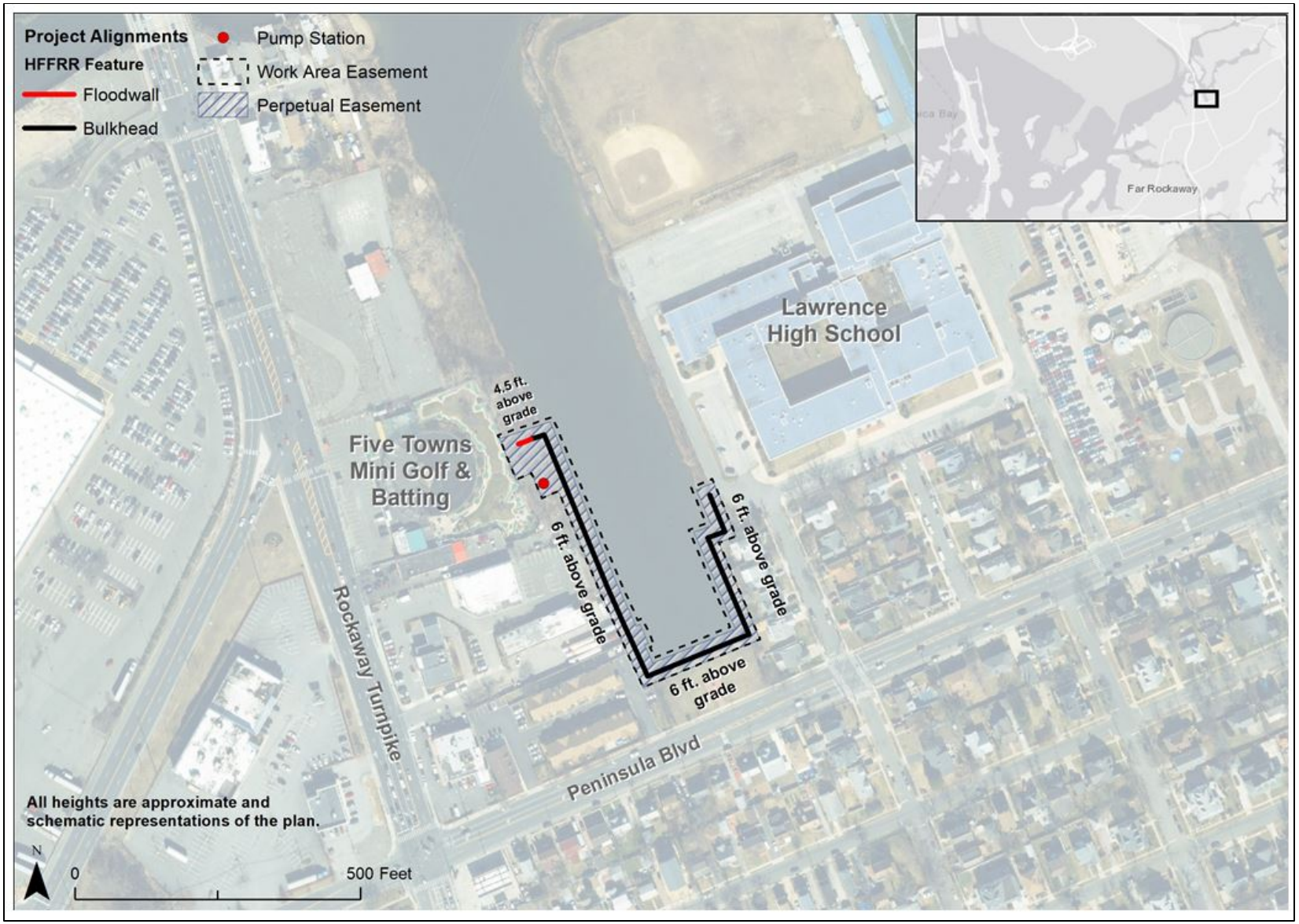


Figure 7: Cedarhurst-Lawrence High-Frequency Flood Risk Reduction Measures

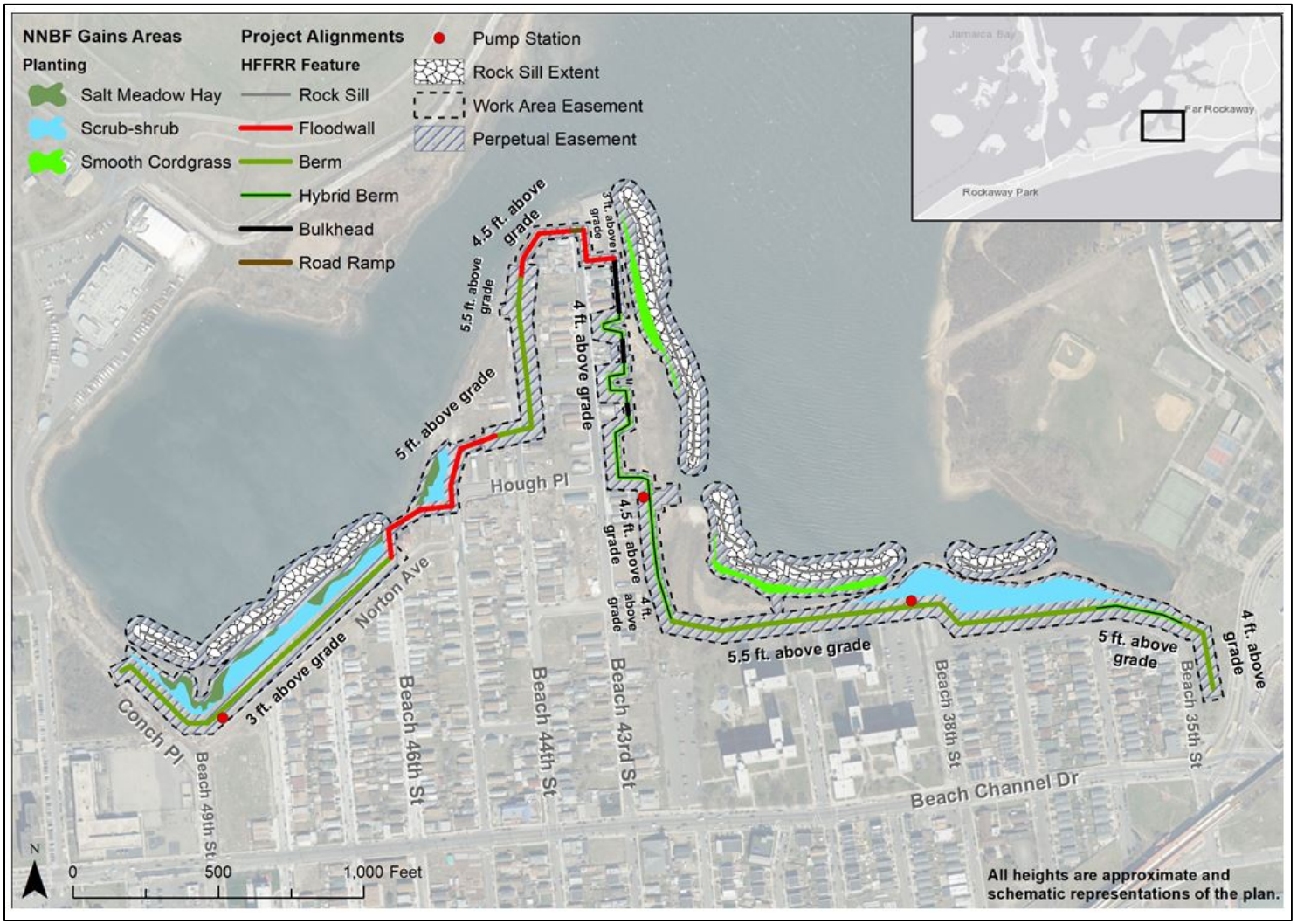


Figure 8: Edgemere High-Frequency Flood Risk Reductions Measures.

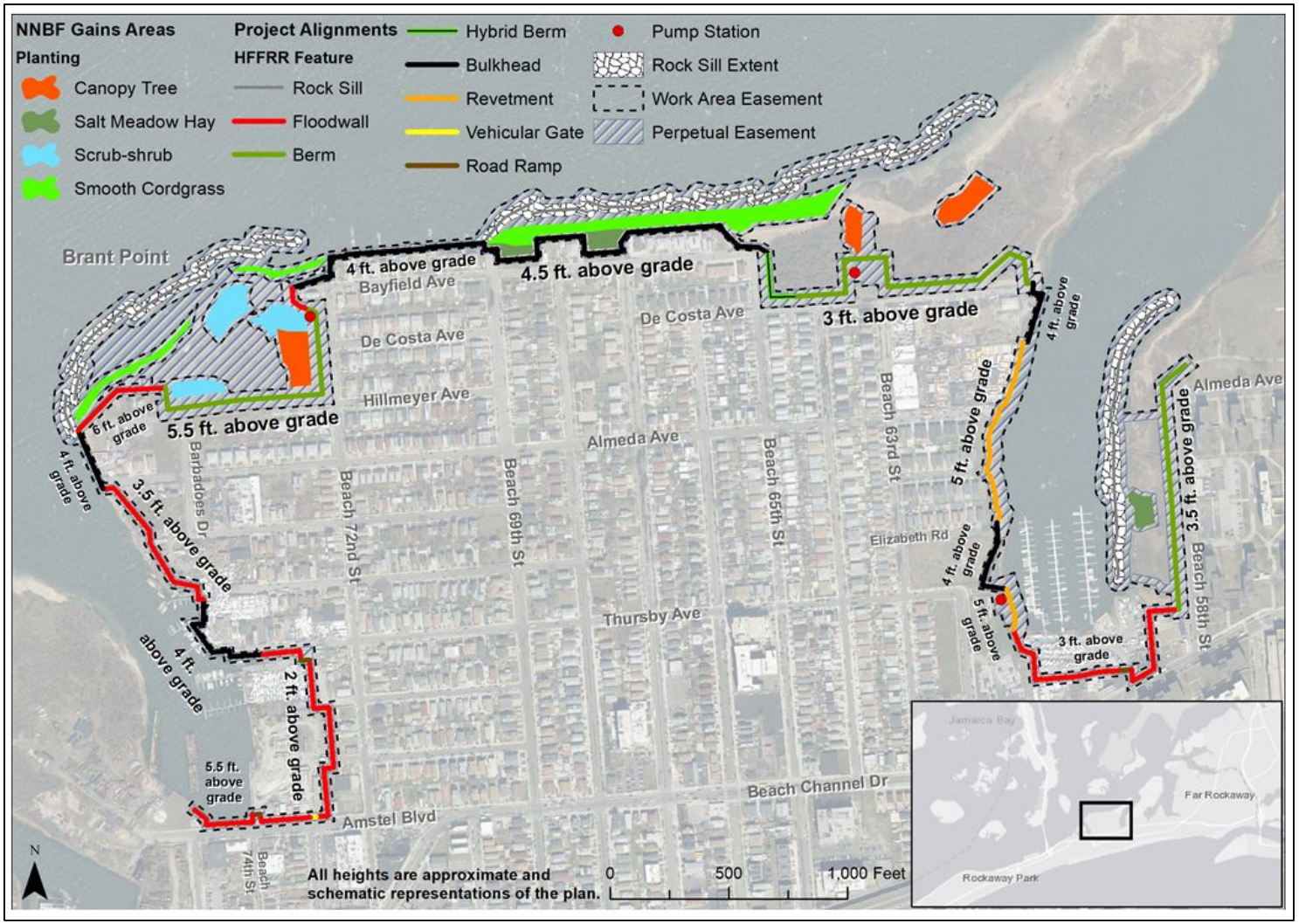


Figure 9: Arverne High-Frequency Flood Risk Reduction Measures

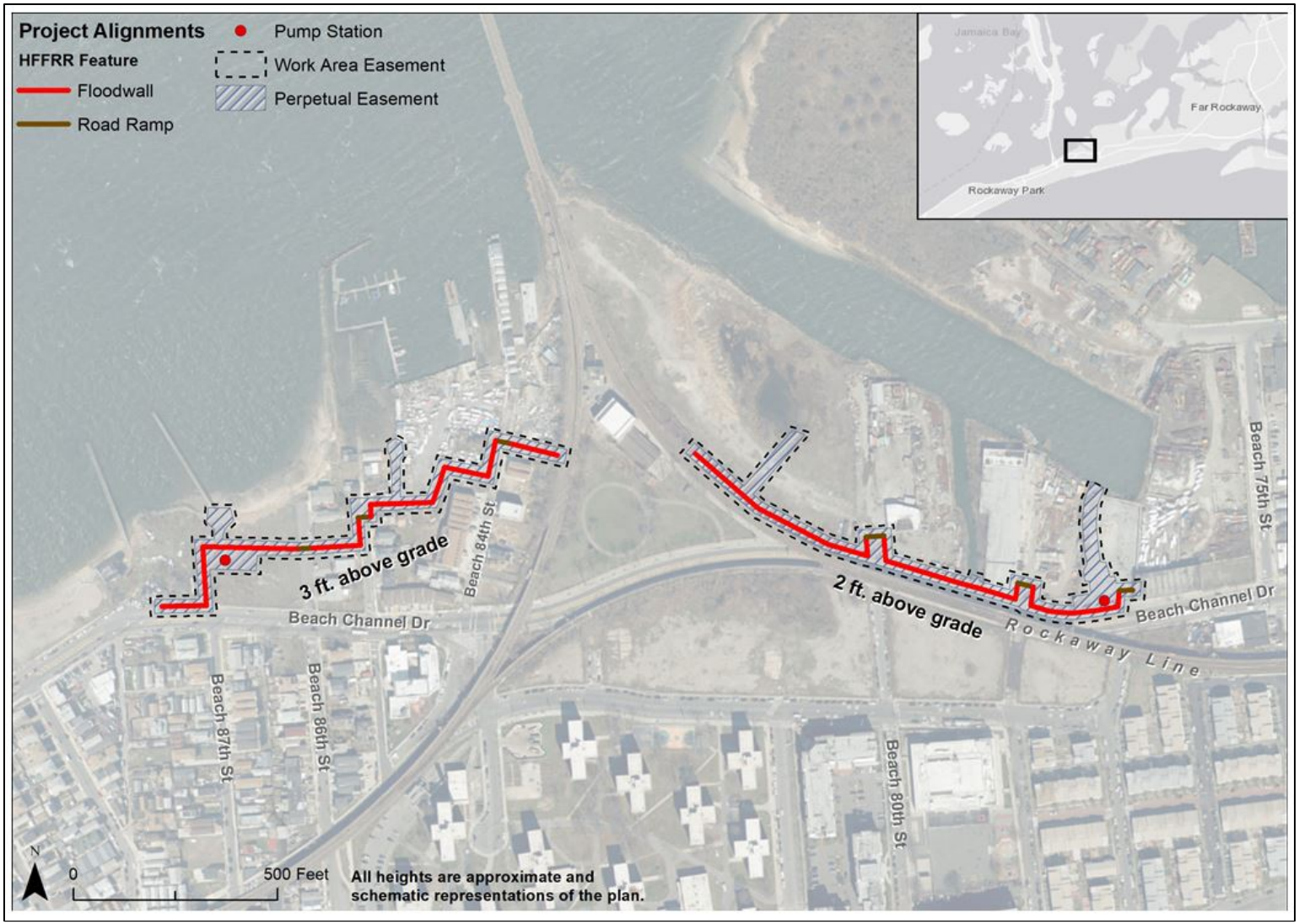


Figure 10: Hammels High-Frequency Flood Risk Reduction Measures

is anticipated that each segment will require one pump station. The segments will also require four road ramps; three on the east and one on the west (Figure 10).

Study Method and APE

The cultural resources investigation for this study has been limited to documentary research and a pedestrian survey. Documentary research consisted of gathering data from previous cultural resource studies and an examination of the New York State Historic Preservation Office (NYSHPO) Cultural Resources Information System (CRIS).

The APE is considered be located along the alignment of each of the measures described above as the undertaking to include the offshore borrow areas. At this time no staging areas or access roads have been identified, however, given the nature of the surrounding area it is anticipated that staging areas will be within existing parking lots or the footprint of the alignment itself. If additional staging areas, access roads or other features are required they will be considered in this analysis once they are defined. The APE for archaeology, historic structures and historic landscapes has been defined as those areas along the proposed line of protection that would likely be directly impacted by project construction. The APE for historic structures and landscapes also includes those locations that would be anticipated to have visual impacts from the completed project.

Previous Work

Reports utilized for this research included the cultural resources surveys conducted within and around the study's APEs. These include Gateway National Recreation Area (Gateway) Final General Management Plan Environmental Impact Statement (National Park Service [NPS] 2014) and the Jamaica Bay Cultural Resources Baseline Study and (Panamerican Consultants 2000, 2003, 2006), and remote sensing and inspection of targets (Panamerican Consultants 2003, 2005 and 2006 and Reiss 1994). This research included a review of the APEs on the NYSHPO CRIS database.

A western section of the Atlantic shoreline component is within the NPS' Gateway – Jamaica Bay Unit and both the eastern shoreline and high-frequency flood risk reduction components are located in the vicinity of the other elements of Gateway. In its cultural resources management plans for the area, the NPS has reported that there have been no Paleo-Indian or Archaic Period sites identified within its property. Woodland sites, characterized by the recovery of ceramic sherds, lithic artifacts and shell middens, have been identified within Gateway as have Contact period settlement sites, which included a mix of European and indigenous cultural items.

- Known Prehistoric Archaeological Sites

The New York State Museum files have a number of sites listed that were identified by Arthur C. Parker in the 1920s in and around Jamaica Bay and the Rockaway Peninsula and possibly within the vicinity of the study's APEs, although the exact locations and other information are unknown. These sites include:

Table 1: Arthur C. Parker sites recorded at the New York State Museum[1]

NYSM No.	Site Name	Period	Comments
4033	ACP NSAU 12A	Prehistoric or historic	Native American cemetery noted on the White Property near Cedarhurst
4034	ACP NSAU 13A	Prehistoric or historic	Possible Native American Village on Hicks Neck near Bannister Creek and Sage Pond
4050	ACP NSAU	Prehistoric	Camp site in general vicinity of Inwood, just southwest of the project area
4538	ACP QUNS	Prehistoric	Possible Native American village near Head of Bay
4547	ACP QUNS	Prehistoric	Traces of occupation near Head of Bay and Hook Creek
7772	ACP NSAU	Prehistoric or historic	Possible Native American village and shell midden site east of Woodmere Creek
7775	ACP NSAU	Prehistoric	Campsite near Sage Pond and Crooked Creek

[1]As reported in Panamerican Consultants 2003 and Merwin 2009.

In addition to Parker, other known prehistoric sites around Jamaica Bay were identified by Bolton (1920, 1922, and 1934) and Harrington (1909) (Panamerican 2003). Few sites have been identified on the Rockaway Peninsula and include NYSM-4050 above. A cemetery with associated artifacts was reported in Bayswater in 1901 as well as large shell deposits. As late as 1988, it was noted that located along the eastern shore of Jamaica Bay, in the vicinity of Bayswater, was a Woodland period site consisting of ceramics, projectile points, and a possible burial (Panamerican 2003).

These identified sites would be located outside the APEs for both the Atlantic shoreline and high-frequency flood risk reduction components but could be located nearby the Cedarhurst and Edgemere segments of the latter. It may be that on the Rockaway Peninsula, similar sites that have not been destroyed by development or storms may be more deeply buried.

- Known Historic Properties

Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th and 26th Streets) are historic districts on the Rockaway Peninsula that

are listed on the New York State and the National Registers of Historic Places. The Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club and Jacob Riis Historic Districts are all located within Gateway and are managed by the NPS. Other National Register listed or eligible properties include 2 Beach 85th Street, Hammels Pier, the New York City Transit System Building, the Rockaway Courthouse, the Temple of Israel Synagogue, the US Post Office at Far Rockaway, Trinity Chapel, the Russell Sage Memorial Church, the Trans World Airlines Flight Center at JFK International Airport, and The Marine Parkway - Gil Hodges Memorial Bridge.

One New York City designated landmark, the Richard Cornell Burial Ground, is located in Far Rockaway. Locally significant landmarks that have not been formally listed include the Waterfront Tribute Park, 9/11 Memorial and the American Airline Flight 587 Memorial.

The beach portion of the Jacob Riis Historic District is located within the western end of the Atlantic Shoreline APE (Figures 11 and 12). The Far Rockaway Beach Bungalow Historic District is located adjacent to the eastern end of the Atlantic shoreline APE (Figure 13). None of these historic districts are located within or near the APEs for the high-frequency flood risk reduction segments. Two Beach 85th Street, Hammels Pier and the New York City Transit System Building are located adjacent and potentially within the APE for two segments the Hammels high-frequency flood risk reduction measure (Figures 14 and 15).

No other historic properties or New York City landmarks are located in either component's APEs. The American Airline Flight 587 Memorial is located at the end of Beach 116th Street and is adjacent to the Atlantic shoreline APE (Figure 16).

Assessment of Effects and Recommendations

Based on the review of the existing data along the ocean and bayside of the Rockaway peninsula and along Jamaica Bay, there are National Register listed or eligible properties within or just adjacent to the APE that may be directly or indirectly effected by the project elements. Potential impacts to specific properties or category of properties is outline below and summarized in Table 2. The activities required to continue further study or to mitigate for adverse effects is included in the project Programmatic Agreement (Appendix A).

Although no prehistoric or Native American archaeological sites have been identified along the Rockaway peninsula, the early discoveries at the eastern end of the peninsula do indicate a potential for utilization of the area. Sites on the peninsula, if present, may be more likely to be deeply buried as a result of the active forces of the ocean and storm surge. As part of the investigations for and construction of the reinforced dune/composite seawall, conduct geomorphological investigations to identify locations of prehistoric land surfaces that may require monitoring during excavation.

As determined for previous sand placement efforts, the placement of beach fill will not have an adverse effect on the known historic districts and properties located along the shoreline. The source of the sand will be from borrow areas for which a remote sensing survey and, in some cases, an underwater inspection of targets, has been completed. If a borrow area is selected for which an investigation has not been completed or additional work is warranted, those investigations will be conducted prior to the use of the borrow area.

The proposed plan also intends to build new groins as well as rehabilitate and/or extend existing groins. Neither the original nomination for the Jacob Riis Park Historic District, nor the 2014 Final General Management Plan and Environmental Impact Statement mention the groins, although there are three within the current bounds of the historic district. A survey of the groins with in the shoreline APE will be conducted determine when they were built and if they are eligible for the National Register on their own or as part of the existing historic district.

Only a portion of the Arverne high-frequency flood risk reduction measures have been subject to a prior survey (Dubos Point (8) and Brant Point (9) in Panamerican 2003). Additional investigations would include expanding this survey to the other portions of this high-frequency flood risk reduction measure as well as to the other three similar measures. In addition, the completed survey recommends additional investigations prior to or as part of construction activities in these areas. These include additional research on the bulkhead, limited subsurface testing, monitoring of deeper excavation, if conducted, for prehistoric land surfaces and potential remote sensing investigations on the water side of the area.

Two eligible properties, the NYC Transit System building and 2 Beach 85th are immediately adjacent to elements associated with the Hammels high-frequency flood risk reduction measure. They will not be adversely effected by the construction of the measures, however, information related to these structures may be identified during the proposed Phase I survey or that determination could change should the alignment of each floodwall or pump station changes.

Figure 11: Location of Jacob Riis Park Historic District in relation to the project alignment APE.

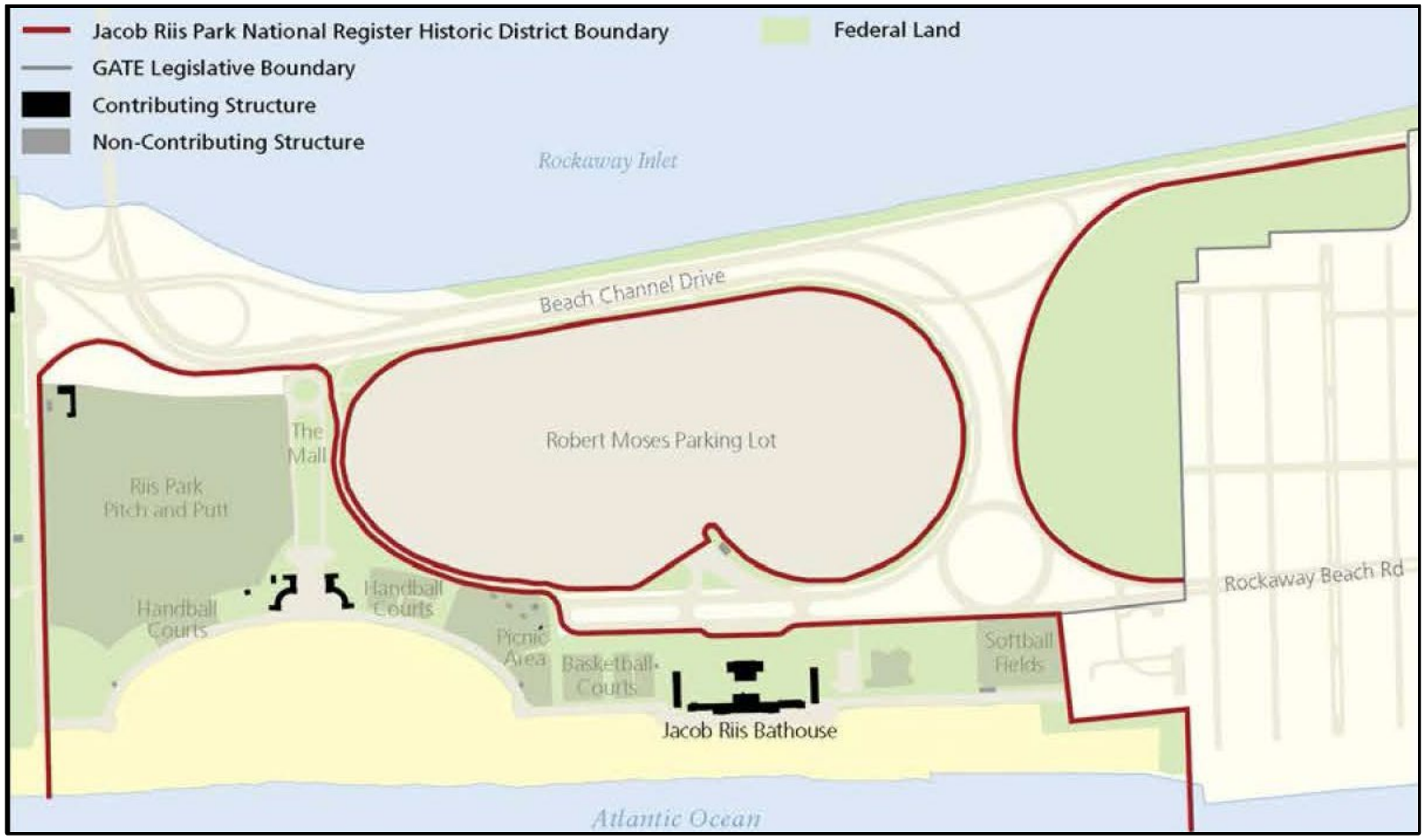


Figure 12: Jacob Riis Park Historic District elements.

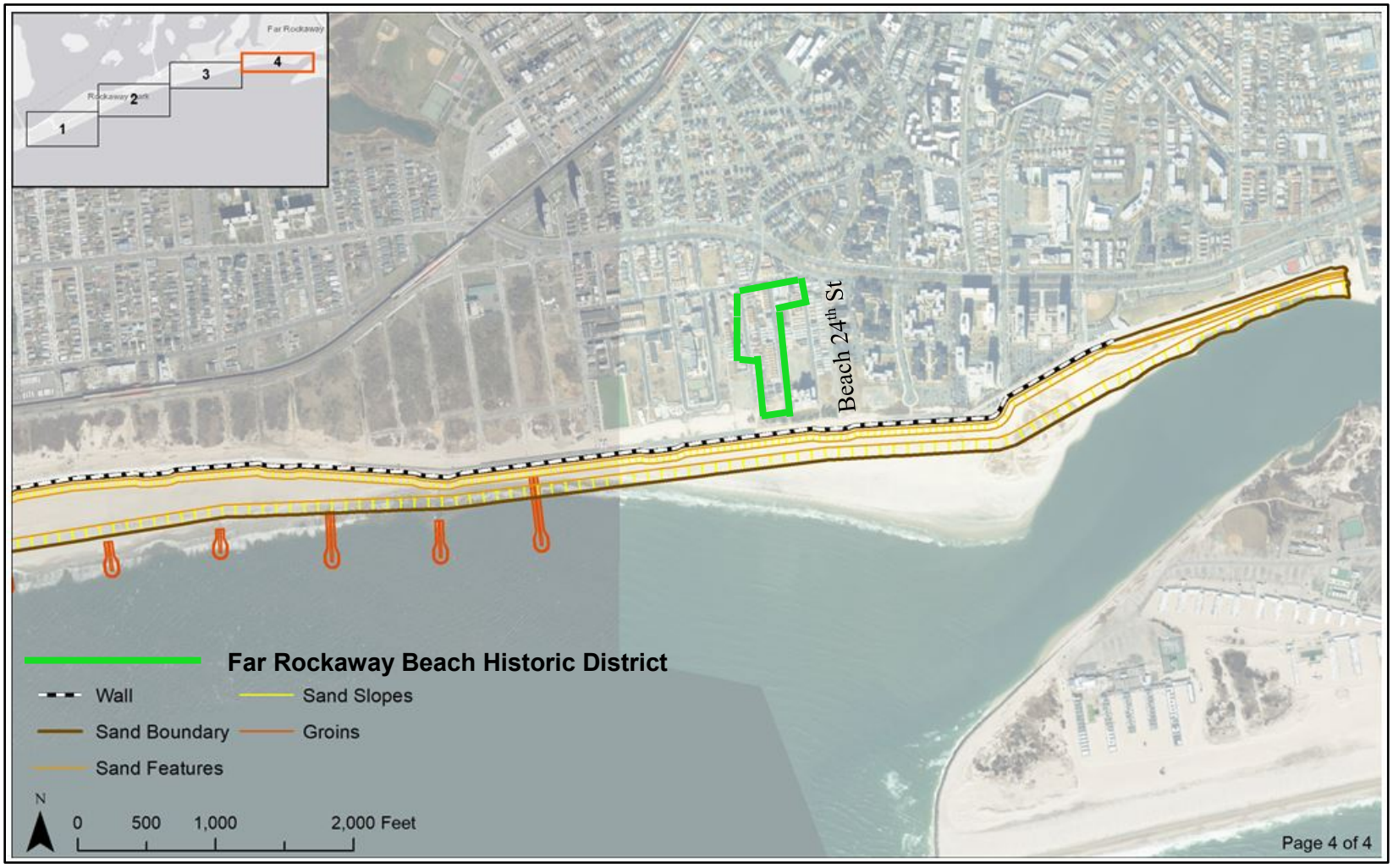


Figure 13: Location of the Far Rockaway Historic District and the project alignment APE.

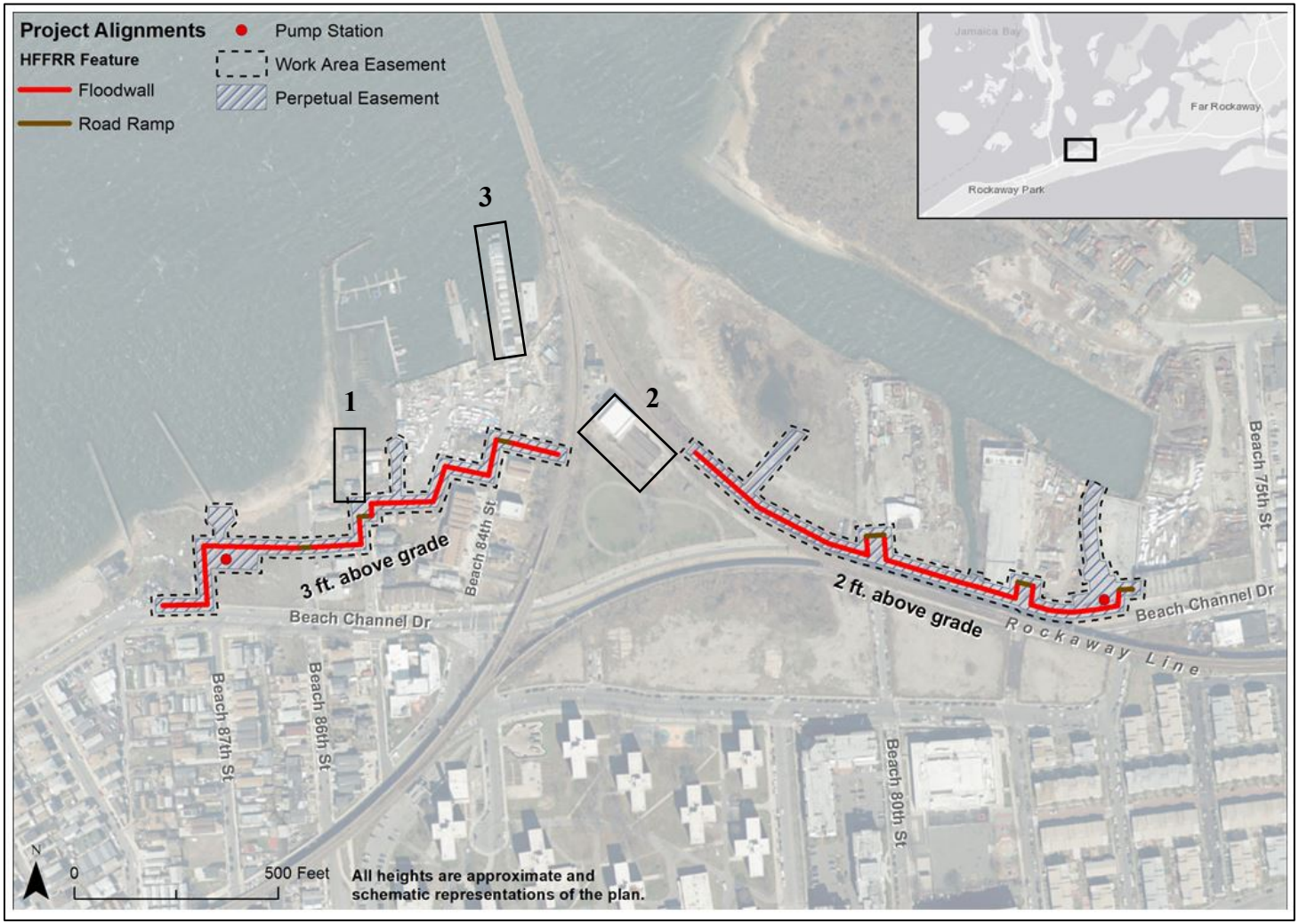


Figure 14: Location of 1) 2 Beach 85th Street; 2) New York City Transit System Building; and 3) Hammel Beach Pier and the Hammels high-frequency flood risk reduction measure alignments APE.

Figure 15: Photographs of the eligible properties near the Hammels high-frequency flood risk reduction: New York City Transit System building (top), 2 Beach 85th Street (middle) and the Hammels Pier (bottom) (NYSHPO CRIS 2019).

Figure 16: Location of Flight 587 Memorial Park.

Table 2: Assessment of Effects and Recommendations for Additional Work

Project Element	Resource	Recommendation
Reinforced dune/composite seawall	Potential prehistoric sites	Geomorphology with potential for monitoring during construction
Beach Fill	No historic properties affected	No additional work
Existing Borrow Areas	No historic properties affected	No additional work
New Borrow Areas	Potential prehistoric/historic resources	Remote sensing survey with potential underwater investigations
Groin Rehabilitation	Groins	Determine eligibility of groins as individual or historic district
Cedarhurst	Potential prehistoric/historic sites	Phase I survey; potential for subsurface investigations and remote sensing
Edgemere	Potential historic sites	Phase I survey
Arverne	Potential prehistoric/historic sites	Phase I survey; potential for subsurface investigations and remote sensing
Hammels	Potential prehistoric/historic sites	Phase I survey; potential for subsurface investigations and remote sensing; monitor alignment and proximity to eligible historic structures.

A Programmatic Agreement has been prepared to complete additional surveys on 1) the National Register eligibility of the groins along the Atlantic shoreline; 2) the potential for land surfaces and archaeological sites buried within the Rockaway peninsula; and 3) the potential for archaeological sites that might be affected by the high-frequency flood risk reduction measures. The public review of the draft General Reevaluation Report and Environmental Impact Statement included the discussion of affected historic properties as well as a preliminary draft of the programmatic agreement. The New York State Historic Preservation Office, the National Park Service, the New York City Landmarks Preservation Commission, the Delaware Nation, the Delaware Tribe, the Stockbridge-Munsee Community, the Shinnecock Nation and the Unkechaug Nation

were also provided a final draft to review and comment prior to execution of the agreement.

References

Merwin, Daria E.

2009 *A Cultural Resources Survey Report 2008-2009 Program Year, PIN 0072.14.101, New York State Route 878 (Nassau Expressway) Operational Improvement, Rockaway Turnpike to Burnside Avenue, Inwood, Town of Hempstead, Nassau County (Minor Civil Division 05930).* Institute for Long Island Archaeology, State University of New York at Stony Brook, Stony Brook, New York. Prepared for the New York State Museum, State Education Department. Sponsored by the New York State Department of Transportation and the Federal Highway Administration.

National Park Service

2014 *A New Vision for a Great Urban National Park: Gateway National Recreation Area, Final General Management Plan, Environmental Impact Statement.* U.S. Department of the Interior.

Panamerican Consultants

2000 *Cultural Resources Assessment of T-Groin Placement, Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens County, New York, Section 934.* Prepared for the U.S. Army Corps of Engineers, New York District.

2003 *Cultural Resources Baseline Study, Jamaica Bay Ecosystem Restoration Project, Kings, Queens and Nassau Counties, New York.* Prepared for the U.S. Army Corps of Engineers, New York District.

2005 *Remote Sensing Survey of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York.* Prepared for the U.S. Army Corps of Engineers, New York District.

2006 *Phase IB Investigations of Bayswater State Park and Paerdegat Basin, Jamaica Bay Ecosystem Restoration Project, Kings, Queens and Nassau Counties, New York*. Prepared for the U.S. Army Corps of Engineers, New York District.

Riess, Warren C.

1994 *East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York, Section 934 Study, Remote Sensing of Borrow Area 2.* Prepared by WCH Industries in association with Boston Affiliates. Submitted to the U.S. Army Corps of Engineers, New York District.

ATTACHMENT B: AREA OF POTENTIAL EFFECTS

FIGURES

Figure 1: Recommended plan overview with Atlantic shoreline features and high-frequency flood risk reduction measures.

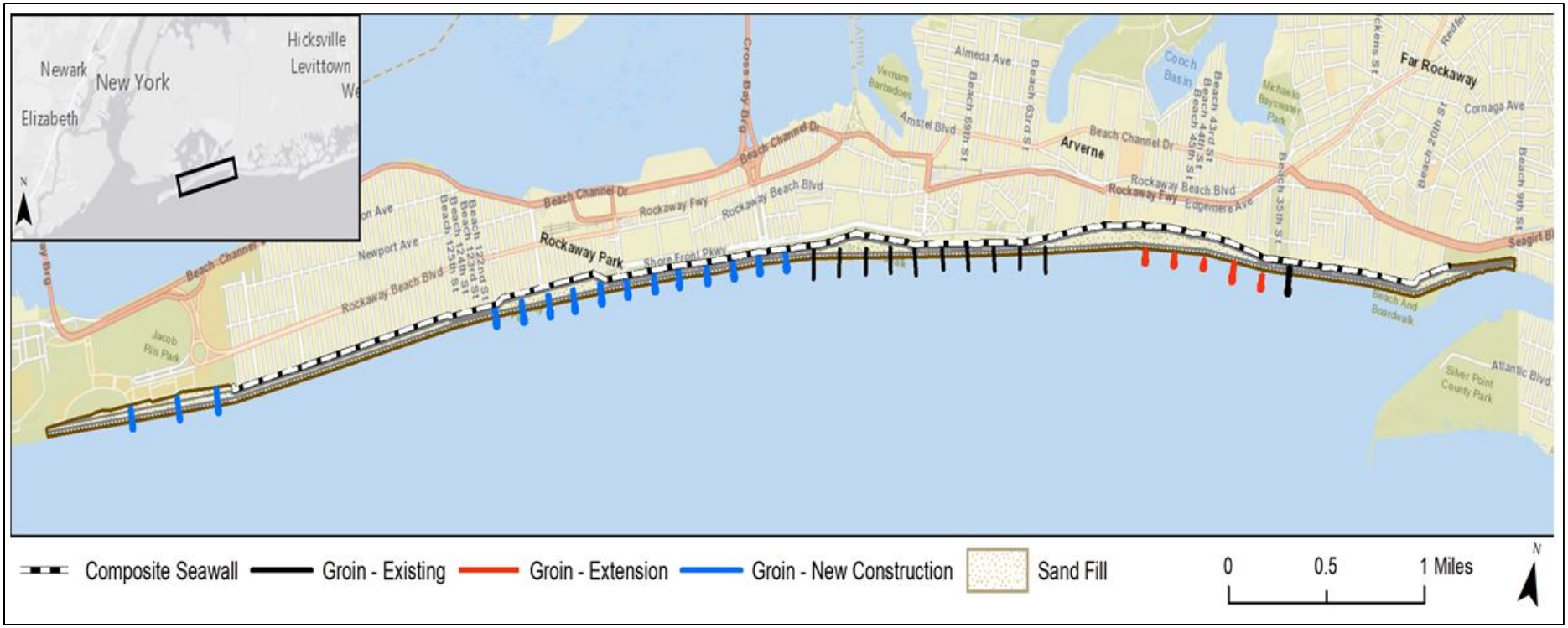


Figure 2: Atlantic Shorefront Component of the Recommended Plan

Figure 3: Groin rehabilitation and beach fill in Jacob Riis Park with the composite seawall just outside the park extending east along the Atlantic shoreline.

Figure 4: Groin Rehabilitation, beach fill and composite seawall along the Atlantic shoreline.

Figure 5: Composite seawall, beach fill and new groin construction (east) along the Atlantic shoreline.

Figure 6: New groin construction, beach fill and composite seawall along the Atlantic shoreline.

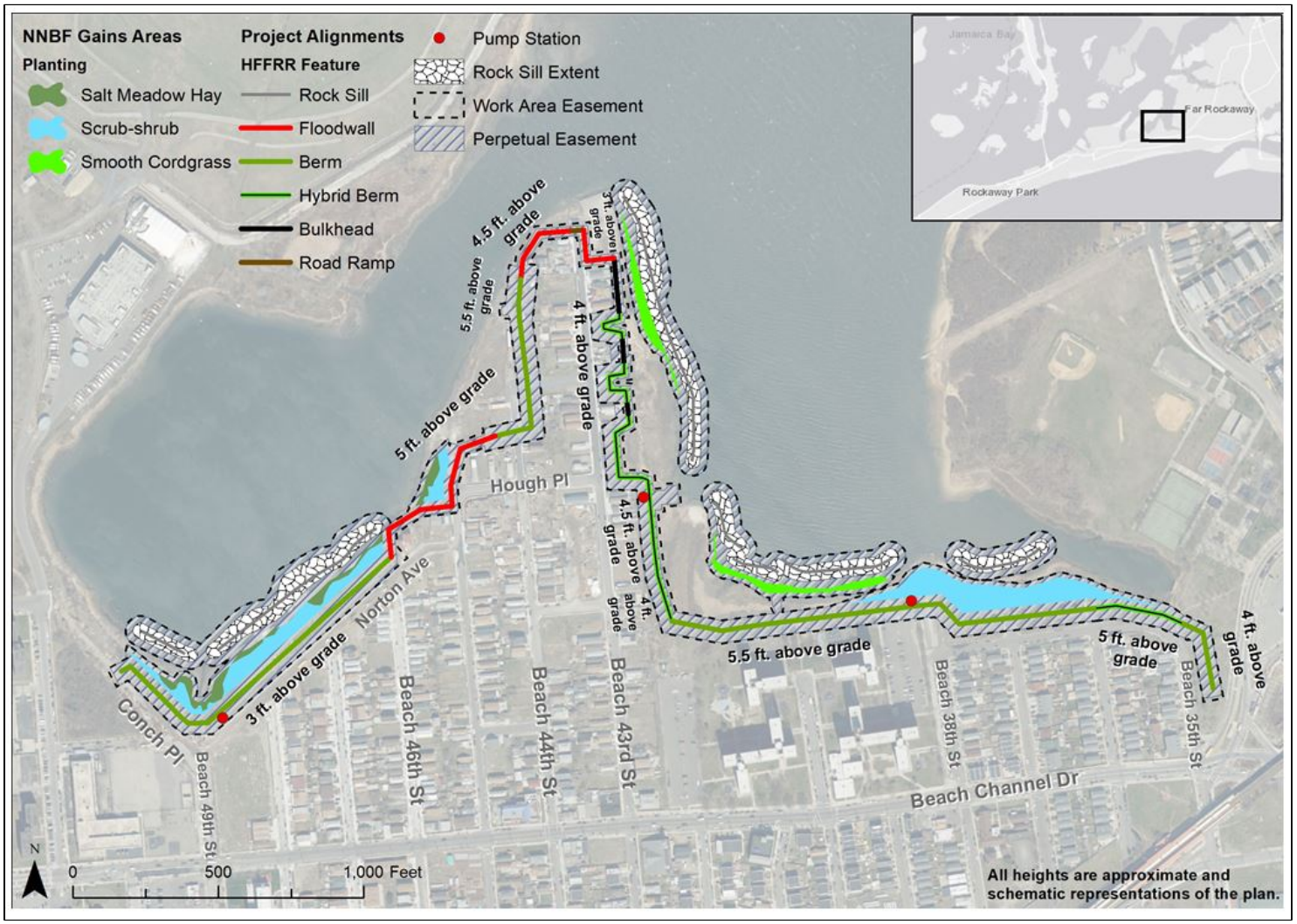


Figure 8: Edgemere High-Frequency Flood Risk Reductions Measures.

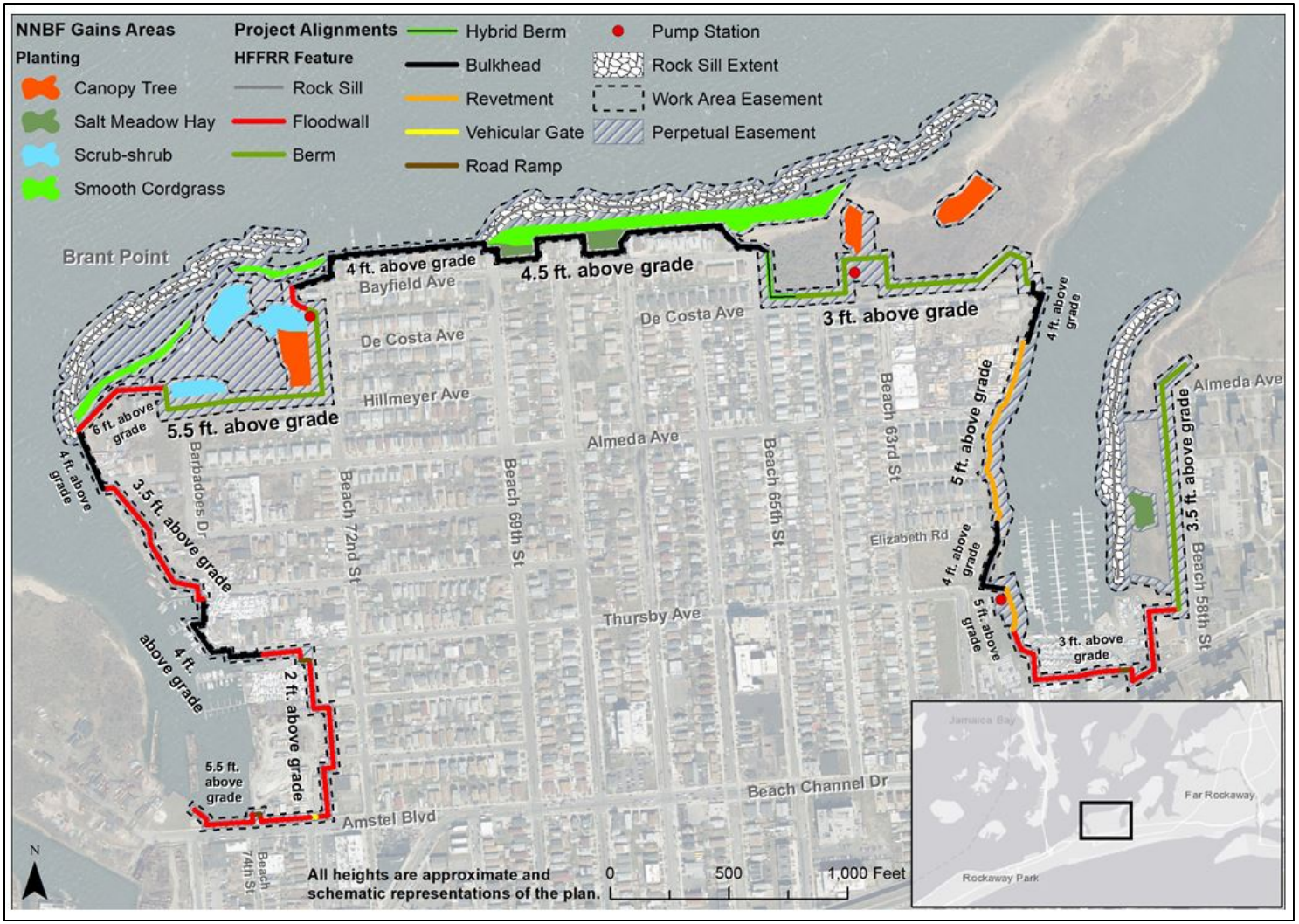


Figure 9: Arverne High-Frequency Flood Risk Reduction Measures

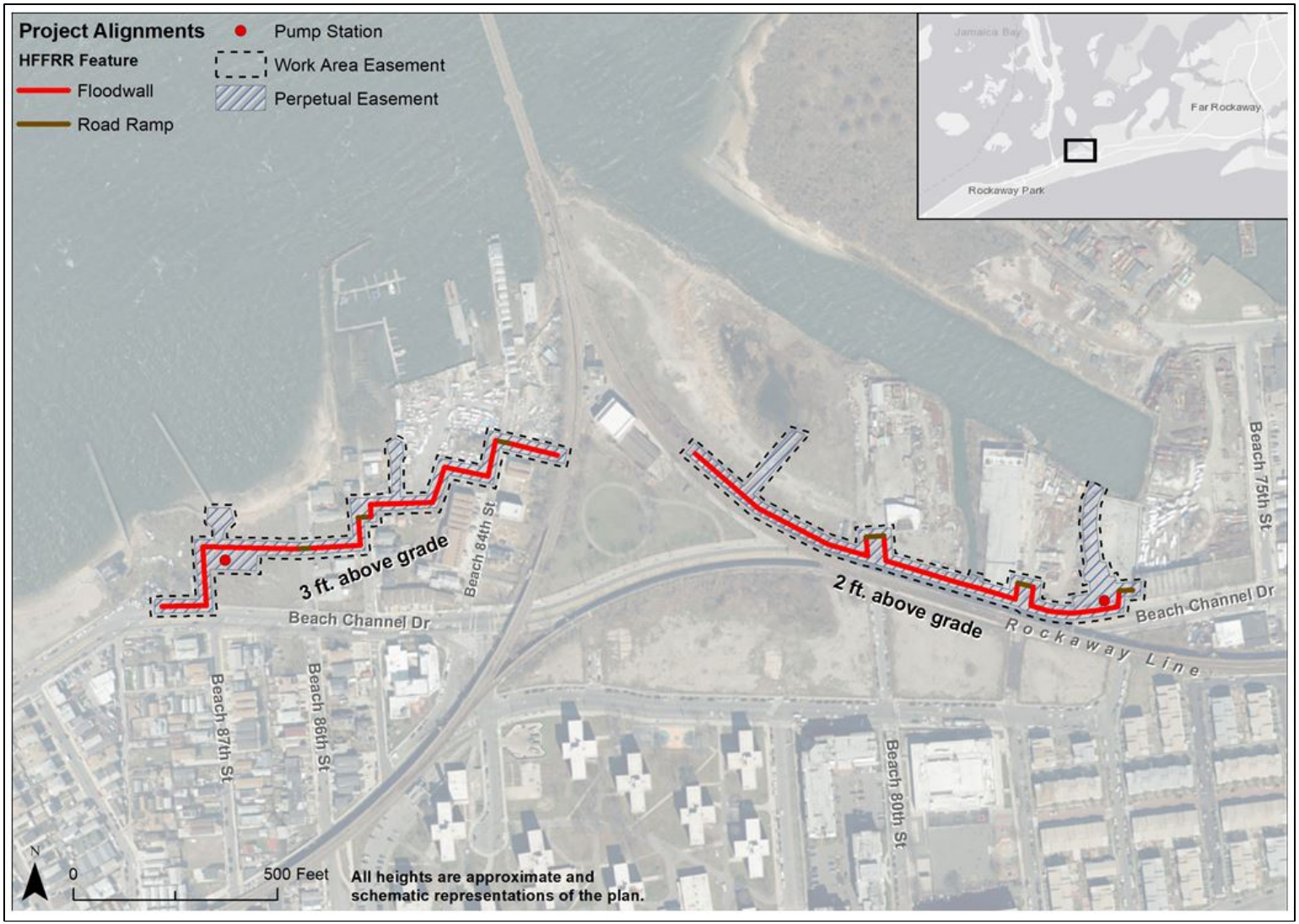


Figure 10: Hammels High-Frequency Flood Risk Reduction Measures

Figure 11: Location of Jacob Riis Park Historic District in relation to the project alignment APE.

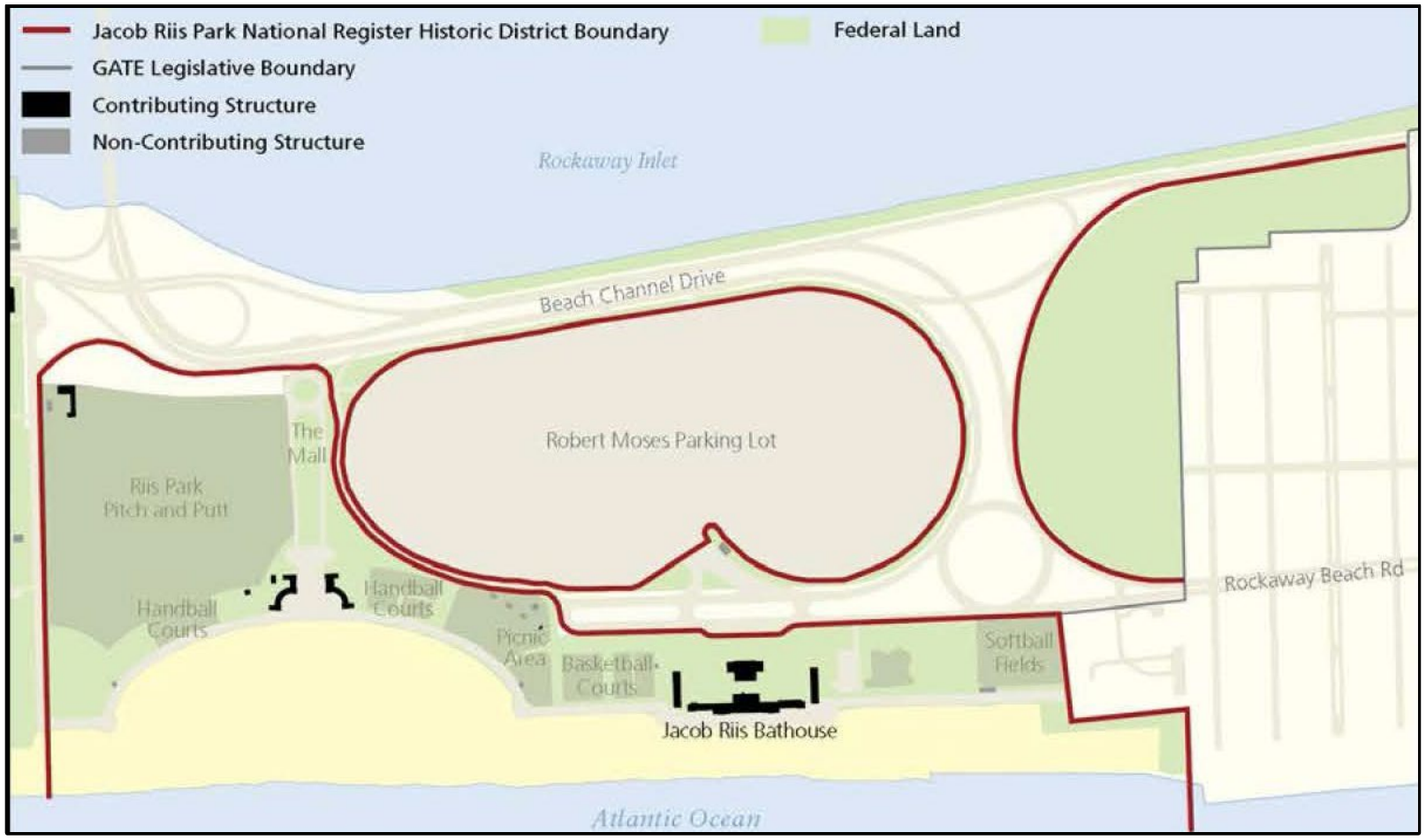


Figure 12: Jacob Riis Park Historic District elements.

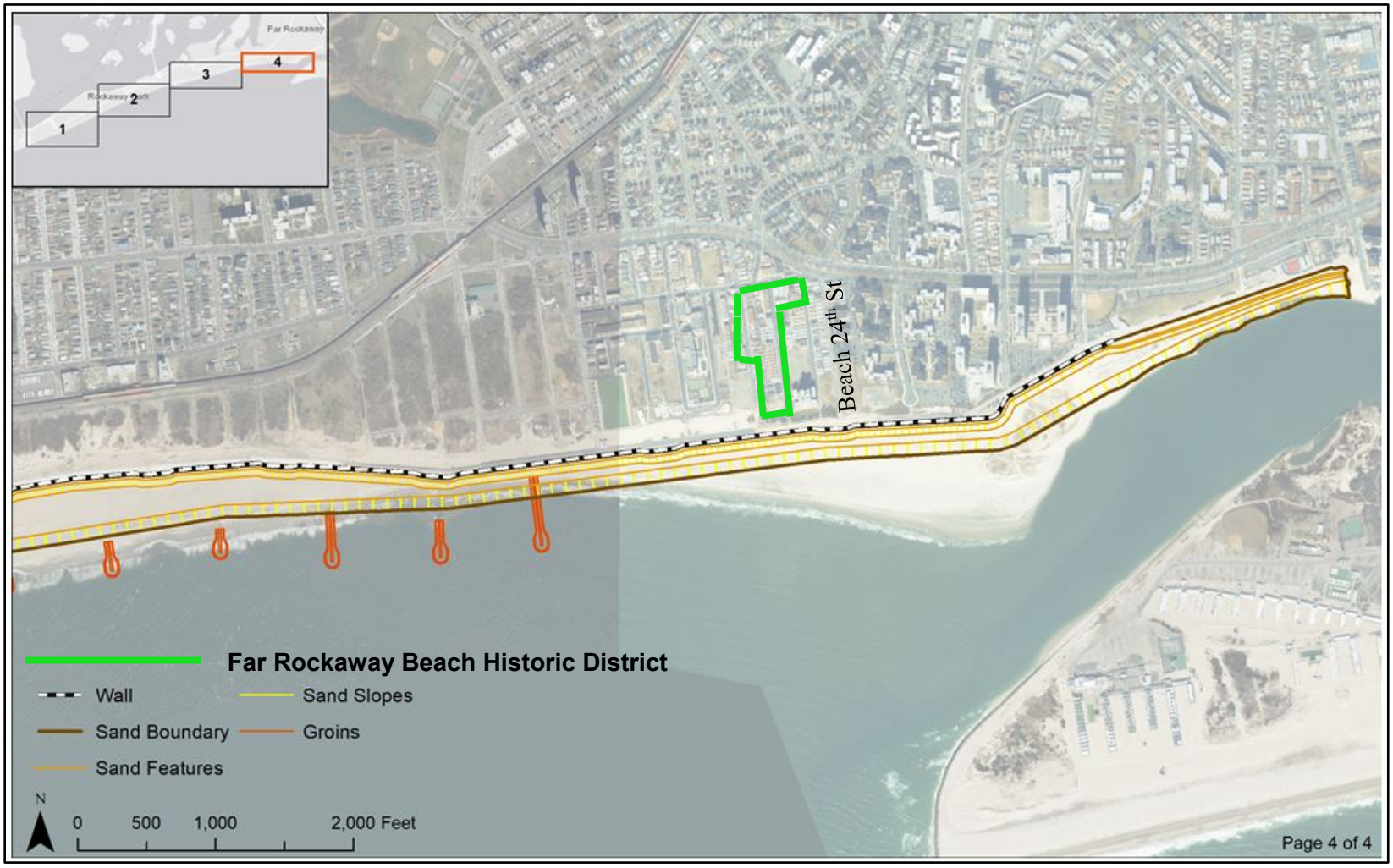


Figure 13: Location of the Far Rockaway Historic District and the project alignment APE.

APPENDIX C: HUMAN REMAINS DISCOVERY PROTOCOL

DRAFT

State Historic Preservation Office/
New York State Office of Parks, Recreation and Historic Preservation
Human Remains Discovery Protocol
(November 28, 2008)

In the event that human remains are encountered during construction or archaeological investigations, the New York State Historic Preservation Office (SHPO) recommends that the following protocol is implemented:

- At all times human remains must be treated with the utmost dignity and respect. Should human remains be encountered work in the general area of the discovery will stop immediately and the location will be immediately secured and protected from damage and disturbance.

- Human remains or associated artifacts will be left in place and not disturbed. No skeletal remains or materials associated with the remains will be collected or removed until appropriate consultation has taken place and a plan of action has been developed.

- The county coroner/medical examiner, local law enforcement, the SHPO, the appropriate Indian Nations, and the involved agency will be notified immediately. The coroner and local law enforcement will make the official ruling on the nature of the remains, being either forensic or archaeological.

- If human remains are determined to be Native American, the remains will be left in place and protected from further disturbance until a plan for their avoidance or removal can be generated. Please note that avoidance is the preferred choice of the SHPO and the Indian Nations. The involved agency will consult SHPO and appropriate Indian Nations to develop a plan of action that is consistent with the Native American Graves Protection and Repatriation Act (NAGPRA) guidance.

- If human remains are determined to be non-Native American, the remains will be left in place and protected from further disturbance until a plan for their avoidance or removal can be generated. Please note that avoidance is the preferred choice of the SHPO. Consultation with the SHPO and other appropriate parties will be required to determine a plan of action.

DRAFT

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D7
General Conformity Determination Notice

December 2018

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

General Reevaluation Report and Environmental Impact Statement

General Conformity Determination Notice

United States Army Corps of Engineers, New York District
General Conformity Determination Notice

On October 30, 2012, New York State (DR-4085) and New Jersey State (DR-4086) declared Super Storm Sandy a Major Disaster. In response to the unprecedented breadth and scope of the damages sustained along the New York and New Jersey coastlines, the U.S. Congress passed Public Law (PL) 113-2 "Disaster Relief Appropriations Act 2013", also known as House Resolution (H.R.) 152-2 Title II which was signed into law on January 29, 2013. PL 113-2, which states "That the amounts... are designated by the Congress as being for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985", provides funding for numerous projects to repair, restore and fortify the coastline in both states as a result of the continuing emergency as people and property along the coast remain in a vulnerable condition until the coastline is restored and fortified. To protect the investments by the Federal, State, local governments and individuals to rebuild damaged sites, it is imperative that these emergency disaster relief projects proceed as expeditiously as possible.

The Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay (Rockaway) study is called a General Reformulation Report, because it seeks to reexamine the Project that was originally authorized by the House of Representatives, dated 27 September 1997, as stated within the Congressional Record for the U.S. House of Representatives. Subsequent to the original authorization, is the new authorization under Public Law 113-2 (29Jan13), The Disaster Relief Appropriations Act of 2013 (the Act), was enacted in part to "improve and streamline disaster assistance for Hurricane Sandy, and for other purposes". The Act directed the Corps of Engineers to: "…reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy" (PL 113-2).

East Rockaway is a Reformulation Study project that is anticipated to start construction during or after January 2019, and this document represents the General Conformity Determination required under 40CFR§93.154 by the United States Army Corps of Engineers (USACE). USACE is the lead Federal agency that will contract, oversee, approve, and fund the project's work, and thus is responsible for making the General Conformity determination for this project.

USACE has coordinated this determination with the New York State Department of Environmental Conservation (NYSDEC) and United States Environmental Protection Agency (EPA) Region 2. Based on the National Ambient Air Quality Standards (NAAQS), Queens, King, and Nassau County are currently classified as 'marginal' nonattainment for the 2008 8-hour ozone standard and 'maintenance' for both the 2006 particulate matter less than 2.5 microns ($PM_{2.5}$) and the 1971 carbon monoxide standards (40CFR§81.333). The counties are part of the Ozone Transport Region. Ozone is controlled through the regulation of its precursor emissions, which include oxides of nitrogen (NO_x) and volatile organic compounds (VOC). Sulfur dioxide (SO_2) is a precursor for $PM_{2.5}$.

The equipment associated with this project that is evaluated under General Conformity (40CFR§93.153) includes direct and indirect nonroad diesel sources, such as dredging equipment and support vessels operating in the back bay. The primary pollutant of concern with this type of equipment is NO_x, as VOCs, $PM_{2.5}$, SO_2, and CO are generated at significantly lower rates. The NO_x emissions associated with the project are estimated to be approximately 158 tons per calendar year for 2019 through 2024, (see emissions estimates provided as Attachment A). The project exceeds the NO_x trigger level of 100 tons in any calendar year and as a result, the USACE is required to fully offset the NO_x emissions of this project. The project does not exceed the ozone related VOC trigger level of 50 tons (for areas in an ozone transport region) in any calendar year, nor the $PM_{2.5}$, SO_2, CO maintenance areas' related trigger levels of 100 tons in any calendar year, per pollutant.

The USACE is committed to fully offsetting the emissions generated as a result of the disaster relief and coastal protection work associated with this project. USACE recognizes that the feasibility and cost-effectiveness of each offset option is influenced by whether the emission reductions can be achieved without introducing delay to the construction schedule that would prevent timely implementation of the project to protect the coastline from future storm events.

USACE will demonstrate conformity with the New York State Implementation Plan by utilizing the emission offset options listed below. The demonstration can consist of any combination of options, and is not required to include all or any single options to meet conformity. The options for meeting general conformity requirements include the following:

a. Emission reductions from project and/or non-project related sources in an appropriately close vicinity to the project location. In assessing the potential impact of this offset option, USACE recognizes the possibility of lengthening the time period in which offsets can be generated as appropriate and allowable under the general conformity rule (40CFR§93.163 and §93.165).

b. Use of Surplus NOx Emission Offsets (SNEOs) generated under the Harbor Deepening Project (HDP). As part of the mitigation of the HDP, USACE and the Port Authority of New York & New Jersey developed emission reduction programs coordinated through the Regional Air Team (RAT). The RAT is comprised of the USACE, NYSDEC, New Jersey Department of Environmental Protection, United States Environmental Protection Agency (EPA) Region 2, and other stakeholders. SNEOs will be applied in concurrence with the agreed upon SNEO Protocols to ensure the offsets are real, surplus, and not double counted.

c. Development of a Marine Vessel Engine Repower Program (MVERP) which replaces older, more polluting marine engines with cleaner engines, the delta in emissions being used to offset project emissions. The MVERP approach worked successfully for offsetting the HDP's construction emissions. The details of the MVERP, its implementation, and tracking would be coordinated with the RAT.

d. Use of Cross-State Air Pollution Rule (CSAPR) ozone season NO_x Allowances with a distance ratio applied to allowances, similar to the one used by stationary sources.

e. Rescheduling the project by elongating the construction schedule so as not to exceed the 100 tons per year threshold for NOx in any one calendar year.

Due to the unpredictable nature of dredge-related construction and the preliminary estimates of sand required to restore the integrity of the coastlines, the project emissions will be monitored as appropriate and regularly reported to the RAT to assist the USACE in ensuring that the project is fully offset.

In summary, USACE will achieve conformity for NO_x using the options outlined above, as coordinated with the NYSDEC and coordinated through the RAT.

Signature Block (TBD)

Attachment A

General Conformity Related Emission Estimates

Emissions have been estimated using project planning information developed by the New York District, consisting of anticipated equipment types and estimates of the horsepower and operating hours of the diesel engines powering the equipment. In addition to this planning information, conservative factors have been used to represent the average level of engine load of operating engines (load factors) and the average emissions of typical engines used to power the equipment (emission factors). The basic emission estimating equation is the following:

$$\mathbf{E = hrs \times LF \times EF}$$

Where:

E = Emissions per period of time such as a year or the entire project.
hrs = Number of operating hours in the period of time (e.g., hours per year, hours per project).
LF = Load factor, an estimate of the average percentage of full load an engine is run at in its usual operating mode.
EF = Emission factor, an estimate of the amount of a pollutant (such as NO_x) that an engine emits while performing a defined amount of work.

In these estimates, the emission factors are in units of grams of pollutant per horsepower hour (g/hphr). For each piece of equipment, the number of horsepower hours (hphr) is calculated by multiplying the engine's horsepower by the load factor assigned to the type of equipment and the number of hours that piece of equipment is anticipated to work during the year or during the project. For example, a crane with a 250-horsepower engine would have a load factor of 0.43 (meaning on average the crane's engine operates at 43% of its maximum rated power output). If the crane were anticipated to operate 1,000 hours during the course of the project, the horsepower hours would be calculated by:

$$\mathbf{250 \text{ horsepower} \times 0.43 \times 1{,}000 \text{ hours} = 107{,}500 \text{ hphr}}$$

The emissions from diesel engines vary with the age of an engine and, most importantly, with when it was built. Newer engines of a given size and function typically emit lower levels of most pollutants than older engines. The emission factors used in these calculations assume that the equipment pre-dates most emission control requirements (known as Tier 0 engines in most cases), to provide a reasonable "upper bound" to the emission estimates. If newer engines are actually used in the work, then emissions will be lower than estimated for the same amount of work. In the example of the crane engine, a NO_x emission factor of 9.5 g/hphr would be used to estimate emissions from this crane on the project by the following equation:

$$\frac{\mathbf{107{,}500 \text{ hphr} \times 9.5 \text{ g } NO_x/\text{hphr}}}{\mathbf{453.59 \text{ g/lb} \times 2{,}000 \text{ lbs/ton}}} = \mathbf{1.1 \text{ tons of } NO_x}$$

As noted above, information on the equipment types, horsepower, and hours of operation associated with the project have been obtained from the project's plans and represent current best estimates of the equipment and work that will be required. Load factors have been obtained from various sources depending on the type of equipment. Land-side nonroad equipment load factors are from the documentation for EPA's NONROAD emission estimating model, "Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling, EPA420-P-04-005, April 2004."

Emission factors have also been sourced from a variety of documents and other sources depending on engine type and pollutant. Nonroad equipment NOx and other emission factors have been derived from EPA emission standards and documentation. On-road vehicle emission factors have also been developed from the EPA model MOVES2014a run for 15-year-old single-unit short-haul trucks operating in CY 2017.

As noted above, the emission factors have been chosen to be moderately conservative so as not to underestimate project emissions.

The following pages summarize the estimated emissions in sum for the project including the anticipated equipment and engine information developed by the New York District, the load factors and emission factors as discussed above, and the estimated emissions for the project.

USACE - New York District
NAN - GRR East Rockaway
General Conformity-Related Emission Estimates
Emission Estimates, East Rockaway to Rockaway Inlet **Dec 2018**

General Conformity-applicable emissions per calendar year based on project duration
Total project emissions (assumes all components proceed concurrently)

	Estimated Emissions, tons per year								
Pollutant	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
NO_x	158.3	158.3	158.3	158.3	158.3	0.0	0.0	0.0	0.0
VOC	6.0	6.0	6.0	6.0	6.0	0.0	0.0	0.0	0.0
$PM_{2.5}$	8.2	8.2	8.2	8.2	8.2	0.0	0.0	0.0	0.0
SO_2	0.08	0.08	0.08	0.08	0.08	0.0	0.0	0.0	0.0
CO	17.7	17.7	17.7	17.7	17.7	0.0	0.0	0.0	0.0

Project Duration and Working Months per Year

Activity	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**Total Construction Months**
Dredging	6	6	6	6	6	0	0	0	0	30

2,617,000 cubic yards dredging (initial placement and renousishment on 4-year cycle)

Due to environmental and ozone season windows in place for the NY projects, there will be a maximum of 6 months of dredging per year for the NY projects
Shore-side work proceeds when dredging occurs. Combination of environmental and ozone season windows results in no dredging during April through September each year.

Attachment B

Greenhouse Gas Emission Estimates

USACE - New York District
NAN - GRR East Rockaway
General Conformity-Related Emission Estimates
Supporting Information, East Rockaway to Rockaway Inlet
Dec2018

						grams per hp-hr					tons				
Description, dredges and vessels	**Category**	**Horsepower (approx.)**	**Load Factor**	**Hours**	**hphrs**	**NOx**	**VOC**	**PM2.5**	**SOx**	**CO**	**NO_x**	**VOC**	**$PM_{2.5}$**	**SO_x**	**CO**
Cutter suction dredge main engine	CSD primary engine	9,000	0.66	8,463	50,269,836	9.7	0.37	0.51	0.005	1.06	537.51	20.503	28.261	0.277	58.738
Cutter suction dredge secondary engine	CSD secondary engi	3,310	0.66	8,463	18,488,129	9.7	0.37	0.51	0.005	1.06	197.68	7.541	10.394	0.102	21.603
Dredge auxiliry engine	CSD aux engine	830	0.40	8,463	2,809,695	7.3	0.2	0.29	0.005	1.27	22.61	0.619	0.898	0.015	3.933
Work tug main engine	Tug main	250	0.68	8,463	1,438,699	9.7	0.37	0.51	0.005	1.06	15.38	0.587	0.809	0.008	1.681
Work tug aux engine	Tug aux	50	0.40	8,463	169,259	7.3	0.2	0.29	0.005	1.27	1.36	0.037	0.054	0.001	0.237
Crew/survey boat main engine	Tug main	100	0.68	8,463	575,480	9.7	0.37	0.51	0.005	1.06	6.15	0.235	0.324	0.003	0.672
Crew/survey boat main engine	Tug aux	40	0.40	8,463	135,407	7.3	0.2	0.29	0.005	1.27	1.09	0.030	0.043	0.001	0.190
Derrick barge main	Crane	200	0.43	8,463	727,812	9.5	0.183	0.16	0.005	1.21	7.62	0.147	0.128	0.004	0.971
Derrick barge aux	Generator	40	0.43	8,463	145,562	9.5	0.183	0.16	0.005	1.21	1.52	0.029	0.026	0.001	0.194
Tug Boat, 1950 hp	Tug main	1,950	0.68	15	19,890	9.7	0.37	0.51	0.005	1.06	0.21	0.008	0.011	0.000	0.023
Tug auxiliary engine	Tug aux	150	0.40	15	900	7.3	0.2	0.29	0.005	1.27	0.01	0.000	0.000	0.000	0.001
Barge Mounted Crane, 100 ton	Crane	200	0.43	25	2,150	9.5	0.183	0.16	0.005	1.21	0.02	0.000	0.000	0.000	0.003
Tug Boat, 1950 hp	Tug main	1,950	0.68	25	33,150	9.7	0.37	0.51	0.005	1.06	0.35	0.014	0.019	0.000	0.039
Tug auxiliary engine	Tug aux	150	0.40	25	1,500	7.3	0.2	0.29	0.005	1.27	0.01	0.000	0.000	0.000	0.002
Barge Mounted Crane, 100 ton	Crane	200	0.43	3	258	9.5	0.183	0.16	0.005	1.21	0.00	0.000	0.000	0.000	0.000
Tug Boat, 1950 hp	Tug main	1,950	0.68	3	3,978	9.7	0.37	0.51	0.005	1.06	0.04	0.002	0.002	0.000	0.005
Tug auxiliary engine	Tug aux	150	0.40	3	180	7.3	0.2	0.29	0.005	1.27	0.00	0.000	0.000	0.000	0.000
Barge Mounted Crane, 100 ton	Crane	200	0.43	5	430	9.5	0.183	0.16	0.005	1.21	0.00	0.000	0.000	0.000	0.001
Tug Boat, 1950 hp	Tug main	1,950	0.68	5	6,630	9.7	0.37	0.51	0.005	1.06	0.07	0.003	0.004	0.000	0.008
Tug auxiliary engine	Tug aux	150	0.40	5	300	7.3	0.2	0.29	0.005	1.27	0.00	0.000	0.000	0.000	0.000
Totals											**791.7**	**29.8**	**41.0**	**0.4**	**88.3**

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix D

Environmental Compliance

Attachment D8
Monitoring Plan

December 2018

TABLE OF CONTENTS

1 SITE INSPECTION....1
2 GEOSPATIAL DATA....2
2.1 Lidar....2
2.2 Aerial Photography....2
3 SHORELINE CHANGE MONITORING....2
4 WAVE MEASUREMENTS....2
5 BORROW AREA MONITORING....3
6 BEACH PLACEMENT AREAS....3
6.1 Beach Profiles....4
6.2 Beach Sediment Grab Samples....4
7 GROIN MODIFICATION....5
8 NATURAL AND NATURE BASED FEATURE PLANTINGS....5
8.1 Hydrophytic Vegetation Monitoring Timing and Performance Target....5
8.1.1 Methods....5
9 BIOLOGICAL MONITORING....6
9.1 Shorebird Species....6
9.2 Surf Clams....6

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

General Reevaluation Report and Environmental Impact Statement

Physical and Biological Monitoring

1 SITE INSPECTION

Site Inspection will be performed for all project elements at each stage of the project (pre-construction, during construction, and post-construction). Prior to initial construction, a thorough site visit will be performed to document pre-construction baseline conditions. Site inspections will be repeated immediately after completion of construction, and seasonally (every three months) for the first year post-construction. Site visits will be performed a minimum of twice a year (March-April and Sept-October time frame) for the second through fourth years post-construction which will coincide with the duration of the first full nourishment cycle. If there are major storms impacting the project area, a post-storm inspection will also be required. Specific items to be part of the site inspection include:

Shoreline Inspection. Site visits will document the general condition of all shoreline reaches, and will note observable erosion or accretion of beaches and dunes. Changes to bay shoreline will be observed and documented. Inspections will document any unusual conditions (e.g., erosion escarpment, other evident erosion or accretion that deviates noticeably from design), newly observed phenomena, or incursions into the project that are either natural or man-induced. Brief memoranda of all observations including still photographs will be compiled following each site inspection, distributed to the AMT, and kept as part of the project records. Recommendations will be included for any required maintenance, or more detailed investigation.

Structure Inspection. All hard structures included in the project such as the groins, inlet jetties, floodwalls, and bulkheads as well as other shore protection elements will be visually inspected and documented. Structures will be inspected for both condition and functionality. Stone structures will be examined for any settlement, shifting or breakage of stone units, loss of interlocking, scour, overtopping, vandalism, etc. Structure function will be evaluated by examining the nearby beach and shoreline for evidence of impoundment, flanking, change in fill elevation, slope or width, up or downdrift impacts, etc. Recommendations will be made for further investigation or appropriate maintenance actions.

2 GEOSPATIAL DATA

2.1 Lidar

LIDAR will be acquired preconstruction, and twice each year, concurrent with semi-annual beach profile surveys during years 1- 4 (first nourishment cycle). Following the first nourishment cycle, one post-winter (late February-early March) LIDAR survey per year will be performed at the fourth year after each nourishment cycle. LIDAR will be taken at the time of low tide.

2.2 Aerial Photography

If LIDAR is unavailable, aerial photography may be used in place if the following requirements are met. Each over flight mission will be a single flight line with 60% overlap stereo coverage including the entire project area shoreline, including both ocean and bay. Bay shoreline will be included as separate single flight lines where the width of landforms requires more than a single flight line. Aerial coverage of inlets will include complete flood shoal and ebb shoal formations. Color film with a 9-inch x 9-inch format is recommended with a scale such that shoreline features are readily identifiable (e.g. 1 inch = 800 feet). All images shall be georeferenced to New York State Plane Lambert projection, Long Island Zone, NAD83 with units in feet. Digital scans of each 9x9 will be provided at a minimum of 300 dpi resolution.

3 SHORELINE CHANGE MONITORING

Mean High Water shorelines will be extracted from spring (late February-early March) LIDAR topography and plotted in overlays to show shoreline evolution over time within the project and immediately up and down drift. Plotting successive shorelines will illustrate the extent of erosion or accretion and will provide a means of measurement of the rate of loss or gain of littoral material. Comparative shoreline plots will be prepared for the entire length of the oceanfront, bay, pond, and island shorelines within the project boundaries. The sediment budget will be updated based on combined shoreline evolution and measured beach profiles.

4 WAVE MEASUREMENTS

A directional wave gage will be deployed in waters off of the East Rockaway barrier spit. The gage will be deployed prior to construction and will remain in place for the length of the first nourishment cycle (project years 1-4). The primary purpose of wave measurement is to assist in quantifying the driving forces behind changes to the native and constructed beach, as well as providing records of storm data. Wave gages will also provide information on wave conditions during construction, as well as for user communities such as homeowners, surfers, fishermen, environmental scientists, etc. during the instrument deployment period. Wave height data will be obtained under storm conditions over the deployment period and will be compiled to develop more accurate wave height-frequency relationships.

The wave gages should be deployed in a nearshore water depth of –25 to –35 ft. NAVD and should be cabled to shore. If cabling to shore is precluded, internal recording gages will be utilized. Data will be posted in real time on a project internet site for cabled gages and following data recovery for internal recording gages and archived to a web-accessible database. Both the bulk wave parameters,

mean currents and wave spectra should be displayed and archived in the database, along with links to water level data from nearby USGS tide gages and wind/wave data from NOAA Buoy #44025, as well as other buoys in the vicinity, if any.

Short term collection of near shore data will be utilized to confirm that borrow area dredging is not changing wave patterns or beach erosion.

5 BORROW AREA MONITORING

Offshore borrow areas will be monitored to document material removal, and to determine borrow area infilling rates for possible borrow area reuse. As part of construction, pre- and post- dredge hydrographic survey will be taken at the designated borrow areas. Some nearby, similar area outside the designated borrow area will be included in the survey to serve as a control (i.e. to document naturally occurring bottom changes). Computations will be done to verify quantity and location of material removed from the borrow areas during initial construction and renourishment operations. For cost estimating purposes, it is assumed that pre- and post-construction survey of the borrow areas will be included in the construction costs.

Midway through the life of the project, hydrographic surveys will be repeated to determine pattern and depth of material accumulation to date. Vibracores will be taken and subbottom seismic profiling will be performed to obtain sediment layering and grain size distribution curves in the in-filled areas. Thirty (30) cores, twenty feet in length are assumed for cost estimating purposes. The actual number and length will be determined based on bathymetry and subbottom survey results. Vibracore data analysis will include a representative number of material samples taken from each core, determined by an experienced geologist, that will be used to characterize each core and sub area within the borrow region. All lab analyses and operations on cores will be standardized as to description of sediment type and grain size distribution. All surveys will be mapped to indicate spatial changes in the borrow area both horizontally and vertically. Suitability of material taken from the cores as beachfill material will be determined. Areas dredged for initial construction or earlier renourishment operations will be examined for possible reuse in future renourishment cycles based on material suitability and available quantities.

6 BEACH PLACEMENT AREAS

Placed beach fill will be monitored to measure its evolution over time. The beach berm and dune will be measured to record characteristics including:

- Berm width and elevation
- Dune crest and base widths and elevations
- Dune ocean side and land side slopes
- Dune baseline

Measurement will be done to aid in determining how the construction profile evolves towards a more stable long-term profile, at what rate erosion or accretion of the advanced nourishment and/or design berm occur, and any changes that occur to the dunes including sand loss or dune growth. Beachfill monitoring will aid in identifying areas of greater than normal erosion (“hot spots”) as well as any

locations that experience sand buildup (accretion). Shoreline updrift and downdrift of the placed fill will be examined for any excessive sand losses or gains due to construction of the project or other causes. Other phenomena including but not limited to beach scarping, offshore bar changes, sand wave migration, overwash, etc. will be documented and quantified. Information gained from beach fill monitoring will be used in design of any future construction activities including renourishment.

Beachfill monitoring is also a critical component in expanding the understanding of coastal processes affecting the project area. Measurements of sand loss and/or gain will allow refinement of local and regional sediment budgets. Greater understanding of coastal processes will allow regional sediment management to be performed effectively. Ultimately, greater understanding of coastal processes will allow more accurate prediction of sediment accumulations and deficits on ocean side shorelines, within the bays, in navigation channels, and in the vicinity of inlets.

6.1 Beach Profiles

Beach profiles will be one of the primary measurement techniques for beach fill monitoring. Beach profiles will be surveyed before and after initial construction to establish pre-fill baseline conditions, and conditions immediately following placement. Under the monitoring program beach profiles will be surveyed twice per year throughout the first nourishment cycle (four years). One survey will capture the characteristics of the beach following winter condition, and will be surveyed in late February-early March, before endangered shorebird nesting season. The second survey will capture the characteristics of the summer beach and will be surveyed in September-October, following departure of nesting shorebirds. Following the first nourishment cycle, one post-winter (late February-early March) profile survey per year will be performed at the fourth year after each nourishment cycle. Should the design four-year cycle need adjustment, timing of profile surveys will be adjusted accordingly. Note that endangered plant species (e.g. seabeach amaranth) may also be present, and surveys should be performed in such a way as to not disturb rare plants.

A total of 82 long-range profiles will be surveyed over the entire project area at 1500 ft. spacing in the areas where fill is to be placed, plus 20 additional control profiles in non-fill areas (same as the pre-construction surveys). Profiles shall extend from a location landward of the dune and berm, along a repeatable line normal to the shoreline, and seaward out to closure depth (-31 ft NAVD) or a minimum of 2500 feet in length from the landward starting point. Profiles will be taken from established benchmarks that are documented and recoverable. Each monitoring survey will cover the same profile locations, unless observations of phenomena indicate that a change in profile locations is warranted. Repetitive surveys of profiles will be the basis for estimates of erosion and accretion volumes. Changes observed in beach profiles will help track the movement of placed fill alongshore and offshore.

6.2 Beach Sediment Grab Samples

Beach sediment grab samples will be collected concurrently with beach profile measurements on 30 long-range profiles (every fourth long range). Samples will be taken at a minimum of nine (9) locations per profile: the seaward and landward edges of the berm, three subaerial locations (Mean high water, mid-tide level, and mean low water), and at three locations offshore (-7 ft. NAVD or bar crest, -13 ft. NAVD, –19 ft. NAVD, and –31 NAVD). Beach sediment sampling will provide pre- and post- construction grain size distribution data that will allow comparison of native and placed

fill material. Beach sediment sampling during subsequent surveys will aid in determining sediment redistribution after placement.

Beach sediment grab samples will be taken concurrent with the pre- and post-construction profile surveys, to obtain baseline information and a measure of placed material characteristics. Sediment samples will be taken concurrent with profile surveys before each nourishment placement to aid in material compatibility analyses for each nourishment operation.

7 GROIN MODIFICATION

LIDAR topography and beach profiles collected during the monitoring program will be used to estimate the effects of groin extension and installation. The information to be analyzed includes initial and annual sand volumes released, updrift and downdrift shoreline impact, and dune and shoreline evolution vicinity of the project site.

8 NATURAL AND NATURE BASED FEATURE PLANTINGS

8.1 Hydrophytic Vegetation Monitoring Timing and Performance Target

Vegetation would be monitored in both the spring and fall, annually to document conditions that indicate achievement of the performance target of at least 85% coverage of planted vegetation or target hydrophytes. Sampling methods would include random circular plot sampling for woody vegetation and quadrat plot sampling for emergent vegetation.

8.1.1 Methods

8.1.1.1 Random Circular Plot Sampling

Protocol would call for typically twenty foot radius plots; however, in areas of high planting density ten foot radius plots may be utilized. Plot locations would be chosen using a simple random sampling procedure. Data recorded at each plot for both herbaceous and woody species include; species name, percent area coverage, and dominance. For woody species, additional data included whether the species was planted or is a recruit, number of live, and number of dead stems, average height, and plant health. Plant health would be rated as “E” representing excellent health (plant is thriving and has little to no signs of herbivory), “G” representing good health (plant is healthy and may have some herbivory), “F” representing fair health (plant is moderately healthy and may have moderate herbivory), and “P” representing poor health (plant is dying and/or has heavy herbivory).

8.1.1.2 Quadrat Sampling

Protocol for emergent vegetation would consist of one square meter quadrat plots along random transects lines no more than 15 meters apart. At each transect, one quadrat will be randomly placed within the low marsh along the transect line and the existing vegetation of the plot will be monitored. Quadrats will be placed on either side (randomly chosen) within one meter of the measuring tape. Once placed, the meter mark on the upper and lower edge of each quadrat will be marked permanently with stakes and recorded on the measuring tape in meters. Plant species, plant height, stem density, flowering density, and percent cover data will be collected within each plot. A narrative

description of plant health will also be collected. The exact location and side the quadrat will be placed on the transect line will be noted with a compass. This will facilitate relocating quadrats on subsequent monitoring visits. Each transect line and 1.0 m2 quadrat will be photographed facing channel-ward at the time of vegetation monitoring. All photographs must be taken at low tide, in the same spot, and at the same height.

8.1.1.3 Adaptive Management

If the restored site is not showing progress to meet the requirements of 85% vegetation cover, additional native vegetation would be planted to meet this goal. If, in the unlikely event, a native, sustainable ecosystem cannot be established within 2 years at the site, changes and modifications to the project site would be initiated immediately by restoration ecologists. A new monitoring plan will be redrawn by USACE to accommodate these changes and monitor the success of the alteration.

After 2 years post-restoration, the monitoring protocol will integrate the standard of 85% vegetative cover with a broad functional assessment focusing on the three ecological parameters listed above. If the restored site fails to meet the requirements of 85% vegetation cover during the first 2 years, the additional native vegetation will be planted to meet this goal. Invasive species will be managed via physical removal and or the use of pesticides.

9 BIOLOGICAL MONITORING

9.1 Shorebird Species

Presence or absence surveys conduct construction activities near active plover nesting areas only from September 2 through March 31 to avoid the protected shorebird nesting period.

9.2 Surf Clams

To ensure that impacts to surf clams are minimized, the borrow areas should be surveyed prior to each dredging cycle and areas of high densities should be avoided. Copies of shellfish survey results should also be provided to us prior to any dredging in the borrow area.

US Army Corps
of Engineers®
New York District

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Atlantic Coast of New York

APPENDIX E

REAL ESTATE PLAN

DECEMBER 2018

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

December 2018 Real Estate Plan

Table of Contents

Page

1. Preamble 1
2. Statement of Purpose 2
3. Project Purpose and Features 3
   a. Project Purpose 3
   b. Plan of Improvement 3
   c. Project Phases: 5
   d. Required Lands, Easements, and Rights-of-Way (LER) 5
   e. Appraisal Information: 6
4. LERRD Owned by the Non-Federal Sponsor 8
5. Non-Standard Estates 8
6. Existing Federal Projects 8
7. Federally-Owned Land 8
8. Navigational Servitude 8
9. Maps 9
10. Induced Flooding 9
11. Baseline Cost Estimate for Real Estate ("BCERE") 9
12. Public Law 91-646, Uniform Relocation Assistance 9
13. Minerals and Timber Activity 10
14. Land Acquisition Experience and Capability of the Non-Federal Sponsor 10
15. Zoning 10
16. Schedule of Acquisition 11
17. Facility and/or Utility Relocations 11
18. Hazardous, Toxic, and Radioactive Waste ("HTRW") 11
19. Project Support 12
20. Notification to Non-Federal Sponsor 12
21. Other Issues 12
22. Points of Contact 13
23. Recommendations 14

Exhibits and Attachments

Exhibit "A"- Real Estate Maps
Exhibit "B"- Required LER
Exhibit "C"- Standard Estates
Exhibit "D"- Baseline Cost Estimate for Real Estate
Exhibit "E"- Non-Federal Sponsor Capability Assessment Checklist
Exhibit "F" – Notification to Non-Federal Sponsor

1. Preamble

Project Authorization: The Project was authorized by Public Law 113-2 (29 January 2013), The Disaster Relief Appropriations Act of 2013, "…reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy".

Official Project Designation: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay project (the "Project").

Project Location: The study area includes the municipal public recreation beach facilities located on the peninsula commonly referred to as the Rockaways, located entirely within the Borough of Queens, New York City. The peninsula extends from Rockaway Inlet to East Rockaway Inlet, approximately 10 miles in length, and separates the Atlantic Ocean from Jamaica Bay immediately to the north. The municipal recreation facilities evaluated in this study are located on both the ocean side and bay side of the peninsula and are under the authority of the City of New York, Department of Parks and Recreation.

The communities located on the Rockaway peninsula from west to east include Breezy Point, Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammels, Arverne, Edgemere, Far Rockaway, Inwood, and Cedarhurst. The former Fort Tilden Military Reservation, owned by the National Parks Service, and the Jacob Riis Park (both part of the National Park Service's Gateway National Recreation Area) are located in the western half of the peninsula between Breezy Point and Neponsit. The characteristics of nearly all of the communities on the Rockaway peninsula are similar. Ground elevations rarely exceed 10 feet, except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from 5 feet, increasing to 10 feet further south toward the Atlantic coast. An estimated 7,900 residential and commercial structures on the peninsula fall within the Federal Emergency Management Agency (FEMA) regulated 100-year floodplain.

The study area also consists of water and lands within and surrounding Jamaica Bay, New York. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, New York, and a section at the eastern end, known as Head of Bay, lies in Nassau County. More than 48,000 residential and commercial structures in this part of the study area fall within the Federal Emergency Management Agency (FEMA) regulated 100-year floodplain.

Jamaica Bay is the largest estuarine waterbody in the New York City metropolitan area covering an approximately 20,000 acres (17,200 acres of open water and 2,700 acres of upland islands and salt marsh). Jamaica Bay measures approximately 10 miles at its widest point east to west and four miles at the widest point north to south, including approximately 26 square miles in total. The mean depth of the bay is approximately 13 feet with maximum depth of 60 feet in the deepest borrow pits. Navigation channels

within the bay are authorized to a depth of 20 feet. Jamaica Bay has a typical tidal range of five to six feet. The portions of New York City and Nassau County surrounding the waters of Jamaica Bay are urbanized, densely populated, and very susceptible to flooding. An estimated 57,400 structures are within the FEMA regulated 100-year Jamaica Bay floodplain.

Non-Federal Sponsor: The Non-Federal Sponsor is the New York State Department of Environmental Conservation (the "Sponsor" or "NYSDEC" or "the State of New York"). The local partner is the City of New York (the "local partner" or "NYC" or "The City of New York"). If approved, initial construction of the project will be 100% Federal funded, subject to the availability of funds.

2. Statement of Purpose

This Real Estate Plan (REP) is prepared in accordance with ER 405-1-12, Chapter 12 and is intended to present the overall plan describing the minimum real estate requirements (lands, easements, rights-of-way and relocations LERR) needed for the construction, operation, maintenance, repair, and rehabilitation herein referred to as the Proposed Plan or "Plan" or "Project". This REP is an appendix to the Hurricane Sandy General Reformulation Report (HSGRR).

3. Project Purpose and Features

a. Project Purpose:

The purpose of this study is to reduce coastal vulnerability to storm surge, erosion, and wave impacts; to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities while also reducing the economic costs and risks associated with large-scale flood and storm events. This will lead to an improvement in community resiliency including infrastructure and service recovery from storm effects.

b. Plan of Improvement:

The recommended HSGRR Coastal Storm Risk Management plan for the area from East Rockaway Inlet to Rockaway Inlet and the lands within and surrounding Jamaica Bay New York consists of the following components, which are generally described for 2 Planning Reaches: 1) A reinforced dune and berm construction, in conjunction with groins in select locations along the Atlantic Ocean Shoreline; 2) high frequency flooding risk reduction (HFFRR) features in locations surrounding Jamaica Bay. Two (2) project HFFRR feature locations have been identified. In general, these features are intended to provide a design height of +8 ft NAVD through various methods to reduce frequent flooding. Various locations in Kings and Queens County fronting Jamaica Bay, including Canarsie, Howard Beach, and Hamilton Beach were analyzed for coastal storm risk management, but were screened out during the evaluation and formulation process, as discussed in the main report.

The Recommended Plan extends along approximately 40,000 linear feet of shoreline in the project area, with approximately 32,000ft of horizontal composite seawall, dune and beach for Atlantic Shorefront reaches 3, 4, 5, 6A and 6B and with 3000 linear feet and 5000 linear feet for the East and West Tapers, respectively, extending from the eastern end of the Rockaway peninsula at Far Rockaway, Queens to the a point just inside the eastern property line of Former Fort Tilden, Queens.

The plan along the Atlantic Ocean Shorefront consists of:

- A reinforced dune (composite seawall) with a structure crest elevation of +17 feet (NAVD88) and dune elevation of +18 feet (NAVD88), and a design berm width of 60 feet extending approximately 35,000 LF from Beach 20th to Beach 149th. The bottom of dune reinforcement extends up to 15 feet below the dune crest which is an elevation of +3.0 feet (NAVD88). The sheet pile elevation is at -8 feet (NAVD88).
- A beach berm elevation of +8 ft NAVD and a depth of closure of -25 ft NAVD;
- Extension of 5 existing groins; and
- Construction of 13 new groins.

- Beach fill tapers from Beach 19th to Beach 9th, being approximately 1,000 ft of dune and beach taper including reinforced dune and approximately 2,000 ft of dune and beach fill without reinforced dune.
- Beach fill tapers from Beach 149 to Beach 169, being approximately 5,000 ft of beach fill only.

The plan for HFFRR features at the 2 project areas consists of:
Mid-Rockaway (Queens County)

Arverne Area
- Average Existing Ground Elevation: 5.0 FT – 6.0FT NAVD88
- Design Elevation 8.0 FT – 11.5 FT NAVD88
- 2,700 ft low berm
- 1080 ft high berm
- 1,400 ft low floodwall
- 1,570 ft medium floodwall
- 440 ft high floodwall
- 1,700 ft of revetments and bulkheads
- 2,400 ft shallow bulkheads
- Three road ramps
- One vehicular gate
- Three pump stations

Edgemere Area
- Average Existing Ground Elevation: 5.0 FT NAVD88
- Design Elevation 8.0 FT – 9.5 FT NAVD88
- 3,200 ft hybrid berm
- 750 ft high berm
- 200 ft shallow bulkhead
- 200 ft medium floodwall
- 660 ft high floodwall
- One road ramp
- NNBFs – stone toe protection and rock sill structure
- Each of the existing outlets will have a valve chamber added with sluice gate and flap valve to prevent high tides or storm surge from flooding the drainage system.
- Three pump stations

Hammels Area
- Average Existing Ground Elevation: 4.0 FT NAVD88
- Design Elevation 8.0 FT NAVD88
- 2 Portions:
    - East Segment being 320 ft west of intersection of Beach 75th and Beach Channel Drive
        - Length: 1400 ft. low floodwall
        - Three road ramps

        - Pump station
    - West segment being to the west of the MTA facility Hammels Wye to the north side of Beach Channel Drive just west of Beach 87th
        - Length: 1400 ft. low floodwall
        - Three road ramps
        - One pump station

Cedarhurst-Lawrence (Nassau County)

- Average Existing Ground Elevation: 4.0 FT – 5.0 FT NAVD88
- Design Elevation 10.0 FT NAVD88
- 1,000 ft deep bulkhead
- 23 ft medium floodwall
- Sluice gate and flap valve each valve chamber added for each of the three existing outlet
- One pump station will be installed for use during times the outlets are blocked by storm tide

c. Project Phases:

It is likely that the groins will be constructed first followed by beachfill and composite dune, but phasing will be determined during PED. Next, would be one of the high frequency flooding risk reduction feature (HFFRRF) projects. Decisions are still being made as to what the sequence would be. The Real Estate Plan will be updated as that information becomes available.

d. Required Lands, Easements, and Rights-of-Way (LER):

The following describes the LER required for the proposed Plan. Exhibit "B" provides a detailed list of impacted parcels as well as the total approximate acres required therein. Language to the recommended estates are provided in Exhibit "C" herein, which are required to be included, as written, within the body of the respective easement or deed agreement between the Sponsor and land owner.

The proposed plan requires a total of 779.01 acres, with 410.11 acres being below MHWL, leaving 368.91acres above MHWL with total impacts approximately 313 parcels:

- 696.66 acres in Perpetual Beach Storm Damage Reduction Easements,
- 59.88 acres in Flood Protection Levee Easements,
- 12.32 acres in Bank Protection Easements,
- 8.11 acres in Temporary Work Area Easements and;
- 2.05 Fee; excluding minerals.

Once the real estate requirements are finalized during PED, prior to LER acquisition, the Sponsor is advised to obtain property line surveys with a corresponding legal description for each different estate acquired for the Project to mitigate against potential

boundary disputes. This Sponsor is also advised to obtain a chain of title and title insurance on all acquired property to identify potential encumbrances and to protect against "defects" in title.

e. Appraisal Information:

A Land Cost Estimate was prepared in July 2018 by the New York District Appraisal team identifying the land values for the plan alternatives. The land values for this plan are estimated at $9,116,683.

I. Perpetual Beach Storm Damage Reduction Easement (Standard Estate No. 26) – Perpetual Beach Storm Damage Reduction Easements must be acquired over approximately 696.66 acres of land, impacting 24 parcels, being all public. The location of the Permanent Easements is identified in Exhibit A. The two owners are the City of New York and National Park Service. NYC has agreed to provide access agreements with standard estate language to the State of New York for the construction of the project. If the Project requires construction of any element of the plan (including beach fill) on NPS property, that construction will require NPS authorization under an appropriate legal authority or instrumentation. See paragraph 21(a) below for further detail.

II. Flood Protection Levee Easement (Standard Estate No. 9) – Flood Protection Levee Easements must be acquired over approximately 59.88 acres of land, impacting 288 parcels, being 158 private and 130 public. The location of the Permanent Easements is identified in Exhibit A. NYC has agreed to provide access agreements with standard estate language to the State of New York for the construction of the project. See paragraph 21(a) below for further detail.

III. Bank Protection Easement (Standard Estate No. 21) - Bank Protection Easements must be acquired over approximately 12.32 acres of land, impacting 41 parcels, being 0 private and 41 public. The location of the Permanent Easements is identified in Exhibit A. NYC has agreed to provide access agreements with standard estate language to the State of New York for the construction of the project. See paragraph 21(a) below for further detail.

IV. Temporary Work Area Easement (Standard Estate No. 15) - Temporary work areas must be acquired preliminarily over approximately 8.11 acres of land, impacting 11 parcels, being 2 private and 9 public. The final layout of temporary work areas will be completed during PED.

V. Borrow Area – The Project proposes to nourish the beach using sand from various Offshore Borrow Areas located in New York State waters. NYSDEC will provide the Corps with authorization to use the Borrow Areas as a sand source through a New York Environmental Conservation Law Section 401 Water Quality Certificate ("WQC"). The WQC functions as a permit allowing borrow of the necessary volume of

sand to complete the Project. The Corp of Engineers has obtained water quality certificates from NYSDEC in support of other projects.

VI. Fee – Fee title must be acquired over approximately 2.05 acres of land, impacting 19 parcels, being 9 private and 10 public, for the installation of the required pumps. The locations of the fee properties are identified in Exhibit A. Of the 10 public parcels, 7 are owned by the City of New York with 6 managed by the City Parks & Recreation Department and 1 managed by the Department of Citywide Administrative Services. There are 2 owned by the NYC Housing Authority. The pumps on the NYC Housing Authority properties are not directly adjacent to the housing complexes on the properties. The remaining public parcel is owned by the State of New York within Nassau County. Since the City of New York will be responsible for operation and maintenance of the pumps, no transfer of title will be needed for those 7 parcels owned by the City. It is not yet known what vehicle the State of New York will provide to the Village of Cedarhurst to access its property in Nassau County for operation and maintenance.

VII. LER Summary - The impacted parcels and LER to be acquired are provided in Exhibit B and the recommended standard estate language in Exhibit C herein. The following chart summarizes the required LER for the Project:

Required Interest	Required Acres	Acres Below the MHWL	Number of Parcels		Number of Owners		Acquisition Cost
			Private	Public	Private	Public	
Perpetual Beach Storm Damage Reduction Easement	696.66	380.78	0	24	0	2	$0.00
Flood Protection Levee Easement	59.88	24.05	158	130	109	4	$7,096,683
Bank Protection Easement	12.32	5.11	0	41	0	1	$10,000
Temporary Construction Easement	8.11	0.17	2	9	2	4	$10,000
Fee excluding minerals	2.05	N/A	9	10	6	3	$2,000,000

Consistent with USACE Real Estate Policy Guidance Letter No. 31 – Real Estate Support to Civil Works Planning Paradigm (3x3x3), the New York District valued the real estate requirements through a cost estimate as the real estate costs will total less than 10% of the total project costs. A 20% contingency is included in the estimated value of the LER.

4. LERRD Owned by the Non-Federal Sponsor

The Non-Federal Sponsor, The State of New York via the NYSDEC owns 410.39 acres of land required for the Project, including lands below the mean high water line outside of any property boundaries. In addition, the NYSDEC's local sponsor owns 285.22 acres of land required for the Project.

The NFS and local sponsor shall not receive credit for publicly owned lands required for the Project.

5. Non-Standard Estates

No non-standard estates are proposed for use in real estate acquisition for the Project.

6. Existing Federal Projects

There are no known existing federal projects that lie either fully or partially within the plan.

7. Federally-Owned Land

There are lands that are owned by National Park Service, known as Gateway National Recreation Area, that lie within the current project alignment. A special use permit providing temporary access for the alignment tapers covering approximately 21.56 acres will be obtained from the National Park Service by the US Army Corps of Engineers to grant the necessary access. The construction of tapers on NPS property is being considered as a mechanism to offset impacts of the Project on NPS property and further evaluation and selection of the final mutually acceptable offset design will occur in during the PED phase. If tapered groins are identified as the mutually acceptable offset, then construction as well as long-term maintenance by a non-federal partner on NPS property would have to be authorized by appropriate legal authority and/or instrument. National Park Service will be reviewing their authorities, and further coordination will be necessary, for the purpose of any permanent access requirements for the 21.56 acres referenced.

8. Navigational Servitude

Approximately 410.11 acres of land required for the Permanent Easements lies below the Mean High Water Line ("MHWL"). Although it is the general policy of the Corps to utilize the navigational servitude in all situations where available, whether or not the Project is cost-shared or full Federal, rights in the Federal navigational servitude will not be exercised for the Project. This is consistent with CECC-R memorandum dated 19 March 2014, subject: Availability of the Navigational Servitude for Coastal Storm Damage Reduction Projects.

9. Maps

The Project real estate maps are provided in Exhibits “A” herein.

10. Induced Flooding

Construction, operation or maintenance of the Project is not anticipated to induce any flooding.

11. Baseline Cost Estimate for Real Estate (“BCERE”)

An itemized BCERE is provided in Exhibit “D” with estimated real estate costs. The following is a summary of the costs for the Lands, Easements, Rights-of-Way, Relocations, and Disposals (“LERRD”) required for new elements of the Project:

a. The Project’s total real estate costs is captured in the Project’s 01-Lands and Damage cost account and amounts to approximately $18,242,284**,** which includes Federal and non-Federal costs.

b. The Project’s LERRD costs is approximately $15,185,884. LERRD costs account for the Sponsor’s upfront costs and consists of the non-Federal costs provided in the 01-Lands and Damages and the 02-Relocations cost accounts. LERRD is the Sponsor’s responsibility to perform (in accordance with the PPA) prior to project construction.

The following is the Sponsor’s estimated creditable LERRD costs:

LERRD Costs	
LER	±$15,185,884
Relocations	$0
Disposals	$0
Total LERRD:	±$15,185,884

If approved, the Project will be 100% federally funded utilizing funds provided by P.L. 113-2. The Sponsor will be entitled to LERRD reimbursement subject to the terms of the Project Partnership Agreement. As of this report, no reimbursable LERRD related expenses have been incurred by the NFS or local sponsor. The Sponsor is eligible to receive credit for the actual associated direct and indirect costs of fulfilling its LERRD responsibilities that are found to be reasonable, allowable and allocable. Supporting documents on all costs incurred by the Sponsor will be submitted to USACE as part of its claim for credit.

12. Public Law 91-646, Uniform Relocation Assistance

There are no anticipated residential relocation assistance benefits, as authorized by Public Law 91-646, for the plan. Moreover, the City of New York expressed a preference to the US Army Corps of Engineers, New York District that acquisition of occupied domiciles by eminent domain be avoided where feasible. At this time, the Corps, the Sponsor, and the City of New York believe the project will not lead to the displacement of any residents. The Corps will work with the City, State, and local residents to further mitigate impacts of the project during PED, as appropriate. The current plan assumes all existing residential structures are or will be vacant prior to acquisition. However, the current design in Edgemere and Arverne show several commercial & industrial buildings being impacted by the alignment and associated permanent easements. There are approximately 8 buildings in Arverne, most appear associated with a cement factory, which will need to be removed for the project. Damages have not been calculated for these buildings at this point. It is not known at this time the importance of these buildings to the on-going enterprises. It will be necessary to evaluate this during PED to further flesh out how many businesses will need to be relocated as a result of this project.

13. Minerals and Timber Activity

No known present or anticipated mineral activities or timber harvesting in the vicinity of the Project.

14. Land Acquisition Experience and Capability of the Non-Federal Sponsor

The Sponsor maintains the legal and professional capability and experience to acquire the majority of the LERRD in support of the Project. The Sponsor will be coordinating with USACE, New York District, and NPS, regarding the appropriate authorities for access to property located on NPS property. The Sponsor has condemnation authority and other applicable authorities that may apply if necessary to support acquisition measures. The local sponsor will be delegated responsibility to acquire all real estate in the name of the Sponsor. The local sponsor intends to obtain legal authority to acquire real property by completing the local Uniform Land Use Review Procedure (ULERP). The Sponsor has successfully acquired the real estate for other projects, and is currently the non-Federal Sponsor for the South Shore of Staten Island Project, among others. The Sponsor has also been advised of P.L. 91-646 requirements and the requirement to document expenses for crediting purposes.

The Non-Federal Sponsor Capability Assessment Checklist is provided in Exhibit “E”. The assessment checklist has been coordinated with the Sponsor. It has been completed based on the Sponsor’s past and current performance on other Corps of Engineers cost-shared civil works projects.

15. Zoning

The Project will not require enactment of land use ordinances prior to construction; however, land use policies recommended to minimize the risk of damage from coastal

storms are contained in the Land Management Appendix. These land use policies are recommended for implementation at the local level.

16. Schedule of Acquisition

The proposed schedule of acquisition is outlined below.

Milestone	Date
PPA Execution	October 2019
Sponsor's Notice to Proceed with Acquisition	October 2019
Plats and Owner Verification Completion	November 2019
Informal Value Estimates Receipt	February 2020
Review Value Estimates	March 2020
Negotiations Completion	June 2020
Condemnation Initiation	July 2020
Closings	July 2020
Amicable Possession	July 2020
Condemnation Order of Possession	November 2020
Certification of Real Estate	April 2021

17. Facility and/or Utility Relocations

There are existing utility lines that will be required to be relocated for implementation of the plan along the high ground tie-ins. The quantity and exact location of the utility lines are not confirmed at this time but will be confirmed during the design phase of the Project and further revision to this real estate plan will be performed.

The current Atlantic Coast beachfront has pre-existing boardwalk, whose cross-overs and connections between the boardwalk and beach will need to be designed/redesigned and/or modified to maintain access.

Any conclusion or categorization contained in this real estate plan, or elsewhere in this project report, that an item is a utility or facility relocation to be performed by the non-federal sponsor as part of its LERRD responsibilities is preliminary only. The government will make a final determination of the relocations necessary for the construction, operation, or maintenance of the project after further analysis and completion and approval of Final Attorney's Opinions of Compensability for each of the impacted utilities and facilities.

18. Hazardous, Toxic, and Radioactive Waste ("HTRW")

There are no known contaminants or HTRW concerns in, on, under or adjacent to the LER required for the Project.

19. Project Support

The New York State Department of Environmental Conservation, acting as the non-Federal sponsor, supports the continued development of the TSP. The NYC Mayor's Office of Recovery and Resiliency, the local sponsor to New York State, supports the continued development of the Recommended Plan. Other project partners, including NYC Department of Parks and Recreation, NYC Department of Environmental Protection, and the National Park Service also support the TSP. Coordination between USACE and NPS will continue through the PED phase to avoid and minimize adverse impacts on NPS resources while advancing the goals of the Project.

20. Notification to Non-Federal Sponsor

Based on its past sponsorship of other Army Corps of Engineers water resource (Civil Works) projects and ongoing discussions during the Project's Feasibility phase, the Non-Federal Sponsor is aware of the risks of acquiring LER required for the Project prior to the signing of the PPA. However, upon the approval of the Plan for the Project, in accordance with paragraph 12-31, Chapter 12, ER 405-1-12, Real Estate Handbook, 20 Nov 85, a formal written notice identifying the risks associated with acquiring the LER for the Project prior to the full execution of the PPA will be provided to the Sponsor.

21. Other Issues

a. Access Agreements - Required access to the public parcels will be acquired through an Access Agreement executed between the non-federal sponsor and the relevant governing entity. These Access Agreements will incorporate the full body of text from the relevant easement standard estate. The Access Agreements will authorize sand placement and other project features like floodwalls and NNBFs over public lands, and where required, construction of groins.

b. The majority of the needed property rights for the Atlantic Coast is owned by the City of New York. There is an existing access agreement between the City of New York and the State of New York for the original Rockaway project from 1974, however the exhibits to that agreement cannot be located. Therefore, due to that missing information in addition to the fact that the proposed project extends beyond the original project, a new access agreement will be needed from the City of New York, which is currently being addressed by those two parties.

c. A number of parks exist within the Project area. The State of New York will be reviewing the process relative to park properties, as well as relevant authorities, as to property requirements within the park areas, and making a further determination as to whether certain property alienation processes would apply.

d. There are historic properties in and adjacent to the LER for the project. Jacob Riis Park Historic District and the Far Rockaway Beach Bungalow Historic District are within the LER for the project. Fort Tilden Historic District, the Marine Parkway - Gil Hodges Memorial Bridge, and the US Coast Guard Far Rockaway are adjacent to the LER for the project.

e. There are no known existing encumbrances (i.e. easements, rights-of-way, etc.) that would impact Project construction. Title for each parcel would be reviewed by the Non-Federal Sponsor during the acquisition process.

f. The City of New York has agreed to operate and maintain the project in the future within its municipal boundaries. Local municipalities will operate and maintain the project in Nassau County.

g. The road ramps included in the HFFRR areas to provide access to the wet side of the project are not at this time proposed to go outside of the existing public way. This will be accomplished by the use of retaining walls as the road elevates over the floodwalls. This will require further review in PED to analyze current access to private properties.

h. There are public roads within the project area, which will be permanently impacted by the project. The City of New York Department of Transportation will need to physically terminate service and public access down particular portions of those streets. The City of New York plans to provide an access agreement to the State of New York for required access.

i. The boundary of the pump stations include approximately 0.25 acres of land within public road rights-of-way. This will need to be addressed by the City of New York. Since they are operating & maintaining the pump stations, they technically have fee ownership already but some type of documentation including some abandonment would need to be done to remove those areas from the Department of Transportation system and put it into the inventory of whichever department within the City would operate and maintain the pump stations.

j. Since the PPA has not been completed, it is not yet known whether NYSDEC will certify the real estate or whether NYC will. This real estate plan is written with the expectation that NYSDEC will certify the real estate. Should that change, then appropriate changes will be made to the real estate plan to address that.

22. Points of Contact

The point of contact for this Real Estate Plan is, Realty Specialist, Warren LaRiviere, who may be contacted at (917) 790-8450 or via email: warren.q.lariviere@usace.army.mil. The undersigned, Acting Chief, Real Estate Division, may be contacted at (917) 790-8430 or via email: susan.l.goding@usace.army.mil.

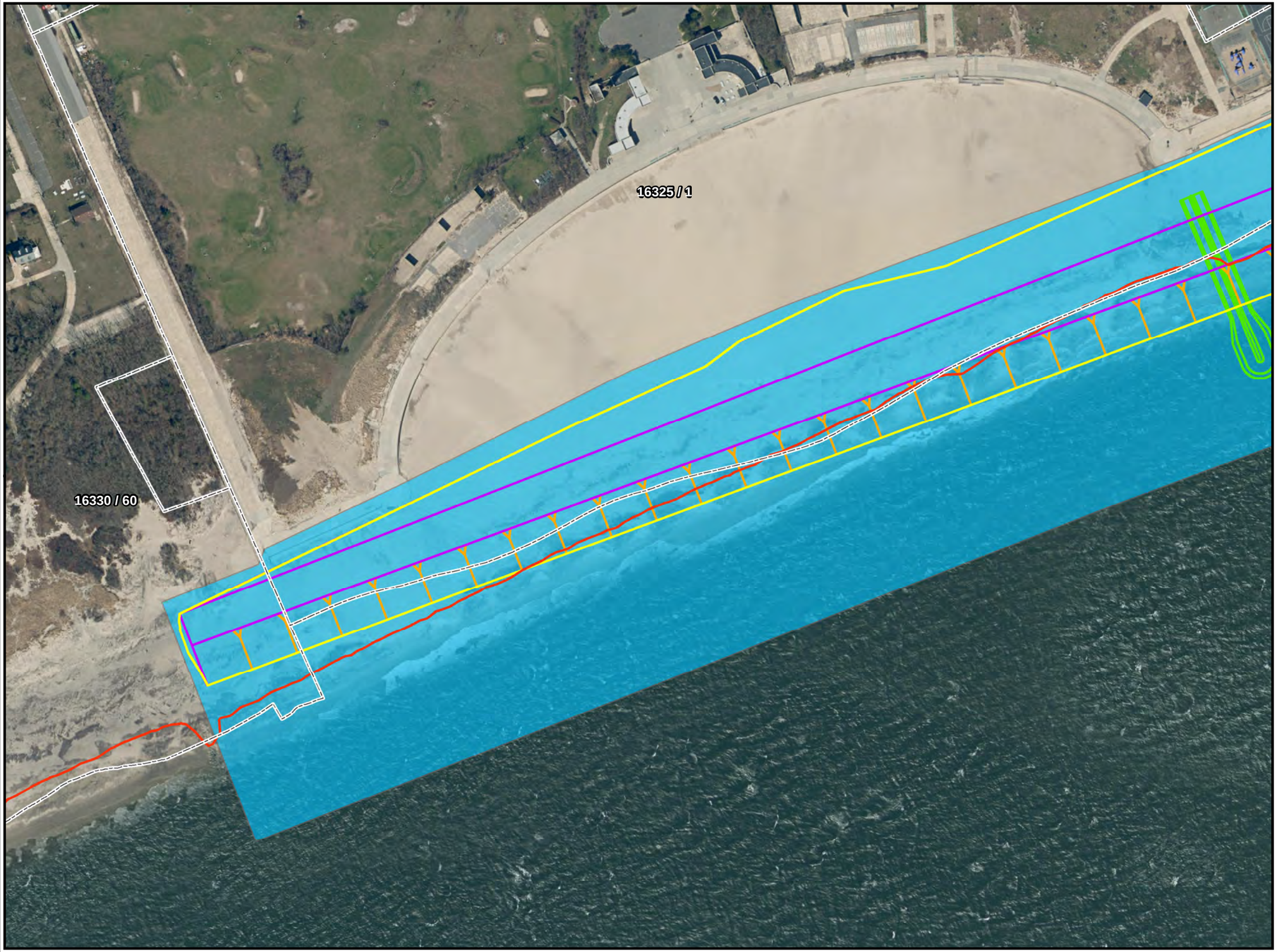
23. Recommendations

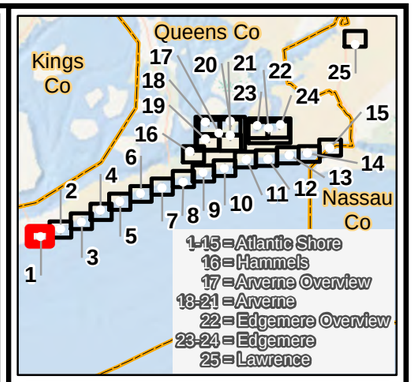
This REP has been prepared in accordance with Chapter 12, ER 405-1-12, Real Estate Handbook, as amended.

Susan L. Goding
Acting Chief, New York District
Real Estate Contracting Officer

EXHIBIT “A”

REAL ESTATE MAPS





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Groins
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

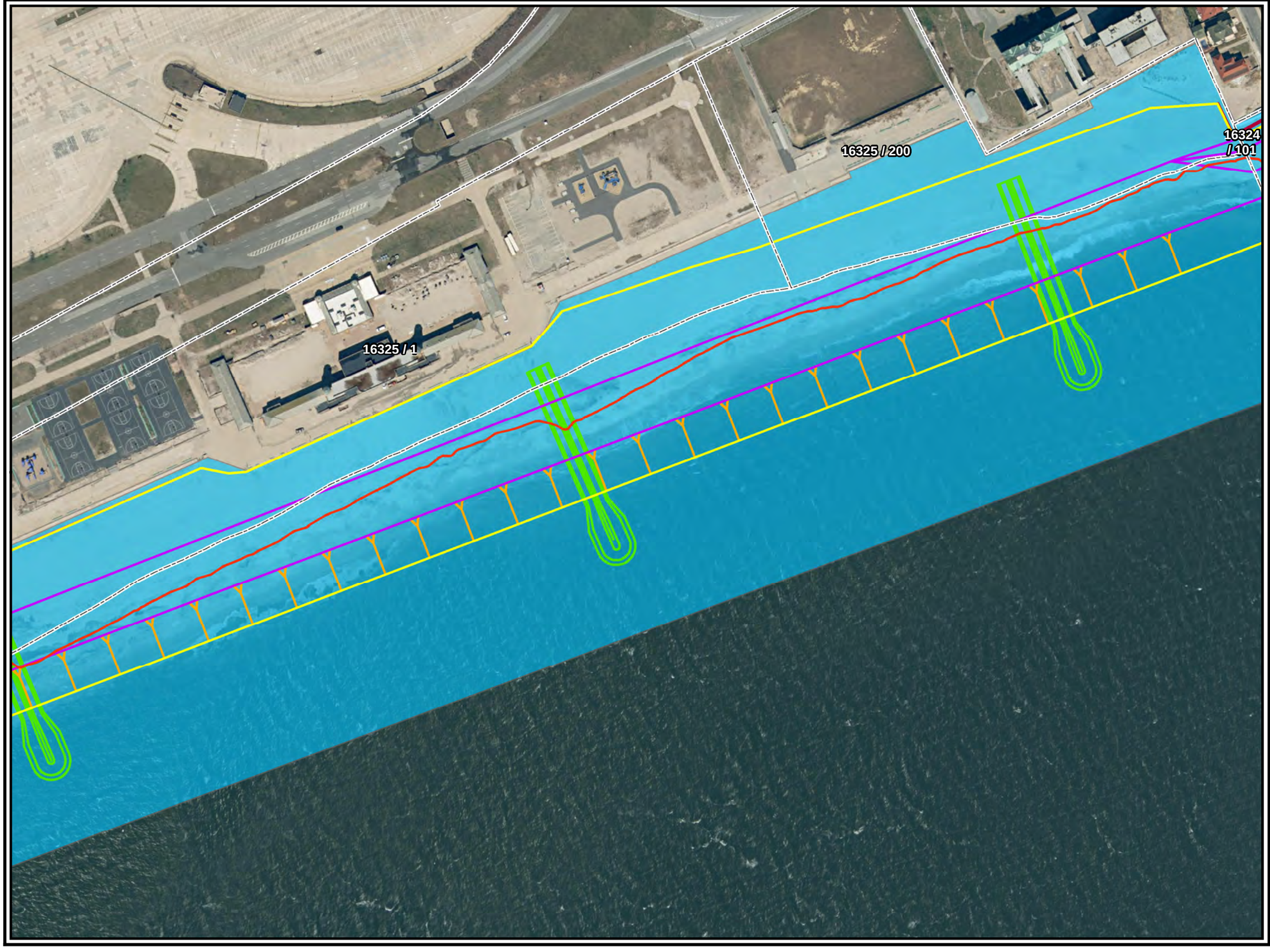
1 inch = 200 feet

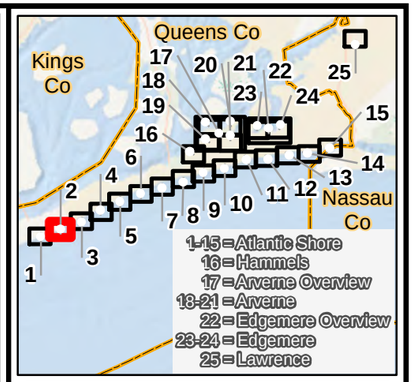
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

 Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Atlantic Shore Groins
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

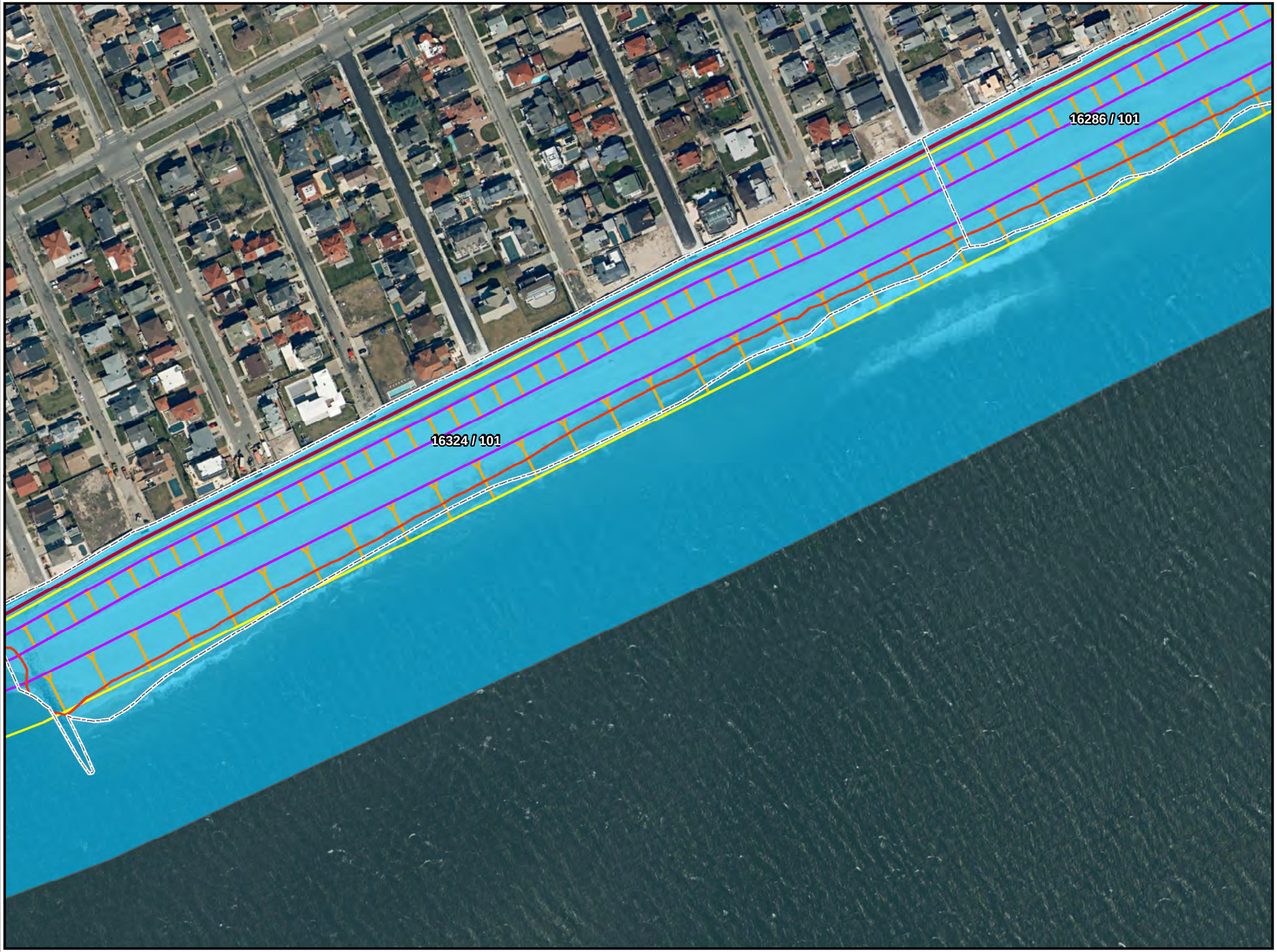
1 inch = 200 feet

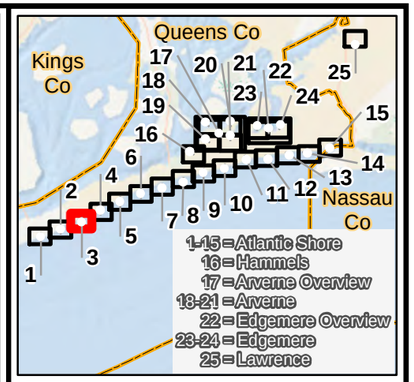
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

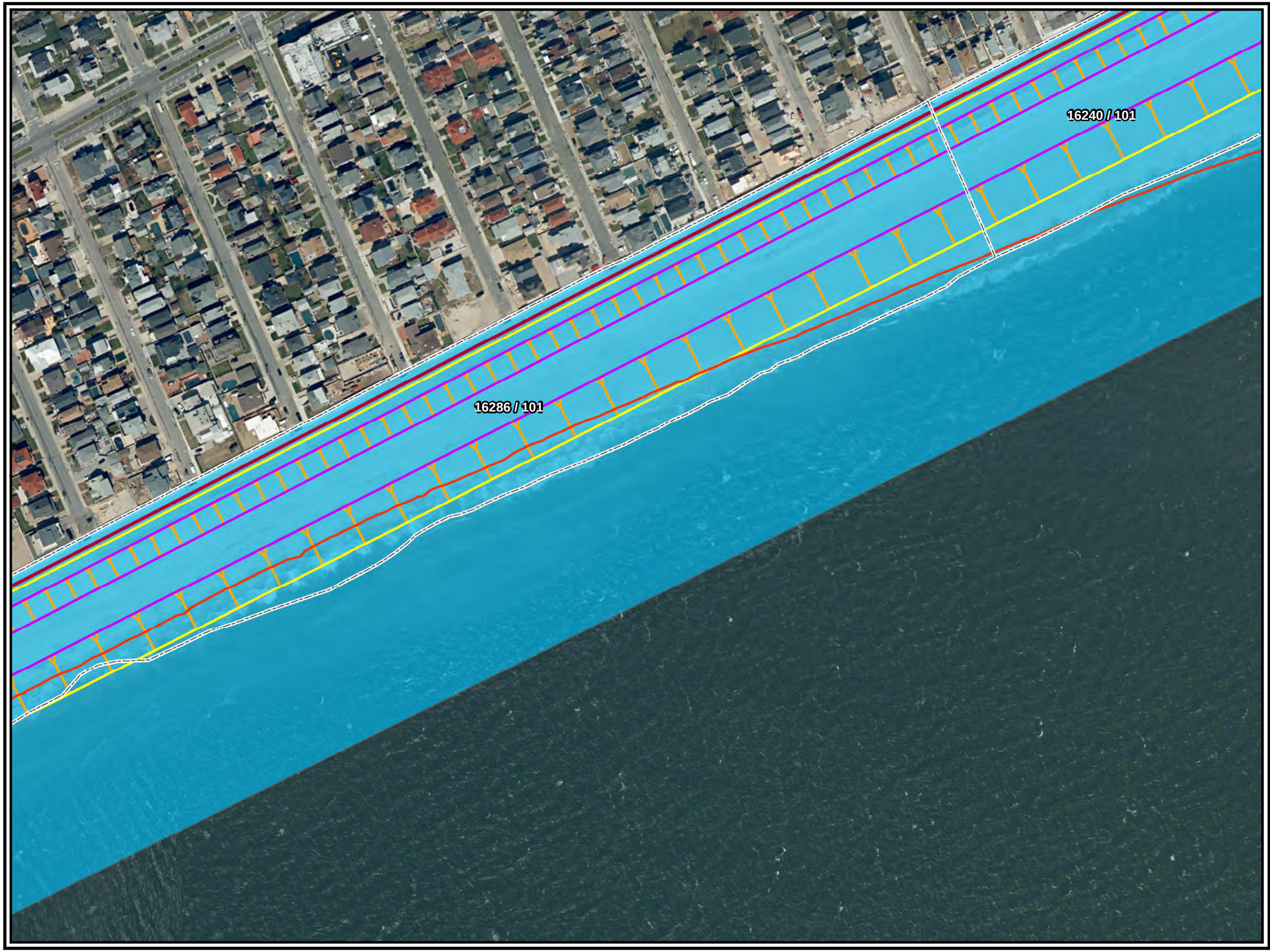
1 inch = 200 feet

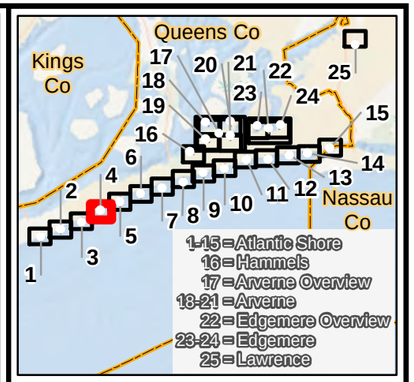
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

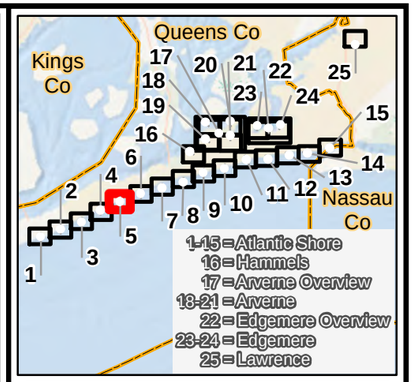
1 inch = 200 feet

EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT



Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Atlantic Shore Groins
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

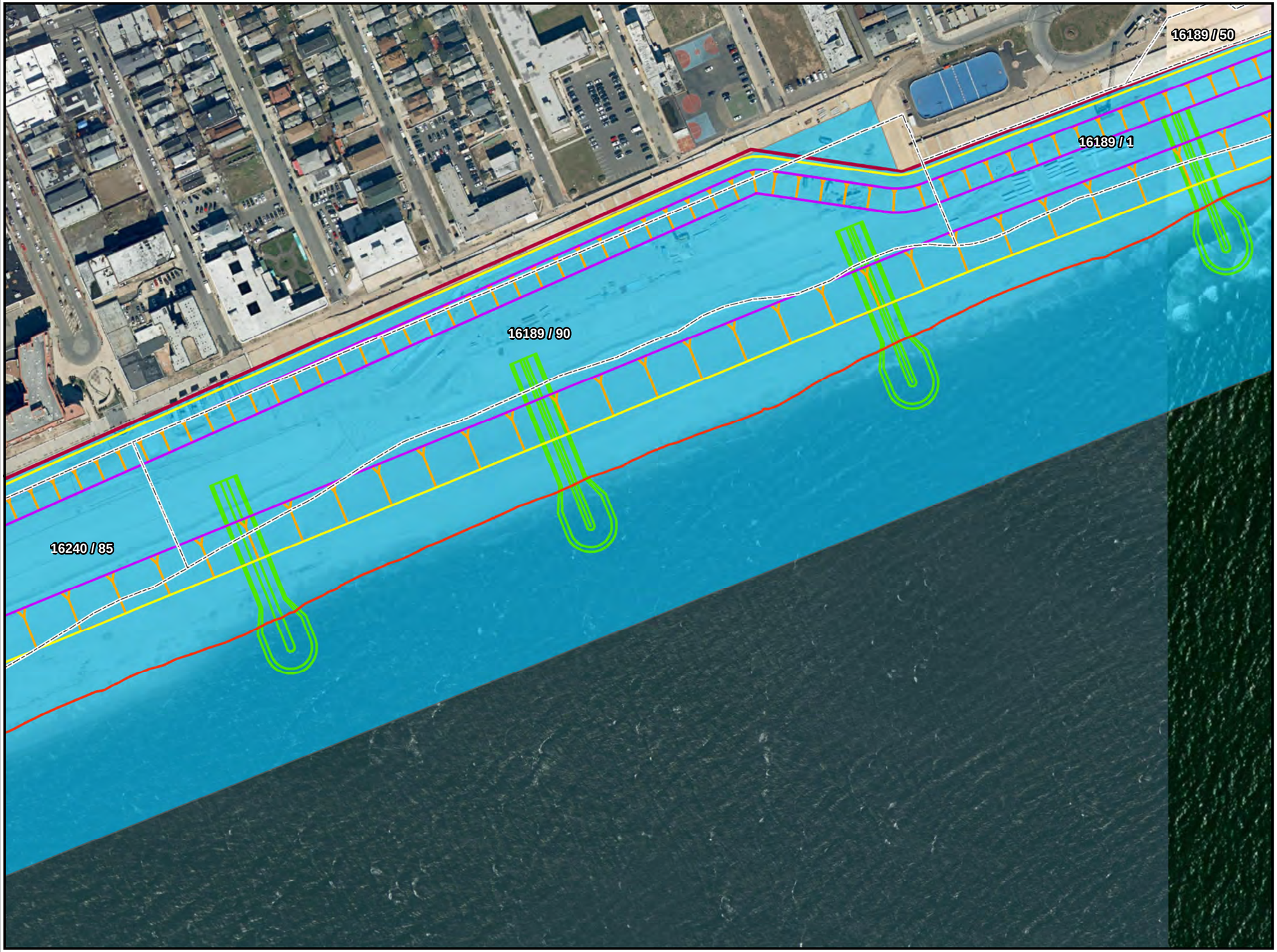
1 inch = 200 feet

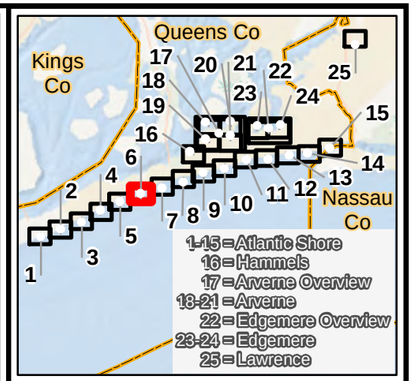
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

 Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Atlantic Shore Groins
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

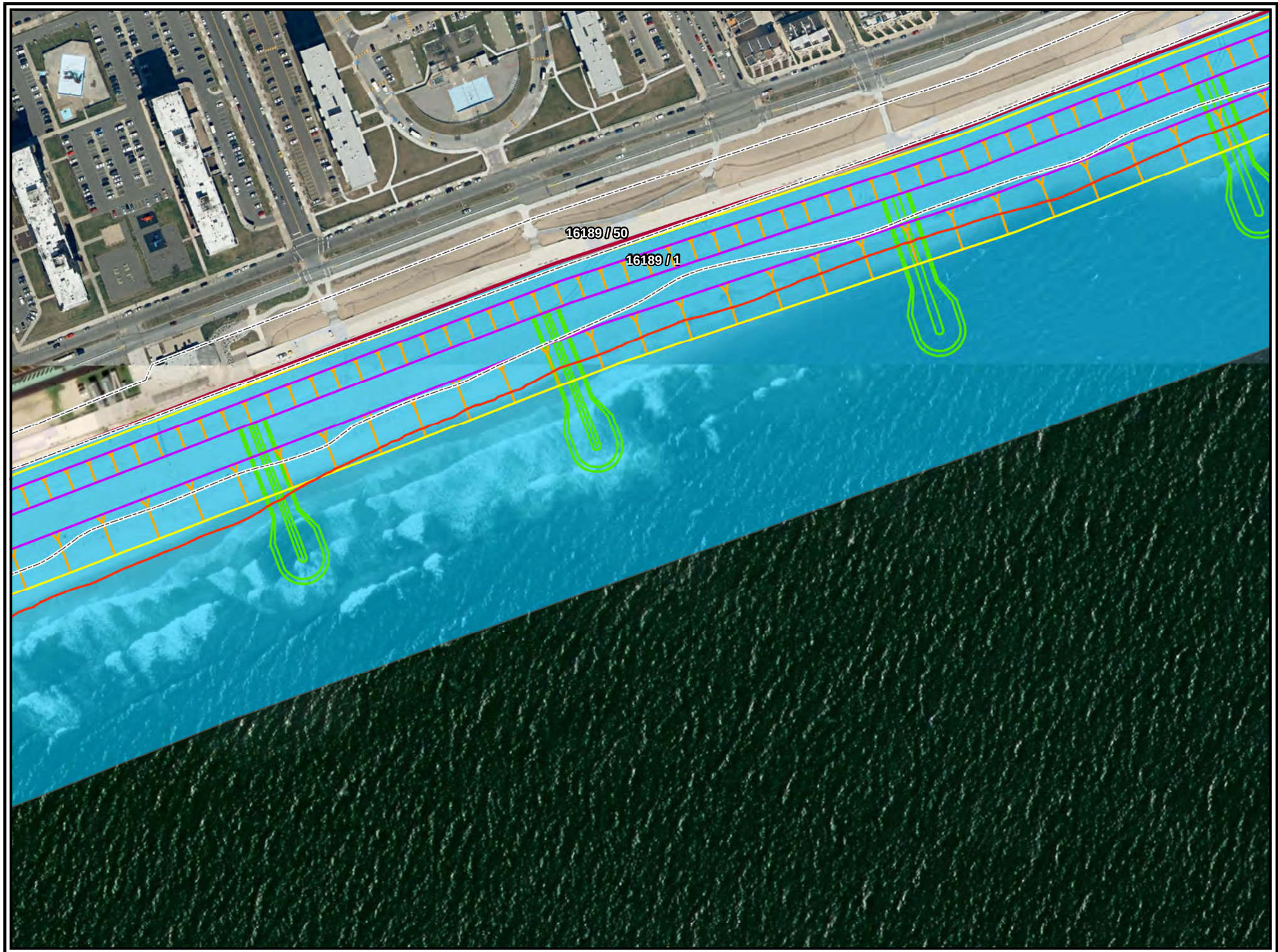
1 inch = 200 feet

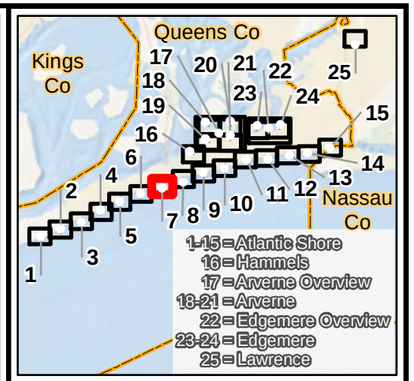
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Atlantic Shore Groins
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

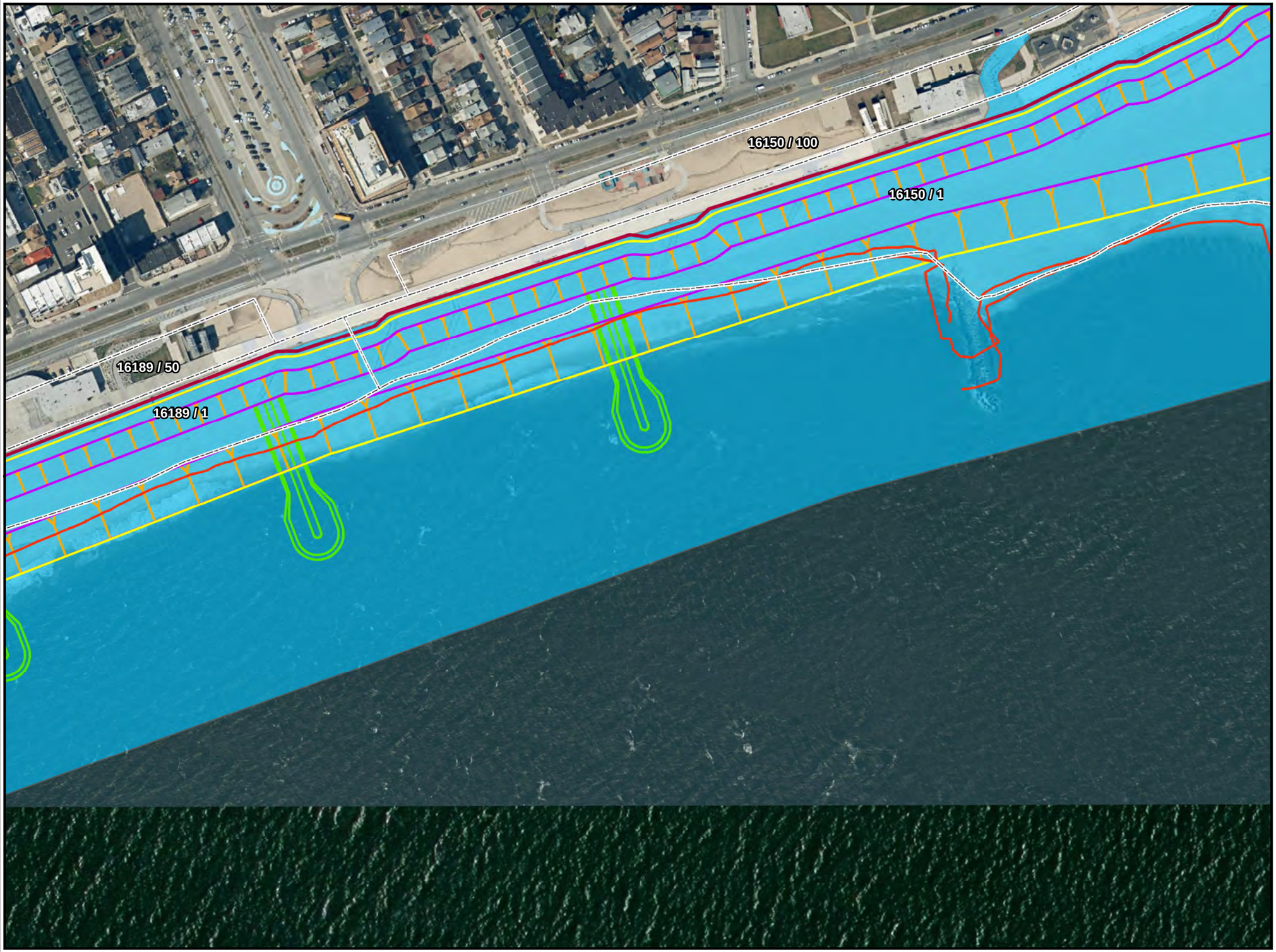
1 inch = 200 feet

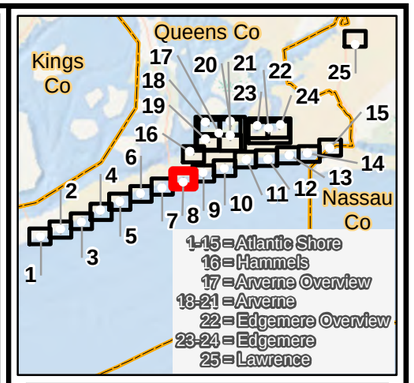
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Atlantic Shore Groins
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

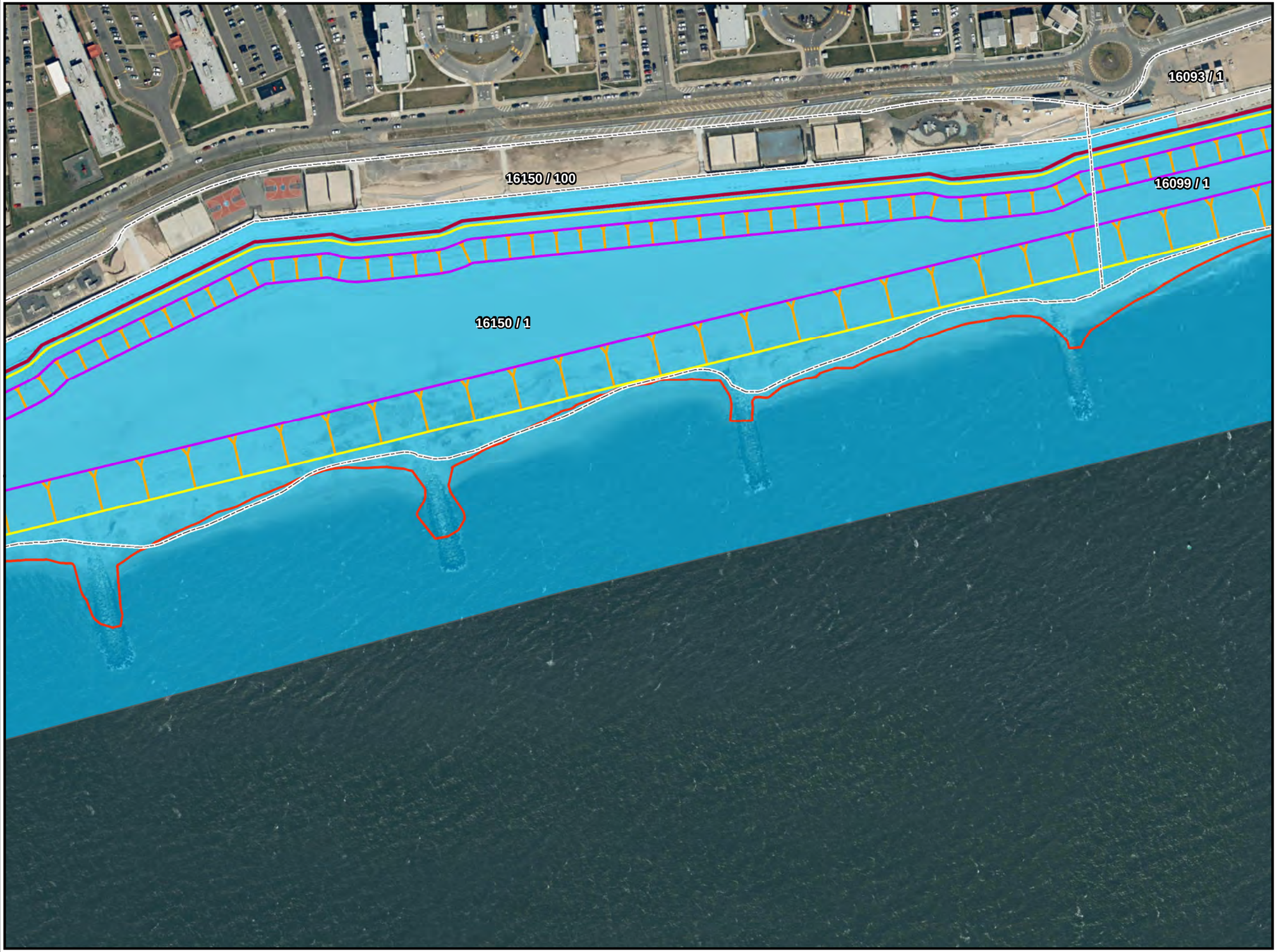
1 inch = 200 feet

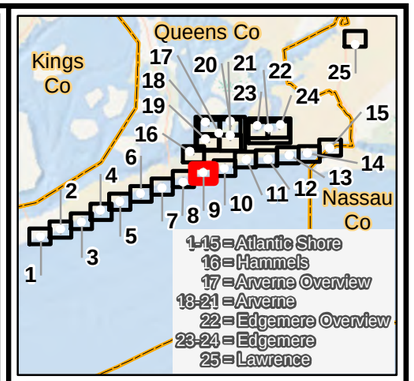
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

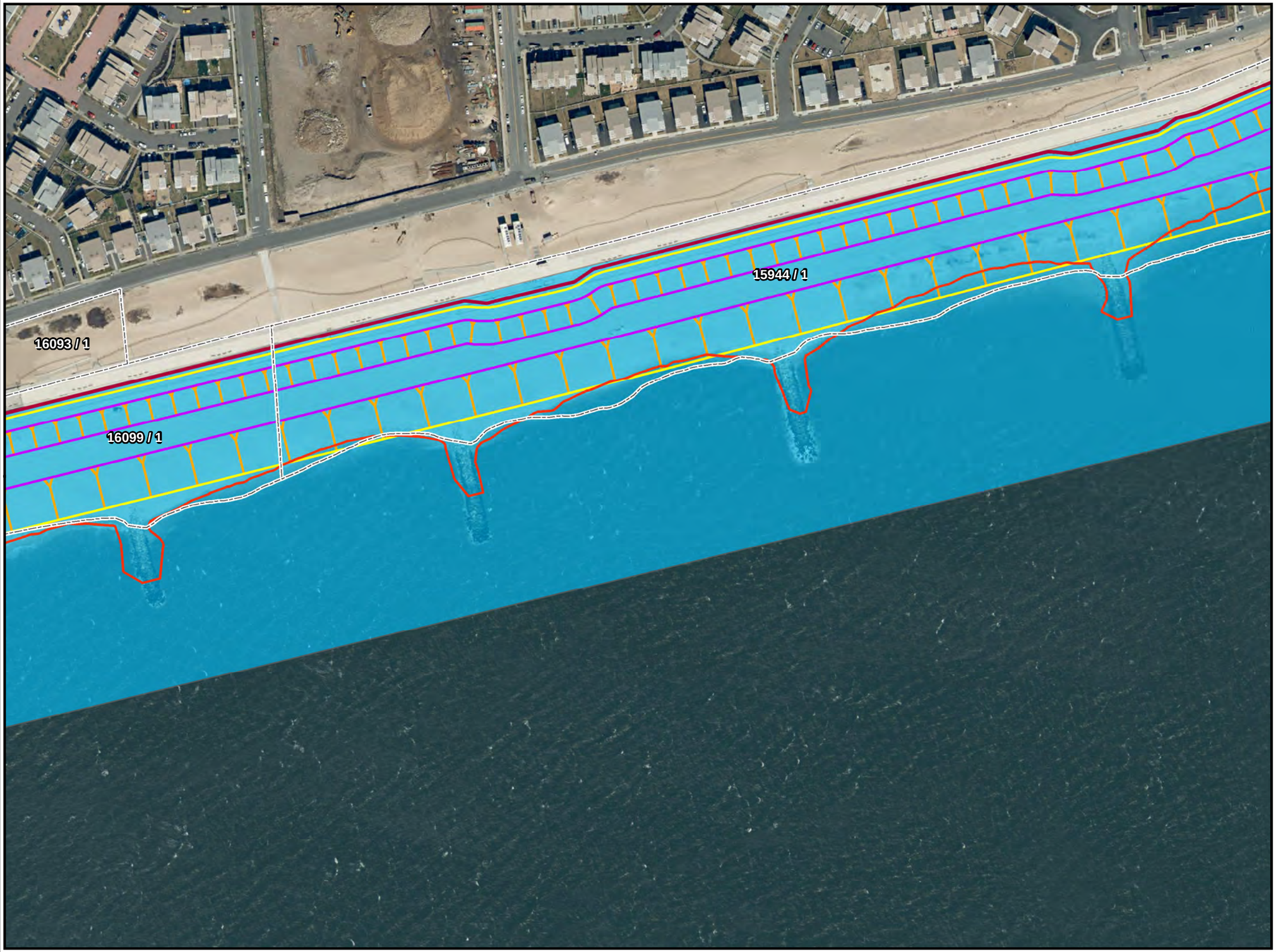
1 inch = 200 feet

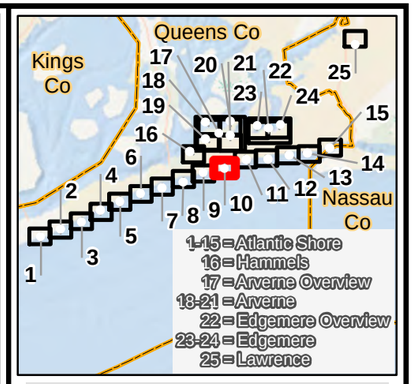
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

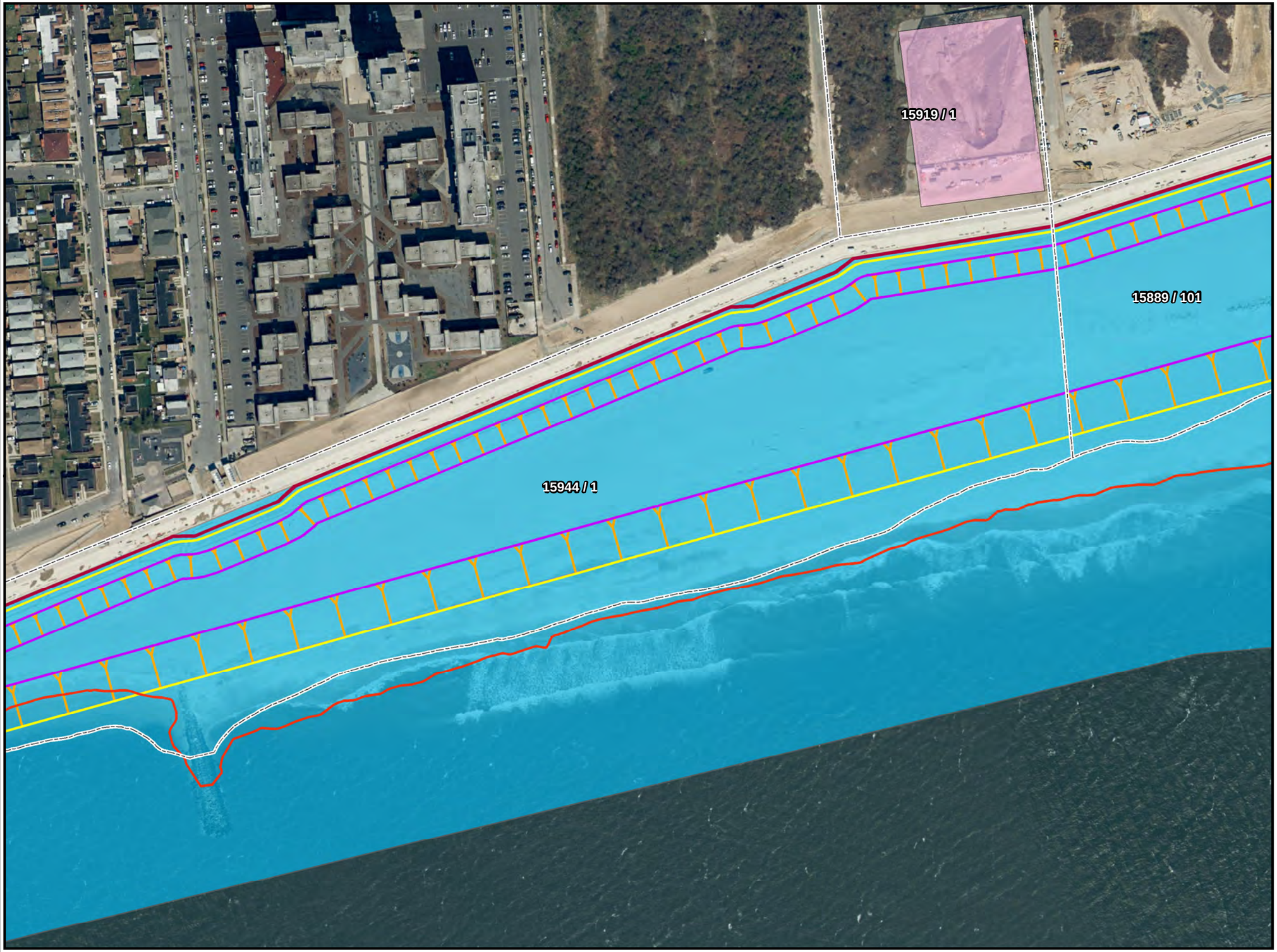
1 inch = 200 feet

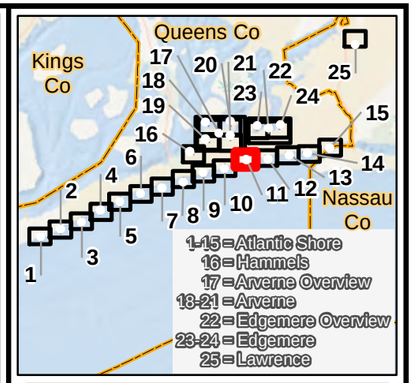
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Permanent Easements
- Temporary Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

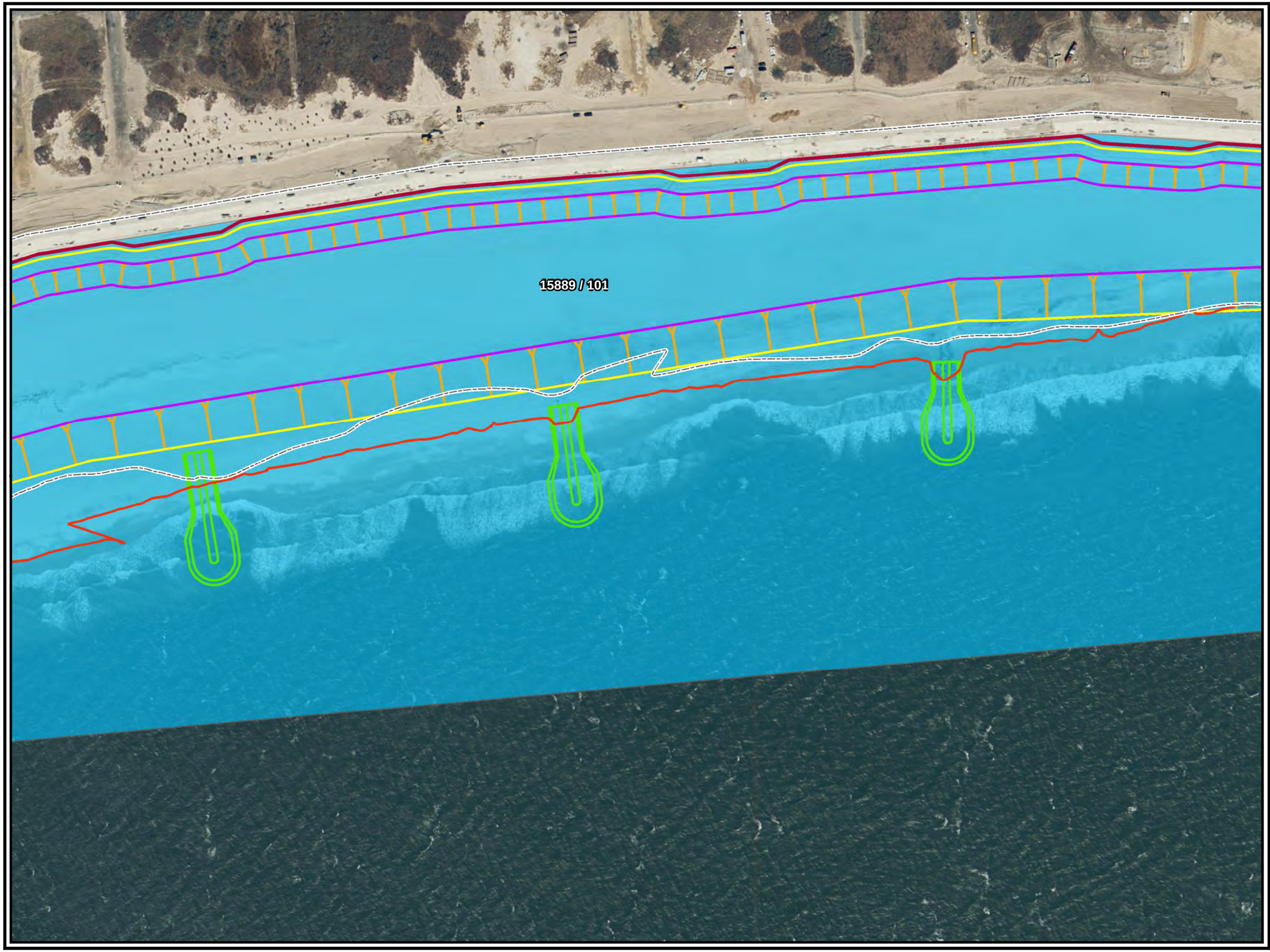
1 inch = 200 feet

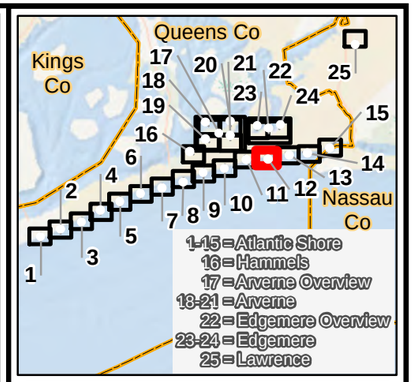
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Atlantic Shore Groins
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

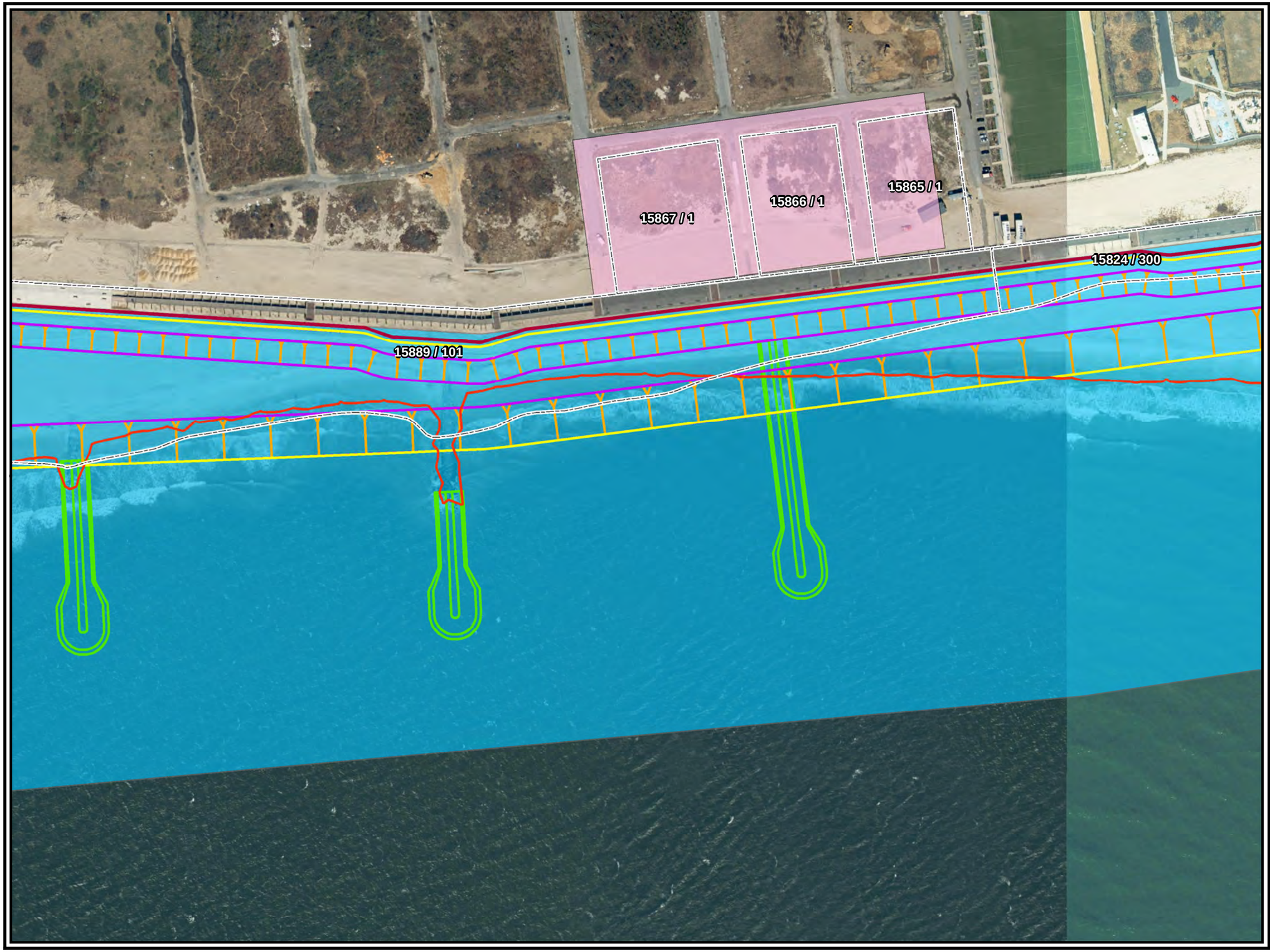
1 inch = 200 feet

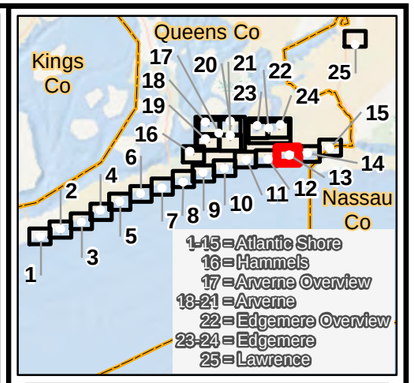
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Atlantic Shore Groins
- Permanent Easements
- Temporary Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

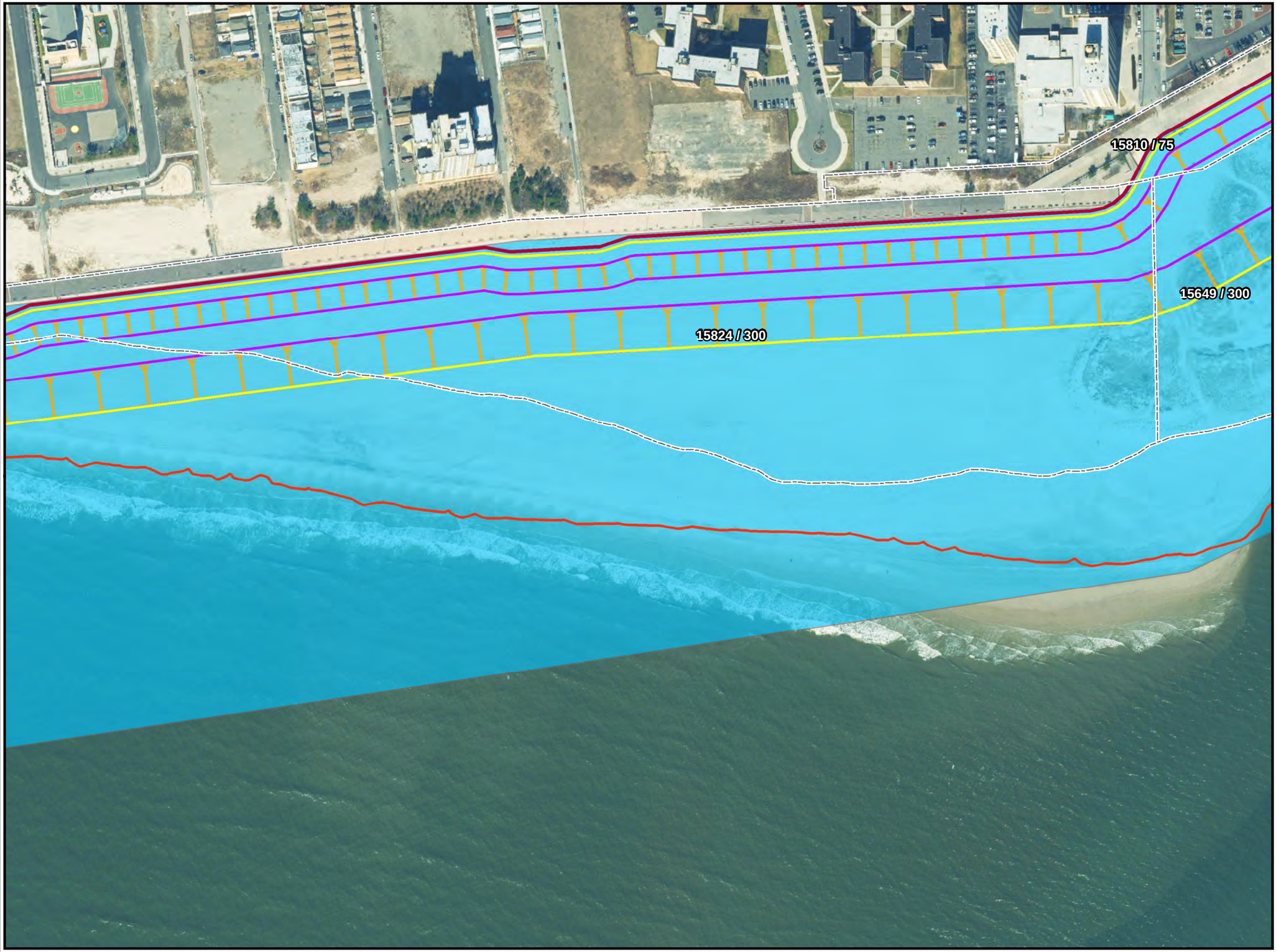
1 inch = 200 feet

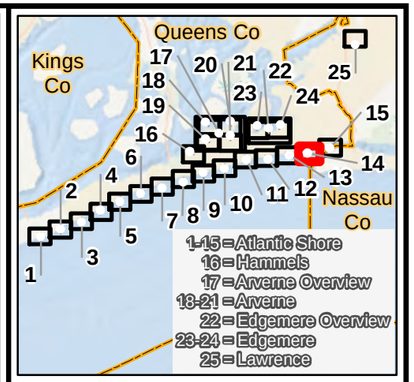
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

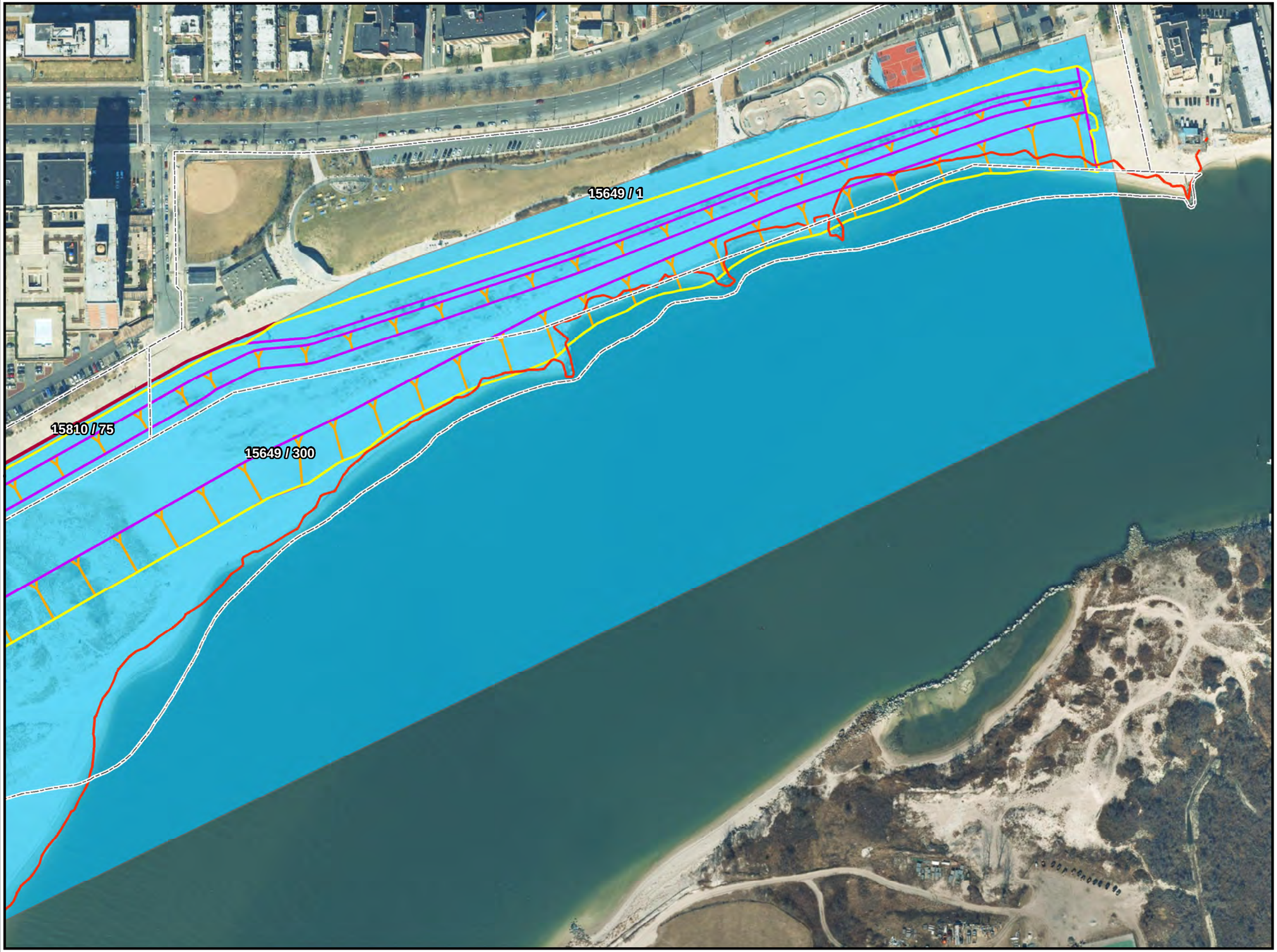
1 inch = 200 feet

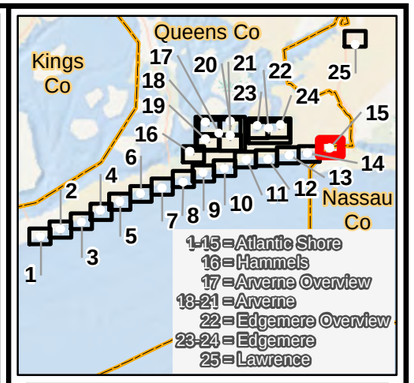
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (Corps Created)
- Atlantic Shore Sand Boundary
- Atlantic Shore Sand Features
- Atlantic Shore Sand Slopes
- Atlantic Shore Wall
- Permanent Easements

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

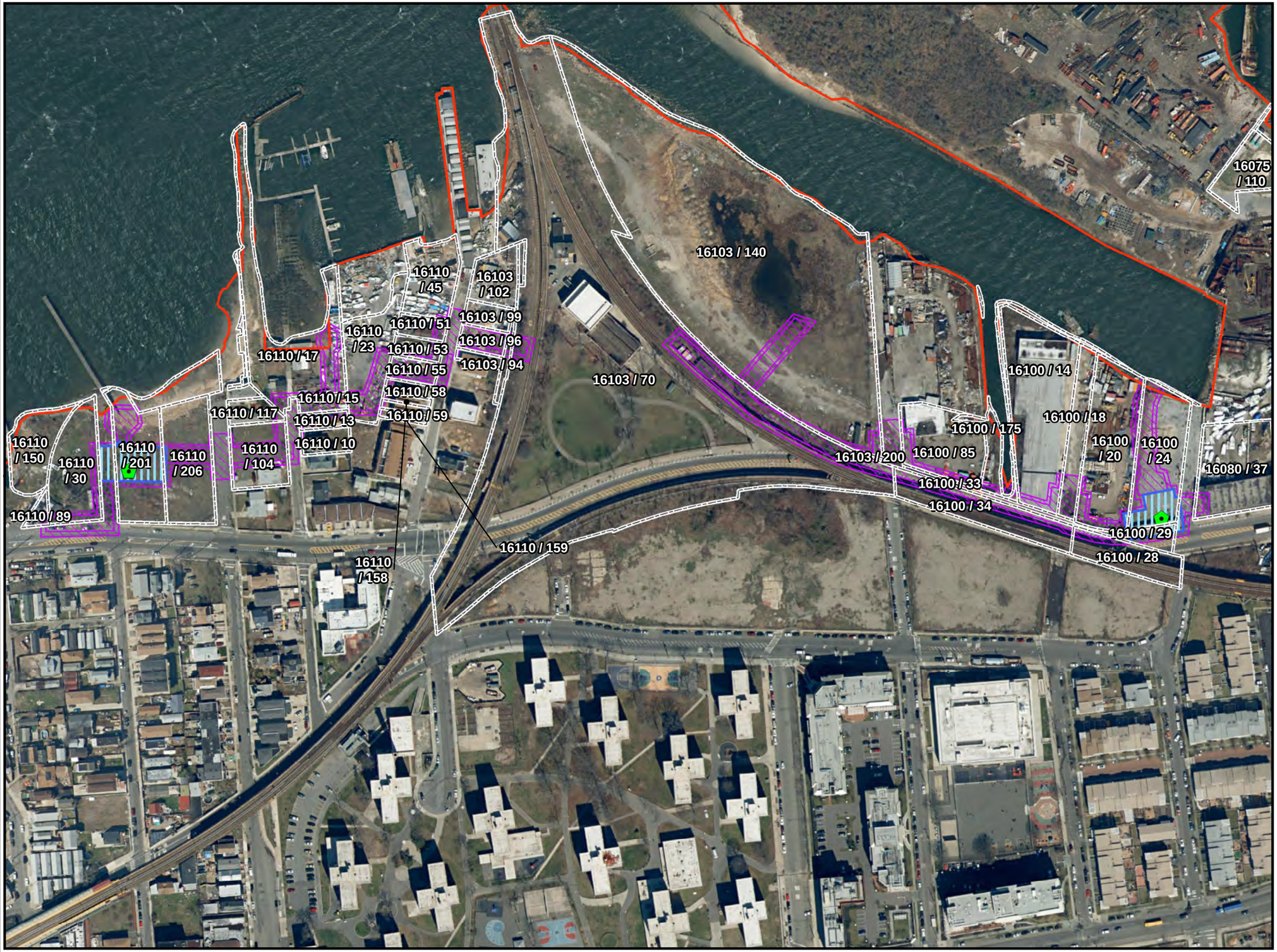
1 inch = 200 feet

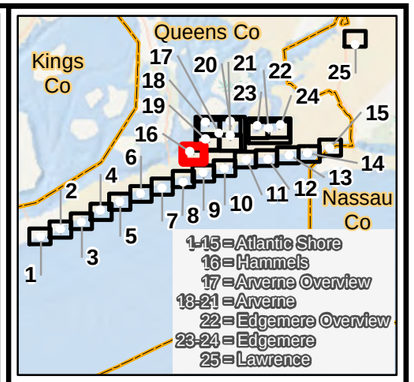
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Atlantic Shore

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Mean High Water Line (CUSP/NOAA, 2011)
- Pump Station
- In Fee (Pump Station)
- Permanent Easement - Levee
- Temporary Easement - Bank Protection & Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

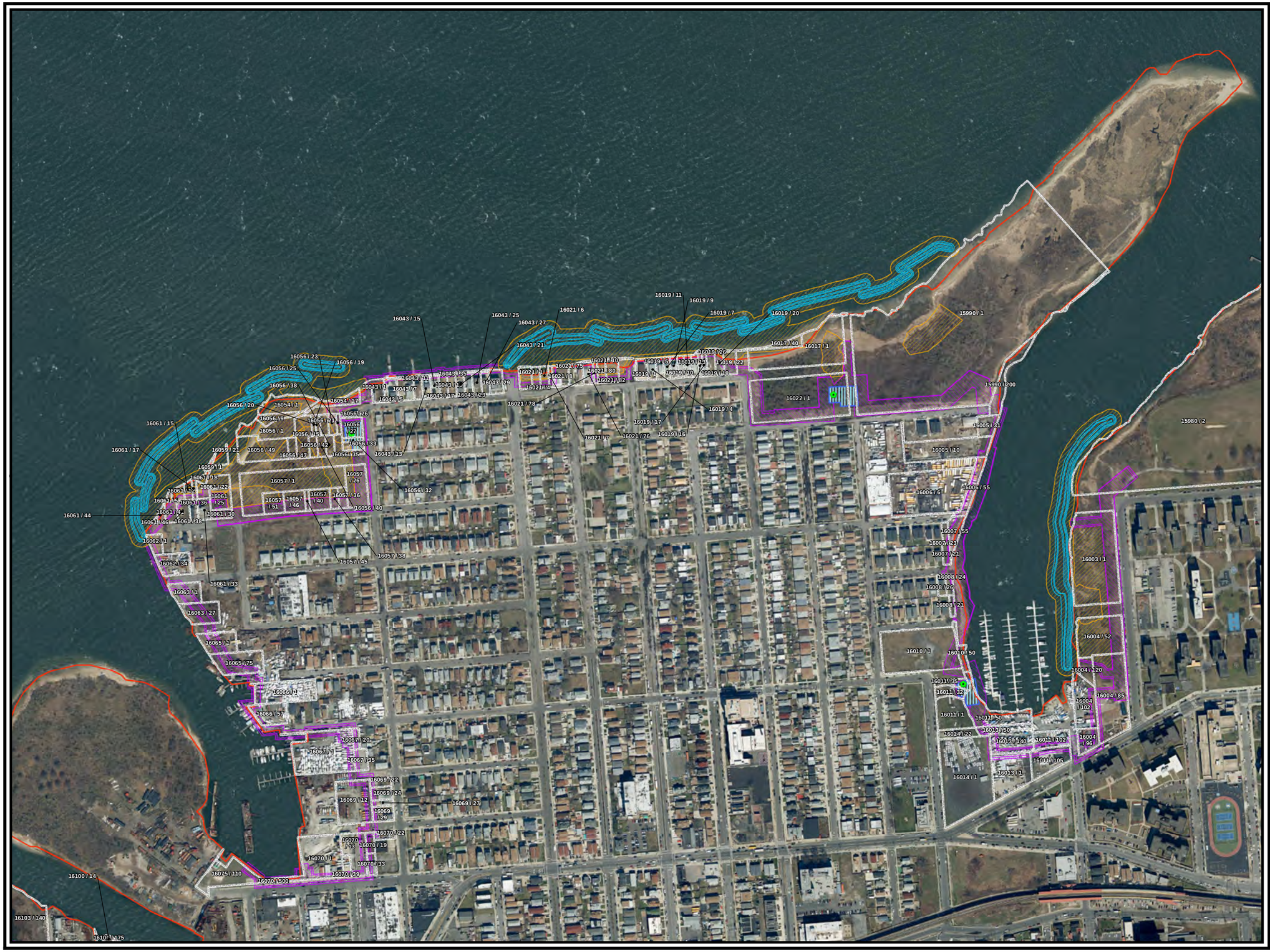
1 inch = 200 feet

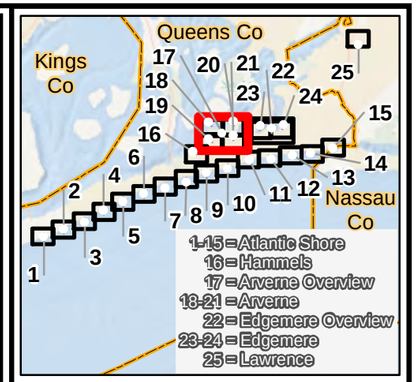
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Hammels

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Rock Sill Footprint
- Mean High Water Line (CUSP/NOAA, 2011)
- Pump Station
- In Fee (Pump Station)
- Permanent Easement - Bank Protection
- Permanent Easement - Levee
- Temporary Easement - Bank Protection & Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 225 450 900 Feet

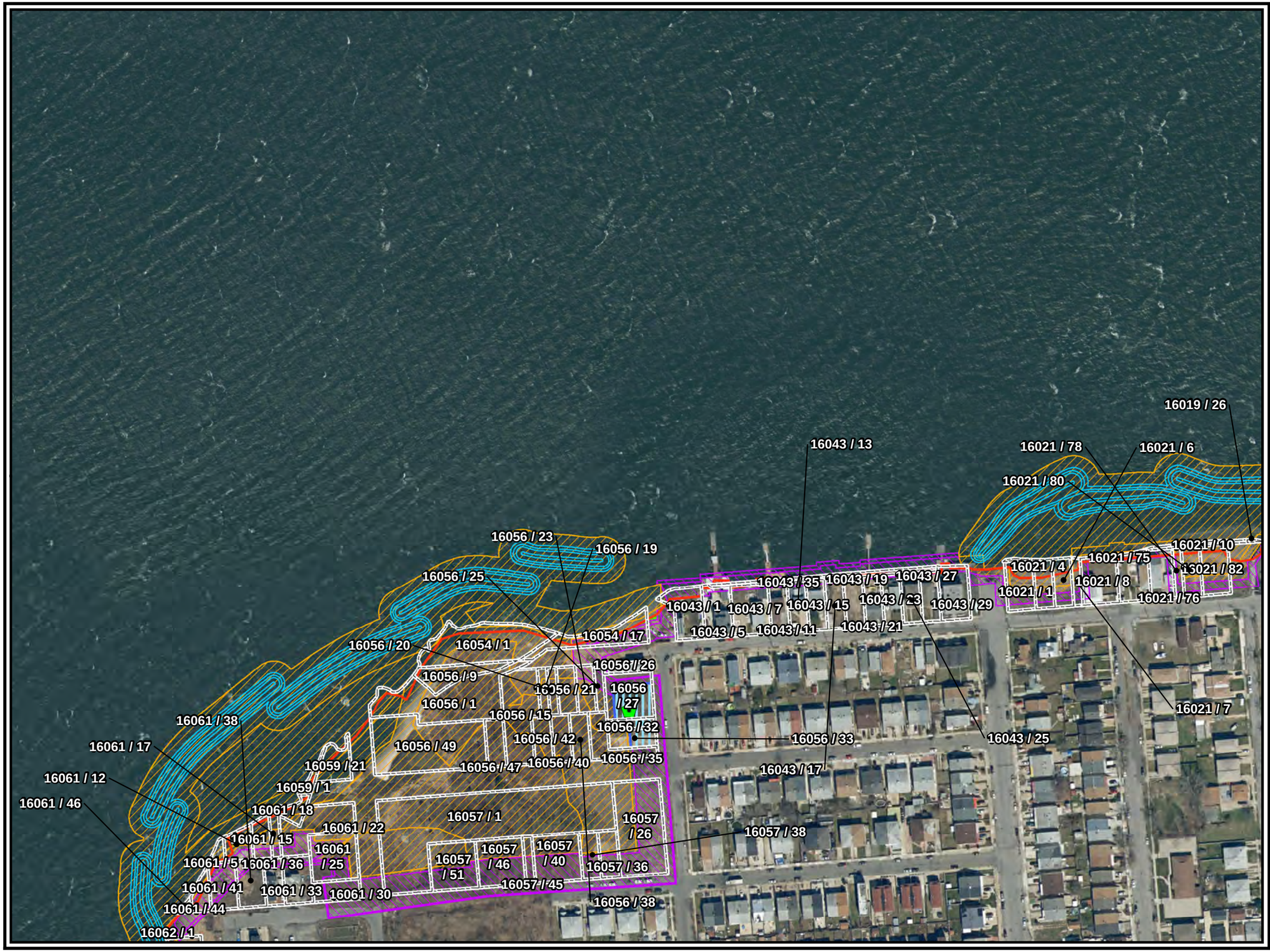
1 inch = 450 feet

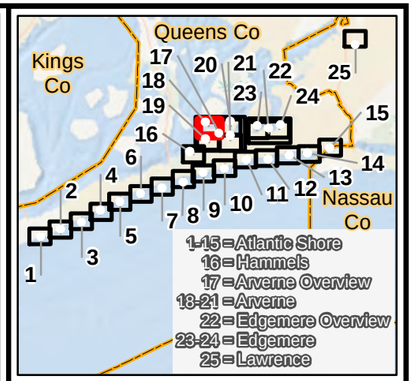
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Arverne

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Rock Sill Footprint
- Mean High Water Line (CUSP/NOAA, 2011)
- Pump Station
- In Fee (Pump Station)
- Permanent Easement - Bank Protection
- Permanent Easement - Levee
- Temporary Easement - Bank Protection & Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

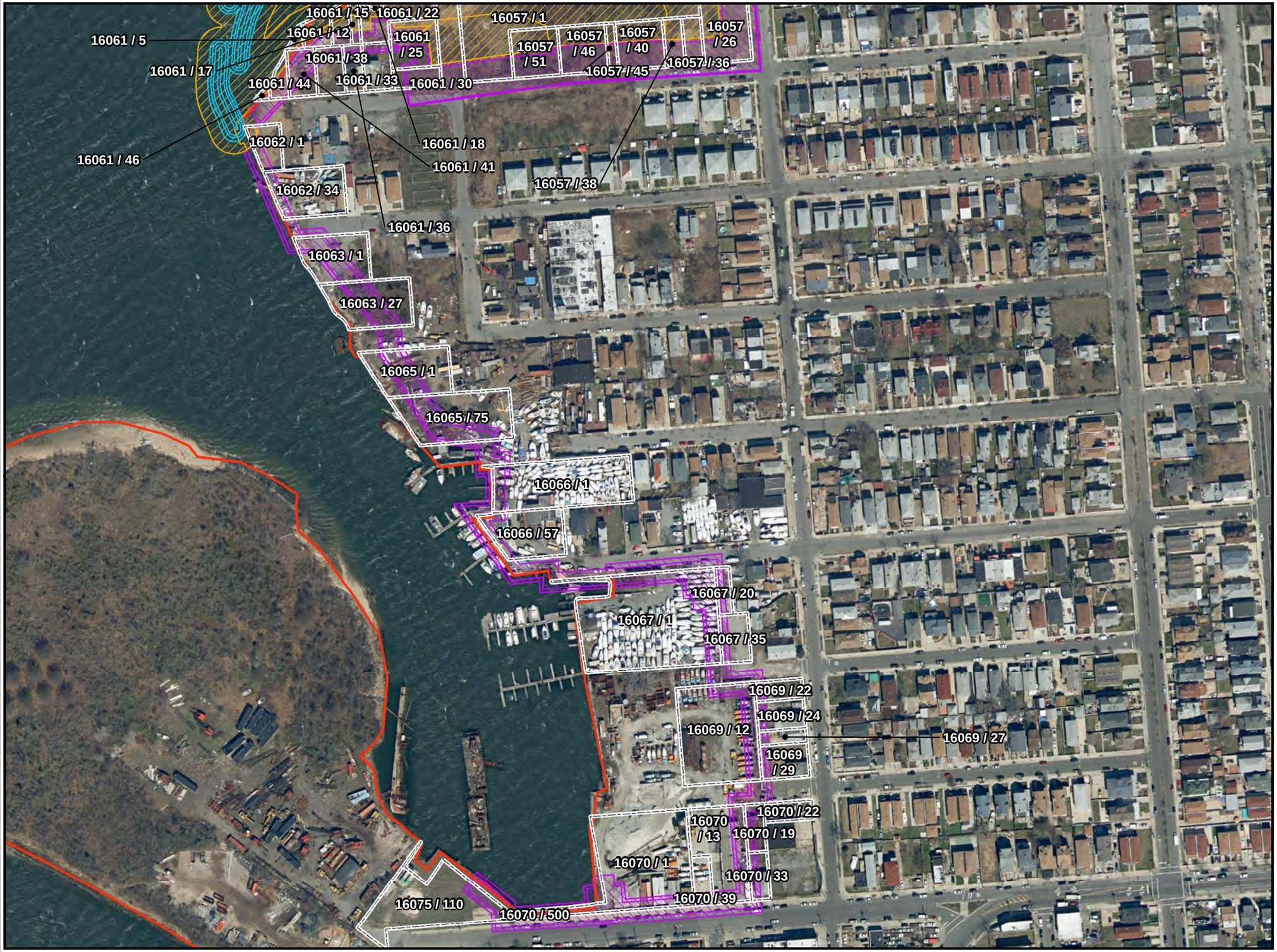
1 inch = 200 feet

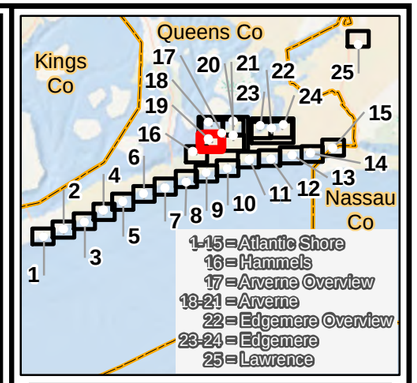
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Arverne

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Rock Sill Footprint
- Mean High Water Line (CUSP/NOAA, 2011)
- Permanent Easement - Bank Protection
- Permanent Easement - Levee
- Temporary Easement - Bank Protection & Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

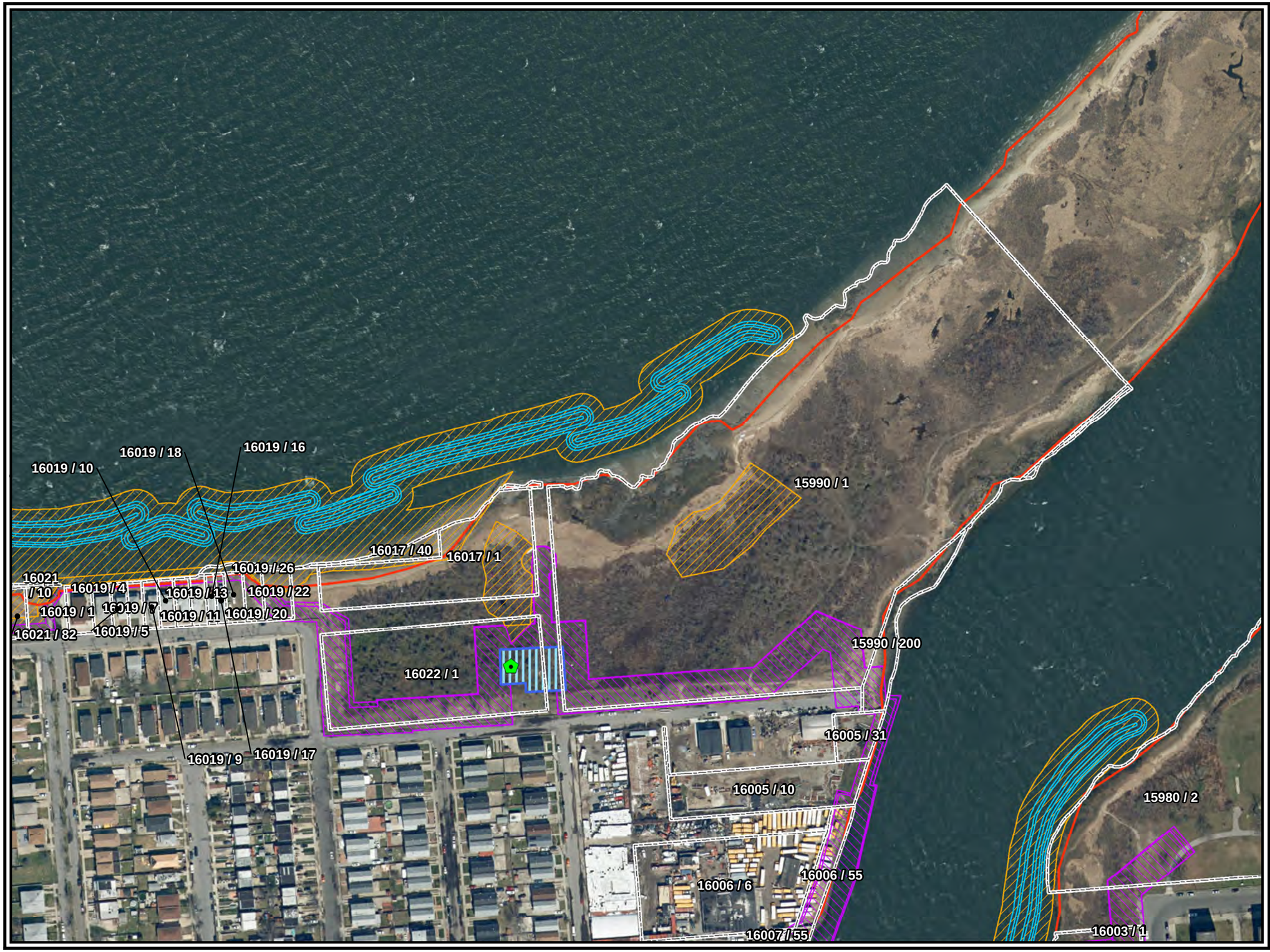
1 inch = 200 feet

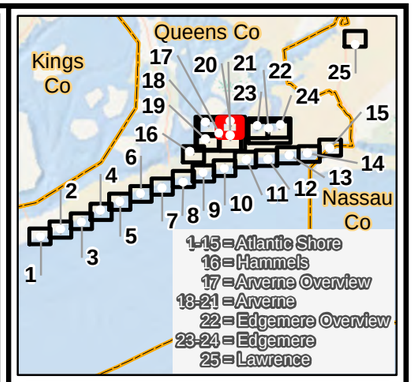
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Arverne

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Rock Sill Footprint
- Mean High Water Line (CUSP/NOAA, 2011)
- Pump Station
- In Fee (Pump Station)
- Permanent Easement - Bank Protection
- Permanent Easement - Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

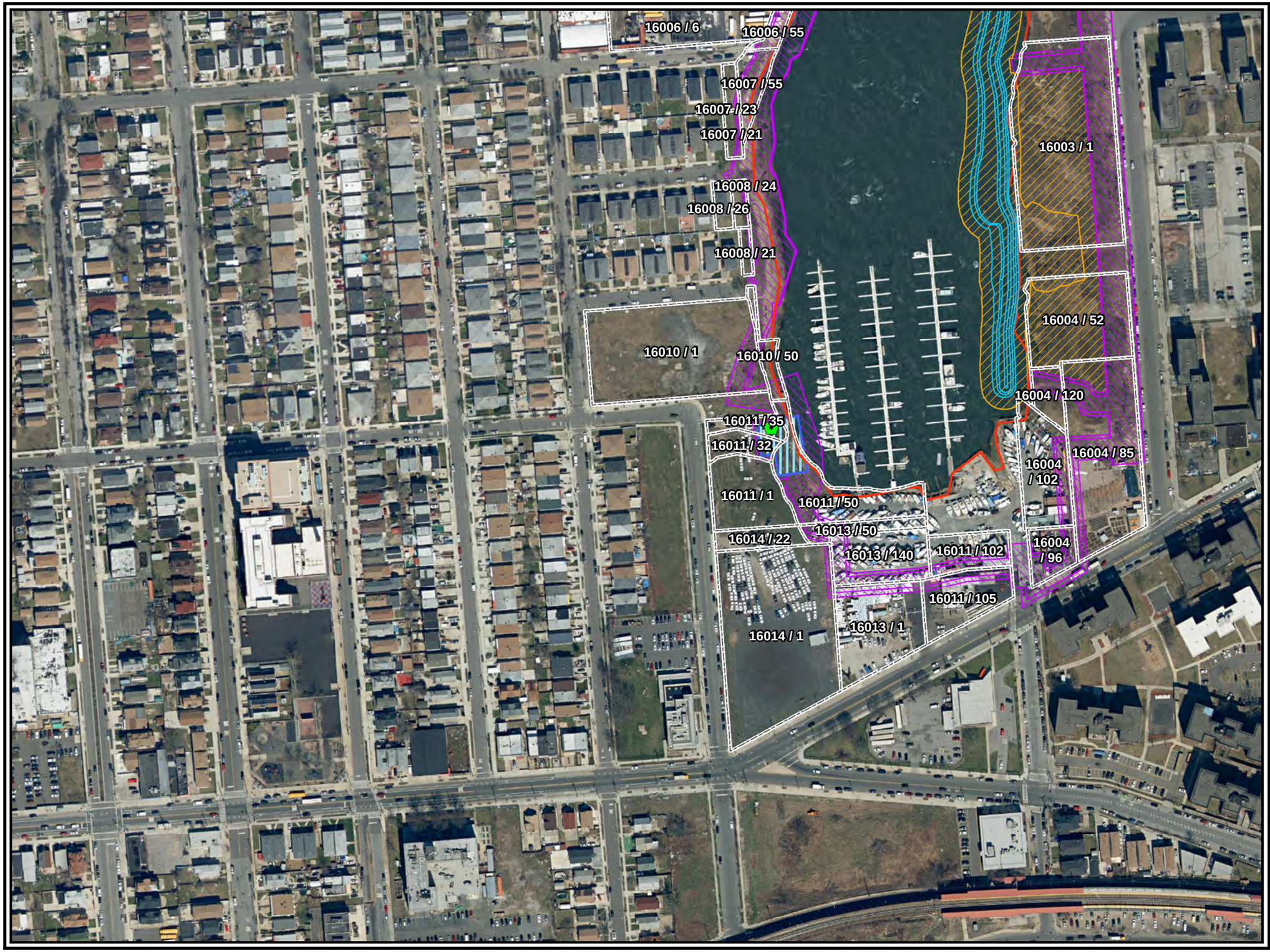
1 inch = 200 feet

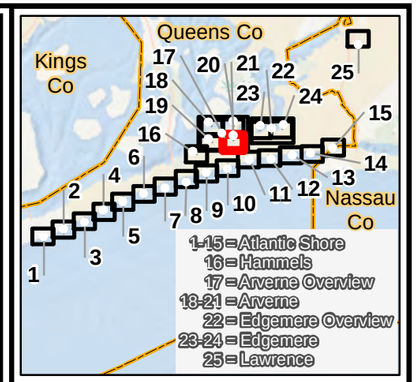
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Arverne

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Rock Sill Footprint
- Mean High Water Line (CUSP/NOAA, 2011)
- Pump Station
- In Fee (Pump Station)
- Permanent Easement - Bank Protection
- Permanent Easement - Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

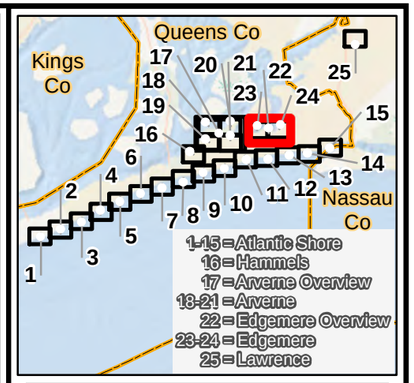
1 inch = 200 feet

EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Arverne

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT



Legend

- NYC Parcels (Block / Lot)
- Rock Sill Footprint
- Mean High Water Line (CUSP/NOAA, 2011)
- Pump Station
- In Fee (Pump Station)
- Permanent Easement - Bank Protection
- Permanent Easement - Levee
- Temporary Easement - Bank Protection & Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 175 350 700 Feet

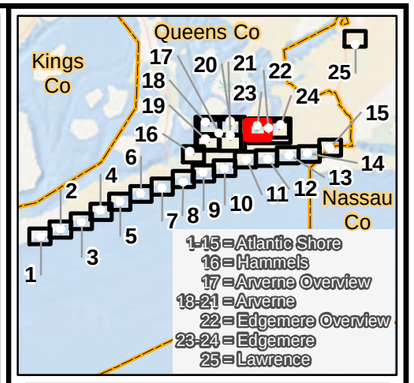
1 inch = 350 feet

EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Edgemere

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT



Legend

- NYC Parcels (Block / Lot)
- Rock Sill Footprint
- Mean High Water Line (CUSP/NOAA, 2011)
- Pump Station
- In Fee (Pump Station)
- Permanent Easement - Bank Protection
- Permanent Easement - Levee
- Temporary Easement - Bank Protection & Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

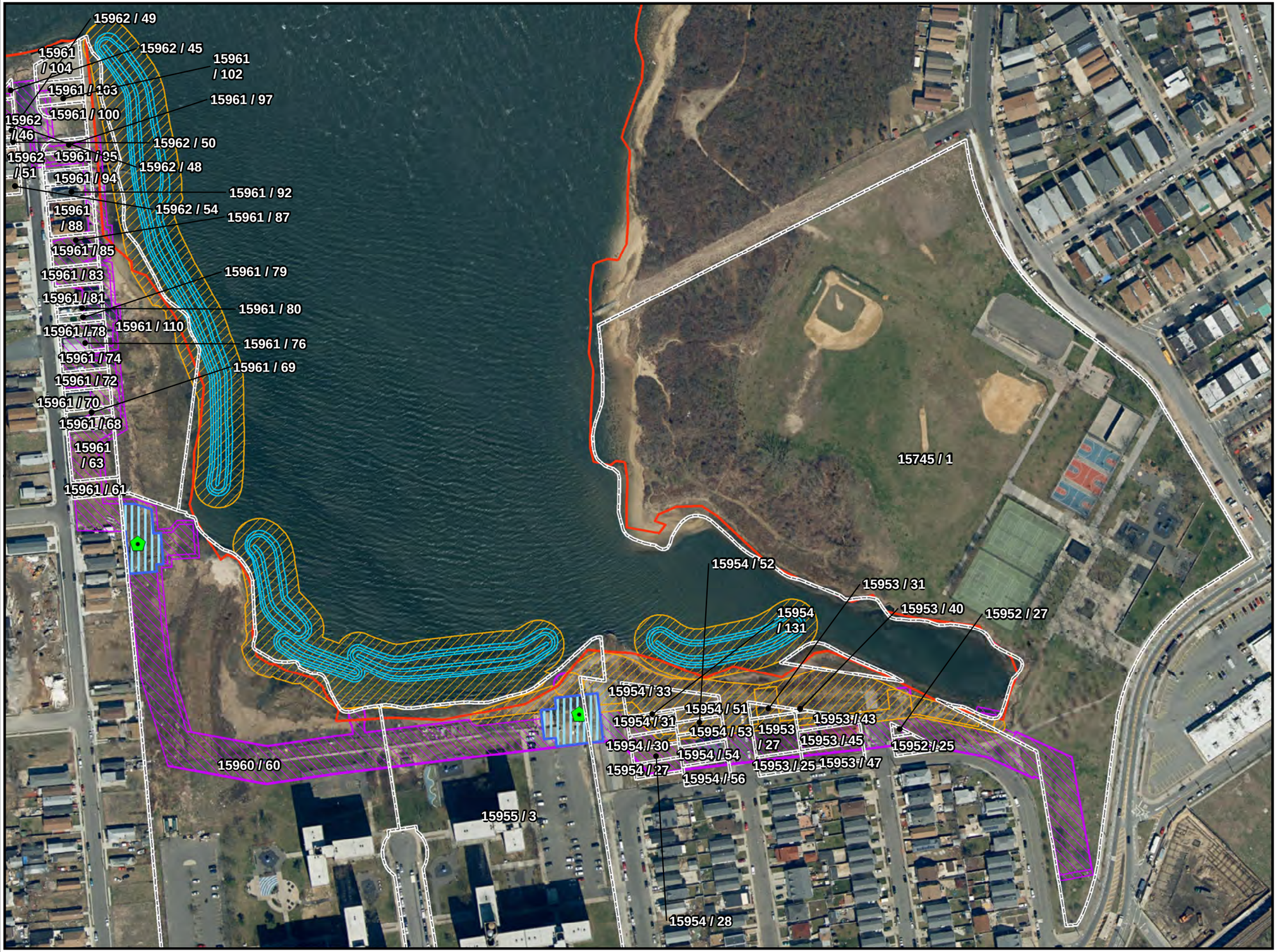
1 inch = 200 feet

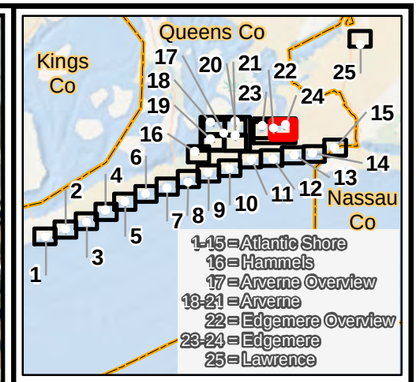
EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Edgemere

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT





Legend

- NYC Parcels (Block / Lot)
- Rock Sill Footprint
- Mean High Water Line (CUSP/NOAA, 2011)
- Pump Station
- In Fee (Pump Station)
- Permanent Easement - Bank Protection
- Permanent Easement - Levee
- Temporary Easement - Bank Protection & Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

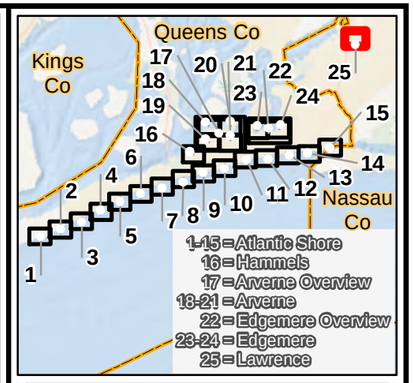
1 inch = 200 feet

EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Edgemere

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT



Legend

- Nassau Parcels (Block / Lot)
- Mean High Water Line (CUSP/NOAA, 2011)
- Pump Station
- In Fee (Pump Station)
- Permanent Easement - Levee
- Temporary Easement - Bank Protection & Levee

Sources:

Imagery Background:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Reference Map:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Coordinate System:
NAD83 StatePlane New York Long Island FIPS 3104 Feet

N

0 100 200 400 Feet

1 inch = 200 feet

EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY PROJECT

Real Estate Map Easements and Parcels Lawrence

Date: 11/15/2018

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT

EXHIBIT “B”

REQUIRED LER

LER SUMMARY TABLE

Project Name	Block	Lot	Type	Permanent Easement - Coastal Storm Damage Reduction	Permanent Easement - Bank Protection	Permanent Easement - Levee	Fee	Temporary Easement - Coastal Storm Damage Reduction	Temporary Easement - Bank Protection & Levee	Grand Total
Arverne	15980	20	Public	0.0000	0.0534	0.3132	0.0000	0.0000	0.0000	**0.3666**
Arverne	15990	10	Public	0.0000	13.3482	1.2955	0.0100	0.0000	0.0000	**14.6437**
Arverne	15990	2000	Public	0.0000	0.0675	0.0998	0.0000	0.0000	0.0000	**0.1673**
Arverne	16003	10	Public	0.0000	1.3445	0.7475	0.0000	0.0000	0.0000	**2.0921**
Arverne	16004	520	Public	0.0000	0.6650	0.2492	0.0000	0.0000	0.0000	**0.9142**
Arverne	16004	850	Public	0.0000	0.1044	0.7444	0.0000	0.0000	0.0000	**0.8488**
Arverne	16004	960	Private	0.0000	0.0000	0.2336	0.0000	0.0000	0.0000	**0.2336**
Arverne	16004	1020	Private	0.0000	0.0000	0.5643	0.0000	0.0000	0.0000	**0.5643**
Arverne	16004	1200	Public	0.0000	0.0192	0.1506	0.0000	0.0000	0.0000	**0.1698**
Arverne	16005	100	Private	0.0000	0.0000	0.0552	0.0000	0.0000	0.0000	**0.0552**
Arverne	16005	310	Private	0.0000	0.0000	0.0435	0.0000	0.0000	0.0000	**0.0435**
Arverne	16006	60	Private	0.0000	0.0000	0.0032	0.0000	0.0000	0.0000	**0.0032**
Arverne	16006	550	Public	0.0000	0.0000	0.2406	0.0000	0.0000	0.0000	**0.2406**
Arverne	16007	210	Private	0.0000	0.0000	0.0312	0.0000	0.0000	0.0000	**0.0312**
Arverne	16007	230	Private	0.0000	0.0000	0.0095	0.0000	0.0000	0.0000	**0.0095**
Arverne	16007	550	Public	0.0000	0.0000	0.1728	0.0000	0.0000	0.0000	**0.1728**
Arverne	16008	210	Private	0.0000	0.0000	0.0065	0.0000	0.0000	0.0000	**0.0065**
Arverne	16008	240	Private	0.0000	0.0000	0.0264	0.0000	0.0000	0.0000	**0.0264**
Arverne	16008	260	Private	0.0000	0.0000	0.0017	0.0000	0.0000	0.0000	**0.0017**
Arverne	16010	10	Public	0.0000	0.0000	0.1668	0.0000	0.0000	0.0000	**0.1668**
Arverne	16010	500	Public	0.0000	0.0000	0.0856	0.0000	0.0000	0.0000	**0.0856**
Arverne	16011	10	Private	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	**0.0030**

Arverne	16011	320	Private	0.0000	0.0000	0.0139	0.0300	0.0000	0.0000	**0.0139**
Arverne	16011	350	Private	0.0000	0.0000	0.0137	0.0400	0.0000	0.0000	**0.0137**
Arverne	16011	500	Public	0.0000	0.0000	0.5132	0.1100	0.0000	0.0000	**0.5132**
Arverne	16011	1020	Private	0.0000	0.0000	0.3098	0.0000	0.0000	0.0000	**0.3098**
Arverne	16011	1050	Private	0.0000	0.0000	0.1136	0.0000	0.0000	0.0000	**0.1136**
Arverne	16013	10	Private	0.0000	0.0000	0.1073	0.0000	0.0000	0.0000	**0.1073**
Arverne	16013	500	Public	0.0000	0.0000	0.1655	0.0000	0.0000	0.0000	**0.1655**
Arverne	16013	1400	Private	0.0000	0.0000	0.5171	0.0000	0.0000	0.0000	**0.5171**
Arverne	16014	10	Private	0.0000	0.0000	0.0349	0.0000	0.0000	0.0000	**0.0349**
Arverne	16014	220	Private	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	**0.0007**
Arverne	16017	10	Public	0.0000	0.9814	0.4783	0.0000	0.0000	0.0000	**1.4596**
Arverne	16017	400	Public	0.0000	0.0102	0.1315	0.0000	0.0000	0.0000	**0.1417**
Arverne	16019	10	Private	0.0000	0.0000	0.0144	0.0000	0.0000	0.0000	**0.0144**
Arverne	16019	40	Private	0.0000	0.0000	0.0102	0.0000	0.0000	0.0000	**0.0102**
Arverne	16019	50	Private	0.0000	0.0000	0.0090	0.0000	0.0000	0.0000	**0.0090**
Arverne	16019	70	Private	0.0000	0.0000	0.0089	0.0000	0.0000	0.0000	**0.0089**
Arverne	16019	90	Private	0.0000	0.0000	0.0093	0.0000	0.0000	0.0000	**0.0093**
Arverne	16019	100	Private	0.0000	0.0000	0.0095	0.0000	0.0000	0.0000	**0.0095**
Arverne	16019	110	Private	0.0000	0.0000	0.0098	0.0000	0.0000	0.0000	**0.0098**
Arverne	16019	130	Private	0.0000	0.0000	0.0114	0.0000	0.0000	0.0000	**0.0114**
Arverne	16019	160	Private	0.0000	0.0000	0.0076	0.0000	0.0000	0.0000	**0.0076**
Arverne	16019	170	Private	0.0000	0.0000	0.0076	0.0000	0.0000	0.0000	**0.0076**
Arverne	16019	180	Private	0.0000	0.0000	0.0166	0.0000	0.0000	0.0000	**0.0166**
Arverne	16019	200	Private	0.0000	0.0000	0.0519	0.0000	0.0000	0.0000	**0.0519**
Arverne	16019	220	Private	0.0000	0.0147	0.1257	0.0000	0.0000	0.0000	**0.1404**
Arverne	16019	260	Public	0.0000	0.0000	0.0575	0.0000	0.0000	0.0000	**0.0575**
Arverne	16021	10	Private	0.0000	0.0000	0.1266	0.0000	0.0000	0.0000	**0.1266**
Arverne	16021	40	Private	0.0000	0.0000	0.0830	0.0000	0.0000	0.0000	**0.0830**
Arverne	16021	60	Private	0.0000	0.0000	0.0825	0.0000	0.0000	0.0000	**0.0825**
Arverne	16021	70	Private	0.0000	0.0000	0.0407	0.0000	0.0000	0.0000	**0.0407**
Arverne	16021	80	Private	0.0000	0.0000	0.0456	0.0000	0.0000	0.0000	**0.0456**

Arverne	16021	100	Public	0.0000	0.0000	0.0369	0.0000	0.0000	0.0000	**0.0369**
Arverne	16021	750	Private	0.0000	0.0000	0.0213	0.0000	0.0000	0.0000	**0.0213**
Arverne	16021	760	Private	0.0000	0.0000	0.0412	0.0000	0.0000	0.0000	**0.0412**
Arverne	16021	780	Private	0.0000	0.0000	0.0413	0.0000	0.0000	0.0000	**0.0413**
Arverne	16021	800	Private	0.0000	0.0000	0.0855	0.0000	0.0000	0.0000	**0.0855**
Arverne	16021	820	Private	0.0000	0.0000	0.1310	0.0000	0.0000	0.0000	**0.1310**
Arverne	16022	10	Public	0.0000	0.9242	0.9624	0.1700	0.0000	0.0000	**1.8865**
Arverne	16043	10	Private	0.0000	0.0000	0.0516	0.0000	0.0000	0.0000	**0.0516**
Arverne	16043	50	Private	0.0000	0.0000	0.0189	0.0000	0.0000	0.0000	**0.0189**
Arverne	16043	70	Private	0.0000	0.0000	0.0181	0.0000	0.0000	0.0000	**0.0181**
Arverne	16043	110	Private	0.0000	0.0000	0.0090	0.0000	0.0000	0.0000	**0.0090**
Arverne	16043	130	Private	0.0000	0.0000	0.0088	0.0000	0.0000	0.0000	**0.0088**
Arverne	16043	150	Private	0.0000	0.0000	0.0088	0.0000	0.0000	0.0000	**0.0088**
Arverne	16043	170	Private	0.0000	0.0000	0.0088	0.0000	0.0000	0.0000	**0.0088**
Arverne	16043	190	Private	0.0000	0.0000	0.0089	0.0000	0.0000	0.0000	**0.0089**
Arverne	16043	210	Private	0.0000	0.0000	0.0058	0.0000	0.0000	0.0000	**0.0058**
Arverne	16043	230	Private	0.0000	0.0000	0.0049	0.0000	0.0000	0.0000	**0.0049**
Arverne	16043	250	Private	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	**0.0050**
Arverne	16043	270	Private	0.0000	0.0000	0.0047	0.0000	0.0000	0.0000	**0.0047**
Arverne	16043	290	Private	0.0000	0.0000	0.0200	0.0000	0.0000	0.0000	**0.0200**
Arverne	16043	350	Public	0.0000	0.0000	0.0921	0.0000	0.0000	0.0000	**0.0921**
Arverne	16054	10	Public	0.0000	0.2530	0.1811	0.0000	0.0000	0.0000	**0.4341**
Arverne	16054	170	Public	0.0000	0.0853	0.1064	0.0000	0.0000	0.0063	**0.1980**
Arverne	16056	10	Public	0.0000	0.1684	0.3439	0.0000	0.0000	0.0000	**0.5123**
Arverne	16056	90	Public	0.0000	0.0352	0.1091	0.0000	0.0000	0.0000	**0.1443**
Arverne	16056	150	Public	0.0000	0.1735	0.1465	0.0000	0.0000	0.0000	**0.3201**
Arverne	16056	190	Public	0.0000	0.0135	0.0331	0.0000	0.0000	0.0000	**0.0466**
Arverne	16056	200	Public	0.0000	0.0110	0.0354	0.0000	0.0000	0.0000	**0.0464**
Arverne	16056	210	Public	0.0000	0.0212	0.0710	0.0000	0.0000	0.0000	**0.0923**
Arverne	16056	230	Public	0.0000	0.0000	0.0914	0.0000	0.0000	0.0000	**0.0914**
Arverne	16056	250	Public	0.0000	0.0000	0.0464	0.0000	0.0000	0.0000	**0.0464**

Arverne	16056	260	Private	0.0000	0.0000	0.0037	0.0000	0.0000	0.0000	**0.0037**
Arverne	16056	270	Public	0.0000	0.0000	0.0661	0.1400	0.0000	0.0000	**0.0661**
Arverne	16056	320	Public	0.0000	0.0000	0.0080	0.0400	0.0000	0.0000	**0.0080**
Arverne	16056	330	Public	0.0000	0.0000	0.0420	0.0500	0.0000	0.0000	**0.0420**
Arverne	16056	350	Public	0.0000	0.0000	0.1358	0.0000	0.0000	0.0000	**0.1358**
Arverne	16056	380	Public	0.0000	0.0000	0.0918	0.0000	0.0000	0.0000	**0.0918**
Arverne	16056	400	Public	0.0000	0.0043	0.0875	0.0000	0.0000	0.0000	**0.0918**
Arverne	16056	420	Public	0.0000	0.0233	0.0685	0.0000	0.0000	0.0000	**0.0918**
Arverne	16056	470	Public	0.0000	0.0911	0.0007	0.0000	0.0000	0.0000	**0.0918**
Arverne	16056	490	Public	0.0000	0.4309	0.1693	0.0000	0.0000	0.0000	**0.6001**
Arverne	16057	10	Public	0.0000	0.8349	0.5531	0.0000	0.0000	0.0000	**1.3880**
Arverne	16057	260	Public	0.0000	0.0000	0.4612	0.0000	0.0000	0.0000	**0.4612**
Arverne	16057	360	Public	0.0000	0.0000	0.0922	0.0000	0.0000	0.0000	**0.0922**
Arverne	16057	380	Public	0.0000	0.0047	0.0875	0.0000	0.0000	0.0000	**0.0922**
Arverne	16057	400	Public	0.0000	0.0962	0.1343	0.0000	0.0000	0.0000	**0.2305**
Arverne	16057	450	Public	0.0000	0.0190	0.0271	0.0000	0.0000	0.0000	**0.0461**
Arverne	16057	460	Public	0.0000	0.0938	0.1367	0.0000	0.0000	0.0000	**0.2305**
Arverne	16057	510	Public	0.0000	0.0184	0.2121	0.0000	0.0000	0.0000	**0.2305**
Arverne	16059	10	Public	0.0000	0.0163	0.0141	0.0000	0.0000	0.0000	**0.0304**
Arverne	16059	210	Public	0.0000	0.1087	0.0000	0.0000	0.0000	0.0000	**0.1087**
Arverne	16061	50	Public	0.0000	0.0055	0.0211	0.0000	0.0000	0.0000	**0.0265**
Arverne	16061	120	Public	0.0000	0.0417	0.0458	0.0000	0.0000	0.0004	**0.0879**
Arverne	16061	150	Public	0.0000	0.0436	0.0351	0.0000	0.0000	0.0000	**0.0787**
Arverne	16061	170	Public	0.0000	0.0274	0.0170	0.0000	0.0000	0.0000	**0.0443**
Arverne	16061	180	Public	0.0000	0.0405	0.0138	0.0000	0.0000	0.0000	**0.0543**
Arverne	16061	220	Public	0.0000	0.1803	0.0662	0.0000	0.0000	0.0000	**0.2465**
Arverne	16061	250	Public	0.0000	0.0282	0.1732	0.0000	0.0000	0.0000	**0.2014**
Arverne	16061	300	Public	0.0000	0.0000	0.0717	0.0000	0.0000	0.0000	**0.0717**
Arverne	16061	330	Private	0.0000	0.0000	0.0278	0.0000	0.0000	0.0000	**0.0278**
Arverne	16061	360	Private	0.0000	0.0000	0.0176	0.0000	0.0000	0.0000	**0.0176**
Arverne	16061	380	Public	0.0000	0.0000	0.0331	0.0000	0.0000	0.0000	**0.0331**

Arverne	16061	410	Public	0.0000	0.0047	0.0892	0.0000	0.0000	0.0000	**0.0939**
Arverne	16061	440	Public	0.0000	0.0003	0.0605	0.0000	0.0000	0.0000	**0.0608**
Arverne	16061	460	Public	0.0000	0.0000	0.0123	0.0000	0.0000	0.0000	**0.0123**
Arverne	16062	10	Private	0.0000	0.0000	0.0476	0.0000	0.0000	0.0000	**0.0476**
Arverne	16062	340	Private	0.0000	0.0000	0.0480	0.0000	0.0000	0.0000	**0.0480**
Arverne	16063	10	Private	0.0000	0.0000	0.1568	0.0000	0.0000	0.0502	**0.2071**
Arverne	16063	270	Private	0.0000	0.0000	0.1390	0.0000	0.0000	0.1008	**0.2398**
Arverne	16065	10	Private	0.0000	0.0000	0.1264	0.0000	0.0000	0.0836	**0.2101**
Arverne	16065	750	Private	0.0000	0.0000	0.2069	0.0000	0.0000	0.0761	**0.2830**
Arverne	16066	10	Private	0.0000	0.0000	0.0632	0.0000	0.0000	0.0000	**0.0632**
Arverne	16066	570	Private	0.0000	0.0000	0.0507	0.0000	0.0000	0.0000	**0.0507**
Arverne	16067	10	Private	0.0000	0.0000	1.2619	0.0000	0.0000	0.0000	**1.2619**
Arverne	16067	200	Private	0.0000	0.0000	0.0375	0.0000	0.0000	0.0000	**0.0375**
Arverne	16067	350	Private	0.0000	0.0000	0.0388	0.0000	0.0000	0.0000	**0.0388**
Arverne	16069	120	Private	0.0000	0.0000	0.7675	0.0000	0.0000	0.0000	**0.7675**
Arverne	16069	220	Private	0.0000	0.0000	0.0181	0.0000	0.0000	0.0000	**0.0181**
Arverne	16069	240	Private	0.0000	0.0000	0.0270	0.0000	0.0000	0.0000	**0.0270**
Arverne	16069	270	Private	0.0000	0.0000	0.0129	0.0000	0.0000	0.0000	**0.0129**
Arverne	16069	290	Private	0.0000	0.0000	0.0303	0.0000	0.0000	0.0000	**0.0303**
Arverne	16070	10	Private	0.0000	0.0000	0.9307	0.0000	0.0000	0.0000	**0.9307**
Arverne	16070	130	Private	0.0000	0.0000	0.4598	0.0000	0.0000	0.0000	**0.4598**
Arverne	16070	190	Private	0.0000	0.0000	0.0562	0.0000	0.0000	0.0000	**0.0562**
Arverne	16070	220	Private	0.0000	0.0000	0.0120	0.0000	0.0000	0.0000	**0.0120**
Arverne	16070	330	Private	0.0000	0.0000	0.0457	0.0000	0.0000	0.0000	**0.0457**
Arverne	16070	390	Private	0.0000	0.0000	0.0913	0.0000	0.0000	0.0000	**0.0913**
Arverne	16070	5000	Private	0.0000	0.0000	0.0334	0.0000	0.0000	0.0000	**0.0334**
Arverne	16075	1100	Private	0.0000	0.0000	0.0669	0.0000	0.0000	0.0000	**0.0669**
Atlantic Shore	15649	1	Public	9.3927	0.0000	0.0000	0.0000	0.0000	0.0000	**9.3927**
Atlantic Shore	15649	300	Public	14.7728	0.0000	0.0000	0.0000	0.0000	0.0000	**14.7728**
Atlantic Shore	15810	75	Public	1.3976	0.0000	0.0000	0.0000	0.0000	0.0000	**1.3976**
Atlantic Shore	15824	300	Public	20.7322	0.0000	0.0000	0.0000	0.0000	0.0000	**20.7322**

Atlantic Shore	15865	1	Public	0.0000	0.0000	0.0000	0.0000	0.9720	0.0000	**0.9720**
Atlantic Shore	15866	1	Public	0.0000	0.0000	0.0000	0.0000	1.3445	0.0000	**1.3445**
Atlantic Shore	15867	1	Public	0.0000	0.0000	0.0000	0.0000	1.7008	0.0000	**1.7008**
Atlantic Shore	15889	101	Public	40.5319	0.0000	0.0000	0.0000	0.0000	0.0000	**40.5319**
Atlantic Shore	15919	1	Public	0.0000	0.0000	0.0000	0.0000	2.2085	0.0000	**2.2085**
Atlantic Shore	15944	1	Public	37.8634	0.0000	0.0000	0.0000	0.0000	0.0000	**37.8634**
Atlantic Shore	16093	1	Public	0.0522	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0522**
Atlantic Shore	16099	1	Public	5.9176	0.0000	0.0000	0.0000	0.0000	0.0000	**5.9176**
Atlantic Shore	16150	1	Public	33.5103	0.0000	0.0000	0.0000	0.0000	0.0000	**33.5103**
Atlantic Shore	16150	100	Public	0.2055	0.0000	0.0000	0.0000	0.0000	0.0000	**0.2055**
Atlantic Shore	16189	1	Public	15.5148	0.0000	0.0000	0.0000	0.0000	0.0000	**15.5148**
Atlantic Shore	16189	50	Public	0.1709	0.0000	0.0000	0.0000	0.0000	0.0000	**0.1709**
Atlantic Shore	16189	90	Public	9.6144	0.0000	0.0000	0.0000	0.0000	0.0000	**9.6144**
Atlantic Shore	16240	85	Public	18.5689	0.0000	0.0000	0.0000	0.0000	0.0000	**18.5689**
Atlantic Shore	16240	101	Public	8.5840	0.0000	0.0000	0.0000	0.0000	0.0000	**8.5840**
Atlantic Shore	16286	101	Public	20.0817	0.0000	0.0000	0.0000	0.0000	0.0000	**20.0817**
Atlantic Shore	16324	101	Public	15.0414	0.0000	0.0000	0.0000	0.0000	0.0000	**15.0414**
Atlantic Shore	16325	1	Public	16.9827	0.0000	0.0000	0.0000	0.0000	0.0000	**16.9827**
Atlantic Shore	16325	200	Public	4.5775	0.0000	0.0000	0.0000	0.0000	0.0000	**4.5775**
Atlantic Shore	16330	60	Public	1.6128	0.0000	0.0000	0.0000	0.0000	0.0000	**1.6128**
Edgemere	15745	10	Public	0.0000	0.0998	0.5122	0.0000	0.0000	0.0000	**0.6120**
Edgemere	15952	250	Public	0.0000	0.0000	0.0287	0.0000	0.0000	0.0000	**0.0287**
Edgemere	15952	270	Public	0.0000	0.0000	0.0131	0.0000	0.0000	0.0000	**0.0131**
Edgemere	15953	250	Public	0.0000	0.0000	0.0244	0.0000	0.0000	0.0000	**0.0244**
Edgemere	15953	270	Public	0.0000	0.0000	0.1720	0.0000	0.0000	0.0000	**0.1720**
Edgemere	15953	310	Public	0.0000	0.0000	0.0466	0.0000	0.0000	0.0000	**0.0466**
Edgemere	15953	400	Public	0.0000	0.0000	0.0021	0.0000	0.0000	0.0000	**0.0021**
Edgemere	15953	430	Public	0.0000	0.0000	0.0814	0.0000	0.0000	0.0000	**0.0814**
Edgemere	15953	450	Private	0.0000	0.0000	0.1197	0.0000	0.0000	0.0000	**0.1197**
Edgemere	15953	470	Public	0.0000	0.0000	0.0459	0.0000	0.0000	0.0000	**0.0459**
Edgemere	15954	270	Public	0.0000	0.0000	0.0489	0.0000	0.0000	0.0000	**0.0489**

Edgemere	15954	280	Public	0.0000	0.0000	0.0669	0.0000	0.0000	0.0000	**0.0669**
Edgemere	15954	300	Public	0.0000	0.0000	0.0691	0.0000	0.0000	0.0000	**0.0691**
Edgemere	15954	310	Public	0.0000	0.0000	0.0691	0.0000	0.0000	0.0000	**0.0691**
Edgemere	15954	330	Public	0.0000	0.0000	0.1930	0.0000	0.0000	0.0000	**0.1930**
Edgemere	15954	510	Public	0.0000	0.0000	0.0622	0.0000	0.0000	0.0000	**0.0622**
Edgemere	15954	520	Public	0.0000	0.0000	0.0578	0.0000	0.0000	0.0000	**0.0578**
Edgemere	15954	530	Public	0.0000	0.0000	0.0578	0.0000	0.0000	0.0000	**0.0578**
Edgemere	15954	540	Private	0.0000	0.0000	0.0890	0.0000	0.0000	0.0000	**0.0890**
Edgemere	15954	560	Public	0.0000	0.0000	0.0235	0.0000	0.0000	0.0000	**0.0235**
Edgemere	15954	1310	Public	0.0000	0.0000	0.0230	0.0000	0.0000	0.0000	**0.0230**
Edgemere	15955	30	Public	0.0000	0.0656	0.8986	0.1900	0.0000	0.0000	**0.9642**
Edgemere	15960	600	Public	0.0000	2.1418	1.6734	0.2200	0.0000	0.0000	**3.8152**
Edgemere	15961	610	Public	0.0000	0.0213	0.0543	0.0000	0.0000	0.0000	**0.0756**
Edgemere	15961	630	Public	0.0000	0.0468	0.1838	0.0000	0.0000	0.0000	**0.2306**
Edgemere	15961	680	Private	0.0000	0.0000	0.0425	0.0000	0.0000	0.0000	**0.0425**
Edgemere	15961	690	Private	0.0000	0.0000	0.0217	0.0000	0.0000	0.0000	**0.0217**
Edgemere	15961	700	Private	0.0000	0.0000	0.0397	0.0000	0.0000	0.0000	**0.0397**
Edgemere	15961	720	Private	0.0000	0.0000	0.0832	0.0000	0.0000	0.0000	**0.0832**
Edgemere	15961	740	Private	0.0000	0.0042	0.0822	0.0000	0.0000	0.0000	**0.0865**
Edgemere	15961	760	Private	0.0000	0.0000	0.0808	0.0000	0.0000	0.0000	**0.0808**
Edgemere	15961	780	Public	0.0000	0.0000	0.0520	0.0000	0.0000	0.0000	**0.0520**
Edgemere	15961	790	Private	0.0000	0.0000	0.0188	0.0000	0.0000	0.0000	**0.0188**
Edgemere	15961	800	Private	0.0000	0.0000	0.0197	0.0000	0.0000	0.0000	**0.0197**
Edgemere	15961	810	Private	0.0000	0.0000	0.0401	0.0000	0.0000	0.0000	**0.0401**
Edgemere	15961	830	Public	0.0000	0.0000	0.0878	0.0000	0.0000	0.0000	**0.0878**
Edgemere	15961	850	Public	0.0000	0.0000	0.0885	0.0000	0.0000	0.0000	**0.0885**
Edgemere	15961	870	Public	0.0000	0.0000	0.0484	0.0000	0.0000	0.0000	**0.0484**
Edgemere	15961	880	Private	0.0000	0.0000	0.0271	0.0000	0.0000	0.0000	**0.0271**
Edgemere	15961	920	Private	0.0000	0.0000	0.0106	0.0000	0.0000	0.0000	**0.0106**
Edgemere	15961	940	Private	0.0000	0.0000	0.0106	0.0000	0.0000	0.0000	**0.0106**
Edgemere	15961	950	Public	0.0000	0.0000	0.0622	0.0000	0.0000	0.0000	**0.0622**

Edgemere	15961	970	Public	0.0000	0.0000	0.0525	0.0000	0.0000	0.0000	**0.0525**
Edgemere	15961	1000	Public	0.0000	0.0000	0.0529	0.0000	0.0000	0.0000	**0.0529**
Edgemere	15961	1020	Private	0.0000	0.0000	0.0454	0.0000	0.0000	0.0000	**0.0454**
Edgemere	15961	1030	Private	0.0000	0.0000	0.0656	0.0000	0.0000	0.0000	**0.0656**
Edgemere	15961	1040	Private	0.0000	0.0000	0.1286	0.0000	0.0000	0.0000	**0.1286**
Edgemere	15961	1100	Public	0.0000	1.9041	0.4469	0.0000	0.0000	0.0000	**2.3509**
Edgemere	15962	70	Public	0.0000	0.0000	0.0115	0.0000	0.0000	0.0000	**0.0115**
Edgemere	15962	90	Public	0.0000	0.0000	0.0407	0.0000	0.0000	0.0000	**0.0407**
Edgemere	15962	100	Public	0.0000	0.0000	0.0407	0.0000	0.0000	0.0000	**0.0407**
Edgemere	15962	110	Public	0.0000	0.0000	0.0326	0.0000	0.0000	0.0000	**0.0326**
Edgemere	15962	140	Public	0.0000	0.0000	0.0814	0.0000	0.0000	0.0000	**0.0814**
Edgemere	15962	150	Public	0.0000	0.0000	0.0465	0.0000	0.0000	0.0000	**0.0465**
Edgemere	15962	170	Public	0.0000	0.0000	0.0249	0.0000	0.0000	0.0000	**0.0249**
Edgemere	15962	190	Public	0.0000	0.0000	0.2748	0.0000	0.0000	0.0000	**0.2748**
Edgemere	15962	280	Public	0.0000	0.0000	0.0603	0.0000	0.0000	0.0000	**0.0603**
Edgemere	15962	300	Public	0.0000	0.0000	0.1227	0.0000	0.0000	0.0000	**0.1227**
Edgemere	15962	330	Public	0.0000	0.0000	0.1815	0.0000	0.0000	0.0000	**0.1815**
Edgemere	15962	450	Private	0.0000	0.0000	0.0187	0.0000	0.0000	0.0000	**0.0187**
Edgemere	15962	460	Private	0.0000	0.0000	0.0539	0.0000	0.0000	0.0000	**0.0539**
Edgemere	15962	480	Private	0.0000	0.0000	0.0024	0.0000	0.0000	0.0000	**0.0024**
Edgemere	15962	490	Private	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	**0.0002**
Edgemere	15962	500	Private	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	**0.0003**
Edgemere	15962	510	Private	0.0000	0.0000	0.0082	0.0000	0.0000	0.0000	**0.0082**
Edgemere	15962	540	Public	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	**0.0011**
Edgemere	15963	10	Public	0.0000	0.6430	0.1080	0.0000	0.0000	0.0000	**0.7510**
Edgemere	15963	400	Public	0.0000	0.0297	0.0096	0.0000	0.0000	0.0000	**0.0394**
Edgemere	15963	410	Public	0.0000	0.0010	0.0384	0.0000	0.0000	0.0000	**0.0394**
Edgemere	15963	420	Public	0.0000	0.0000	0.0394	0.0000	0.0000	0.0000	**0.0394**
Edgemere	15963	430	Public	0.0000	0.0000	0.0396	0.0000	0.0000	0.0000	**0.0396**
Edgemere	15963	440	Public	0.0000	0.0000	0.0299	0.0000	0.0000	0.0000	**0.0299**
Edgemere	15963	530	Private	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**

Edgemere	15963	540	Public	0.0000	0.0000	0.0209	0.0000	0.0000	0.0000	**0.0209**
Edgemere	15963	550	Public	0.0000	0.0000	0.0139	0.0000	0.0000	0.0000	**0.0139**
Edgemere	15964	500	Private	0.0000	0.0000	0.0316	0.0000	0.0000	0.0000	**0.0316**
Edgemere	15964	510	Private	0.0000	0.0000	0.0202	0.0000	0.0000	0.0000	**0.0202**
Edgemere	15964	540	Private	0.0000	0.0000	0.0094	0.0000	0.0000	0.0000	**0.0094**
Edgemere	15964	550	Public	0.0000	0.0170	0.2239	0.0000	0.0000	0.0000	**0.2408**
Edgemere	15964	580	Public	0.0000	0.0000	0.1730	0.0000	0.0000	0.0000	**0.1730**
Edgemere	15964	590	Private	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	**0.0001**
Edgemere	15964	1520	Private	0.0000	0.0000	0.0343	0.0000	0.0000	0.0000	**0.0343**
Edgemere	15970	240	Private	0.0000	0.0000	0.0582	0.0000	0.0000	0.0000	**0.0582**
Edgemere	15970	250	Public	0.0000	0.0000	0.1107	0.0000	0.0000	0.0000	**0.1107**
Edgemere	15970	270	Public	0.0000	0.0000	0.2215	0.0000	0.0000	0.0000	**0.2215**
Edgemere	15970	320	Private	0.0000	0.0000	0.2215	0.0000	0.0000	0.0000	**0.2215**
Edgemere	15971	10	Public	0.0000	0.0000	0.0697	0.1500	0.0000	0.0000	**0.0697**
Edgemere	15971	50	Private	0.0000	0.0000	0.1271	0.0400	0.0000	0.0000	**0.1271**
Edgemere	15971	80	Private	0.0000	0.0000	0.1107	0.0000	0.0000	0.0000	**0.1107**
Edgemere	15971	100	Private	0.0000	0.0000	0.2271	0.0200	0.0000	0.0000	**0.2271**
Edgemere	15971	140	Private	0.0000	0.0000	0.0877	0.0000	0.0000	0.0000	**0.0877**
Edgemere	15971	160	Public	0.0000	0.0000	0.0865	0.0000	0.0000	0.0000	**0.0865**
Edgemere	15971	170	Private	0.0000	0.0000	0.1154	0.0000	0.0000	0.0000	**0.1154**
Edgemere	15971	190	Private	0.0000	0.0000	0.1154	0.0000	0.0000	0.0000	**0.1154**
Edgemere	15971	210	Public	0.0000	0.0000	0.1754	0.0000	0.0000	0.0000	**0.1754**
Edgemere	15971	1000	Public	0.0000	0.0000	0.0802	0.0000	0.0000	0.0000	**0.0802**
Edgemere	15977	10	Private	0.0000	0.0000	0.0022	0.0000	0.0000	0.0000	**0.0022**
Edgemere	15977	500	Public	0.0000	0.0047	0.7373	0.0000	0.0000	0.0000	**0.7420**
Hammels	16080	370	Private	0.0000	0.0000	0.0325	0.0000	0.0000	0.0000	**0.0325**
Hammels	16100	140	Private	0.0000	0.0000	1.1136	0.0000	0.0000	0.0000	**1.1136**
Hammels	16100	180	Private	0.0000	0.0000	0.3052	0.0000	0.0000	0.0000	**0.3052**
Hammels	16100	200	Private	0.0000	0.0000	0.8188	0.0100	0.0000	0.0000	**0.8188**
Hammels	16100	240	Private	0.0000	0.0000	0.2793	0.1400	0.0000	0.0000	**0.2793**
Hammels	16100	280	Public	0.0000	0.0000	0.0452	0.0000	0.0000	0.0000	**0.0452**

Hammels	16100	290	Private	0.0000	0.0000	0.0511	0.0500	0.0000	0.0000	**0.0511**
Hammels	16100	330	Private	0.0000	0.0000	0.0887	0.0000	0.0000	0.0000	**0.0887**
Hammels	16100	340	Public	0.0000	0.0000	0.1994	0.0000	0.0000	0.0000	**0.1994**
Hammels	16100	850	Private	0.0000	0.0000	0.0984	0.0000	0.0000	0.0000	**0.0984**
Hammels	16100	1750	Public	0.0000	0.0000	0.0691	0.0000	0.0000	0.0000	**0.0691**
Hammels	16103	700	Public	0.0000	0.0000	0.6190	0.0000	0.0000	0.0000	**0.6190**
Hammels	16103	940	Private	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	**0.0018**
Hammels	16103	960	Private	0.0000	0.0000	0.1076	0.0000	0.0000	0.0000	**0.1076**
Hammels	16103	990	Private	0.0000	0.0000	0.0076	0.0000	0.0000	0.0000	**0.0076**
Hammels	16103	1020	Private	0.0000	0.0000	0.0156	0.0000	0.0000	0.0000	**0.0156**
Hammels	16103	1400	Public	0.0000	0.0000	0.2694	0.0000	0.0000	0.0000	**0.2694**
Hammels	16103	2000	Public	0.0000	0.0000	0.0072	0.0000	0.0000	0.0000	**0.0072**
Hammels	16110	100	Private	0.0000	0.0000	0.0031	0.0000	0.0000	0.0000	**0.0031**
Hammels	16110	130	Private	0.0000	0.0000	0.0375	0.0000	0.0000	0.0000	**0.0375**
Hammels	16110	150	Private	0.0000	0.0000	0.0815	0.0000	0.0000	0.0000	**0.0815**
Hammels	16110	170	Private	0.0000	0.0000	0.7810	0.0000	0.0000	0.0000	**0.7810**
Hammels	16110	230	Public	0.0000	0.0000	0.1554	0.0000	0.0000	0.0000	**0.1554**
Hammels	16110	300	Private	0.0000	0.0000	0.1106	0.0000	0.0000	0.0000	**0.1106**
Hammels	16110	450	Private	0.0000	0.0000	0.0072	0.0000	0.0000	0.0000	**0.0072**
Hammels	16110	510	Private	0.0000	0.0000	0.0273	0.0000	0.0000	0.0000	**0.0273**
Hammels	16110	530	Private	0.0000	0.0000	0.0392	0.0000	0.0000	0.0000	**0.0392**
Hammels	16110	550	Private	0.0000	0.0000	0.1021	0.0000	0.0000	0.0000	**0.1021**
Hammels	16110	580	Private	0.0000	0.0000	0.0077	0.0000	0.0000	0.0000	**0.0077**
Hammels	16110	590	Private	0.0000	0.0000	0.0027	0.0000	0.0000	0.0000	**0.0027**
Hammels	16110	890	Private	0.0000	0.0000	0.0106	0.0000	0.0000	0.0000	**0.0106**
Hammels	16110	1040	Private	0.0000	0.0000	0.2501	0.0000	0.0000	0.0000	**0.2501**
Hammels	16110	1170	Private	0.0000	0.0000	0.1214	0.0000	0.0000	0.0000	**0.1214**
Hammels	16110	1500	Public	0.0000	0.0000	0.2431	0.0000	0.0000	0.0000	**0.2431**
Hammels	16110	1580	Private	0.0000	0.0000	0.0038	0.0000	0.0000	0.0000	**0.0038**
Hammels	16110	1590	Private	0.0000	0.0000	0.0013	0.0000	0.0000	0.0000	**0.0013**
Hammels	16110	2010	Private	0.0000	0.0000	0.2189	0.1700	0.0000	0.0001	**0.2190**

Hammels	16110	2060	Private	0.0000	0.0000	0.3412	0.0100	0.0000	0.0000	**0.3412**
Lawrence	335	58	Public	0.0000	0.0000	0.0513	0.0000	0.0000	0.0000	**0.0514**
Lawrence	335	108	Private	0.0000	0.0000	0.0051	0.0000	0.0000	0.0000	**0.0051**
Lawrence	335	109	Private	0.0000	0.0000	0.0219	0.0000	0.0000	0.0000	**0.0219**
Lawrence	335	110	Private	0.0000	0.0000	0.0051	0.0000	0.0000	0.0000	**0.0051**
Lawrence	335	111	Private	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	**0.0003**
Lawrence	335	126	Private	0.0000	0.0000	0.0269	0.0000	0.0000	0.0000	**0.0269**
Lawrence	A	529	Public	0.0000	0.0000	0.0569	0.0000	0.0000	0.0071	**0.0640**
Lawrence	A	541	Private	0.0000	0.0000	0.0560	0.0000	0.0000	0.0000	**0.0560**
Lawrence	A	550	Private	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	**0.0009**
Lawrence	A	554	Public	0.0000	0.0000	0.0498	0.2100	0.0000	0.0158	**0.0656**
Lawrence	A	1003	Private	0.0000	0.0000	0.0768	0.0000	0.0000	0.0106	**0.0873**
Lawrence	*[None]*	*[None]*		0.0000	0.0000	0.2972	0.0000	0.0000	0.1353	***0.4325***
Hammels	*[None]*	*[None]*		0.0000	0.0000	0.9422	0.0000	0.0000	0.0019	***0.9440***
Edgemere	*[None]*	*[None]*		0.0000	5.0259	9.3368	0.0000	0.0000	0.0132	***14.3759***
Atlantic Shore	*[None]*	*[None]*		423.4928	0.0000	0.0000	0.0000	1.6990	0.0000	***425.1918***
Arverne	*[None]*	*[None]*		0.0000	13.2042	23.6400	0.2500	0.0000	0.1684	***37.0126***
Grand Total				**698.6182**	**43.6167**	**70.7330**	**2.0500**	**7.9247**	**0.6700**	**821.5626**

EXHIBIT “C”

STANDARD ESTATES

FEE EXCLUDING MINERALS (With Restriction on Use of the Surface) (Standard Estate No. 3)

The fee simple title to the land, subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; excepting and excluding all (coal) (oil and gas), in and under said land and all appurtenant rights for the exploration, development, production and removal of said (coal) (oil and gas), but without the right to enter upon or over the surface of said land for the for the purpose of exploration, development, production and removal therefrom of said (coal) (oil and gas).

FLOOD PROTECTION LEVEE EASEMENT (Standard Estate No. 9)

A perpetual and assignable right and easement in (the land described in Schedule A) (Tracts Nos, ____, ____ and ____) to construct, maintain, repair, operate, patrol and replace a flood protection (levee) (floodwall)(gate closure) (sandbag closure), including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

TEMPORARY WORK AREA EASEMENT (Standard Estate No. 15)

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____), for a period not to exceed _____, beginning with date possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the _____ Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

BANK PROTECTION EASEMENT (Standard Estate No. 21)

A perpetual and assignable easement and right-of-way in, on, over and across the land hereinafter described for the location, construction, operation, maintenance, alteration, repair, rehabilitation and replacement of a bank protection works, and for the placement of stone, riprap and other materials for the protection of the bank against erosion; together with the continuing right to trim, cut, fell, remove and dispose therefrom all trees, underbrush, obstructions, and other vegetation; and to remove and dispose of structures or obstructions within the limits of the right-of-way; and to place thereon dredged, excavated or other fill material, to shape and grade said land to desired slopes and contour, and to prevent erosion by structural and vegetative methods and to do any other work necessary and incident to the project; together with the right of ingress and egress for such work; reserving, however, to the

landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however to existing easements for public roads and highways, public utilities, railroads and pipelines.

PERPETUAL BEACH STORM DAMAGE REDUCTION EASEMENT (Standard Estate No. 26)

A perpetual and assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract No. __) for use by the (Project Sponsor), its representatives, agents, contractors, and assigns, to construct; preserve; patrol; operate; maintain; repair; rehabilitate; and replace; a public beach [a dune system] and other erosion control and storm damage reduction measures together with appurtenances thereto, including the right to deposit sand; to accomplish any alterations of contours on said land; to construct berms [and dunes]; to nourish and renourish periodically; to move, store and remove equipment and supplies; to erect and remove temporary structures; and to perform any other work necessary and incident to the construction, periodic renourishment and maintenance of the (Project Name), together with the right of public use and access; [to plant vegetation on said dunes and berms; to erect, maintain and remove silt screens and sand fences; to facilitate preservation of dunes and vegetation through the limitation of access to dune areas;] to trim, cut, fell, and remove from said land all trees, underbrush, debris, obstructions, and any other vegetation, structures and obstacles within the limits of the easement (except_____); [reserving, however, to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns, the right to construct dune overwalk structures in accordance with any applicable Federal, State or local laws or regulations, provided that such structures shall not violate the integrity of the dune in shape, dimension or function, and that prior approval of the plans and specifications for such structures is obtained from the (designated representative of the Project Sponsor) and provided further that such structures are subordinate to the construction, operation, maintenance, repair, rehabilitation and replacement of the project; and further] reserving to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns all such rights and privileges as may be used and enjoyed without interfering with or abridging the rights and easements hereby acquired; subject however to existing easements for public roads and highways, public utilities, railroads and pipelines.

EXHIBIT “D”

BASELINE COST ESTIMATE FOR REAL ESTATE

	ATLANTIC COAST OF NEW YORK EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY GRR			
	ATLANTIC COAST OF NEW YORK			
	TOTAL PROJECT REAL ESTATE COSTS	**Non-Federal**	**Federal**	**Total Cost**
	Cost Summary:			
	Incidental Costs (01A)	$324,000	$204,000	$528,000
	Real Estate Acquisition Costs (01B)	$0	$0	$0
	Subtotal:	$324,000	$204,000	$528,000
	20% Contingency, Less Land Payments (01B1)	$64,800	$40,800	$105,600
01	**LANDS AND DAMAGES**	$388,800	$244,800	**$633,600**
				-
02	**RELOCATIONS**	$0	$0	**$0**
				-
	Cost Breakdown:			-
01A	**INCIDENTAL COSTS**	**$324,000**	**$204,000**	**$528,000**
01A1	**Acquisition (Admin Costs)**	**$180,000**	**$60,000**	**$240,000**
01A1A	By Government (Gov't)			
01A1B	By Non-Federal Sponsor (NFS)	$180,000		
01A1C	By Gov't on behalf of NFS		$60,000	
01A2	**Survey**	**$36,000**	**$24,000**	**$60,000**
01A2A	By Gov't (In-house)			
01A2B	By Gov't (Contract)			
01A2C	By NFS	$36,000		
01A2D	By Gov't on behalf of NFS			
01A2E	Review of NFS		$24,000	
01A3	**Appraisal**	**$60,000**	**$36,000**	**$96,000**
01A3A	By Gov't (In-house)			
01A3B	By Gov't (Contract)			
01A3C	By NFS	$60,000		
01A3D	By Gov't on behalf of NFS			
01A3E	Review of NFS		$36,000	
01A4	**Title Services**	**$48,000**	**$24,000**	**$72,000**
01A4A	By Gov't (Contract)			
01A4B	By NFS	$48,000		
01A4C	By Gov't on behalf of NFS			
01A4D	Review of NFS		$24,000	
01A5	**Other Professional Services**	**$0**	**$0**	**$0**
01A5A	By the Gov't			
01A5B	By the NFS	$0		
01A5C	By Gov't on behalf of NFS			
01A5D	Review of NFS		$0	
01A6	**Closing Cost (4% of Land Payments-01C1)**	**$0**	**$0**	**$0**

01A6A	By Gov't			
01A6B	By NFS	$0		
01A6C	By Gov't on behalf of NFS			
01A5D	Review of NFS			
01A7	**PL 91-646 Assistance**	**$0**	**$0**	**$0**
01A7A	By Government			
01A7B	By NFS			
01A7C	By Gov't on behalf of NFS			
01A7D	Review of NFS			
01A8	**Audit**	**$0**	**$60,000**	**$60,000**
01A8A	By Gov't		$60,000	
01A9B	By NFS			
01B	**REAL ESTATE ACQUISITION COSTS**	**$0**	**$0**	**$0**
01B1	**Land Payments**	**$0**	**$0**	**$0**
01B1A	By Government			
01B1B	By NFS	$0		
01B1C	By Gov't on behalf of NFS			
01B2	**Damage Payments**	**$0**	**$0**	**$0**
01B3A	By Government			
01B3B	By NFS			
01B3C	By Gov't on behalf of NFS			
01B3	**PL 91-646 Payment**	**$0**	**$0**	**$0**
01B3A	By Government			
01B3B	By NFS			
01B3C	By Gov't on behalf of NFS			
01B4	**Condemnation**	**$0**	**$0**	**$0**
01B6A	By Government			
01B4A	By NFS	$0		
01B5	**Facility / Utility Relocations**	**$0**	**$0**	**$0**
01B5A	By NFS			
01B6	**Disposals**	**$0**	**$0**	**$0**
01B6A	By Government			
01B6B	By NFS			
01B6C	By Gov't on behalf of NFS			
02A	**RELOCATION COSTS**	**$0**	**$0**	**$0**
02A1	**Relocation Costs**			
02A1A	By Government			
02A1B	By NFS			

	ATLANTIC COAST OF NEW YORK EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY GRR			
	MID ROCKAWAY HFRRF			
	TOTAL PROJECT REAL ESTATE COSTS	**Non-Federal**	**Federal**	**Total Cost**
	Cost Summary:			
	Incidental Costs (01A)	$3,777,418	$2,246,000	$6,023,418
	Real Estate Acquisition Costs (01B)	$9,360,456	$0	$9,360,456
	Subtotal:	$13,137,874	$2,246,000	$15,383,874
	20% Contingency, Less Land Payments (01B1)	$905,484	$449,200	$1,354,684
01	**LANDS AND DAMAGES**	$14,043,358	$2,695,200	**$16,738,558**
				-
02	**RELOCATIONS**	$0	$0	**$0**
				-
	Cost Breakdown:			-
01A	**INCIDENTAL COSTS**	**$3,777,418**	**$2,246,000**	**$6,023,418**
01A1	**Acquisition (Admin Costs)**	**$2,085,000**	**$695,000**	**$2,780,000**
01A1A	By Government (Gov't)			
01A1B	By Non-Federal Sponsor (NFS)	$2,085,000		
01A1C	By Gov't on behalf of NFS		$695,000	
01A2	**Survey**	**$417,000**	**$278,000**	**$695,000**
01A2A	By Gov't (In-house)			
01A2B	By Gov't (Contract)			
01A2C	By NFS	$417,000		
01A2D	By Gov't on behalf of NFS			
01A2E	Review of NFS		$278,000	
01A3	**Appraisal**	**$375,000**	**$300,000**	**$675,000**
01A3A	By Gov't (In-house)			
01A3B	By Gov't (Contract)			
01A3C	By NFS	$375,000		
01A3D	By Gov't on behalf of NFS			
01A3E	Review of NFS		$300,000	
01A4	**Title Services**	**$556,000**	**$278,000**	**$834,000**
01A4A	By Gov't (Contract)			
01A4B	By NFS	$556,000		
01A4C	By Gov't on behalf of NFS			
01A4D	Review of NFS		$278,000	
01A5	**Other Professional Services**	**$0**	**$0**	**$0**
01A5A	By the Gov't			
01A5B	By the NFS			
01A5C	By Gov't on behalf of NFS			
01A5D	Review of NFS		$0	

01A6	**Closing Cost (4% of Land Payments-01C1)**	**$344,418**	**$0**	**$344,418**
01A6A	By Gov't			
01A6B	By NFS	$344,418		
01A6C	By Gov't on behalf of NFS			
01A5D	Review of NFS			
01A7	**PL 91-646 Assistance**	**$0**	**$0**	**$0**
01A7A	By Government			
01A7B	By NFS			
01A7C	By Gov't on behalf of NFS			
01A7D	Review of NFS			
01A8	**Audit**	**$0**	**$695,000**	**$695,000**
01A8A	By Gov't		$695,000	
01A9B	By NFS			
01B	**REAL ESTATE ACQUISITION COSTS**	**$9,360,456**	**$0**	**$9,360,456**
01B1	**Land Payments**	**$8,610,456**	**$0**	**$8,610,456**
01B1A	By Government			
01B1B	By NFS	$8,610,456		
01B1C	By Gov't on behalf of NFS			
01B2	**Damage Payments**	**$0**	**$0**	**$0**
01B3A	By Government			
01B3B	By NFS			
01B3C	By Gov't on behalf of NFS			
01B3	**PL 91-646 Payment**	**$0**	**$0**	**$0**
01B3A	By Government			
01B3B	By NFS			
01B3C	By Gov't on behalf of NFS			
01B4	**Condemnation**	**$750,000**	**$0**	**$750,000**
01B6A	By Government			
01B4A	By NFS	$750,000		
01B5	**Facility / Utility Relocations**	**$0**	**$0**	**$0**
01B5A	By NFS			
01B6	**Disposals**	**$0**	**$0**	**$0**
01B6A	By Government			
01B6B	By NFS			
01B6C	By Gov't on behalf of NFS			
02A	**RELOCATION COSTS**	**$0**	**$0**	**$0**
02A1	**Relocation Costs**			
02A1A	By Government			

02A1B	By NFS			

	ATLANTIC COAST OF NEW YORK EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY GRR			
	CEDARHURST-LAWRENCE HFRRF			
	TOTAL PROJECT REAL ESTATE COSTS	**Non-Federal**	**Federal**	**Total Cost**
	Cost Summary:			
	Incidental Costs (01A)	$166,249	$97,000	$263,249
	Real Estate Acquisition Costs (01B)	$546,227	$0	$546,227
	Subtotal:	$712,476	$97,000	$809,476
	20% Contingency, Less Land Payments (01B1)	$41,250	$19,400	$60,650
01	**LANDS AND DAMAGES**	$753,726	$116,400	**$870,126**
				-
02	**RELOCATIONS**	$0	$0	**$0**
				-
	Cost Breakdown:			-
01A	**INCIDENTAL COSTS**	**$166,249**	**$97,000**	**$263,249**
01A1	**Acquisition (Admin Costs)**	**$82,500**	**$27,500**	**$110,000**
01A1A	By Government (Gov't)			
01A1B	By Non-Federal Sponsor (NFS)	$82,500		
01A1C	By Gov't on behalf of NFS		$27,500	
01A2	**Survey**	**$16,500**	**$11,000**	**$27,500**
01A2A	By Gov't (In-house)			
01A2B	By Gov't (Contract)			
01A2C	By NFS	$16,500		
01A2D	By Gov't on behalf of NFS			
01A2E	Review of NFS		$11,000	
01A3	**Appraisal**	**$25,000**	**$20,000**	**$45,000**
01A3A	By Gov't (In-house)			
01A3B	By Gov't (Contract)			
01A3C	By NFS	$25,000		
01A3D	By Gov't on behalf of NFS			
01A3E	Review of NFS		$20,000	
01A4	**Title Services**	**$22,000**	**$11,000**	**$33,000**
01A4A	By Gov't (Contract)			
01A4B	By NFS	$22,000		
01A4C	By Gov't on behalf of NFS			
01A4D	Review of NFS		$11,000	
01A5	**Other Professional Services**	**$0**	**$0**	**$0**
01A5A	By the Gov't			
01A5B	By the NFS			
01A5C	By Gov't on behalf of NFS			
01A5D	Review of NFS		$0	

01A6	**Closing Cost (4% of Land Payments-01C1)**	**$20,249**	**$0**	**$20,249**
01A6A	By Gov't			
01A6B	By NFS	$20,249		
01A6C	By Gov't on behalf of NFS			
01A5D	Review of NFS			
01A7	**PL 91-646 Assistance**	**$0**	**$0**	**$0**
01A7A	By Government			
01A7B	By NFS			
01A7C	By Gov't on behalf of NFS			
01A7D	Review of NFS			
01A8	**Audit**	**$0**	**$27,500**	**$27,500**
01A8A	By Gov't		$27,500	
01A9B	By NFS			
01B	**REAL ESTATE ACQUISITION COSTS**	**$546,227**	**$0**	**$546,227**
01B1	**Land Payments**	**$506,227**	**$0**	**$506,227**
01B1A	By Government			
01B1B	By NFS	$506,227		
01B1C	By Gov't on behalf of NFS			
01B2	**Damage Payments**	**$0**	**$0**	**$0**
01B3A	By Government			
01B3B	By NFS			
01B3C	By Gov't on behalf of NFS			
01B3	**PL 91-646 Payment**	**$0**	**$0**	**$0**
01B3A	By Government			
01B3B	By NFS			
01B3C	By Gov't on behalf of NFS			
01B4	**Condemnation**	**$40,000**	**$0**	**$40,000**
01B6A	By Government			
01B4A	By NFS	$40,000		
01B5	**Facility / Utility Relocations**	**$0**	**$0**	**$0**
01B5A	By NFS			
01B6	**Disposals**	**$0**	**$0**	**$0**
01B6A	By Government			
01B6B	By NFS			
01B6C	By Gov't on behalf of NFS			
02A	**RELOCATION COSTS**	**$0**	**$0**	**$0**
02A1	**Relocation Costs**			

02A1A	By Government			
02A1B	By NFS			

EXHIBIT “E”

NON-FEDERAL SPONSOR CAPABILITY ASSESSMENT CHECKLIST

ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY

EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY
GENERAL REFORMULATION REPORT

I. Legal Authority.

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? Yes, the State can obtain the authority but intends to have the local sponsor, NYC, obtain the property amicably and through condemnation as necessary. This will be detailed in their local agreement. The local sponsor intends to obtain the legal authority to acquire real property by completing their local Uniform Land Use Review Procedure (ULERP) process. This may be an issue if NYC acquires title in its own name and the PPA ultimately requires the State to certify the real estate.

b. Does the sponsor have the power of eminent domain for this project? Yes

c. Does the sponsor have "quick-take" authority for this project? Yes

d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? No

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? Yes, federally owned property under control of the National Park Service. USACE will work with NPS to identify appropriate legal authority or instrumentation to authorize construction of the Project on NPS property.

II. Human Resource Requirements.

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? No

b. If the answer to II.a is "yes," has a reasonable plan been developed to provide such training?

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? Yes

d. Is the sponsor's projected in-house staffing level sufficient considering its other workload, if any, and the project schedule? Yes

e. Can the sponsor obtain contractor support, if required in a timely fashion? Yes

f. Will the sponsor likely request USACE assistance in acquiring real estate? No

III. Other Project Variables.

a. Will the sponsor's staff be located within reasonable proximity to the project site? Yes, local sponsor offices located in Manhattan.

b. Has the sponsor approved the project/real estate schedule/milestones? Not yet.

IV. Overall Assessment.

a. Has the sponsor performed satisfactorily on other USACE projects? Yes

b. With regard to this project, the sponsor is anticipated to be: highly capable/fully capable/moderately capable/marginally capable/insufficiently capable. If sponsor is believed to be "insufficiently capable," provide explanation. Highly capable

V. Coordination.

a. Has this assessment been coordinated with the sponsor? Yes

b. Does the sponsor concur with this assessment? Yes

Concur:

Susan D. McCormick 12/4/18
Susan D. McCormick, P.E.
Chief, Coastal Erosion Management Program
New York State Department of Environmental Conservation

Reviewed and approved by:

Susan L. Goding
Acting Chief of Real Estate Division
Real Estate Contracting Officer
New York District Corps of Engineers

EXHIBIT “F”

NOTIFICATION TO NON-FEDERAL SPONSOR

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix F

Public Access Plan

December 2018

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

Final General Reevaluation Report and Environmental Impact Statement

Public Access Plan

1 EXECUTIVE SUMMARY

The purpose of this public access plan is to describe how the public will access areas where sand will be placed, or future renourishment will take place, as a result of the implementation of the Recommended Plan proposed in the Atlantic Coast of NY, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS). In order for the project to be consistent with the State of New York Coastal Management Program policies, public access is required. Furthermore, public access is a prerequisite to federal financial participation in the protection of shores and beaches, whether they are privately owned or public (33 USC 426e, 33 USC 2213(d)). The USACE requirements for establishing conditions of sufficient public use and access are defined in ER 1165-2-130, paragraph 6h and sufficient parking and/or public transportation access must be provided within ¼ mile of beach access points in order to meet the federal requirement for public access. A series of maps showing beach access points, public parking areas, and nearby public transit services are presented in Figures 1-4. These figures demonstrate that the requirement for public access has been met to meet both federal and state requirements.

2 SCOPE

The primary geographical scope of this public access plan extends for approximately six miles of municipally-owned Rockaway Beach; from the eastern boundary at Beach 19th Street, to the western boundary at Beach 149th Street. Dependent on the selected tie- in measures for the final recommended plan as proposed in the HSGRR, the scope may also extend west along the beach from Beach 149th Street to Beach 193rd Street and from Beach 193rd Street to the tip of the Rockaway Peninsula (Rockaway Point) just south of Breezy Point.

3 PROPERTY OWNERSHIP

Areas of sand placement or renourishment under the HSGRR that are included in the public access plans discussed above include Rockaway Beach, which is owned in its entirety by the City of New York under their Department of Parks & Recreation.

4 PUBLIC USE

As a result of an agreement between the Department of Environmental Conservation (Department) of the State of New York and the City of New York (City) entitled, “The Atlantic Coast of New

York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York Shoreline Protection Project," Agreement #C003373 dated May 25, 1995, the City "shall maintain for the duration of the economic life of the Project, continued public ownership of the publicly owned shores and their administration for public use." This agreement indicates the Rockaway Beach property is available for use by the general public. There are no residency restrictions.

5 ACCESS WAYS AND DUNE WALKOVER STRUCTURES

At Beach 19th Street, an existing at-grade vehicle access point from the boardwalk will be maintained to facilitate both vehicular and pedestrian access. Between Beach 20th Street and Beach 126th Street, there are 66 ramps and 47 stairs from the street to the boardwalk and 41 ramps and 33 stairs from the boardwalk to the beach.

Currently between Beach 126th Street and Beach 149th Street, there are 24 dune walkover beach mats (mobi-mats) that begin at each street end that provide access to the beach. When construction of the final recommended plan under the HSGRR is completed in this area, these mobi-mats will removed and elevated dune walkover structures will be constructed to provide access over the dune to the beach. Beach access for wheelchairs is located at Beach 17th, 60th, 67th, 74th, 81st, 84th, 108th, 113th, 121st, 124th, 131st, 133rd, and 137th. Six (6) beach wheelchairs available for use are located at Beach 86th Street and the Shorefront Parkway (Beach Operations Office).

Number of Access ways: There are a total of approximately 211 access ways between Beach 19th Street and Beach 149th Street.

Ownership and Use: Ownership of all access ways and elevated dune walkover structures will rest with the City of New York through their Department of Parks & Recreation. The use of the access ways shall be in accordance with the City of New York ordinance code.

Dune Walkover Structures: Elevated dune walkover structures will be located at public access ways and oriented over the dune to protect and maintain the integrity and stability of the dune. The design of the elevated walkover structures will take into account the anticipated pedestrian traffic of the area.

6 PARKING ACCOMMODATIONS

Vehicle parking is available in various parking areas and side streets off of Seagirt Boulevard, Edgemere Avenue, Rockaway Beach Boulevard, Beach Front Road and Shore Front Parkway from Beach 19th Street to Beach 116th Street, including but not limited to; Beach 19th, Crest Road, Beach 24th (east side), Beach 26th (east side), Beach 29th, Beach 32nd Street, Beach 40th, Beach 50th, Beach 56th Place, Beach 59th Street Playground, Beach 73rd, Beach 77th, Beach 81st, Beach 84th, Beach 90th, Beach 94th and 95th, Beach 102nd, Beach 105th, and Beach 108th Street. Parking is first-come, first-serve and some side streets and parking areas in this stretch are metered and/or have parking restrictions during certain days and times due to sanitation schedules, school days, etc. Parking is permitted along the north side of Shore Front Parkway only. There are no residency restrictions. The current hourly rate for metered parking is $1.00 per hour from Monday through Saturday; Sundays are free. Free New York City Parks Department parking lots are available from Beach 11th to Beach 15th Streets, and between Beach 94th and 95th Streets.

Public municipal parking is also available at the Rockaway Park Municipal Parking Field located at 248 Beach 116th Street (between Beach Channel Drive and Rockaway Beach Blvd, at

Rockaway Park A Train Terminal). There are 148 parking spaces, (including 6 spaces for people with disabilities) and is open year round Monday to Saturday, 8 am to 10 pm. The parking field is a pay and display facility and accepts quarters, dollar coins, NYC Parking Cards and credit cards. Rates are 25 cents per 15 minutes, four hour limit (44 spaces, including 6 spaces for people with disabilities) and 25 cents per 15 minutes, $8 max, 14 hour limit (104 spaces). The municipal parking area is within one-quarter mile of the street end at Beach 116th street and access to the boardwalk and the beach. This complies with the Department of the Army, Engineer Regulation (ER) 1165-2-130, paragraph 6h.2 and paragraph 6h.3. There are no residency restrictions.

There is limited public vehicle parking along Rockaway Beach Boulevard and the side streets from Beach 116th Street to Beach 149th Street. However, there are several public transportation (bus route) stops along this stretch that complies with the Department of the Army, Engineer Regulation (ER) 1165-2-130, paragraph 6h.2 and paragraph 6h.3. Additional detail on public transportation options are listed in the following section.

7 PUBLIC TRANSIT

The Metropolitan Transportation Authority (MTA) provides access to Rockaway Beach via several elevated subway lines and bus routes. New York City Transit's A line provides service to eastern stretches of Rockaway Beach via the Far Rockaway-Mott Avenue branch. Stations within one half-mile of the beach on this branch include Beach 67th Street-Arverne by the Sea, Beach 60th Street-Station Avenue, Beach 44th Street, and Beach 36th Street-Edgemere. The A line also provides service to western stretches of Rockaway beach via the Rockaway Park branch. The Rockaway Park S train provides duplicate service in this area. Stations within one half-mile of the beach on these branches include Beach 90th Street, Beach 98th Street-Playland, Beach 105th Street-Seaside, and Rockaway Park-Beach 116th Street. The fare for these subway lines is $2.75.

The MTA's New York City Transit (NYCT) and Nassau Inter-County Express (NICE) bus lines that provide access to Rockaway Beach include Q114, Q113, Q53 SBS, Q52 SBS, Q35, Q22, QM17, QM16, N33, N32, N31. The following table includes descriptions of the service provided by the aforementioned routes.

Bus Route	Access From	Beach Access	Bus Operator	Fare
Q114	Jamaica, Queens	Beach 9th to Beach 20th Streets	NYCT	$2.75
Q113	Jamaica, Queens	Beach 9th to Beach 20th Streets	NYCT	$2.75
Q53 SBS	Woodside, Queens	Beach 95th to Beach 116th Streets	NYCT	$2.75
Q52 SBS	Elmhurst, Queens	Beach 54th to Beach 95th Streets	NYCT	$2.75
Q35	Midwood, Brooklyn	Beach 116th Street to Jacob Riis Park	NYCT	$2.75
Q22	Far Rockaway, Queens	Beach 20th to Beach 169th Streets	NYCT	$2.75
QM17 Expr	Midtown Manhattan	Beach 19th to Beach 95th Streets	NYCT	$6.50
QM16 Expr	Midtown Manhattan	Beach 95th Street to Jacob Riis Park	NYCT	$6.50
N33	Long Beach, NY	Beach 9th to Beach 20th Streets	NICE	$2.75
N32	Hempstead, NY	Beach 20th to Beach 24th Streets	NICE	$2.75
N31	Hempstead, NY	Beach 20th to Beach 24th Streets	NICE	$2.75

Public transit access to Rockaway Beach is also available via the New York City Ferry's Rockaway route. This ferry service travels from Wall Street/Pier 11 with stops at Sunset Park,

Brooklyn and at the intersection of Beach 108th Street and Beach Channel Drive in Rockaway Park. NYC Ferry fare is $2.75.

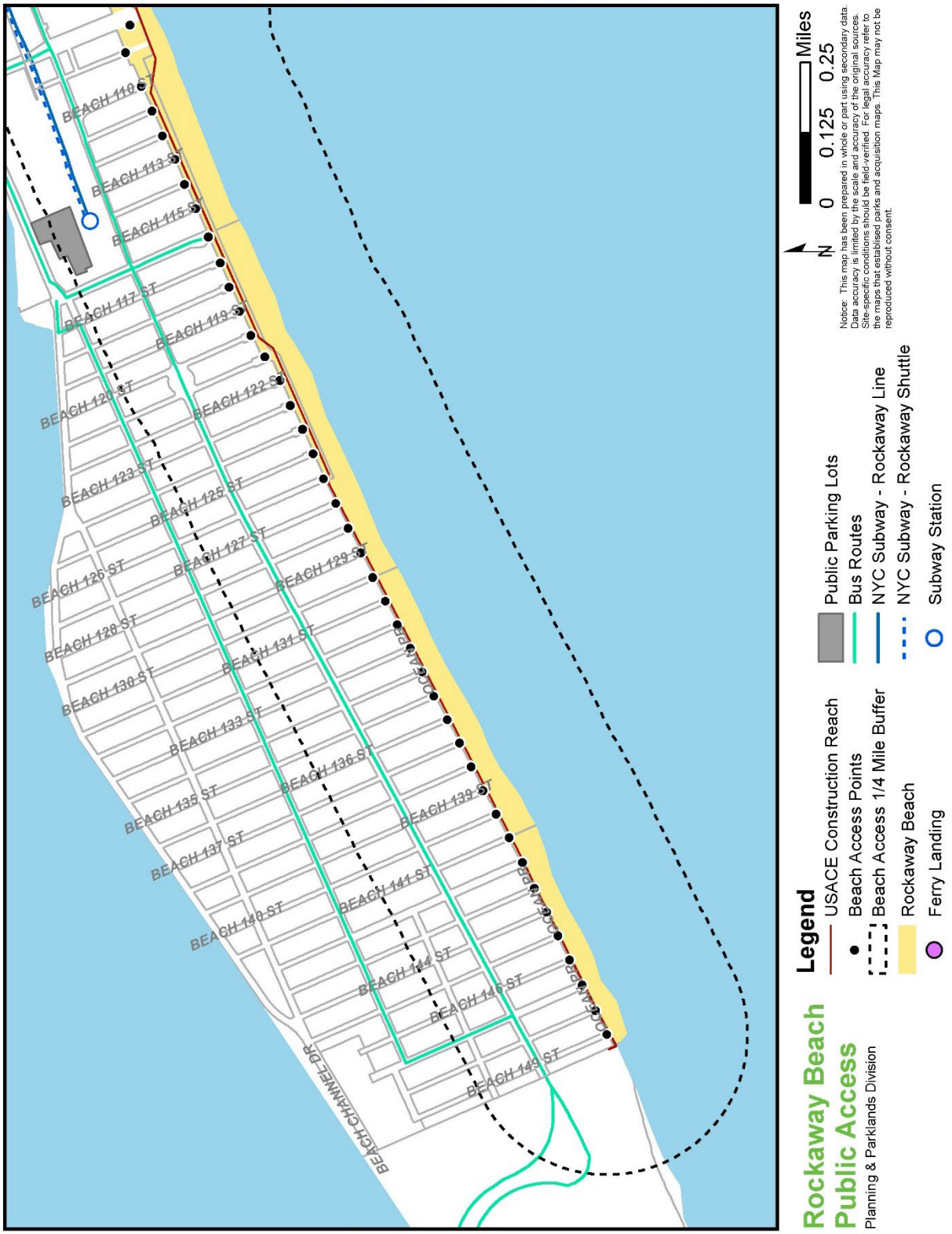

Rockaway Beach
Public Access
Planning & Parklands Division
Legend
USACE Construction Reach
Beach Access Points
Beach Access 1/4 Mile Buffer
Rockaway Beach
Ferry Landing
Public Parking Lots
Bus Routes
NYC Subway - Rockaway Line
NYC Subway - Rockaway Shuttle
Subway Station
N
0 0.125 0.25 Miles
Notice: This map has been prepared in whole or part using secondary data. Data accuracy is limited by the scale and accuracy of the original sources. Site-specific conditions should be field-verified. For legal accuracy refer to the maps that established parks and acquisition maps. This Map may not be reproduced without consent.
BEACH 110 ST
BEACH 113 ST
BEACH 115 ST
BEACH 117 ST
BEACH 119 ST
BEACH 120 ST
BEACH 122 ST
BEACH 123 ST
BEACH 125 ST
BEACH 126 ST
BEACH 127 ST
BEACH 128 ST
BEACH 129 ST
BEACH 130 ST
BEACH 131 ST
BEACH 133 ST
BEACH 135 ST
BEACH 136 ST
BEACH 137 ST
BEACH 139 ST
BEACH 140 ST
BEACH 141 ST
BEACH 144 ST
BEACH 146 ST
BEACH 149 ST
BEACH CHANNEL DR
OCEAN FRONT
OCEAN FRONT
OCEAN FRONT

Figure 1

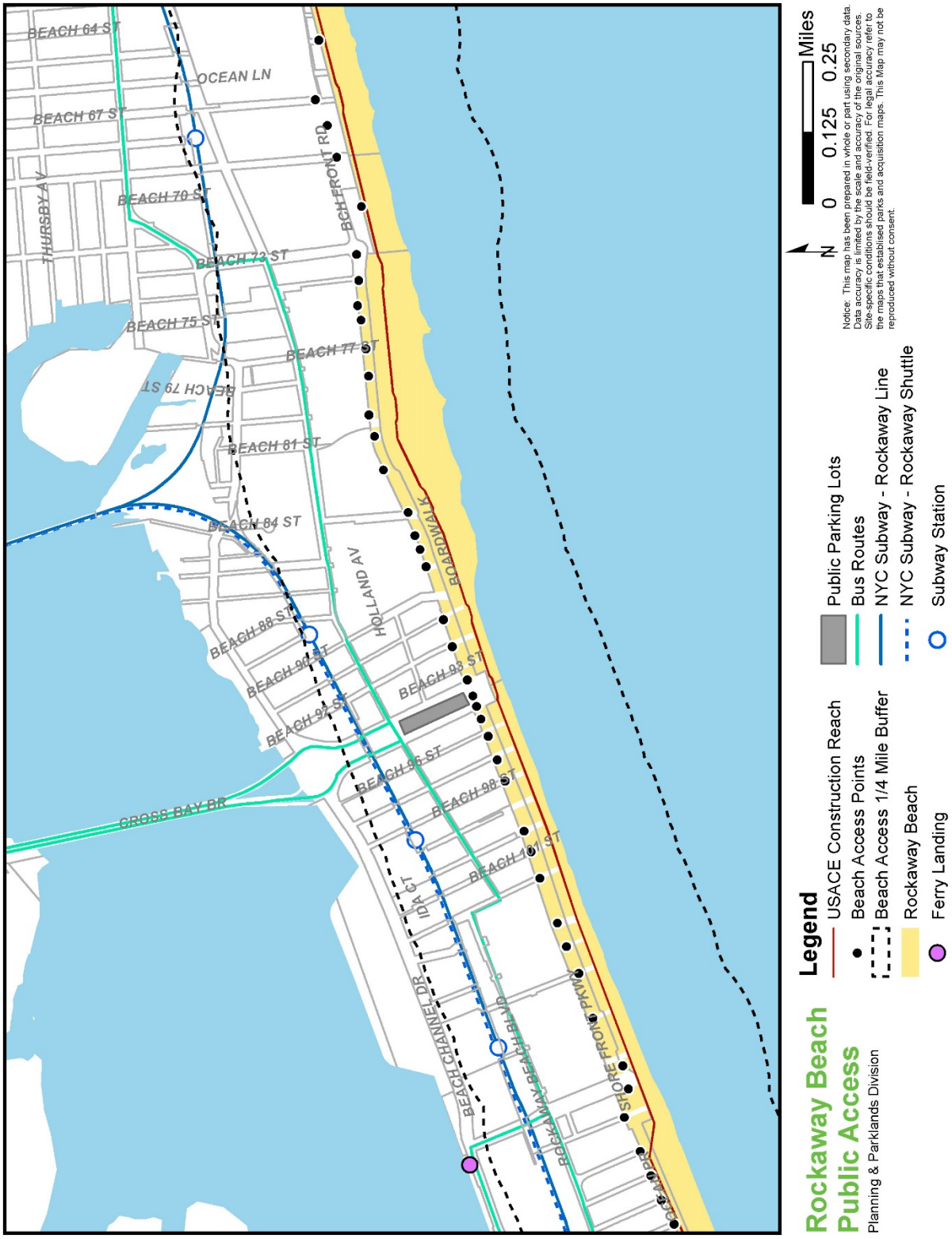

BEACH 64 ST
OCEAN LN
BEACH 67 ST
THURSBY AV
BEACH 70 ST
BCH FRONT RD
BEACH 72 ST
BEACH 75 ST
BEACH 77 ST
BEACH 79 ST
BEACH 81 ST
BEACH 84 ST
HOLLAND AV
BOARDWALK
BEACH 88 ST
BEACH 90 ST
BEACH 93 ST
BEACH 95 ST
BEACH 96 ST
BEACH 98 ST
BEACH 101 ST
CROSS BAY BR
IDA CT
BEACH CHANNEL DR
ROCKAWAY BEACH BLVD
SHORE FRONT PKWY
ROCKAWAY PT BLVD
Rockaway Beach
Public Access
Planning & Parklands Division
Legend
USACE Construction Reach
Beach Access Points
Beach Access 1/4 Mile Buffer
Rockaway Beach
Ferry Landing
Public Parking Lots
Bus Routes
NYC Subway - Rockaway Line
NYC Subway - Rockaway Shuttle
Subway Station
N
0 0.125 0.25 Miles
Notice: This map has been prepared in whole or part using secondary data. Data accuracy is limited by the scale and accuracy of the original sources. Site-specific conditions should be field-verified. For legal accuracy refer to the maps that established parks and acquisition maps. This Map may not be reproduced without consent.

Figure 2

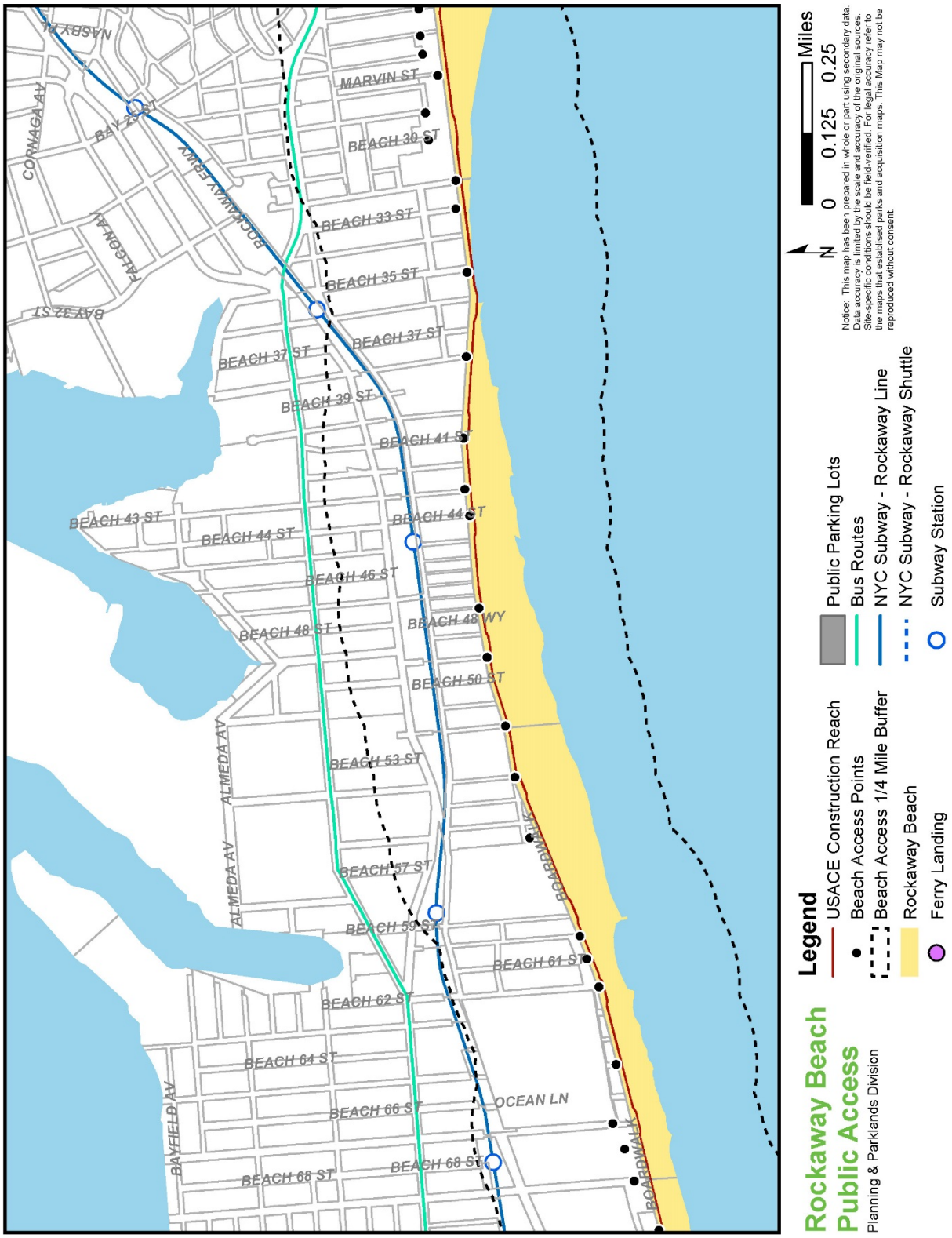

Rockaway Beach
Public Access
Planning & Parklands Division
Legend
USACE Construction Reach
Beach Access Points
Beach Access 1/4 Mile Buffer
Rockaway Beach
Ferry Landing
Public Parking Lots
Bus Routes
NYC Subway - Rockaway Line
NYC Subway - Rockaway Shuttle
Subway Station
N
0 0.125 0.25 Miles
Notice: This map has been prepared in whole or part using secondary data. Data accuracy is limited by the scale and accuracy of the original sources. Site-specific conditions should be field-verified. For legal accuracy refer to the maps that established parks and acquisition maps. This Map may not be reproduced without consent.
MARVIN ST
BEACH 30 ST
BEACH 33 ST
BEACH 35 ST
BEACH 37 ST
BEACH 39 ST
BEACH 41 ST
BEACH 43 ST
BEACH 44 ST
BEACH 46 ST
BEACH 48 ST
BEACH 48 WY
BEACH 50 ST
BEACH 53 ST
BEACH 57 ST
BEACH 59 ST
BEACH 61 ST
BEACH 62 ST
BEACH 64 ST
BEACH 66 ST
BEACH 68 ST
OCEAN LN
ALMEDA AV
BAYFIELD AV
BOARDWALK
CORNAGA AV
FALCON AV
BAY 32 ST
BAY 35 ST
NASSAU AV
ROCKAWAY FRWY

Figure 3

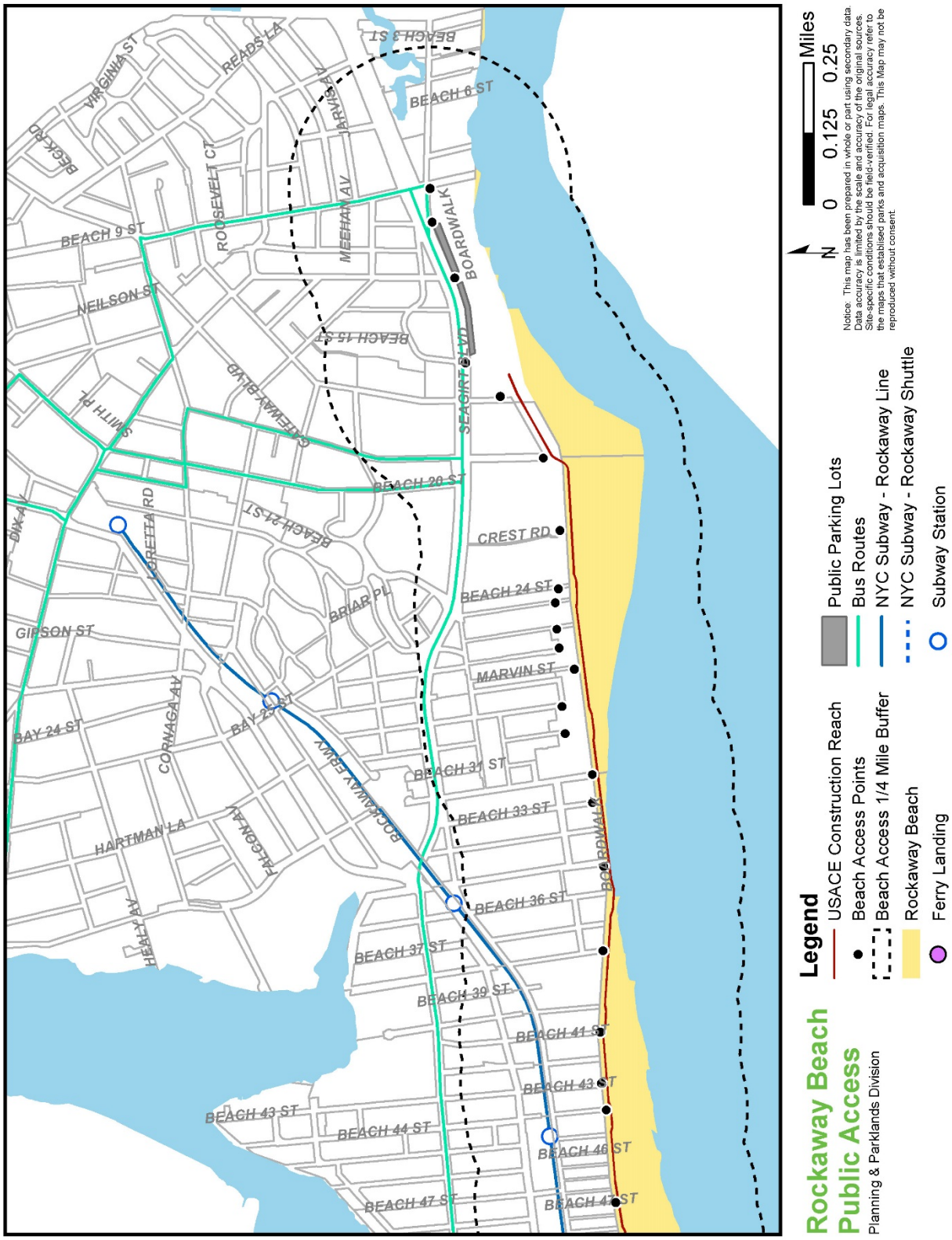

Rockaway Beach
Public Access
Planning & Parklands Division
Legend
USACE Construction Reach
Beach Access Points
Beach Access 1/4 Mile Buffer
Rockaway Beach
Ferry Landing
Public Parking Lots
Bus Routes
NYC Subway - Rockaway Line
NYC Subway - Rockaway Shuttle
Subway Station
N
0
0.125
0.25
Miles
Notice: This map has been prepared in whole or part using secondary data. Data accuracy is limited by the scale and accuracy of the original sources. Site-specific conditions should be field-verified. For legal accuracy refer to the maps that established parks and acquisition maps. This Map may not be reproduced without consent.
BEACH 6 ST
BEACH 9 ST
BEACH 15 ST
BEACH 20 ST
BEACH 21 ST
BEACH 24 ST
BEACH 31 ST
BEACH 33 ST
BEACH 36 ST
BEACH 37 ST
BEACH 39 ST
BEACH 41 ST
BEACH 43 ST
BEACH 44 ST
BEACH 46 ST
BEACH 47 ST
BEACH 3 ST
VIRGINIA ST
READS LA
BEACH RD
ROOSEVELT CT
MEEHAN AV
JARVIS LA
BOARDWALK
NEILSON ST
SMITH PL
CAFFEWAY BLVD
SEAGIRT BLVD
CRETTA RD
BRIAR PL
CREST RD
GIPSON ST
BAY 24 ST
CORNAGA AV
BAY 25 ST
ROCKAWAY FERRY
HARTMAN LA
PALSON AV
HEALY AV

Figure 4

US Army Corps of Engineers®
New York District

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix G

Public Engagement

December 2018

TABLE OF CONTENTS

SECTION 1: NOTICE OF INTENT……3

SECTION 2: PUBLIC ENGAGEMENT MEETINGS……3

SECTION 3: COMMENTS ON THE REVISED DRAFT GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT (GRR/EIS)

3.1 Agency Letters and Responses……6

3.1.1 New York City Department of Transportation……6

3.1.2 US Environmental Protection Agency……10

3.1.3 City of New York Additional Comments and Responses……14

3.1.4 National Park Service……18

3.1.5 Mayors' Office of Resiliency……24

3.1.6 Department of City Planning……25

3.1.7 Department of Environmental Protection……26

3.1.8 Department of Parks and Recreation……27

3.1.9 Department of Housing Preservation and Development……28

3.1.10 New York City Economic Development Corporation……30

3.2 Stakeholder Comments and Responses

3.2.1 Environmental Defense Fund……32

3.2.2 National Parks Conservation Association……35

3.2.3 Riverkeeper……39

3.2.4 Surfrider Foundation……48

3.2.5 Nature Conservancy……58

3.2.6 Breezy Point Cooperative……64

3.3 Public Comments and Responses on the Revised Draft GRR/EIS……66

SECTION 4: COMMENTS AND RESPONSES ON THHE 2016 GRAFT GRR/EIS

4.1 Agency Comments and Responses……131

4.2 Stakeholder Comments and Reponses……244

4.3 Public Comments and Reponses……298

1.0 NOTICE OF INTENT

A Notice of Intent (NOI) to prepare an Environmental Impact Statement for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study was issued on April 2, 2015 in the Federal Register (Volume 80, Number 63). The NOI also invited public comment on the scope of the issues and alternatives to be addressed in the draft EIS. Input was received through public meetings with both oral and written comments being provided and written comments were also submitted and considered throughout the study process.

2.0 PUBLIC ENGAGEMENT MEETINGS

Two types of public engagement are required through the National Environmental Policy Act (NEPA) process. The study team must hold a NEPA Scoping meeting to obtain public input on the scope of the study and to help gather local expertise that can be woven into the study, as well a public meeting during the public review period of the Draft Integrated Report. During the public review period, the study team meets with stakeholders and members of the public to solicit comments on the *Tentatively Selected Plan* prior to the agency decision on whether or not to finalize the recommendation. The Rockaway study team held additional public meetings throughout the scoping process and the Feasibility Study. Local elected officials also facilitated a number of public meetings where they requested and obtained participation from the Rockaway study team members in order to further the public engagement on this study.

NEPA Scoping Meetings

NEPA scoping occurred between April and June 2015. Three NEPA scoping meetings were held. The first occurred on April 22, 2015 at the Knights of Columbus 333 Beach 90th Street Rockaway Beach. The second was on April 29, 2015 at Floyd Bennett t Field 50 Aviator Road (Ryan Visitor Center, Floyd Bennett t Field). The final NEPA scoping meeting was held on June 24, 2015 at Challenge Prep Charter Academy, 704 Hartman Lane, Far Rockaway.

Public Meetings

There were seven public meetings held in 2016 to obtain feedback on the alternatives under consideration as part of the public comment period on the Draft GRR/EIS. Originally, five were scheduled, but two additional ones were subsequently held. The original five took place on October 1st, 5th, 13th, 20th, and 25th in 2016 and the two additional meeting took place on November 9 and 16, 2016.

The Wednesday October 5, 2016 meeting was held in Brooklyn at Kingsborough College, 2001 Oriental Blvd, Room C124, Brooklyn. 165 people attended and 23 comments were received after this meeting.

The Thursday October 13, 2016 meeting was held in Rockaway Beach, at Knights of Columbus 333 Beach 90th Street Rockaway Beach. 77 people attended and 20 comments were submitted.

The Wednesday October 19, 2016 meeting was held in Queens, at Knights of Columbus 135-45 Lefferts Blvd, South Ozone Park. Two people signed in and 5 comments were submitted.

The Thursday October 20, 2016 meeting was held in Rockaway Park, PS 114, 400 Beach 135th Street. 120 people attended this meeting and 70 comments were received.

The Tuesday October 25, 2016 meeting was held in Far Rockaway, Queens at Macedonia Baptist Church, 330 Beach 67th street, Arverne. 55 people attended and 19 comments were submitted.

Two additional meetings were held on November 16, 2016 for the Jamaica Bay Task Force and on November 9, 2016 at CB 13.

Some of the common concerns expressed during public scoping meetings included the sense of urgency to move forward to construction of a risk management feature. Some expressed concerns about the coordination among multiple agencies addressing CSRM issues. Other concerns included maintaining access to the water, preserving views, and balancing CSRM with environmental impacts. Specifically, there were some concerns on how public access would be handled in the project area. The public had concerns about Jamaica Bay flushing times (as in, how the water circulates within the bay and flushes pollutants out, as well as circulates oxygen within the bay). People were concerned about a potential 'bathtub effect' if circulation were to be limited by a storm surge barrier. Other concerns centered on sea level rise and wildlife that inhabit Jamaica Bay. There was concern about internal flooding from the sewer system in front of homes since the water table is so high in some areas and the sewer relies on gravity drainage. Additionally, the length of the construction period and when it would commence were also concerns. The type of barrier and how high the seawalls would be along the interior of Jamaica bay were identified as concerns. Lastly, the effect that this project will have on flood insurance for homeowners was a concern. Many people asked for more groins between 123 Street and 149 Street.

<u>Second Round of Public Engagement for the Revised Draft GRR/EIS</u>

Based on the comments received from the USACE policy review, Agency Technical Review, Independent External Peer Review, agency and public review, substantial new analysis and edits to the Draft Report were warranted, including a reformulation based on the agency decision to move further analysis of the proposed storm surge barrier to the New York and New Jersey Harbor and Tributaries Study. The Revised Draft GRR/EIS was re-released for a second public and agency review on August 31, 2018 in order to afford agencies and the public an opportunity to comment on the changes to the Recommended Plan, most specifically the deferral of the storm surge barrier

component of the plan, and the refined sites and design for the Bayside “residual risk” features, newly termed *high frequency flooding risk reduction* features, or HFFRRFs. The public comment period extended until October 22, 2018. As part of the public engagement, two additional public meetings were held in/adjacent to the areas where the new HFFRRF features are sited, namely in Arverne/Far Rockaway on October 4, 2018 at the Rockaway Waterfront Alliance RISE Center and in the Village of Cedarhurst on October 10, 2018 at the Village of Cedarhurst Hall. Section 3.0 includes the comments received during the second public and agency review period with responses and Section 4.0 includes the comments received and responses for the initial public and agency review period.

3.0 COMMENTS ON THE REVISED DRAFT GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT (GRR/EIS)

3.1 Agency Letters and Responses

3.1.1 New York City Department of Transportation

Comment 1: Page xvii: Please confirm the middle segment of bulkhead east of Beach 43rd Street is proposed to be 9' above grade.

Response 1: A height of 9’ above grade is incorrect. Incorrect annotations will be omitted or updated as needed.

Comment 2: Appendix A2, Page C33: Can the following sentence be clarified: “Although not used as a direct part of the HFFRRF alignment per say, a series of drainage feature types were developed to be used in conjunction with the line of protection.”

Response 2: Change and clarification has been added to HFFRRF E&D Appendix.

Comment 3: Bayswater Park and Beach 35th St are currently being redesigned by DOT and Parks. Any berm proposed in that area would need design coordination with both agencies. It cannot restrict pedestrian access thru the park.

Response 3: Concur. USACE will coordinate with DOT and Parks. A note has been added to the recommendations section of the HFFRRF E&D appendix to highlight this need for further coordination during PED.

Comment 4: Bayswater Park and Beach 35th St are currently being redesigned by DOT and Parks. Any berm proposed in that area would need design coordination with both agencies.

Special attention needs to be given to maintaining east-west pedestrian access between Edgemere/Beach 41st NYCHA Houses and shopping center east of Bayswater Park (as well as to recreational opportunities in northern section of the Park itself).

Edgemere is an underserved community that this berm design could further isolate.

All pedestrian ramps throughout the project limits should be upgraded to ensure ADA compliancy to the maximum extent feasible. Any missing ramps determined necessary should be installed using ADA 2010 standards. All ramp work must be reviewed and approved by DOT- Ped Ramp Program prior to final design.

Response 4: Design and engineering analyses regarding HFFRRF site integration, notably as it relates to HFFRRF within or in close proximity to the DOT ROW will be further refined during PED. This may include, amongst other

items, transportation and traffic analyses, maintenance of traffic, road raising details, ADA compliance and pedestrian access. NYC standard details and specifications for roadway design will be used there where applicable.

Comment 5: USACE or their consultants will need to explain how storm surge barriers affect geometries of current study streets and provide related quantitative traffic/pedestrian/ parking analyses, if they changes roadway and sidewalk widths.

Response 5: USACE will work with DOT during PED to conduct appropriate traffic analyses. Storm surge barriers are no longer part of the plan for Rockaway. Any impacts related to barriers will be addressed by the HATS study. Design and engineering analyses regarding HFFRRF site integration, notably as it relates to HFFRRF within or in close proximity to the DOT ROW will be further refined during PED. This may include, amongst other items, transportation and traffic analyses, maintenance of traffic, road raising details, ADA compliance and pedestrian access. NYC standard details and specifications for roadway design will be used there where applicable.

Comment 6: USACE or their consultants will need to provide travel demand assumptions on construction workers and trucks and relevant Maintenance and Protection of Traffic (MPT) plans during construction period.

Response 6: Transportation analysis during construction will be added to the EIS for the Final EIS, but will not be ready in time for the release of the Revised Draft.

During pre-engineering and design, Maintenance and Protection of Traffic (MPT) plans would be developed, reviewed, and approved by the NYCDOT Office of Construction Mitigation and Coordination (OCMC) for curb-lane and sidewalk closures as well as equipment staging activities.

Comment 7: The raising of the roads would require full-depth reconstruction of roadways and sidewalks, and as part of reconstruction, traffic signals and lighting and all associated conduits need to be removed, redesigned, and installed. Any impacts to structure or utilities, street furniture/appurtenances, etc. should be coordinated with NYCDOT and other appropriate entities.

Response 7: There are no remaining road raisings in the plan. There are road ramps, of roughly 100 feet. Design and engineering analyses regarding HFFRRF site integration, notably as it relates to HFFRRF within or in close proximity to the DOT ROW will be further refined during PED. This may include, amongst other items, transportation and traffic analyses, maintenance of traffic, road raising details, ADA compliance and pedestrian access. NYC standard details and specifications for roadway design will be used there where applicable.

Comment 8: NYC standard details and specifications should be used for the roadway design. USACE should coordinate closely with NYCDOT on the details and specifications and on avoiding any potential impacts to adjacent property owners and agencies.

Response 8: Concur. Design and engineering analyses regarding HFFRRF site integration, notably as it relates to HFFRRF within or in close proximity to the DOT ROW will be further refined during PED. This may include, amongst other items, transportation and traffic analyses, maintenance of traffic, road raising details, ADA compliance and pedestrian access. NYC standard details and specifications for roadway design will be used there where applicable.

Comment 9: USACE or their consultants will need to describe any additional control devices be needed along the adjacent roadway to provide safe crossing for the proposed action and identify assessing and any cost responsibility associated with design and implementation.

Response 9: Design and engineering analyses regarding HFFRRF site integration, notably as it relates to HFFRRF within or in close proximity to the DOT ROW will be further refined during PED. This may include, amongst other items, transportation and traffic analyses, maintenance of traffic, traffic control, road raising details, ADA compliance and pedestrian access. NYC standard details and specifications for roadway design will be used there where applicable.

Comment 10: The text refers to a maximum access slope of 10%. Is this compatible with ADA specifically and good accessibility practice?

Response 10: The text refers to maintenance access and slopes of surfaces allowing access to the HFFRRF. A maximum access slope of 10% provides good accessibility for a vehicle. It is however noted that for ADA access, the slope surface should be 12 (horizontal): 1 (vertical) or less steep. The road ramp feature was developed as a generic design that could be implemented at various locations throughout the study area. The final, site specific, design will depend on site conditions, site elevations and the design crest elevation to establish the rate of rise of ramps. Further details with respect to developing road ramps and ADA compliance are recommended for the PED phase after the completion of site surveys.

Comment 11: This section states that the contemplated drainage infrastructure would only collect runoff currently flowing to the surface water over land. Is this the only water that would be trapped behind the line of protection, and does this assumption potentially underestimate street flooding near the line of protection?

Response 11: The Feasibility level hydrologic analysis is not believed to underestimate street flooding in areas near the line of protection. The methodology, however, is limited in estimating flooding away from the line of

protection since it does not reflect limitations in the hydraulic capacity of the drainage system. We are estimating the hydraulic capacity of the storm outfalls only (nearest catch basin to the proposed line of protection). Analysis of the storm sewer system will be done in the PED phase, if necessary.

Comment 12: We note that 10 of the 11 Road Gates contemplated earlier have been eliminated. As noted in our previous comment, we would like to see the elimination of the remaining gate explored

Response 12: Noted. The remaining gate is not in the DOT right of way, but on private property. During PED, outreach and further analysis will be performed to assess whether this gate can also be removed.

Comment 13: Page 25: Reference to "road ramps" raises concerns with NYCDOT, in that the design has not identified how inland flooding and drainage will be mitigated and managed

Response 13: A culvert would be put under the road ramp to convey drainage to nearby outfalls/pump stations, as needed. The design incorporates outlet pipes on either side of the road ramps to help with this. A sentence has been added to section 4.11 of the HFFRRF E&D Appendix to clarify the above.

Comment 14: Page 27: Road ramps included to maintain access raises issues and challenges including access consideration to adjacent property owners and drainage that must be addressed in detail during design.

Response 14: Design and engineering analyses regarding HFFRRF site integration, notably as it relates to HFFRRF within or in close proximity to the DOT ROW will be further refined during PED. This may include, amongst other items, transportation and traffic analyses, maintenance of traffic, traffic control, road raising details, ADA compliance and pedestrian access. NYC standard details and specifications for roadway design will be used there where applicable.

Comment 15: Some of the construction would be parallel to NYCDOT roadways/sidewalks and possibly within the limits of right-of-way. We will need to consider the details of any work (including walls, berms, and ditches) either on *or adjacent to* any roadway or sidewalk.

Response 15: Noted.

Comment 16: We will require coordination on the road ramps, which are undoubtedly more complicated than they appeared schematically, both technically and procedurally.

Response 16: Noted.

Comment 17: We do not have sufficient information to consider the right-of-way impacts on roadways of the proposed pump stations and their associated ditches and

other inflow – this will need to be examined closely during design, and may have “real estate” related implications.

Response 17: Noted.

Comment 18: The details regarding the street segments to be cut off will need to be examined closely during design.

Response 18: The project is currently preparing plans and specifications as part of the expedited schedule to construct. Suggest a meeting to discuss.

Comment 19: Issues of roadway access to private properties, including the closure gate on private property will require careful examination.

Response 19: Noted.

Comment 20: Since the installation of permanent flood mitigation infrastructure may encroach on the right of way a de mapping action under ULURP may be required but more time and information needs to be given to review this issue as well as whether the permanent use of City Streets by USACE will necessitate the disposition of easements which generally requires ULURP.

Response 20: Rep states the assumption that an access agreement will be used for the project.

3.1.2 US Environmental Protection Agency (23 October 2018)

Comment 1: In accordance with our responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency is providing comments for the Revised Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRRIEIS) (CEQ#20180206). The U.S. Army Corps of Engineers (USACE), based on significant comments received on the first version, determined that substantial revision to the Draft EIS would be required in order to proceed to a final decision document. Moreover, the USACE decided to move all further evaluation of the Jamaica Bay storm surge barrier measure, which is a significant component of the tentatively selected plan (TSP), to the ongoing New York and New Jersey Harbor and Tributaries (NYNJHATS) Feasibility Study. Therefore, the discussion of the surge barrier in this EIS does not represent a comprehensive approach to providing coastal storm risk management solutions for the Jamaica Bay study area. The full comprehensive approach regarding the surge barrier is deferred until completion of the NYNJHATs Feasibility Study,

The study area consists of the Atlantic Coast of New York City between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York. The study area also includes the low-lying Coney Island section of Brooklyn, which can be overtopped and flood the Brooklyn neighborhoods surrounding Jamaica Bay. This Revised Draft HSGRRIEIS is focused upon approximately ten miles of the Rockaway Peninsula in Queens, from East Rockaway Inlet to Rockaway Inlet/Jamaica Bay. The document is generally divided into flood control alternatives for the Atlantic shore and for Jamaica Bay.

An array of structural and non structural management measures, including natural and nature-based features, were developed to address one or more of the planning objectives. Since the problems and opportunities vary across the study area, alternatives were formulated for two separate planning reaches to identify the most efficient solution for each reach: the Atlantic Ocean Shoreline Reach and the Jamaica Bay Reach. Beach restoration with renourishment, five groin extensions and the addition of 13 new groins were selected for the Atlantic Ocean Shorefront Planning Reach. Preliminary screening of comprehensive alternative plans for the Jamaica Bay Planning Reach resulted in two alternatives: a Jamaica Bay Perimeter Plan and a Storm Surge Barrier Plan. Both plans would tie into the plan features for the Atlantic Ocean Shoreline Planning Reach.

While the TSP Plan includes a storm surge barrier across Rockaway Inlet, a final decision on this component is being delayed until more is known about the larger proposed barrier between Sandy Hook, NJ and Breezy Point, NY. The 3930-foot storm barrier would have an 1100-foot gated opening, and construction would permanently disturb 34.6 acres of subtidal bottom and 7.5 acres of intertidal mudflat. EPA has definite interest in the barrier's modeled effects upon Jamaica Bay, such as possible changes in salinity, temperature, dissolved oxygen and water quality, and awaits that information for review. This Revised Draft EIS mentioned two potential wetlands

mitigation sites: Floyd Bennet Field and Elders Island. More information regarding aquatic mitigation should be provided with respect to these locations.

> **Response 1:** As noted in Section 5 and throughout the report, further evaluation of the storm barrier was deferred, and its evaluation moved to the NYNJHATs study. Environmental impacts and mitigation sites discussed above were not carried forward for full evaluation in the Revised HSGRR/EIS.

Comment 2: There is very little discussion of the possible effects of the new groins upon the Atlantic shore west of 121st Street. Given the westward longshore drift, beaches on the western portion of the peninsula may experience reduced sand deposition and may therefore become diminished. Comparing Table 5-10 with Table 5-13, it is not clear how the permanent environmental impact acreages presented in Table 5-13 were calculated.

> **Response 2:** Regarding impacts down-drift from groins, the project will be designed to minimize negative impacts to down-drift areas. Guidance precludes negatively impacting adjacent areas. During PED, this will be evaluated to ensure impacts to downdrift areas are negligible.
>
> Regarding Tables 5-10 and 5-13, there is no correlation between information provided in Tables 5-10 and 5-13 with the potential impacts of the Recommended Plan, as these potential impacts relate to an alternative (the barrier plan), which was eliminated from consideration, and its evaluation moved to the NYNJHATs study.

Comment 3: Additionally, EPA encourages the incorporation of sustainability and green design into any potential future development/construction plans with this project. Please go to: https://www.epa.gov/sustainability for information. The final EIS should include a separate sustainability section that address the ways in which this project incorporates sustainability in its planning, construction and operations phases.

> **Response 3:** Sustainability is discussed in Section 9.2.2 of the report. Sustainability is part of all USACE decision processes and our organizational culture. The Corps is a steward for some of the Nation's most valuable natural resources, and must ensure that the non-federal partners on USACE projects receive products and services that provide for sustainable solutions that address short and long-term environmental, social, and economic considerations. Specifically, in a coastal district such as the New York District, study teams focus their efforts addressing climate variability and adaptation and building resilience in infrastructure to better serve and support U.S. citizens, local communities and the Nation. In achieving this mission, the USACE provides solutions to the Nation's water resources problems in a manner that is environmentally, economically, and socially sustainable, and that focuses on public safety and collaborative partnerships.

Comment 4: During any phase of construction, project managers are encouraged to utilize local and recycled materials; to recycle materials generated onsite; and to utilize technologies and fuels that minimize greenhouse gas emissions. If concrete removal occurs during repair of the existing structures, recycling and/or reuse of construction and demolition (C&D) material or beneficial reuse of dredged materials should be considered in order to lessen the impacts disposal at solid waste facilities. EPA recommends that any such measures applying these practices be identified in future project documents. You may find more detailed information about recycling of C&D waste at:

http://www.epa.gov/osw/conserve/imr/cdm/recycle.htm

EPA also recommends implementing diesel controls, cleaner fuel, and cleaner construction practices for on-road and off-road equipment used for transportation, soil/sand movement, or other construction activities, including:

- Strategies and technologies that reduce unnecessary idling, including auxiliary power units, the use of electric equipment, and strict enforcement of idling limits; and
- Use of clean diesel through add-on control technologies like diesel particulate filters and diesel oxidation catalysts, repowers, or newer, cleaner equipment. For more information on diesel emission controls in construction projects, please see:

  http://www.northeastdiesel.org/pdfINEDC-Construction-Contract-Spec.pdf

  http://www.epa.gov/cleandieselltechnologies/index.htm

Response 4: The Corps is minimizing emissions (see Clean Air Act Compliance and Conformity discussions in main report and the Environmental Appendix) as part of proposed construction. The Corps incorporates sustainability practices into Construction and prepares Waste Management Plans and implements oversight in PED Phase which further the objectives of sustainability, where practicable. The Corps utilizes BMPs and Best Construction Practices where practicable to reduce waste and maximize recycling.

Comment 5: Thank you for the opportunity to comment on the Revised Draft HSGRRIEIS. As indicated above additional information is needed to fully assess the environmental impacts of the project. The additional data, analyses, and discussion should be included in the final EIS. Our comments contained in this letter are intended to help provide useful information that will ultimately inform local, state and federal decision-making and review related to land and water resource use and impacts. Should you have any questions regarding the comments detailed in this letter, please feel free to contact Michael Poetzsch of my staff at 212-637-4147 or poetzsch.michael@epa.gov.

3.1.3 City of New York (24 August 2018)

Comment 1: The City of New York strongly supports efforts to make communities in the Rockaways and Jamaica Bay more resilient to the impacts of coastal storms and nuisance flooding, and we thank the U.S. Army Corps of Engineers (USACE) for their efforts to advance protections for the beachfront and bayside of the Rockaway peninsula.

Please allow this letter to serve as formal support of the initiation of public comment on the Hurricane Sandy General Reevaluation Report, dated August 2018, and the continued refinement of the recommendations contained therein. This letter also confirms New York City's interest in serving as the Local Sponsor to the Non-Federal Sponsor, New York State Department of Environmental Conservation (DEC), on the East Rockaway to Rockaway Inlet and Jamaica Bay Storm Damage Reduction Project (Project).

The City strongly supports the USACE's recommendations for the Atlantic Beach and reaffirms our belief that beachfront projects should not be delayed as analysis on the bayside continues.

The City also supports continued analysis of bayside interventions, which were first conceptualized in 2018, and therefore need additional community input and technical review before design is finalized and construction can start. While we firmly believe that communities on Jamaica Bay are among the most at- risk to sea level rise and coastal storms, we also believe these solutions need to be appropriate for the communities in which they are sited.

Therefore, while we support the advancement of the Project, we have concerns with bayside components that will need to be addressed moving forward. These concerns include:

- Robust community input will be needed on new bayside measures to ensure any community concerns are addressed
- NYCDEP will need to be consulted as assumptions pertaining to Stormwater Pumping are refined, in particular with regards to operations & maintenance, N+1 redundancy of pumps, automated trash racks, and pump station siting
- Road Closure Gates and proposed road raisings will need to be coordinated with NYCDOT
- Wetland impacts must be minimized to the greatest extent possible
- Additional information and coordination will be needed with regard to infrastructure siting and required property interests

Although we are excited to see this important milestone being met, we also urge the USACE not to neglect important project components, namely the Jamaica Bay barrier and Coney Island tie-off, which have been moved to the New York New Jersey Harbor and Tributaries study. These federal investments are crucial to a comprehensive

solution for the long-term resilience of low-lying communities in South Brooklyn and Southeast Queens.

We thank USACE for their continued interest in providing protection to neighborhoods in Rockaway and look forward to working with the USACE on to find appropriate solutions for the ongoing resilience of these neighborhoods.

> **Response 1:** Response: The District appreciates New York City's continued engagement and support on this important project. The Corps will continue to coordinate with NYSDEC and NYC as we move into the PED Phase to ensure that community input is appropriately incorporated into the Project design. The District will also continue to coordinate with NYCDEP and NYCDOT on the interior drainage and road interface aspects of the project, as well as other agencies as appropriate for infrastructure siting and property interests needed to implement the Project. The District concurs that wetland impacts must be minimized to the greatest extent practicable; we have sought to do so in the Feasibility Phase designs and this will continue throughout the PED Phase. Furthermore, The District shares the commitment to continue the investigation of the Jamaica Bay barrier and tie-ins in the New York and New Jersey Harbor and Tributaries Study in order to meet the objective of a comprehensive solution for the long-term resilience of the low-lying at risk communities in South Brooklyn and Southeast Queens.

Comment 2: The City believes that bayside High Frequency Flood Risk Reduction Features (HFFRRF) will require significant additional design work before real estate requirements are finalized. Will the Corps update the real estate report as design progresses on bayside features?

> **Response:** Yes.

Comment 3: The real estate report identifies easements and fee acquisition across both non-City and City property. The City intends to purchase easements or fee title in accordance with the final determinations made by the Corps (once design is more fully fleshed out) only in areas where the City does not currently hold fee title interest. Please confirm this is acceptable to the Corps.

> **Response 3:** This is something which will need to be clarified in the PPA as the NFS at this point in NYS which is responsible for providing and holding all necessary real estate interests. It is our understanding there will be some sort of access agreement between the city and state on city owned property. So in actuality, the state would need to acquire all areas not owned in fee by the state. If the state delegates, this down to the city, the city would need to acquire all necessary rights not owned by the state and in being a chief owner of the real estate needed, it can accomplish this on its own property through the aforementioned access agreement.

Comment 4: The City does not intend to convey easements to any second party, including New York State DEC, in order to facilitate this project. The City will provide access to the necessary real estate through our real estate certification. This is in accordance with guidance received from USACE's attorneys in DC for the Staten Island Coastal Storm Risk Reduction project. Please confirm that this is acceptable to the Corps.

Response 4: See comments above RE: Access Agreements and the PPA language.

Comment 5: The City views the construction of the Atlantic Shorefront project to be a significant priority. The HFFRRF projects' complicated real estate requirements create concern that the Atlantic Shorefront project will become further delayed. The City requests confirmation from ACOE that the required real estate for the HFFRRF projects do not need to be acquired before Atlantic Shorefront construction begins.

Response 5: Provided that these will be broken into contracts, the state can provide the real estate required by contract.

3.1.4 National Park Service

Comment 1: Mutually Acceptable Plan: The Revised Draft HSGRR/EIS identifies that the plan must be mutually acceptable. On page 3 and throughout the HSGRR/EIS, the text should clarify that any portion of the CSRM that falls within the boundaries of or impacts the resources of Gateway National Recreation Area must be mutually acceptable to NPS and USACE.

Response 1: Concur, change has been made.

Comment 2: NPS will adopt the HSGRR/EIS and issue a NPS Record of Decision (ROD) to document mutual acceptability of any portion of the CSRM that falls within the boundaries of or impacts the resources of GATE. Therefore, the HSGRR/EIS must adequately and appropriately identify and analyze project impacts to NPS resources, offsets (mitigation) for impacts to NPS resources, and meet NPS NEPA requirements to allow for issuance of a NPS ROD.

In comments submitted to USACE on the Draft HSGRR/EIS, NPS identified that we are committed to work collaboratively with USACE to arrive at a mutually acceptable plan and to implement a project that will reduce storm damage risks for NYC residents and communities; however, NPS lacks sufficient capacity to participate in the multi-year planning, design and implementation phases necessary for successful development of this project. USACE has been funded for this project. NPS has not. Full participation by NPS to maintain the engagement and collaboration necessary for this project will require staff and technical resources that are currently not available within NPS and are not currently funded as part of this project.

Response 2: Noted. USACE appreciates NPS' engagement and coordination.

Comment 3: Real Estate: Construction of any portion of the Project on NPS property is contingent upon an appropriate legal authority or instrumentation to authorize construction on NPS property and commitment of a non-federal sponsor for long-term maintenance obligations and liability and risk considerations for the project on NPS lands. The 1974 deed transferring property from the City of New York to the United States of America for the use and development by the National Park Service, established that the City, subject to federal approval, has the right to "easements and other rights as may be reasonably necessary for the construction, operation, maintenance, repair and reconstruction of any municipal facility". The easement provision of the deed may be an appropriate legal mechanism for construction of any mutually acceptable portion of the Project on NPS property.

Response 3: Concur with the need to identify the appropriate legal authority or instrumentation to authorize construction on NPS property and commitment of a non-federal sponsor for long-term maintenance obligations and liability and risk considerations for the project on NPS lands. USACE will coordinate with NPS

and NYC to review the referenced deed to assess whether or not it can serve as the legal mechanism to construct the project.

Comment 4: Appendix E page 5 Section e. I. Perpetual Beach Storm Damage Reduction Easement (Standard
Estate No. 26) states that "The National Park Service would issue a Special Use Permit to the US Army Corps of Engineers for the beach fill on its property." This statement should be revised to indicate that if the Project requires construction of any mutually agreed upon elements of the plan (including beach fill) on NPS property, that construction will require NPS authorization under an appropriate legal authority or instrumentation.

Response 4: Concur. The Real Estate Plan has been updated accordingly.

Comment 5: Appendix E page 8. Section 7. Federally-Owned Land states that "There are lands that are owned by National Park Service, known as Gateway National Park, that lie within the current project alignment. A special use permit providing temporary access for the alignment tapers covering approximately 21.56 acres will be obtained from the National Park Service by the US Army Corps of Engineers to grant the necessary access. National Park Service will be reviewing their authorities, and further coordination will be necessary, for the purpose of any permanent access requirements for the 21.56 acres referenced." This section should be revised to indicate that "Gateway National Recreation Area" is the name of the lands owned by NPS. In addition, the section should be revised to provide greater transparency by indicating that construction of tapers on NPS property is being considered as a mechanism to offset impacts of the Project on NPS property and that further evaluation and selection of the final mutually acceptable offset design will occur in the PED phase. If tapered groins are identified as the mutually acceptable offset, then construction as well as long-term maintenance by a non-federal partner on NPS property would have to be authorized by appropriate legal authority and/or instrument.

Response 5: Concur. The Real Estate Plan has been updated accordingly.

Comment 6: Appendix E page12 Section 19. Project Support states "Coordination and analysis between USACE and National Park Service will be necessary, including coordination and analysis to identify the least impactful design of the final plan." This statement should be revised to provide greater transparency. Coordination between USACE and NPS will continue through the PED phase to avoid and minimize adverse impacts on NPS resources while advancing the goals of the Project.

Response 6: Concur. The Real Estate Plan has been updated accordingly.

Comment 7: Appendix E pdf page 60 Assessment to Non-Federal Sponsor's Real Estate Acquisition Capability Section I. Legal Authority states "Are any of the lands/interests in land required for the project owned by an entity whose property the

sponsor cannot condemn? Yes, federally owned property under control of the National Park Service, of which USACE will directly handle its acquisition." NPS lands will not be acquired for this Project. NPS will work with USACE to identify appropriate legal authority or instrumentation to authorize construction of any mutually acceptable portions the Project on NPS property.

Response 7: Concur. The Real Estate Plan has been updated accordingly.

Comment 8: Sediment Transport: The HSGRR/EIS identifies that the Atlantic Shorefront Component will extend in length 5 existing groins and construct 13 new groins. Through the public meetings and participation in the bi-weekly project management team meetings, NPS understands that the exact number, location and length of groins will be refined during the pre-construction engineering and design (PED) phase. As stated in the NPS comments on the Draft HSGRR/EIS, the terminal groin at Beach 149th Street has and will continue to interrupt natural littoral transport mechanisms to the beach face at Jacob Riis. Expansion of the Rockaway groin field will further impact sediment transport processes. The sediment starved Riis beach provides protection for the Jacob Riis Park Historic District. The loss of the beach also threatens the integrity of the cultural landscape including character defining elements such as the "large scale of the beach space." Loss of sand and narrowing of these beaches also reduces the quantity and quality of habitat available for wildlife such as the federally threatened piping plover (*Charadrius melodus*) and is likely to increase the risk of human-wildlife conflicts.

USACE and NPS have discussed that alternatives to offset impacts of the project on sediment transport processes to NPS property may include tapered groins at Riis. NPS and USACE have agreed that evaluation of the offset alternatives will occur during the PED phase of the project. NPS has previously indicated that additional data, including modeling and economic analysis, will be required to evaluate offset alternatives and to inform the decision on a mutually acceptable offset. Detailed designs for groin extension and construction within reaches 3 to 6 and more detailed modeling of sediment transport will provide the information necessary for USACE and NPS to select a mutually acceptable alternative to offset for impacts to sediment transport.

Response 8: USACE is working on more detailed sediment transport modeling as part of the Plans and Specifications more detailed design in the PED phase. The modeling results will be shared with NPS to coordinate a mutual acceptable final design. Further economic analysis will not be conducted unless changes during PED trigger a post-authorization change report due to the total cost of the project increasing more than 20%.

Comment 9: Page X of the Executive Summary: Figure ES-4a identifies three tapered groins at Riis Beach in reach 2 of the project. The Executive Summary text does not provide any context for this figure or these tapered groins. In addition, these groins are not depicted in Figure ES-3 which provides the plan overview. If the Executive Summary is going to include Figure ES-4, then text must be added to this section to

provide context for the figure to explain why the project may include tapered groins at Riis beach. The HSGRR/EIS must be transparent with regard to the offset and the additional evaluation that will be conducted in the PED.

Response 9: Explanatory text was added for Figure ES-4.

Comment 10: Page 69 Table 3-4 and Figure 3-1 and Appendix A1: NPS monitoring does not support findings of the USACE seven-cell sediment budget indicating that Riis beach is stable. Psuty and others (2018) conclude that the **"**large terminal groin at the eastern border of Jacob Riis Park effectively retained sediment at the beach face updrift and also directed sediment transport offshore limiting any accumulation on the beach".

> Psuty, N. P., K. Butler, K. Ames, and A. Habeck. 2018. Shoreline position (1D) and coastal topographical (2D) change monitoring at Gateway National Recreation Area: 2012-2017 trend report. Natural Resource Report NPS/NCBN/NRR—2018/1739. National Park Service, Fort Collins, Colorado. https://irma.nps.gov/DataStore/DownloadFile/607165

Page 148 Section 6.1.3 states "The groins that are recommended for NPS property are to ensure that the Recommended Plan does not negatively impact the NPS beaches. Final design will be developed in PED phase, in coordination with NPS." This paragraph requires expansion to ensure that it is clear that the actions will be taken as part of the project to eliminate and/or compensate for the effects of the expanded groin field east of Riis Beach on sediment transport to NPS property. The report should identify that the project will be responsible for OMRR&R for any offset features. This may include renourishment and/or groin maintenance.

Response 10: The explanation was expanded to note that groins on NPS property are proposed to offset any negative effects that the Project may have on NPS property. The current Recommended Plan does not include renourishment on NPS property and OMRR&R will be the responsibility of the non-federal sponsor. As stated earlier, USACE will work with NPS and the non-federal partners to refine the design based on PED level analysis.

Comment 11: Page 186 Section 7.1.2.3 identifies only beneficial impacts to erosion from groins. Page 187 Section 7.2.2 identifies minor long-term effects on sediment transport on the down-current side of the groins. HSGRR/EIS impact analysis must identify impacts of project on sediment transport on NPS property that require offset. All impacts to NPS property and resources must be identified and evaluated. NPS will adopt the HSGRR/EIS to issue a NPS ROD.

Response 11: Text in Section 7.1.2.3 was edited to address impacts associated with enhanced erosion on the drown-current side of groins, consistent with Section 7.2.2. Both sections now recognize NPS concerns regarding the sand starved beach at Jacob Riis and potential impacts of proposed groins. The District is committed to continuing to work with NPS in regards to a more detailed

sediment model and identification of any offset of impacts associated with the Recommended Plan.

In terms of other biological resources that would be impacted on NPS lands, the EIS addresses potential concerns regarding construction of groins in section 7.6 (Shoreline Habitats), 7.7 (Invertebrate and Benthic Resources), 7.8 (Finfish), 7.9 (Reptiles and Amphibians), 7.10 (Birds), 7.11 (Mammals), and 7.12 (Protected Species).

Comment 12: Page 202 Section7.13.2: Text identifies that portions of Jacob Riis Park will gain protection from the project. The HSGRR/EIS does not provide protection for any portion of Gateway National Recreation Area. The project will impact sediment transport to GATE property; therefore, the project must compensate for that impact to be mutually acceptable. GATE will be made whole by the compensation. GATE is not gaining storm damage protection from the project.

Response 12: Text in 7.13.2 was edited to clarify the GATE property will not receive protection and that groins at Riis Park are included to offset potential impacts due to the Project.

Comment 13: Cultural Resources: NPS has previously indicated to USACE that there are historic groins at Riis beach. If the mutually acceptable offset requires groins at Riis to efficiently maintain sand, rehabilitation of historic groins is preferable to new groin construction. In addition, any groin work at Riis may require mitigation for impacts to historic resources.

Response 13: Noted.

Comment 14: Page 52 Section 2.18.3.1: The Fort Tilden Historic District consist of the fortification, the post and wharf areas. Fort Tilden Warf is not a separate Historic District.

Response 14: Fort Tilden Wharf was removed from the list of Historic Districts.

Comment 15: Page 59 Section 2.18.1: If there is any excavation on NPS property as part of the offset, then consultation with Stockbridge Munsee Community will be required. This federally-recognized tribe has identified interest in consultation on GATE property.

Response 15: The Stockbridge Munsee tribe was added as a tribe that will need to be consulted if any excavation occurs on NPS property.

Comment 16: Page 232 National Historic Preservation Act: Text should identify that NPS will also be a signatory on the Programmatic Agreement. Appendix D6 acknowledges NPS as signatory to PA and the document should be consistent throughout.

Response 16: Change made to indicate NPS will be a signatory on the PA.

Comment 17: Protected Species: Page 31-32 Section 2.12.1: Discussion of the presence, distribution and productivity of threatened and endangered species in reaches 1 and 2 is not included in the text. Attached to these comments is 2014 threatened and endangered species data for these reaches. NPS determination of mutual acceptability will be by adoption of the USACE EIS and issuance of NPS ROD for any elements of the plan that will be constructed on or impact NPS property and resources. Therefore it is necessary that the report includes resources within reaches 1 and 2.

Response 17: Discussion of T&E species in reaches 1 and 2 has been added to the EIS. Specifically, 2014 data is referenced in Section 2.12. In addition, Section 7.12 includes reference to continuing to work with NPS to protect threatened and endangered species managed by NPS.

Comment 18: Hazardous, Toxic, and Radioactive Waste: Page 47 Section 2.17: Spring Creek is located within Jamaica Bay Planning Reach. In 2017, Spring Creek was designated by NPS as CERCLA site.

Response 18: Spring Creek CERCLA site was added to Section 2.17. Thank you.

Comment 19: High Frequency Flood Risk Reduction Features: Page 117 Section 5.10 Figure 5.9, Page 119 Figure 5-11 and Page 120 5-12: These figures identify some low lying natural habitats (JoCo, Black Bank and Big Egg and part of Little Egg marshes) as areas of interest but not all of the marsh islands. Figure should either identify all area that is subject to AEPs depicted in the graphic of should exclude all of the marsh island habitat. NPS has previously recommended that marsh islands should not be identified in these figures because the islands are not areas of interest for location of HFFRRFs.

Response 19: Noted, this does not affect the plan formulation as CSRM measures were focused in areas with dense development. Based on time constraints, the study team does not have time to correct this.

Comment 20: Other Comments: Page 6 Figure 1-2: Some NPS property is not depicted on the map.

Response 20: Figure 1-2 will be checked and corrected.

Comment 21: Page 35 Sections 2.13.1.1 and 2.13.1.2 Page 43 Section 2.14 and throughout the report: Text states “Gateway National Recreation Area parks”. Text should state “Gateway National Recreation Area property”.

Response 21: Change will be made.

Comment 22: NPS encourages USACE to complete a robust external technical review of the Revised Draft HGRR/EIS and any modeling conducted in PED phase that relates to the evaluation of impacts and/or design of an offset for impacts to NPS property and resources.

> **Response 22:** Independent External Peer Review was conducted on the Draft GRR/EIS and the results of which will be included in the Final Report and shared with/coordinated with the PED study team.

Comment 23: As identified in NPS comments on the Draft HSGRR/EIS, citations in the document should reference the primary literature rather than summary reports or agency reports that referenced the primary literature. On the pages indicated, the plan cites NPS publications rather than the primary literature that is cited within these NPS publications: Page 24 should cite primary literature and not Rafferty and others, 2010; and, Page 223 cites NPS GMP/EIS 2014 and not primary literature related to impact of borrow areas on nearshore fish communities.

> **Response 23:** It is common USACE practice to cite past decision documents rather than primary literature because USACE reviewers are aided by being pointed to previously approved decision documents. Citing literature produced by our Cooperating Agencies or non-federal partners is also a helpful indicator to reviewers of where our partners stand and if the cited report is published, it is considered an appropriate source document. Due to time constraints on finalizing the report for the next round of reviews, and the late receipt of comments from NPS well after the end of the 45 day public and agency review period on October 22nd, the team will do our best to add the primary literature to the citations noted if it can be done so without incurring delays to the next deadline.

3.1.5 Mayors' Office of Resiliency

Comment 1: Please note that NYCHA property is not City-owned. Any construction on the property would require acquisitions as well as a federal Section 18 process.

Response 1: Noted.

Comment 2: Regarding the first bullet in the Assessment of Non-Federal Sponsor's Real Estate Acquisition Capability:
"Does the sponsor have legal authority to acquire and hold title to real property for project purposes? Yes, through the local sponsor."

Response 2: The City does not currently have the legal authority to acquire property for this project; a Uniform Land Use Review Procedure (ULURP) is required for the City to have this authority. It is the City's understanding that the State does currently have the authority to acquire property for the project.
THE ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY WILL BE EDITED TO READ:
"Does the sponsor have legal authority to acquire and hold title to real property for project purposes?
Yes, the State can obtain the authority, however it intends to have the local sponsor, NYC, obtain the property amicably and through condemnation as necessary. This will be detailed in their local agreement. The local sponsor intends to obtain the legal authority to acquire and hold title to real property by completing their local Uniform Land Use Review Procedure (ULERP) process. "

3.1.6 Department of City Planning

Comment 1: The following statement on page 12 of the report should be amended to reflect the fact that, while no zoning changes are necessary, the acquisition of private property and map changes needed to change streets will require local land use approvals (ULURP), as well as potential mapping/site selection actions.

"The Project will not require enactment of land use ordinances prior to construction; however, land use policies recommended to minimize the risk of damage from coastal storms are contained in the Land Management Appendix. These land use policies are recommended for implementation at the local level."

Response 1: Updated.

3.1.7 Department of Environmental Protection

Comment 1: The acquisition schedule of 18 months from NTP to Certification of Real Estate is very aggressive, and not consistent with DEP's experience with land acquisition for New York City.

Response 1: The Corps will continue to coordinate with the city to update the timeline to better reflect the ULERP process associated with city acquisitions.

Comment 2: Since the project has not been final designed, DEP believe that the pumping station locations may not be located where indicated in the report. When solutions to conveying stormwater to the pumping stations meet with a complete assessment of all the physical constraints, some locations may shift a little, and this makes a final assessment of the extent of ponding and conveyance easements impossible at this time.

Response 2: Noted.

3.1.8 Department of Parks and Recreation

Comment 1: Minor Correction:
Page 1: "The former Fort Tilden Military Reservation, *owned by the City of New York…"* should be corrected to reflect NPS ownership.

Response 1: Changed.

3.1.9 Department of Housing Preservation and Development

Comment 1: We request that all materials, including maps, center the areas of impact on the page so impact on the sites and adjacent area can be more easily assessed. Currently many of the maps include substantial areas of open water, which are not relevant to a study of real estate and would be more relevant for chapters focused on open water navigation. As presented, the areas of impact of the proposed measure are unreadable particularly on pages 17, 19, 22.

Response 1: The design team will look into this for possible modifications.

Comment 2: The proposed HFFRRFs includes several sites where occupied housing is left outside the area of protection. This occurs on these sites that include blocks 16110 NS 16103. In particular, that analysis does not include the occupied housing (18 units) that is on a pier on the extension of Beach 84th street (Block 16110 lot 44). Although the condition of the pier and housing is deteriorated, it is still occupied. How does USACE propose to ensure that the proposed investments will not make flooding conditions worse for these properties? If it is determined that conditions will be made worse, please confirm that these properties and tenants are served by URA.

Response 2: Flooding in the back bay area is caused by a combination of astronomical tide and storm induced water-level rise. During feasibility, the assumption was made that structures on piers would want to retain access to the waterfront and were therefore not included within the alignment. However, the intent was not to leave occupied personal residences on the unprotected side of the alignment. As such, non-structural measures and/or changes to the alignment could be considered for these residences during the PED phase. To answer tour concern about induced risk for the structures outside of the high frequency flood risk reduction features, the coastal flood risk for the occupied housing on the pier is not affected by the project's proposed series of floodwalls and other features that are setback from the coastline. Based on this, the Uniform Relocation Act, is not likely to be triggered. Further modeling and more detailed analysis of the area will occur during PED Phase in coordination with the city and the state.

Comment 3: There are a number of locations in Arverne and Edgemere where the proposed permanent measure runs through the rear yards of occupied residential property. Although it may appear that there is enough space through a desktop analysis using GIS and Lidar, once surveys are produced, HPD believes that it is unlikely that that proposed alignment will be possible without additional condemnation. In particular, the proposed alignment in Edgemere, at the northern end of Beach 43rd street runs directly through the rear extensions of several homes. Moreover, the irregular shape of the alignment may have unpleasant impacts on the streetscape, drainage, and flooding. All of these will need to be addressed.

Response 3: Noted.

Comment 4: The proposed project locates a Pump Station directly behind private occupied housing on Beach 43rd Street, despite vacant public parcels to the north and

south of the proposed location. If feasible, it might make sense to locate the Pump station on a site that will not so directly affect adjacent occupied parcels.

Response 4: Noted.

3.1.10 New York City Economic Development Corporation

Comment 1: Baseline Cost Estimate for Real Estate ("BCERE") (page – 9 of the appendix). The land cost seems low for the number of properties implicated.

> **Response 1:** Costs are currently being updated by appraiser and will remain in flux to an extent until final design.

Comment 2: "There are no anticipated residential relocation assistance benefits, as authorized by Public Law 91-646, for the plan. Moreover, the City of New York expressed a preference to the US Army Corps of Engineers, New York District that acquisition of occupied domiciles by eminent domain be avoided where feasible. At this time, the Corps, NFS, and the City of New York believe the project will not lead to the displacement of any residents…The current plan assumes all existing residential structures are or will be vacant prior to acquisition." (page - 10 of the appendix). The assumptions should be confirmed. The anticipation that no residential relocation assistance benefits will be needed may not be accurate as there are residential properties in close proximity to the project.

> **Response 2:** As the design is further refined in PED, the Corps will continue to review impacts to adjacent properties during PED.

Comment 3: If there are residents and businesses in the project area, why are no allowances anticipated for relocation?

> **Response 3:** The Corps does not yet know whether any will require relocations. Even the businesses where we see buildings slated for impact may not require the actual relocation of the business for reasons noted in the REP.

Comment 4: By what basis is it assumed that all existing residential structures are or will be vacant?

Response 4: The city and state reviewed available information regarding properties that will need to be acquired in fee and relayed that these properties are not currently occupied. This assumption will be reevaluated as additional information concerning the properties becomes available and as real estate requirements are refined.

Comment 5: What is anticipated to happen to occupied residences and private commercial properties that will be on the Jamaica Bay side of the levee?

> **Response 5:** They will be provided access to the properties.

Comment 6: As of January 2017, multiple residences were observed to be occupied in the areas Beach 86th St, Beach 85th St, and Beach 84th St.

Response 6: Noted.

Comment 7: “Block 16103, Lot 140 is under SBS jurisdiction, and may be redeveloped in the future with a mix of uses. The USACE should coordinate with EDC to ensure the planned Corps project does not negatively impact the ability to insure the site, access to and from the site, and site drainage.”

Response 7: This will be reviewed and coordinated as appropriate.

3.2 Stakeholder Comments and Responses

3.2.1 Environmental Defense Fund (18 October 2018)

Comment 1: We have reviewed the August 2018 Revised Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement Atlantic Coast of New York East Rockaway Inlet to Rockaway Inlet and Jamaica Bay. In summary, we support the implementation of the program as described in this document. Our support is contingent on the adoption of the Natural and Nature-Based Features ("NNBFs) in the flood risk reduction program for Jamaica Bay in the final Plan that is the subject of the PPA, final engineering designs and the project as actually implemented. While we are pragmatic enough to realize that it is unlikely that the final plan would incorporate additional NNBFs as defined in Section 1184 of the 2016 WRDA, as much as we would consider that to be desirable, we consider the NNBFs that are presented in the Revised Draft Report to provide minimal compliance with the Sandy appropriations legislation, and any reduction in those Features would result in a plan that is not in compliance with that legislation.

The Draft Revised Report represents a significant advance over the August 2016 Draft Report, and we do acknowledge and are deeply appreciative of the Corps September 28, 2018 response from Peter Weppler to our November 14, 2016 comments on that Draft Report. First, the latter not only lacked a description of any Sandy-funded program, but would also have resulted in a long and uncertain congressional authorization and additional appropriations process. By contrast, the plan of action as set forth in the Draft Revised Report needs no additional congressional authorization, so long as it complies with the pertinent terms of the Sandy legislation, and needs no further congressionally approved appropriations. Second, the Draft Report lacked any serious consideration of NNBFs in the Bay. In contrast, the Draft Revised Report includes two wetland features of 2 and 7 acres, respectfully, in the Mid-Rockaways Edgemere and Arverne Areas. The Mid-Rockaway HFFRRRF with its three areas is by far the largest of the three HFFRRFs that passed economic screening, a precondition for inclusion in the Recommended Plan.

The Corps has struggled since the adoption of the Sandy legislation, now coming on six years ago, with the incorporation of any NNBFs that included wetland components in any plan for the Rockaways and Jamaica Bay. A central reason was that the Corps denominated this project as a "flood control" project subject to all of the restrictions inherent in Corps flood control planning and evaluation regulations, ERs and guidance. Under a strict construction of these regulations, the benefits of the flood risk reduction features of any NNBF alone would have to exceed the total cost of that feature, with no water quality, ecological or other benefits included, and the likelihood of a favorable BCA of any such feature under such extreme siloing of a project's real world benefits would doom it to the scrap heap. The Corps is in the process of undertaking extensive research into the risk reduction and associated beneficial attributes of different kinds of NNBFs. As noted in Section 5.16 of the Revised Draft Report, quantification of wave attenuation and reduced operations and maintenance benefits would strengthen the economic case for NNBFs even further in certain cases. Hopefully that will lead to more realistic and useful BCA methodology and more reliance on living shorelines that have

the capacity to grow response effectively to sea level rise and intensified storms. Without some breakthroughs in methodology, the Corps' capacity to provide really useful advice concerning coastal shoreline measures will be unduly restricted, if not outright useless and dangerous. In the Corps' research, it will be critical for the benefits of NNBFs, relative to grey features, to be considered in uncertainty analysis, as the Revised Draft Report's analysis assumes an intermediate rate of sea level rise. It is possible future sea levels will exceed current intermediate projections. Thus, it is of critical importance for the Corps to consider tail risks and understand the flood risk reduction benefits that NNBFs may provide under these more extreme- but possible- conditions.

Under these circumstances, we applaud the action of the New York District with the support of the North Atlantic Division and ultimately Headquarters to incorporate these NNBFs into the flood risk reduction projects with their hard structures so that the NNBFs become integral and necessary parts of the larger green-gray whole. We certainly had advocated for such an approach. The experience of Katrina bears out the wisdom of coupling NNBFs with more traditional measures where the levees on the east side of New Orleans that had extensive wetlands in front of them did not breach whereas those that did breach had few if any wetlands to serve as the first line of defense. We understand that the incorporation of such NNBFs into a larger multi-featured risk reduction project in this manner is unprecedented. If so, we welcome such movement in thought and action since, in accordance with the Chinese proverb, to climb a mountain one has to take the first step. The history of the world is replete with first steps that have served mankind well, and, if the New York District has taken such a first step, it should be proud of that accomplishment.

> **Response 1:** Thank you for your support and engagement. It has been a useful component to our process. As part of plan formulation, New York District considers policy consistent NNBFs where applicable, for managing coastal storm risk in our Recommended Plan. The project offers a model for how the Corps can continue to include NNBFs as viable measures in CSRM projects going forward. The District concurs that this is a valuable first step for the affected stakeholders.

Comment 2: We stressed in the opening paragraph that the NNBFs incorporated into the Recommendation Plan represent a minimal level of compliance with the Sandy emergency appropriations legislation, PL 113-2 dated January 29, 2013, Chapter 4 Department of the Army "Construction". That section of the legislation states that the funds provided "shall be used to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events…" in the area of the northeast coast impacted by Sandy. As far as the Jamaica Bay part of the Recommended Plan is concerned, it is hard to maintain that the multiple hard structures proposed for the frequently flood high risk areas provide "support for the long-term sustainability of the coastal ecosystem" of the Bay. The two features that clearly do "support the long-term sustainability of the coastal ecosystem" are the two wetland NNBFs that are incorporated into and are integral parts of the risk reduction programs

for the Mid-Rockaways areas. The incorporation of those features make the recommended plans for those two areas consistent with this legislative text. If the Recommended Plan had included only one NNBF, we would have considered such a course of action to be sufficiently de minimis that it would not be in compliance with the clear and forceful text quoted above.

On the assumption that these features remain as integral parts of the Bay Recommended Plan, we urge that the Corps at all levels, the office of the Assistant Secretary and requisite State and City agencies move forward with finalization of the Recommended Plan and EIS, the encapsulation of the Plan in a PPA, engineering design and then construction with deliberate speed. The Final Plan/EIS and an executed PPA should be in place before we celebrate the sixth anniversary of the adoption of the Sandy emergency appropriations in January 2013.

Response 2: The comment is acknowledged, thank you.

3.2.2 National Parks Conservation Association (22 October 2018)

Comment 1: On behalf of National Parks Conservation Association (NPCA) and our 72,000 members and supporters in New York and 1.3 million nationally, we respectfully submit these comments on the August 2018 Revised Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (EIS) for the Atlantic Coast of New York East Rockaway Inlet to Rockaway Inlet and Jamaica Bay to the Army Corps of Engineers New York District. Since 1919, NPCA has been the leading voice for safeguarding our national parks. NPCA and its more than one million members and supporters work together to protect and preserve our nation's natural, historical and cultural heritage for future generations.

Our interest in this project stems from the study area's proximity to Gateway National Recreation Area (NRA) and relative impacts on the health and function of this national park and other national parks in the New York New Jersey Harbor as well as our interest to call for greater flood protection for coastal residential communities in Jamaica Bay and across New York City. NPCA has reviewed the August 2018 Revised Draft EIS for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay and in sum, we support the plan with the condition that Army Corps of Engineers adopt the proposed natural and nature-based features in the final EIS.

Natural and Nature-Based Features (NNBF)

The NNBFs proposed in the Draft EIS will provide a net gain of roughly 9 acres of wetlands at an estimated cost of $22 million. The inclusion of these NNBFs is an integral part of the flood protection plan for the Mid-Rockaway project site. If the NNBFs were removed from this project site, the proposed hard structures would not provide equal and adequate protection for such a highly vulnerable, frequently flooded, low-lying community. Furthermore, the August 2018 Revised Draft EIS demonstrates how the proposed NNBFs in Mid-Rockaway are more cost- effective than stand-alone traditional hard infrastructure solutions like floodwalls, bulkheads and revetments when trying to reduce the risk of frequent flooding.

In addition to the positive cost benefit analysis (CBA) that NNBFs provide, the Draft EIS states that the adoption of NNBFs in the Mid-Rockaway project will offset the need for mitigation for this specific high frequency flood risk reduction feature (HFFRRF). The money saved from not having to design, engineer and construct mitigation was not taken into account during the cost benefit analysis referenced above. This leads us to believe that the money the Corps will save by including NNBFs in the overall project is much higher than the CBA shows in the Draft EIS.

NPCA encourages the Army Corps of Engineers to reconsider including more NNBFs in existing HFFRRF locations to control frequent flooding and alleviate stressors from high tides, heavy rainfall events, long-term sea level rise and storm surge. Other low-lying communities in the project study area that the Corps does not address in the August 2018 Revised Draft EIS would also benefit from similar NNBF proposals. Even if the Army Corps cannot take on the cost and construction of all NNBFs in the project study area, it would be a valuable exercise for the Corps to undertake such an analysis so that regional and local entities have the information they need should they desire to move forward with smaller, more localiz9 d flood protection projects. A more robust

analysis of how NNBFs can be used in the Jamaica Bay watershed to reduce flood risk would help meet original project goals that the Corps prioritized the onset of this project - to come up with a more wholistic approach to address flooding in Rockaway *and* upland Jamaica Bay communities. Should the Corps decided to do additional analysis of NNBFs in the Jamaica Bay watershed, it is important that any additional analysis does not delay the implementation of projects outlined in the August 2018 Revised Draft EIS.

Response 1: Thank you for your support of the Recommended Plan. As part of plan formulation, New York District considers policy consistent NNBFs where applicable, for managing coastal storm risk in our Recommended Plan. The project offers a model for how the USACE can continue to include NNBFs as viable measures in CSRM projects going forward.

Multiple strategies for incorporating NNBFs into the Recommended Plan were considered, many of which would have required a policy waiver from the Corps Headquarters. The approach the District advanced was coordinated and agreed upon between our non-federal partners, and the USACE vertical team within the regional and Headquarters offices. As this time in the Study, the study team cannot alter its plan formulation to rescreen measures based on new criteria. Furthermore, any reformulation to further analyze NNBFs based on new criteria would indeed incur significant delays to the implementation of the projects recommended in the Revised Draft GRR/EIS. The Project is authorized as a whole and it is not possible to move forward with some aspects for implementation while continuing to study others. However, the study did provide some information that may be useful to others.

The study team assessed the feasibility of constructing NNBFs throughout the study area, though the other sites not in the Recommended Plan were screened out because they did not meet the screening criteria established in the Feasibility Study. This information can be used, however, for regional and local entities as your letter suggests, should they desire to move forward with smaller, localized projects for managing coastal storm risk. In fact, other agencies have different criteria for measuring cost benefits which may result in different outcomes. For example, the Governor's Office of Storm Recovery (GOSR) is moving ahead with a project called Fresh Creek, which is very similar to the Canarsie HFFRRF originally evaluated in this study, except that the GOSR project includes a restoration objective and as such, incorporated living shoreline components into their design. USACE has coordinated closely with the GOSR Fresh Creek team and has shared information and analyses to cooperate and help each other. Should other groups wish to pursue CSRM projects in the study area where none are recommended by USACE, the District is similarly open to providing information from our analysis to help, where that information is available.

Comment 2: Hurricane Sandy Emergency Relief Funds: Inclusion of more NNBFs would further justify the Army Corps' utilization of the remaining Hurricane Sandy Emergency Relief funds that were allocated and appropriated in legislation PL 113-2 dated January 29, 2013. According to law, those funds shall be used for flood risk reduction projects that "support the long-term sustainability of coastal ecosystems and communities and reduce the economic cost and risks associated with large-scale flood and storm events." By including NNBFs in the Mid-Rockaway project, the Corps is now eligible for those remaining funds. With access to the Sandy funds, the Corps can speed up project timeline and implementation by removing hurdles that would require Congress to pass a separate funding bill or funding clause in the next Water Rights Development Act which is scheduled for 2020. Removal of the proposed NNBFs in the final EIS would not meet project funding compliance outlined in PL 113-2 and as a result the project would not be eligible for remaining Hurricane Sandy funds, prolonging flood protection for thousands of New Yorkers.

> **Response 2:** See response above. The Recommended Plan includes five areas of NNBFs and is already in accordance with the authorization as outlined in PL 113-2.

Comment 3: Impacts to Gateway National Recreation Area: It is vital that any extension or construction of new groins on the Atlantic shorefront do not starve National Park Service properties at Jacob Riis Park and Fort Tilden of sand. In years past, we have seen that groin construction in Rockaway can have adverse effects in NPS shorefront properties, leaving natural, cultural and historical resources exposed and vulnerable to sea level rise while park visitors are at risk of encountering shrinking beaches. Significant modeling should be done to confirm NPS resources are not compromised by groin construction and beach restoration should the Atlantic shorefront project move forward.

> **Response 3:** The Recommended Plan, consists of a beachfill taper approximately 5,000 ft in shorefront length from Beach 149th Street west to Beach 169th street fronting Riis Park. The beachfill taper will be beach fill only with a berm width tapered from the design width at 149th Street to the existing width and height at 169th Street. In addition to the beachfill taper, a tapered groin system comprised of three (3) rock groins is included for this section to offset any potential impacts to the NPS sediment budget in Riis Park. USACE will continue to work with NPS in the PED Phase as the analysis and design is refined to ensure that the Project does not negatively impact NPS resources.

Comment 4: Lastly, we want to acknowledge the tremendous progress the Corps has made in the August 2018 Revised Draft EIS compared to the August 2016 Draft Report. We appreciate the Corps consideration to include NNBFs where appropriate and look forward to continuing to work with the NY District to find ways to show NNBFs can bring a series of co-benefits to not only reduce the risk of flooding but also provide significant

improvement to the health of the Jamaica Bay estuary, its wildlife inhabitants and NYC resident populations.

We recognize that NNBFs alone will not save Jamaica Bay from the next major hurricane. Instead, we believe the solution will heavily rely on combined green and gray strategies that mimic natural systems, absorb water and alleviate wave energy. This green-gray approach can address a multitude of future problematic flooding scenarios beyond the scope of this project. Coupling hard infrastructure with NNBFs can address intense storm surges and the next major hurricane while also helping ecosystems and communities cope with heavy rain, full moon tides, long-term sea level rise that are inevitable in low-lying areas like Jamaica Bay and Rockaway.

Thank you for considering NPCA's comments on the August 2018 Revised Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (EIS) for the Atlantic Coast of New York East Rockaway Inlet to Rockaway Inlet and Jamaica Bay.

Response 4: Thank you. Concur.

3.2.3 Riverkeeper (22 October 2018)

Comment 1: Thank you for the opportunity to submit comments on behalf of Riverkeeper, Inc. in response to the U.S. Army Corps of Engineers ("Corps") New York District's August 2018 Revised Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay ("Revised Draft EIS").

We welcome the Corps' focus and attention on "examin[ing] coastal storm risk management problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area," also known as the Jamaica Bay Reformulation Study. Riverkeeper acknowledges that climate change is already significantly affecting—and will continue to affect with increasing severity—New Yorkers' interactions with the oceanic and riverine ecosystems which surround the islands of New York City. We agree that sea level rise and more frequent, intense storms require planning and action. Riverkeeper advocates for reexamining land use decisions and constructing more protective, resilient shorelines over time rather than installing massive, in-water barriers that threaten to change the nature of the Jamaica Bay ecosystem forever. The Corps can and should address flooding threats New Yorkers face without sacrificing this entire ecosystem.

> **Response 1:** The Corps does not have jurisdiction over local land use decisions. The Corps partners with non-federal sponsors and works with them to identify feasible alternatives for addressing coastal storm risk in compliance with policy and regulations. The Recommended Plan no longer includes the proposed storm surge barrier measure is no longer part of the Rockaway Reformulation recommendation, but is currently under further investigation in the New York New Jersey Harbor and Tributaries Study in order to assess the feasibility of this measure, in particular with regards to environmental impacts, how those can be avoided, minimized and mitigated for.

Comment 2: Additionally, we commend the Corps for recognizing that a "substantial revision" to the Draft EIS4 was necessary in light of "significant (extent and content) partner, agency, and public comments" and feedback from Corps Headquarters. Further, such reevaluation is essential in light of changes to the August 2016 Draft EIS's "tentatively selected plan" resulting from the Corps' decision to "move all further evaluation of the Jamaica Bay storm surge barrier measure, a significant component of the TSP [tentatively selected plan for Jamaica Bay-Rockaway Inlet], to the ongoing New York and New Jersey Harbor and Tributaries Feasibility Study."

Below we provide our comments on 1) Riverkeeper's procedural concerns now that the Jamaica Bay/Rockaway Inlet Barrier portion of the Jamaica Bay Reformulation Study has been transferred to the NYNJHAT project for full review; 2) concerns about the adequacy of the Corps' response to our December 2016 comments on the Draft EIS; 3) new, highly relevant and significant information which must be evaluated and taken into account in the Final EIS for this project; and 4) our comments on the remaining

measures in the Revised Draft EIS for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay recommending shoreline projects.

Transfer of Bay Measures from Jamaica Bay Reformulation Study to NYNJHAT

Transferring the Jamaica Bay/Rockaway Inlet Barrier proposal from the Jamaica Bay Reformulation Study to the NYNJHAT Feasibility Study raises numerous concerns. The original Draft EIS for Jamaica Bay/Rockaway Inlet considered measures both in the bay and on the shore to address coastal storm risks. As the Revised Draft EIS explains, the Jamaica Bay Reformulation Study now only addresses shoreline measures for dealing with coastal storm risks, and moves the in-water, bay measures to the NYNJHAT study for further consideration. However, this shift creates numerous procedural concerns that the Corps must consider and address in its final EIS.

First, since funding was already earmarked in the Hurricane Sandy Recovery Fund for the projects contemplated by the Jamaica Bay Reformulation Study, the Corps must explain—now that the project proposals have been split up—how any such funding would be allocated among shoreline and bay measures. Similarly, the Corps must ensure that all environmental impacts associated with the alternatives proposed for the bay are adequately studied in the NYNJHAT study in light of the implementation of the recommended shoreline measures in the Rockaway Inlet/Jamaica Bay region. Additionally, the Corps should explain which of the NYNJHAT study alternatives would incorporate the bay measures shifted from the Jamaica Bay Reformulation Study. The Corps must clarify which NYNJHAT alternatives would include the Jamaica Bay/Rockaway Inlet barrier alternatives.

> **Response 2:** The Disaster Relief Appropriations Act of 2013 provides authority and funding to implement a project in line with the authority as long as funds remain. The storm surge barrier component of the Tentatively Selected Plan (TSP) was estimated to cost more to implement than was left in the entire Appropriations bill, which is shared between multiple projects and allocated upon completion of each decision document (first come first serve basis). The storm surge barrier component of the TSP would never have been funded under the Disaster Relief Appropriations as it would have needed further appropriations to construct. Moving this measure to the NYNJHAT study for further investigation poses no procedural concern, as such a measure would still require further authority and appropriations in order to implement.
>
> It is the intent of the Corps to adequately study this measure within a regional context as suggested. Alternatives 3A, 3B, and 4 of the NYNJHAT study include the Jamaica Bay barrier, as is noted in the NYNJHAT study materials which are publically available. Alternative 2 would obviate the need for the Jamaica Bay barrier.

Comment 3: Further, the bay measure alternatives proposed in the Jamaica Bay Reformulation Study are authorized under “an existing, authorized project for the area that was constructed in 1977 and renourished through 2004, based upon the 1965

construction authorization" under the Flood Control Act of 1965 with an "original multiple purpose" of "coastal erosion control and coastal flooding protection." However, the NYNJHAT Feasibility Study is authorized under Public Law 84-71, June 15, 1955 (69 Stat. 132) with the purpose of conducting an investigation into potential coastal storm risk management solutions. It specifically directs the Corps to examine damages in coastal and tidal areas due to coastal storms such as hurricanes "and of possible means of preventing loss of human lives and damages to property, with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams, and other structures, warning services, or other measures which might be required."

The Corps must reconcile the studies' differing statutory mandates in discussing the purposes and goals these alternatives would seek to meet. With different alternatives formulated in pursuit of differing goals, the bay measure alternatives shifted to the NYNJHAT for further study may need to be reformulated. The Corps should disclose each statutory mandate and how they may differ or align in its discussion of its decision to shift the bay measure alternatives to the NYNJHAT study.

> **Response 3:** Please note that the constructed project at Rockaway Beach was originally authorized by the Flood Control Act of 1965 and modified by the Water Resources Development Act of 1974 which deauthorized the recommendation within Jamaica Bay and provided for initial construction and periodic nourishment for a 10-year period. The initial beach replenishment was completed through 5 construction contracts in 1977. The Rockaway Reformulation revived investigation into the coastal storm risk within Jamaica Bay. The agency decision to conduct further analysis of the storm surge barrier aspect of the recommendation under a new study, the NYNJHAT study, was appropriate given the NYNJHAT regional focus. The NYNJHAT study includes, as you know, Alternative 2, which would obviate the need for the Jamaica Bay barrier. Therefore, it is more appropriate to evaluate and compare this measure in NYNJHATs. The Bayside features which are part of the Rockaway Recommended Plan explicitly consider the proposed storm surge barrier in order to compliment it, should it be implemented under NYNJHATs. The *high frequency flooding risk reduction features* (HFFRRFs) recommended in the Jamaica Bay reach will help to control coastal erosion and manage the risk of frequent flooding from both sea level rise and small storms, as well as high tides. This will complement a potential future barrier by addressing flooding that would still occur with a barrier in place as you would not wish to close the barrier at every high tide or small rainfall event. However, the HFFRRFs are also explicitly designed to stand alone and be incrementally justified such that if the barrier is never built, they will still function as intended.

Comment 4: Finally, similar to Riverkeeper's December 2016 comments on the Draft EIS, we are concerned about the Corps' lack of information about the bay measure alternatives even as they are moved to the NYNJHAT study. First, the Corps' failed to provide adequate information and detail about the bay measure alternatives in the Draft EIS. In response to these comments, the Corps merely repeatedly stated that these

concerns would be “reevaluated” “[a]s the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM [coastal storm risk management] Study.” However, the Corps has similarly failed to provide information about other in-water alternatives thus far in the NYNJHAT study process. We are concerned that the bay measure alternatives shifted into the NYNJHAT study will continue to receive short shrift by the Corps.

As echoed in our original comments on Draft EIS, project information provided by the Corps both on the bay measure alternatives and NYNJHAT alternatives has been unsatisfactory. The Corps has provided only meager information to the public about the proposed alternatives, and the studies, research and data underlying the Jamaica Bay/Rockaway Inlet Barrier proposal. Without the underlying data, studies, or research information to critically evaluate, the public is robbed of its right to meaningfully comment on the proposals. In fact, the CEQ regulations explain that National Environmental Policy Act (“NEPA”)

> procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. Most important, NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail.

With limited specific information currently available, the Corps can hardly be said to have provided “high quality” environmental information to the public “before decisions are made and before actions are taken.”

> **Response 4:** It takes time to conduct the analysis that Riverkeeper is requesting. In a study area that is larger than the State of Delaware, data collection and sorting alone is time consuming. The District engaged in meaningful public outreach during the Scoping period for NYNJHATs which is helping to shape our analysis and has not made any decisions to date to screen alternatives. Your comments will be shared with the NYNJHAT study team.

Comment 5: Corps Response to Riverkeeper’s Comments on the Draft EIS: As the Corps is aware, the Pace University Environmental Litigation Clinic at the Elisabeth Haub School of Law (“PELC”) submitted extensive comments on the original Draft EIS on December 2, 2016 on Riverkeeper’s behalf. As reflected in the Revised Draft EIS, responses to many of those comments have been deferred for consideration in connection with the preparation of the NYNJHAT Feasibility Study, and, as such, those comments remain open and unresolved. Rather than restate them here, all comments from the December 2, 2016 comment letter submitted by PELC on behalf of Riverkeeper (attached here as Attachment A) are incorporated into this comment letter

by reference. As to the specific responses and additional information contained in the Revised Draft EIS, Riverkeeper has the following comments.

As noted above, responses to many of Riverkeeper's original comments have been deferred to the planned release of the NYNJHAT Feasibility Study. Indeed, it appears that the Corps concurs that further comments and analysis of environmental issues related to the storm barrier portion of the original tentatively selected plan ("TSP") should be deferred to the NYNJHAT Feasibility Study. Thus, these comments will not be addressed again here, but rather are incorporated by reference. To the extent that the Corps provided substantive responses to Riverkeeper's comments, those responses are addressed below.

Response 5: Noted.

Comment 6: Riverkeeper expressed concern that the original Draft EIS failed to include sufficient detail to comply with the NEPA or to allow for adequate public review and comment.21 The specific information Riverkeeper identified as missing, however, was related to the storm surge barrier portion of the tentatively selected plan ("TSP"), which the Corps has made clear will now be included as part of the NYNJHAT study. Accordingly, Riverkeeper will withhold further comment on these issues until that document becomes available. Insofar as the Corps represents that the "Draft GRR/EIS has been revised to include more details, remove inconsistencies, and incorporate comments received on the 2016 draft," Riverkeeper does not have further comments on those revisions.

Response 6: Noted.

Comment 7: Likewise, Riverkeeper's comments and concerns with data gaps, incomplete or outdated information, adverse effects on essential fish habitat, exacerbation of existing environmental issues and water quality impacts, were focused on impacts of and information related to the storm barrier portion of the TSP. As to these issues, the Corps has stated that "The sufficiency of the analyses of effects to important fish species is being coordinated with the National Marine Fishery Service ("NMFS"). The Essential Fish Habitat ("EFH") Assessment has been revised to reflect the updates to the Recommended Plan and is included as part of the Environmental Compliance Appendix D. The latest available data was used for this analysis. If you are in possession of newer data, please provide." Riverkeeper has no further comments with respect to the sufficiency or timeliness of data, or impacts to ecosystems or EFH, as they relate to the proposed work in the Revised Draft EIS. Riverkeeper will comment on those issues as they relate to the storm barrier, if such issues still remain, in the context of the NYNJHAT Feasibility Study, which appears to be what the Corps envisions.

Response 7: A revised water quality analysis write-up was provided as part of the Public Engagement Appendix to include more detail on the analysis and data

used in the JEM modeling. Please refer to Appendix G of the Revised Draft Report.

Comment 8: Similarly, the remaining numbered and bulleted comments in Riverkeeper's original comment letter focused on the impacts of, and analysis regarding the storm surge barrier. As recognized by the Corps in its responses, these issues are more appropriately addressed in connection with the NYNJHAT Feasibility Study. As such, these comments are merely incorporated by reference here, and Riverkeeper reserves the right to raise them, to the extent necessary, in that public comment period.

Response 8: Noted.

Comment 9: Relevant New Information to Incorporate into the Final EIS: The Corps must take recent NYC Council bills into account in its evaluation of the project recommendations in the Revised Draft EIS, and it must incorporate such analysis into the Final EIS. In early October 2018, Councilman Costa Constantinides's (D-Astoria) package of environmental protection bills passed the New York City Council. These bills are currently awaiting signature by Mayor Bill de Blasio, and would require mandatory creation of flood maps by the City, in an attempt to alleviate damage from sea-level and storm-related emergencies, and would re-establish the Jamaica Bay Task Force. The Corps must commit to coordination with the City's Jamaica Bay Task Force, if reestablished, in implementing the shoreline measures recommended in the Revised Draft EIS. The flood mapping proposed in these bills would be more detailed and more conservative than existing Federal Emergency Management Agency ("FEMA") flood maps. The Final EIS must incorporate the additional flood mapping information gathered and created through the passage of these bills.

Response 9: The District used both FEMA and NACCS flood maps, with Corps SLR projections as part of its analysis. These were compared to State and NYC SLR projections and found to be rather similar. Sensitivity analysis was performed to see how the plan would perform under the varying USACE SLR projection curves. The CZM Consistency Determination in Appendix D discusses the Recommended Plan using New York City's SLR projection curves and discusses potential future adaptive measures, as does Appendix A1 and A2.

The District does not concur that the Final EIS should incorporate additional flood mapping information from unsigned local bills. The current Rockaway Reformulation schedule is targeting initiating a second round of reviews on the Final Report in late November 2019, with the Final Report being sent to HQUSACE for review and approval in December 2019. Reanalysis is not required, nor warranted at this time.

The Corps Feasibility Phase is intended to recommend a project that is project is technically feasible, economically justified and environmentally acceptable. Under the risk-informed planning paradigm, further analysis is justified in such that it is likely to provide a better Recommendation or the risk of not conducting the analysis is unacceptable to the Corps. The District, as common practice,

coordinates early and often with the Corps' Vertical Team to communicate and manage the risk and uncertainty associated with decisions as the recommendation moves into the PED Phase. As designs are further refined in the PED Phase, it is assumed that changes will be made. If the changes cause a 20% or more increase in the overall cost of the project then a Post Authorization Change Report is required. If the changes trigger further impact analysis under NEPA, than appropriate supplemental NEPA analysis is conducted.

Comment 10: Additionally, the Corps must consider that the bay measure alternatives initially contemplated by the Jamaica Bay Reformulation Study (now moved to the NYNJHAT study) may never actually be implemented. In its public meetings on the NYNJHAT Feasibility Study alternatives, the Corps has acknowledged that many of the in-water barrier alternatives being studied would take decades to design, permit, and secure funding from Congress; none of the alternatives being studied under NYNJHAT are currently funded. Further, the Corps has stated that the in-water barrier alternatives could cost billions of dollars to implement, with the largest barrier – a 5-mile sea gate from Rockaway to Sand Hook – currently estimated to cost up to $140 billion to construct, with additional millions of dollars of maintenance costs. Thus, it is very real that the NYNJHAT proposals may never actually be funded nor constructed, or may be delayed decades before being implemented.

Response 10: As discussed above, District has already taken this into consideration. Each HFFRRF is designed to stand alone regardless of whether a barrier is built or not.

Comment 11: In contrast, the Jamaica Bay Reformulation Study's shoreline measures are already funded by Congress' disaster relief appropriations in the wake of Superstorm Sandy. Thus, the Corps must assess the effect of the already funded shoreline measures here in the Jamaica Bay Reformulation Study even if bay measures are never constructed. In the Final EIS, the Corps must evaluate the potential impact of bay measures never being implemented on the efficacy of shoreline measures that comprise the Rockaway Inlet/Jamaica Bay recommended projects here. These changed project assumptions and new information must be evaluated in the Final EIS.

Response 11: The Revised Draft EIS has addressed this concern. At the outset of the discussion for how the HFFRRFs were formulated, this is explicitly stated in Section 5.9.1 of the report. The designs as laid out in the GRR follow the understanding that the HFFRRFs must be able to stand alone and function with or without a storm surge barrier and withstand frequent overtopping.

Comment 12: Shoreline Measures Recommended in the Revised Draft EIS: The shoreline measures recommended for implementation in the Revised Draft EIS for the Jamaica Bay Reformulation Study represent a fundamental, philosophical change to New York City's existing flood management strategy, and therefore must be carefully considered before being approved for implementation. The shoreline measures

discussed in the Revised Draft EIS rely heavily on the use of pumping stations to remove salt water from low-lying areas (primarily located behind flood walls) as it intrudes during tidal and storm-related flooding events. This represents the first time that New York City would be opting to pump out storm water from actively flooding low-lying locations.

The Corps and local project sponsor the New York City Office of Resiliency and Recovery must carefully evaluate the ongoing maintenance and operation costs of implementing such pumping stations. Operation and maintenance costs will only increase over time as flood pumps are utilized ever more frequently, and during ever more intense flood events—whether higher daily tidal surges, sea level rise, or storms of greater intensity and frequency due to climate change. Operation and maintenance costs will increase until a more permanent solution to flooding is implemented, proving that pumping stations act more as a stop- gap measure than a final solution to coastal flood risks.

Additionally, the agencies must evaluate the vulnerability introduced into this system by relying on electric pumping stations to preserve low-lying, flood-prone areas. For example, if electricity is lost to a pump during a rainfall event, tidal flood, or coastal storm, that entire previously protected area becomes immediately vulnerable to flooding. Further, the use of pumping stations in Jamaica Bay as a response to flood risks has a precedential effect for the rest of New York City as it will be forced to respond to future increased flood risks. The agencies must carefully consider the potential precedential effect of implementing measures like this in their Final EIS before putting forth a recommendation.

Despite our concerns about the implementation of flood management strategies such as pumping stations, we applaud the Corps for considering green infrastructure and natural and nature-based features in its shoreline proposal for Mid-Rockaway. We commend the Corps for recommending the creation of nine acres of wetland which function in conjunction with a flood wall and bulkhead to operate as a whole functioning system of flood protection. We ask that the Corps evaluate the extent to which other built features in its proposal could be complemented by green infrastructure or natural and nature-based features to create a more resilient system of flood protection for this region.

We thank the Corps for taking the time to revise the Draft EIS and respond to our comments. We look forward to reviewing all aspects of the agency's recommendation for the Rockaway Inlet/Jamaica Bay once more specific plans are released for public review, as well as the proposed Rockaway Inlet Barrier in the NYNJHAT Feasibility Study process.

> **Response 12:** NYC shared this concern and the District has coordinated with NYCDEP to address this by presenting NYCDEP officials via a site visit to a recently built pump stations in Greenbrook, NJ and discussing the operations and maintenance with staff at the NJ location. Substantial coordination with NYCDEP resulted in their support for the Recommended Plan, including the introduction of pump stations, to which they were keenly aware was precedent setting for this area. The District will continue to work with NYCDEP in the PED Phase to ensure that concerns are adequately addressed.

Please note that the Study Team undertook a significant effort to identify a HFFRRF plan for Mid-Rockaway and other sites that did not require the use of pumping to function as intended but this was not possible due to the low-lying elevations and the existing low capacity for stormwater infrastructure. The interior drainage improvements, including the construction of pump stations, will work with the natural and nature based features to improve the overall resiliency of this community in the face of flood risk and rising seas.

3.2.4 Surfrider Foundation (22 October 2018)

Comment 1: On behalf of the New York City Chapter of the Surfrider Foundation's (Surfrider) hundreds of members in New York City, please accept our comments on the US Army Corps of Engineers (USACE or Corps) Revised Draft Integrated Hurricane Sandy General Reevaluation Report/and Environmental Impact Statement (Draft HSGRR/EIS) for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay (the project). Surfrider Foundation is a nonprofit environmental organization dedicated to the protection and enjoyment of the world's ocean, waves and beaches through a powerful activist network. Our members live and enjoy the beach in the Rockaways year round.

We appreciate that USACE has spent additional time on this project, since its implementation will drastically change the communities, economies, and ecosystems of the Rockaways and Jamaica Bay area. This project is funded and authorized under the Disaster Relief Appropriations Act of 2013, which directs USACE to "support the long-term sustainability of coastal ecosystems and communities and reduce the economic costs and risks associated with large-scale flood and storm events".

The dual goals of long-term community and ecosystem sustainability are intrinsically at odds with each other in a coastal community such as the Rockaways, which depends on a clean and healthy beach to support the local economy. The same beach can be a pathway of destruction for the community from rising sea levels and storm surges.

Surfrider is sensitive to this balancing act, but is concerned that this project could come at the expense of the beach (leading to significant economic and ecosystem losses for the Rockaways in the long run), when there are other alternatives available that will safeguard the community while better maintaining the health of the beach and local economy.

> **Response 1:** Existing conditions of the beach includes a currently eroding shoreline, which if left unchecked, will negatively impact the local economy that you referenced. The Recommended Plan provides a means to ensure long-term sustainability of the recreational resource that is the beach, while helping the local community manage flood risk.

Comment 2: Dangers of Sea Walls and Hardened Structures: Beach erosion is a natural, dynamic process inherent to beach geology. Problems occur when a static structure such as a building is built too close to a dynamic, moving beach. If buildings and roads were not built close to the shore, we would not have to worry about erosion and sea level rise to the extent we do now. According to USACE measurements, Rockaway Beach is eroding at an average rate of 10 feet per year and rates as high as 20 feet per year have been observed in some sections.

Surfrider cannot support adding additional hard structures into the surf zone or on the beach. Groins are a swimming hazard and will, by USACE estimates, only slow down the loss of sand from Rockaway Beach. Surfrider would also like to highlight that groins are not meant to function as storm protection barriers. Many Rockaway residents believe that groins will protect against future storms surges and impacts but this is not how they function. We are concerned that misguided expectations are being reinforced

by the proposed alternatives and that long term, adequate protection is beyond the feasible capacity of groin structures.

> **Response 2:** The District considered various alternatives to construct and maintain a beach for the Atlantic Ocean Shorefront. These maintenance alternatives are referred to as the erosion control alternatives (see section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the least-costly solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life again and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The Recommended Plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The Recommended Plan does include construction of new groins, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the PED phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will then be improved upon such that erosion control is further refined.
>
> The District concurs with Surfrider's notion that the coastal groins do not directly contribute to a reduced risk of flooding during major coastal storm events. The coastal groins, the beach construction and periodic beach renourishment provide an erosion control function. The buried seawall and dune do provide a flood risk reduction function and are included within the Recommended Plan between Beach 17th and Beach 149th Street. This has been noted in all responses to public comments which request additional groins in Belle Harbor and Neponsit, in large part due to the misconception that Surfrider notes that groins protect against flooding. In providing clear responses and meeting with stakeholders, the District seeks to help correct this misconception.

Comment 3: Similarly, Surfrider cannot support placing hardened structures such as the "composite dune", proposed in this project, on the beach. When waves hit a seawall, the wave is reflected back towards the ocean taking beach sand with it. Both the beach and the surf may disappear. If high erosion or lack of funding allows the composite seawall to be uncovered, the structure will lead to the disappearance of the public beach in the Rockaways.

For this reason we recommend Alternative #3, which includes moving the boardwalk landward, and constructing a larger dune without hardened structures. According to USACE calculations on page 96, adding the hardened structures to the dune only reduces the chance of overtopping from 1% to .67% per year, and reduces possible damage from $31 million to $29 million.

Response 3: It is unclear where these values were taken from. Alternative 3 is not the National Economic Development (NED) Plan (i.e. the plan that maximizes net benefits) and was not Recommended. There are significant costs associated with moving the newly constructed boardwalk landward and acquiring the real estate necessary to do so, which would displace residents and businesses. Furthermore, the composite seawall is non-permeable and stops cross-shore flooding which was a significant damage factor during Hurricane Sandy, it also provides higher resiliency in the face of back to back Hurricanes since the sand is erodible but the composite seawall is not. The buried seawall design is intended to function as a nature-based feature, will be vegetated and will accrete naturally, by trapping sand, and the vegetation should help to stabilize the dune (see additional detail below). As part of continued coordination with USFWS, the District will work to refine the dune design in the PED phase to include sand in the portions that currently have uncovered portions of the composite seawall, where feasible.

Comment 4: This small increase in overtopping and subsequent damage is worth the risk compared to the risk of losing the beach in the Rockaways if beach renourishment does not materialize through lack of sand, lack of funds, or lack of political will. If the hardened structures within the dune are exposed during a storm--and are not immediately covered back up--wave dynamics will rapidly destroy the beach.

Response 4: Please note that the hardened structure is not just “simply” placed on the beach. The horizontally composite seawall is a reinforced dune concept designed to reduce the risk to inland areas from erosion and wave damages and also limit storm surge inundation and cross-island flooding during severe storm events such as Hurricane Sandy. The composite seawall is compatible with comprehensive storm surge barrier plans which are still being considered for the region. The hardened structure is buried within the core of a conventional dune. The sand placed in the dune section is stabilized by dune grass plantings which will develop extensive horizontal and vertical roots over time. The dune provides sufficient substrate for a variety of dune plants to develop. Only during the most severe events there is a potential for the composite seawall to become exposed, yet at that time it will perform the function it is designed for, i.e. reduce the risk to inland areas from erosion and wave damages and also limit storm surge inundation and cross-island flooding. In the eventuality of a severe storm and significant erosion or damage the Corps will be able to complete emergency repairs and repair the project to pre-storm conditions.

Regarding the level of risk reduction, the District would like to emphasize that plan formulation of the erosion control alternatives focused on identifying the least-costly solution to maintaining a wide beach and dune over the 50-year planning horizon for which it is assumed that agreements between the federal and non-federal sponsor will be in place prior to construction such that funds are available. As documented within the GRR the horizontal composite seawall was selected as it has the highest net

benefits. It can furthermore be noted that a borrow site has been identified with sufficient capacity to maintain the project throughout the 50 year project life.

Comment 5: Surfrider would like to see the agreements and financial projections between USACE, NY State government, and local municipalities for the continued maintenance of this project. There is a serious financial responsibility for local governments attached to this project; we would like to be certain that this project is financially and legally sound.

Response 5: The Project Partnership Agreement (PPA) is being developed between the Corps and the non-federal partner. The Operation, Maintenance, Repair, Replacement and Rehabilitation Manual will be prepared during PED and will establish the maintenance for the project, which will be the responsibility of the non-federal sponsor. Currently, it is expected that New York City will operate and maintain the Atlantic Shorefront reach components in question. The Corps requires a financial self-certification and letter of support from our non-federal sponsors as part of the package for the Final Report that is sent to Corps Headquarters. It is a required component in order for the Corps to approve the project for implementation.

Comment 6: Recreation/Tourism Impacts: The ocean economy in New York contributes $22 billion per year in GDP, of which $18 billion is attributed to the economic contributions of tourism and recreation. Surfrider completed a study in 2013 showing that when millions of annual New York beach goers visit our shores they spend an average of $56 per person. This data can be viewed as an endorsement for continuing to nourish our valuable beaches, but it also serves as a warning that excessively engineered beaches put this economic driver at risk. At some point, sea level rise (SLR) will make beach nourishment untenable and residents will be forced to retreat, or live in a community encased in walls without beaches.

Response 6: Please see Appendix A1 for a discussion of how the oceanfront design is expected to perform under varying SLR conditions and potential future adaptations that can be employed to ensure continued performance after the 50-year project life or in the event that sea levels rise even quicker than anticipated. Recreation benefits were analyzed and included as part of this study.

Comment 7: USACE's analysis of impacts to surfing and other types of recreation are inadequate. Page 108 discusses "Recreation Benefits" but only mentions the economic implications of beach visits, without assessing possible impacts to recreational users such as surfers, swimmers, or wildlife viewers. It is commonly known that after beach nourishment projects in the Rockaways the surfing is significantly negatively affected, leading to less visits to the area by surfers. In order to analyze the effects of the proposed project on recreation, a deeper analysis of recreational use impacts is needed.

Response 7: The Recreation Benefits Model used to estimate recreation benefits was designed in accordance with Corps policies and guidelines. It was reviewed and certified by a team of highly qualified economists within the Corps.

Please note that recreation was removed by the U.S. Office of Management and Budget as a mission of the Corps. Therefore, the Recommended Plan must be justified using CSRM benefits alone. Recreation benefits are added in order to provide decision makers with a benefit to cost ratio, or BCR, which reflects recreation as well to paint a fuller picture.

Comment 8: We recommend amending the information about Plum Beach, found on page 44, to include information about the large community of kite surfers that use that beach and adjacent shallow water areas.

Response 8: This information has been added to the report. Thank you.

Comment 9: Benefits of Living Shorelines: Surfrider appreciates that USACE is considering the use of living shoreline structures in Jamaica Bay and other low energy areas where such practices are possible. USACE released Proposed Nationwide Permit B to streamline the process of implementing living shorelines. Living shorelines are an important tool for erosion control, while supporting environmental and public access goals.

Living shoreline techniques have been gaining recognition and usage—largely because the science is clear that coastal armoring exacerbates erosion, while living shorelines curtail erosion by substituting natural vegetation for hard armoring structures and natural methods for shoreline erosion control. Living shorelines strengthen existing connections between riparian, intertidal, estuarine and aquatic areas that are essential for ecosystem health. These methods must be utilized in order to protect the valuable ecosystems located in Jamaica Bay.

Response 9: The District appreciates your support for the Natural and Nature-Based Features that we have incorporated in the Recommended Plan.

Comment 10: Sea Level Rise: Surfrider is still concerned that the SLR estimates used by USACE are overly conservative. USACE is projecting only 5.36 feet of SLR by 2100 in the “high” scenario (table on page 72), while the New York Department of Environmental Conservation estimate is 6.25 feet. New models by scientists that include larger Antarctic ice melting scenarios estimate that sea levels could rise as much as 6 feet by 2100.10 Due to the conservative SLR estimates, we believe that the parameters of this project need to be reconsidered.

USACE must use the best available science in estimating SLR to ensure that the millions of dollars of funds put into the proposed project are not wasted on an inadequately built project. Using realistic SLR estimates may add costs to the proposed project, but they will pay off in less damage in the future.

Response 10: Sea Level Change scenarios have been evaluated in accordance with USACE guidance, specifically Engineering Regulations ER 1100-2-8162. These regulations provide USACE guidance for incorporating the direct and indirect physical effects of projected future sea level change across the project life cycle in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects.

Furthermore, adaptation strategies have been assessed and proposed for how the project could be adapted in the future should sea levels rise quicker than the design assumptions. Even in a worst case scenario, the Recommended Plan would still help to manage risk and perform a valuable function, the benefit would just be decreased and decision makers would need to assess whether to adapt the project to new changed conditions. There is a risk to overbuilding if high SLR scenarios are utilized, as well as a risk to a project underperforming until it can be adapted if sea levels rise quicker than USACE projections. The inherent uncertainty in projections is something that USACE seeks to manage by assessing adaptability and risk.

Comment 11: Negative Effects from Nourishment and Sand Mining: Beach nourishment can negatively affect beach and ocean ecosystems. Offshore, important habitat areas can be negatively affected by so called “borrow” sites if they do not fill back in with sand. One study estimated that it took three years for borrow areas to fully recover, meaning that these areas could be left in a permanently decimated state with beach nourishments scheduled every four years. Other borrow sites have filled in with mud or silt and have become anoxic areas after sand mining has occurred.

Once the sand is on the beach, negative effects can occur to the beach ecology. Studies have shown that the tiny animals that live in the surf zone, which form the base of the food chain in those areas, can be severely depleted for 6-24 months after nourishment activities. This document does not adequately discuss those impacts or examine their effects to other trophic levels including commercially and recreationally important fish species that might be affected.

The type of sand can also significantly affect the beach ecosystem and the enjoyment of beach goers. If incorrect grain sizes are used they can harm beach organisms that are accustomed to a specific size. Grain size can also lead to steep beaches, which can result in dangerous shore breaks for beach goers. Additionally, if poor sand with shells, dark or smelly material, or rocks is used this can affect beach goer attendance, which could lead to severe economic consequences for beach communities.

Rockaway locals reported that after the beach fills following superstorm Sandy, there was a bad smell associated with the sand that was brought in and they opted to stay away from the beach until this subsided from fear of getting sick. It was also clearly visible to residents that the most recent beach fill projects on Rockaway Beach did not last as long as initially planned. Much of the sand was washed away with the first big storm. Surfrider is concerned that the frequency of beach nourishments will be increased, leading to further environmental degradation and negative effects to recreational use.

Response 11: Please note that the Surfrider assumptions about dredge practices are incorrect. As best management practice, the District avoids going back to the same spots within a borrow area for consecutive dredges in order to avoid the impact scenario laid out in your comment. The Corps has extensively studied the effects of dredging on borrow areas and helped to develop and utilize these best management practices which minimize the

temporary effects, including matching grain size to the placement area as discussed in the report. References and links to this research will be added to the Final Draft of the report to bolster the analysis of the effects of dredging and nourishment activities.

There are also positive environmental effects from beach renourishment. In New York and New Jersey, shorebird populations have increased and returns of previously extirpated seabeach amaranth to the beaches that the Corps has nourished.

Finally, the perception of sand not lasting as long as initially planned is not correct, though it is understandable that residents feel this way. This is because sand is placed on the beach with the intent to letting natural coastal processes occur that will adjust the placed sand to the most stable natural profile. The adjustment of the profile is planned for and expected. The District will look into posting signage during future phases of construction to help educate the public about this aspect of the construction to correct the misconception.

Comment 12: Endangered Species: As residents and frequent visitors to Rockaway, we are aware of the efforts that are required to ensure the protection of the piping plover and other endangered species such as the red knot and humpback whale. We are concerned that a project of this scale will negatively affect these species despite assurances by USACE. USACE proposes seasonal and temporal limits on construction and maintenance of the proposed project to negate impacts to mating seasons of endangered species, but this seems infeasible given the large geographic and temporal size of the project.

Response 12: The Corps has a successful track record at accomplishing beach nourishment work in this area using work windows, in coordination with the resource agencies. In addition to work windows to avoid work during mating season of threatened and endangered species, the District engages in monitoring during construction.

Comment 13: Permanent Sand Moving System: Surfrider requests that USACE evaluate a sand moving system as part of the proposed project, perhaps in conjunction with the composite seawall structure. There is considerable sand accretion at Breezy Point and erosion along the Rockaways and East Rockaway Inlet. Sand moved between those two points through a permanent system could be cheaper, less environmentally damaging, and result in better sand quality than large beach fill projects every four years. A similar system was proposed and implemented for Sandy Hook, New Jersey, but was destroyed by superstorm Sandy before it was finalized.

Response 13: Back-passing sand is a measure that the Corps sometimes utilizes where one area is accreting heavily and others are eroding. However, the accreting area in this case, Breezy Point, is a nesting area for the federally threatened piping plover and roughly five miles away from the closest part of the

project area. This distance exceeds the distance from the borrow area identified for use in the Recommended Plan. Removing nesting area for federally protected species would be a significant adverse impact on this species and would require National Parks Service deeming this proposal on their property "mutually acceptable" in order for it to be implementable. Given that this is a negative impact on NPS resources, it is unlikely that they would accept this measure.

Comment 14: Managed Retreat and Buybacks: While managed retreat of beach communities from the shore is politically unpopular, it is cheaper in the long term and – at some point in the near future – will be the only option left to residents. At some point we will either run out of sand, money for more sand, or height above sea level. A situation where residents have to gain elevation to access the beach is untenable.

Managed retreat is most effective in situations where erosion threats have been anticipated and plans made in advance of an imminent threat to structures. Retreat strategies promote the ability of natural systems (e.g., beaches, dunes, wetlands) to respond to wave action and migrate landward, ensuring their survival. Managed retreat strategies can benefit coastal ecosystems and serve as protective buffers against sea level rise and storm events while continuing to provide access, recreation opportunities, and other social benefits.

Managed retreat can be more economical in the long run. For example, the City of Imperial Beach in California conducted a long-term assessment of focusing on managed retreat instead of armoring. The study concluded that by 2100 the City will spend nearly five times as much on continued maintenance and new armoring compared to managed retreat.

The proposed project does not include a buyback or retrofit option, which USACE blames on high density and real estate prices. We realize that the large amount of private residents in the 100-year flood zone makes these types of adaptations economically expensive. However, many residents are not yet willing to move, so the option could be given on a first come, first served basis for those who want and need this option until funding is depleted. Purchased properties could then be converted to community green spaces or gardens for the immediate future. To use superstorm Sandy appropriated federal funds to solely focus on coastal armoring is a misuse of taxpayer funds and does not meet the goal of long term sustainability in the Disaster Relief Appropriations Act of 2013.

Response 14: The District considers non-structural measures as part of its plan formulation in all coastal storm risk management projects. For this study, the District worked closely and extensively with our non-federal partners and locals to investigate the feasibility of implementing non-structural measures such as buyouts, home raising and floodproofing. It was this coordination, particularly with *Build it Back* who has successfully implemented non-structural measures on a large scale in areas like Broad Channel and Breezy Point, as well as Edgemere, which jointly as a team, screened out this measure as infeasible. Underlying this screening was the fact that *Build it Back* already offered landowners in many parts of the

Rockaway project area an option to relocate, raise their home, or be bought out. Those who relocated or took the buyout did have their damaged homes removed and returned to green space. The study team concluded that residents who were willing to take a buyout would have already done so with *Build it Back*. For house raisings, a Corps plan would have required any upgrades needed to bring a building up to code to be paid by the homeowner, whereas the *Build it Back* program did not have this requirement. Therefore, a further assumption was made that residents would not voluntarily opt in to a program that would cost them money when they had recently refused a program with the same objective that would have been free.

As Surfrider notes, many residents are not willing to accept a voluntary buyout at this time. In order for a non-structural plan to provide a comprehensive solution without the need for structural plans in addition to them, it would need to be complete, or at least have geographic areas where each resident agrees to a buyout. This was not feasible at this time. The screening of non-structural measures was coordinated through the Corps vertical team with participation and concurrence from both the North Atlantic Division and Corps Headquarters, as well as the concurrence of our non-federal partners without whom it would be impossible to implement non-structural measures.

The economic evaluation of the Recommended Plan estimated that for every tax dollar spent on this project, roughly three dollars will be generated in the national economy, with even more local economic gains adding to that. This does not fall under a potential misuse of taxpayer funds. Furthermore, the Corps received just a portion of the total appropriation the Disaster Relief Appropriations Act of 2013. Many agencies and programs who also received funding, including NYC's *Build it Back* program engaged in non-structural work, including buyouts and retrofits for particularly flood prone areas, something our agency is cognizant of.

Sustainability includes the continued safety and ability to thrive for communities, in addition to ecological sustainability. The Rockaway Reformulation project area is home to roughly 850,000 people, which is more populous than Seattle, Washington. The Recommended Plan will help this community manage flood risk and be more resilient in the face of future flooding, contributing to the long term sustainability of the Rockaways and Jamaica Bay communities. While the District acknowledges that in the face of sea level rise managed retreat will likely become a reality for many communities, our analysis did not find this to be a good solution for our project area due to the immense infrastructure and dense development already here which is a good investment to protect. There is an ecological, social and economic impact of relocating people as well, namely the new infrastructure, housing, and services that must be provided wherever people are relocated to, in addition to the cultural and historical ties that people often have to the places they live.

Comment 15: Thank you for the opportunity to comment on this proposed USACE project for Rockaway Beach and Jamaica Bay. Please contact us if you have any questions or comments.

3.2.5 Nature Conservancy (22 October 2018)

Comment 1: Thank you for the opportunity to comment on the Revised Draft Environmental Impact Statement (EIS) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study. On behalf of The Nature Conservancy (the Conservancy), please accept the following comments in support of a flood risk management plan that ensures the long-term health and function of Jamaica Bay's coastal and marine ecosystems, as well as the safety and equitable distribution of resources that enhance the resilience of coastal communities and businesses.

The Conservancy's mission is to conserve the lands and waters on which all life depends. With the support of more than one million members, the Conservancy has protected over 120 million acres and 5,000 river miles around the world, and currently has more than 150 marine conservation projects in 72 countries and in every coastal state in the U.S. The Conservancy has been working to conserve, protect, and restore coastal and marine habitats and species along the U.S. Atlantic Coast for over four decades. The Conservancy has a vested interest in the health of the Jamaica Bay ecosystem as well as the safety and quality of life of residents. We serve on the Jamaica Bay Science and Resilience Institute's Advisory Committee, and we partner with the National Park Service and the Natural Areas Conservancy on ecological restoration and stewardship projects at the Jamaica Bay Wildlife Refuge and at Marine Park.

The Conservancy recognizes that the communities in the Rockaway-Jamaica Bay-Coney Island region are vulnerable to rising sea-level and storms, and we believe that Nature and Nature-based Features can play a central role in addressing that vulnerability. We believe that structural solutions are only one component of a risk reduction strategy. Even after groins, floodwalls, dunes, berms, wetlands, and other structural measures are constructed there will still be flooding and property damage due to storm events larger than the design standard or the failure of the engineered solutions. Therefore, we urge the Corps to work closely with the City of New York and other parties to implement additional local, non- structural solutions to reduce flood risk. These measures include strategies such as flood proofing, raising homes, and voluntary buy-outs.

We present our specific comments in five thematic areas – Coastal Risk Management using Nature and Nature-Based Features, Accounting of Ecosystem Services, the Jamaica Bay Storm Surge Barrier and NY/NJ Harbor and Tributaries Feasibility Study, Design Standards and Project Lifespan, and Non- structural Measures, as follows.

Coastal Risk Management using Nature and Nature-Based Features

A recent study by Nature Conservancy scientists found that coastal wetlands prevented $625M in property damages during Superstorm Sandy. Another recent study by a Nature Conservancy scientist and colleagues illustrated that there are synergistic resilience benefits of restoring reefs and emergent wetlands together. Although wetlands and reefs alone will not protect the residents of Jamaica Bay from future high intensity storms, living shorelines and reefs can protect against frequent, low-intensity storms.

While we are encouraged to see some Nature and Nature-Based Features (NNBF) included in this study to improve resilience by reducing erosion and flooding risk, we believe NNBF are underutilized. With only nine acres of the total project areas identified to provide "NNBF Gains," this study represents a missed opportunity to implement practices that benefit both human and natural communities. The study area falls within the Hudson Raritan Estuary Comprehensive Restoration Plan, yet little attention seems to have been given to potential restoration or creation of NNBFs identified by that plan. By only considering the creation of NNBF at locations already with natural shoreline, parks, or wetlands (p. 115), the Corps has missed opportunities to transform aging hardened shorelines that provide minimal flood risk management or socio-ecological benefits into NNBFs that provide both. Only a small portion of Jamaica Bay was considered for NNBFs, with just eight sites in the southeast corner of the Bay (p. 119, Fig 5-11) evaluated. Low-income and vulnerable communities in other parts of Jamaica Bay such as Coney Island, Broad Channel, and Canarsie stand to be disproportionately affected by flooding, storms, and sea-level rise. These communities deserve protection from the more frequent, low-intensity storms that cause nuisance flooding, erosion, and limit safe outdoor access. NNBFs should be seriously considered for these communities.

> **Response 1:** The plan that was evaluated at Broad Channel did include a reef as a natural breakwater (NNBF), but the plan was not economically justified and was screened out. For Canarsie, there is an existing Governor's Office of Storm Recovery (GOSR) project in this area that has broad restoration authority and is already planning NNBFs in that area, as well as other planned restoration projects. That coupled with the limited remaining space was why NNBFs were not included in the Canarsie design. This, however, is no longer occurring because Canarsie was also screened out as not economically justified. The Coney Island community that TNC also sites will be evaluated as part of the NYNJHATS study now as it would be part of a tie-in to the proposed storm surge gate.

Comment 2: We also caution the Corps against over-stating the benefits of the project, especially the NNBFs as designed. For example, wetland plantings created behind hard structures are not ecologically equivalent to undisturbed natural wetlands, and it is an exaggeration to consider all rock revetments as oyster habitat creation. Additionally, there will undoubtedly be effects beyond the footprint of the project boundaries, and those are not accounted for in this analysis.

We encourage the Corps to reconsider the use of NNBF to create greater resilience for these communities that will enable them to recover from future storms more quickly, provide relief from chronic implications of sea level rise (e.g. tidal flooding) while providing access opportunities during periods of tranquil conditions. Wetlands, barrier islands, oyster reefs, and dunes can provide wave attenuation and flood control during the storm events.

> **Response 2:** The devastating effects of Hurricane Sandy heightened awareness of the need for resilient coastal communities that can protect valuable infrastructure and homes against future storms. In the aftermath of the storm, federal, state, and municipal assessment and planning

documents emphasized the need for NNBFs. Many recommendations of these plans directly coincide with the goals and objectives of the Corps ecosystem restoration mission to restore and create coastal habitats.

The District, as part of plan formulation, sought to include wetlands, dunes, and potentially oyster reefs among the measures for managing coastal storm risk as part of the Recommended Plan. These are sited in a low-income, diverse, and vulnerable community. The analysis focused on siting these measures where they could be justified meeting the Corps' CSRM benefit criteria. As this study authority is not a restoration authority, the Corps cannot implement and fund plans strictly for ecological restoration of an area under the Disaster Relief Appropriations Act of 2013 as the District must demonstrate their connection to coastal storm risk management for which the Study is authorized. However, the Hudson Raritan Ecosystem Restoration Study will be recommending 22 restoration sites with the following 8 sites within Jamaica Bay:

- Perimeter Sites: Fresh Creek, Brant Point and Dead Horse Bay
- Marsh Islands: Elders Center, Duck Point, Pumpkin Patch- East and West, and Stony Creek

Comment 3: Accounting of Ecosystem Services: We understand that the Corps uses Benefit Cost Ratios to choose the Tentatively Selected Plan (TSP). However, these dollar-to-dollar ratios do not account for the full suite of ecosystem functions, services or the associated economic impacts from the proposed project because ecosystem services can be difficult to accurately monetize. Benefits accruing from NNBF can have sizable economic consequences, thus, the omission of these benefits from the process can create flawed ratios and misguided comparison of alternatives, ultimately resulting in sub-optimal decision-making. While the Corps acknowledges this shortcoming, additional tools should be utilized to meet this need. We recognize and compliment the Corps on the use of functional assessments to determine the current ecological value of existing ecosystems. We urge the Corps to use additional ecosystem service accounting methods, such as Habitat Equivalency Analysis and others, to evaluate the alternatives and use this information to complement the existing Benefit Cost Ratio method.

The Conservancy demonstrated the use of functional assessments and Habitat Equivalency Analysis in our Urban Coastal Resilience Report: A Case Study in Howard Beach, Queens. Using these analytical approaches, we illustrate that hybrid infrastructure strategies integrating tidal gates, salt marshes, and shellfish can provide sufficient, cost-effective flood management and superior ecosystem services compared to gray-only (i.e., non-NNBF) alternatives.

Response 3: The study team used a functional habitat assessment to account for habitat quality in our assessment of habitat created and do not believe that the benefits of NNBFs are overstated, but rather concur with the latter part of TNC comments that they are understated because they do

not account for ecosystem services. TNC's statement that the rock revetments are being counted as oyster reefs is not correct. As discussed at multiple meetings with TNC representatives present, rock sills are to be designed to provide habitat as a secondary measure by incorporating bagged oyster shells or reef balls that will be pre-seeded with mats of ribbed mussels and oysters. The designs will build upon the best management practices of the existing ongoing mussel and oyster restoration projects in Jamaica Bay. They are also similar to methods to oyster restoration NNBF projects that TNC has sponsored along the Georgia coast, and elsewhere. The District has been coordinating with NYCDEP to learn from their pilot projects and will continue to coordinate with them and others, as warranted, to inform the next stages of design for how to recruit oysters to the NNBF sites.

Comment 4: Jamaica Bay Storm Surge Barrier and NY/NJ Harbor and Tributaries Feasibility Study: Although included in previous versions of this study, a Jamaica Bay storm surge barrier is now under consideration in the NY/NJ Harbor and Tributaries Feasibility Study (NYNJHATS) along with in-water storm surge barriers at several locations beyond Jamaica Bay. Segmentation of the analysis by moving the storm surge barrier proposal into another study is problematic for several reasons, including:

1) The environmental conditions (flow, depth, wave height, etc.) of the present TSP could be considerably altered by the outcomes and implementation of recommendations stemming from the NYNJHATS. This TSP would require re-evaluation once a plan is selected or implement under NYNJHATS.

Response 4: The Recommended Plan for the Bayside has been particularly designed to be compatible with a potential future storm surge barrier, as discussed in the report, but also to stand-alone without one in the event that it is never built.

Comment 5: 2) Although the high frequency flooding risk reduction features (HFFRRFs) are not designed to protect against larger, low frequency flooding events, those events and their impacts cannot be ignored in the cost-benefit assessments presented here, simply because they are also addressed in NYNJHATS.

Response 5: The HFFRRF analysis did account for large events, both from an economic perspective, environmental, and engineering/design.

Comment 6: Design Standards and Project Lifespan: The future without project condition (FWOP), which is the baseline for the analysis and comparison of alternatives developed for this study, was analyzed following an "intermediate" rate of relative sea level rise in the future, which is approximately one foot over 50 years, from 2020-2070. Based on the Community Risk and Resiliency Act (CRRA) sea level rise projections, one foot of sea level rise by the 2080s would be considered low – not "intermediate". A medium sea level rise projection for the 2080s would be 2.42 feet, more than double the Corps' estimate. The sea level rise projection increases to 3.25 feet under the CRRA

high-medium scenario for 2080s. The USACE guidance (ETL 1100-2-1 and ER 1100-2-8162) requires “consideration of a range of relative sea level change” including historic rates and projections of increased rates. According to Fischbach et al. (2018), Jamaica Bay will likely reach threshold effects between 1.5 - 3 feet of sea level rise, which would lead to rapid ecosystem loss, among other impacts. The Nature Conservancy urges the Corps to consider future projections of sea level rise that more closely follow the medium and high-medium range CRRA projections to ensure that all likely sea level rise related impacts are factored into the analyses.

> **Response 6:** The District utilized its own agency projections which track closely with those of both New York City and New York State. The District also performed a sensitivity analysis to see how the project would perform under a high scenario and identified adaptive measures for how the project could be adapted to higher levels than the intermediate curve.

Comment 7: The construction of groins along the Atlantic Ocean Shorefront will affect the natural depositional processes that create and maintain barrier islands. Over time, the engineered system may become sediment deficient dramatically increasing erosion and hydraulic forces. The permanent seawall along the Rockaway Peninsula will require costly sand re-nourishment and maintenance over the 50-year life cycle of the project. The result being communities separated from their waterfront, sand deprived beaches with continuous maintenance and replenishment costs, exposed sheet pile with little to no biological benefit, and damaged homes and community infrastructure behind them following the next storm that exceeds design specifications.

> **Response 7:** Through the Flood Control and Coastal Emergencies (FCCE) Act, PL 84-99, the District returned the project area to the original design profile and constructed a temporary dune. The FCCE dune that the District has constructed and vegetated has been accreting nicely since construction despite the existing groin field.
>
> The composite seawall is designed to protect against erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding. The Recommended Plan spans from Beach 20th Street to Beach 149th Street (Reach 3 through Reach 6b) and combines Beach Restoration and Erosion Control and two tapered beach sections at both the east and west end of the project (Beach 9-19, and Beach 150-Beach 169, respectively). The Recommended Plan (and cost estimates) include the cost to maintain and replenish this design and restore the dune should a large flood event wash the sand away and expose sheet pile. The exposed sheet pile, should it encounter back to back storms before the opportunity to restore the project to pre-storm conditions, would still provide some protection to the densely populated communities behind it. The sheetpile also serves a critical role in minimizing the risk of cross-shore flooding from the ocean which was a huge damage driver during Sandy and contributed to much of the devastation.

Comment 8: Non-structural Measures: In this study, the assessment of non-structural solutions, including home raising and buy-outs, is inadequate. Simple assumptions are

made about the infeasibility and expense of those kinds of solutions, and they are dismissed without thorough evaluation. We urge the Corps and surrounding communities to consider the long-term benefits of raising homes or buyouts. This approach has been successfully implemented in this region in Oakwood Beach, Staten Island after Hurricane Sandy.

> **Response 8:** The District worked extensively with our non-federal partners and locals to investigate the feasibility of implementing non-structural measures such as buyouts, home raising and floodproofing. It was this coordination, particularly with *Build it Back* who has successfully implemented non-structural measures on a large scale in areas like Broad Channel and Breezy Point, as well as Edgemere, the team jointly screened out this measure as infeasible. As part of the Corps' risk-informed screening using existing information is acceptable and, in fact, encouraged as a means to reduce study cost and duration and more scrupulously manage taxpayer resources. The screening of non-structural measures was coordinated through the Corps vertical team with participation and concurrence from both the North Atlantic Division and USACE Headquarters, as well as the concurrence of our non-federal partners without whom it would be impossible to implement non-structural measures.

Comment 9: Thank you for the opportunity to participate in the public comment process of the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study Revised Draft EIS. We look forward to working with you to enhance both coastal and community resilience to the impacts of climate change in our region.

3.2.5 Breezy Point Cooperative (22 October 2018)

Comment 1: We are deeply disappointed that there is no level of protection planned for Gateway properties as the lack of protective measures will put all neighboring communities at risk. Dangerous erosion continues in the vicinity of Beach 193rd Street at the cove area. State Road/Rockaway Point Boulevard is a mere 50 feet away from the waterline and the vegetation between is beginning to rot away from the severe nor'easters that now have become all too common. A breach of the roadway is eminent which will create a life and safety issue for those homeowners, businesses and community facilities west of Beach 193rd Street. Proactivity is needed here, not reaction once the damage is done.

> **Response 1:** There is an ongoing resiliency project with FEMA, HUD, and New York City for Roxbury/Breezy Point, namely the Breezy Point Hazard Mitigation Grant Program (HMGP). As noted in the main report Section 3.2.4.3 on the Future Without Project Condition, Coastal Storm Risk Resiliency Efforts by Non-Federal Entities, the City is working with the Breezy Point Cooperative to implement an approximately $60 million flood risk reduction project for the communities of Breezy Point and Roxbury. The project, which is funded through a combination of FEMA HMGP and HUD CDBG-DR funds, will include a combination of dunes, berms, and floodwalls as well as potential erosion control measures, so there are planned efforts underway to address the risk in this area. However, the cove in the vicinity of Beach 193rd Street which is part of Gateway National Park (aka owned and operated by the National Park Service, or NPS) is not part of the Breezy Point HMGP. There is an opportunity to address this area under the New York and New Jersey Harbor and Tributaries (NYNJHAT) Study which is underway in the New York District.
>
> As part of the Agency Decision Milestone for this study, the decision was made to conduct further analysis on the proposed storm surge barrier and tie-in areas, including the areas west of the Marine Parkway Bridge (Roxbury, Rockaway Point, Breezy Point, Coney Island, Manhattan Beach, Brighton Beach, Gerritsen Beach, etc.), under a different ongoing study—the NYNJHAT study. If features were proposed or constructed in these areas as part of the Rockaway Reformulation they would need to be modified or removed later should the Rockaway storm sure barrier move forwards, which would cause duplicative federal expenditures.

Comment 2: It appears that very little conversation or coordination is taking place among all of the agencies with funding or projects. The corps should work closely with FEMA on their funded projects to ensure they are tied in with the Corps projects and provide total and complete protection for the communities individually and the peninsula as a whole. One outage is the weak spot for protection of all.

There must also be a formal study regarding the implications of all plans, designs, and their impact. We must be sure that protection of one area does not create greater problems for another area or create other issues in the future.

Response 2: The USACE coordinates regularly with state and local agencies, working with our partners, New York State and New York City to coordinate directly with other state and city agencies, and working with other federal agencies for environmental coordination and to ensure that we are apprised of ongoing efforts that would affect the completeness of a recommendation. The planned work of others, including FEMA / HUD and NYC efforts in Breezy Point/ Roxbury and throughout the project area, are discussed in the report.

The General Reevaluation Report and Environmental Impact Statement (GRR/EIS) for this General Reformulation Study analyzes and discusses the implications of the Recommended Plan as part of a full impact analysis, to include cumulative impacts of the Recommended Plan with the work by others and other USACE projects (see Section 7.21 of the GRR/EIS). The designs have been evaluated to ensure that the Recommended Plan will not induce problems in adjacent areas or create unintended problems. The design team will continue to ensure that the project does not induce impacts as the design is refined to a higher level of detail.

Comment 3: Finally, there must be expedited processes for protection projects and emergency repairs. Plans are hitting roadblocks because of governmental bureaucracy. All levels of government and their agencies must work together to expedited plans, permits and construction before it's too late. The longer our communities remain exposed, the greater the negative impact.

Response 3: Concur, the USACE is committed to timely and open coordination and communication with other local, state, and federal agencies to effectively communicate plans, expedite the permitting processes, and advance the construction of potentially life-saving projects. The coastal storm risk management mission remains a priority for USACE and the schedule has been expedited to the maximum extent practicable, including early initiation of the development of Plans and Specifications, completing concurrent reviews of work products, early permitting coordination, and frequent inter-agency/ inter-departmental coordination calls.

3.3. Public Comments and Responses on the Revised Draft GRR/EIS

Comment	Response
I wanted to express concern over the revised draft provided by the army corps specifically about the lack of protection along Jamaica Bay/Beach Channel Drive from the intersection of BCD and Rockaway Freeway to BCD and 116th Street. As a property owner in the area I witnessed the flooding that took place along this stretch during Hurricane Sandy and am worried about the lack of protection in the area. Beach Channel Drive is after all our coastal evacuation route and when inundated with storm surge will almost certainly cause increased loss of life. Perhaps I am missing something in the study? What is being done to protect this area? Thank you for taking the time to read my comments.	Reg: comprehensive Jamaica Bay wide risk reduction features Given the low lying elevations of the Rockaway peninsula you cite, and the fact that the entire evacuation route would need to either be elevated or flooding kept out of it, comprehensive risk reduction would need a large-scale solution that covers the whole evacuation route in order to be effective. The proposed storm surge barrier (which is economically justified based on the preliminary analysis and is being studied under the NYNJHAT study now) would provide this comprehensive risk management and is the most cost effective alternative for this. However, it needs to be studied further before it could be implementable and the funding in the Sandy bill would not cover the ~$3 billion cost of this feature, and would need further authority and funding in order to implement. In the interim, the Recommended Plan attempts to provide the feasible risk reduction for Back-Bay communities that can be accomplished under the existing study using existing funds. In the area you note, the Mid-Rockaway HFFRRF would reduce flood risk from smaller storms for Beach Channel Drive in much of the area you discuss. See Figure 2-3 in the Interior Drainage Sub-Appendix A2E which shows the drainage basins for Mid-Rockaway. Also, the parts of Beach Channel Drive behind the HFFRRF alignments for Mid-Rockaway would remain dry up to a 20% annual exceedance probability (AEP) event. However, for larger events major road closures are still expected. The pump stations that the project will install should, however, greatly improve the resiliency of the neighborhood and roads by allowing water to be pumped out of the neighborhood more quickly than it could naturally drain when water levels in the Bay remain elevated.
I just browsed the new USACE revised report that was released yesterday. I am curious why the newly installed groins would stop at Beach 121st Street, rather than continue to the existing groin at Beach 149th Street. I live on Beach 140th Street, and our	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1).

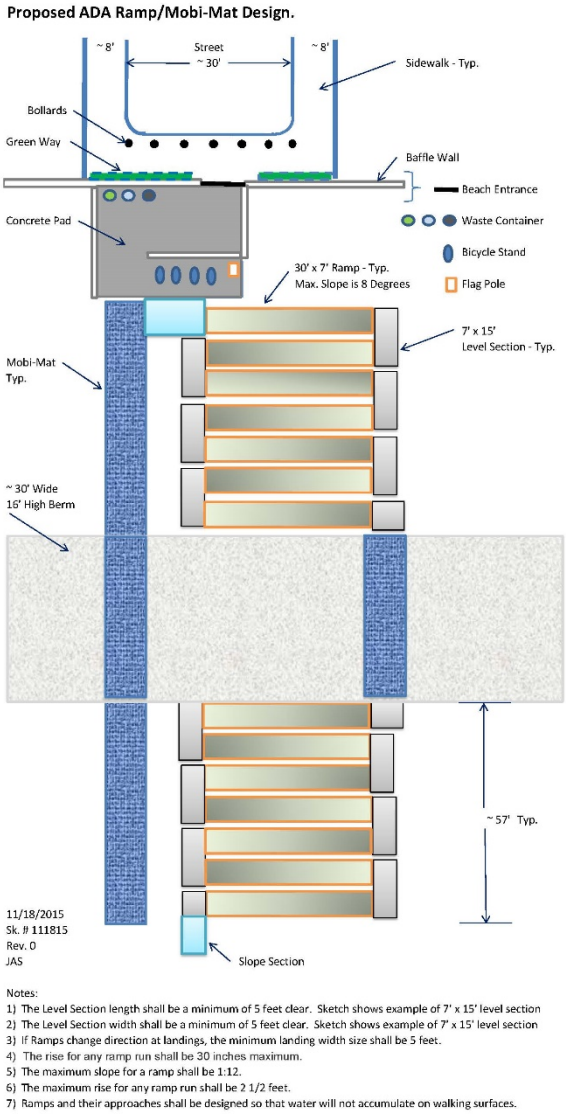
beach is extremely small, and it only gets worse from 141st to 148th. I would think that the beach could benefit from some groin placement somewhere in the beaches between. Thanks for your hard work!	Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined.
REFERENCE - Sheet ID CS-302 (20 & 21 of 38) - Preliminary - Not for Construction. Note: 1. Requires explanation! Figure 6-2 Atlantic Shorefront - Composite Seawall Figure 6-4 Design Beach Profile A. Over a year ago, the USACE landside design from Beach 126th Street to Beach 149th Street was identified in error. This length of 23 Beach Block Entrances involves three communities, namely, Rockaway Park, Belle Harbor and the Neponsit communities. This error was identified and verbally stated on several occasions to the USACE representatives. B. The newly issued USACE 9/4/18 draft for community comments again shows the believed major engineering error for Beach 126th Street	A. The plans have been updated in the latest draft. Please see appendix A1C. B. entrances Re. Beach-Entrances; The Recommended Plan is the result of a Feasibility Study and the design details presented are in line with typical feasibility design plans. The goal of a Feasibility Study is to recommend a feasible plan which meets the objectives laid out during the study and complies with the law and the policies of the USACE. The level of design and analysis performed during the Feasibility Study is geared towards reducing the amount of uncertainty about what the alternative(s) would cost to implement and what the potential impacts of the plan(s) may be in order for decision makers to feel comfortable with approving the Recommended Plan for implementation. Please note that additional design details will be worked out during the next phase—the

through Beach 149th street. It's evident that no changes were made from the previous design drawing(s). It's possible that the Project Manager is not aware that there are approximately 23 Beach entrances. The drawings appears to require major engineering redesign changes along with dollar estimates, for the entire 1 mile length of beach-front. C. The problem with the proposed design is that the landside slope ends at the "baffle wall's top area." Also, this allows for Beach/Dune sand to blow onto the landside beachfront street homes, adjacent beachfront homes along the baffle walls, NYC streets, sewers, etc. and also the 23 beach entrances have not been taken into account. D. With "ADA" requirements foreseen in the future it hasn't been considered as required by law. E. At the New York City Council meeting held on June 25th, 2018 (NYC Council Meeting of Parks & Recreation of Rockaway's Beach Closing), the USACE representative stated there is new software purchased and will be run for an analysis to see if ocean groins can be permitted for the Rockaway Park, Belle Harbor and Neponsit communities. There hasn't been any mention in the recent issued USACE September draft and the June 25th, 2018 meeting for the new analysis. F. Sheet ID CS-302 (21 of 38) -- 1* Define and show what a "Splash Apron (W50=800 lbs.) is and how fastened. 2* What is the distance from the Baffle Wall to the Sheetpile Wall (PZ27)? 3* Won't the 18' sand height blow onto the landside "existing grade elevation" and "Homes (bordering the Baffle walls)"? 4* is there an additional drawing that hasn't been presented showing the typical 23 beach entrances in relation to the new Dune design? G. The Jamaica Bay Planning Reach doesn't include Rockaway Park, Belle Harbor and Neponsit areas for the Beach Channel Drive to evaluate increasing the bay wall height by approximately 2 feet. This would be a temporary attachment to the existing wall that	Pre-Construction Engineering and Design (PED) Phase. During the Feasibility Study the focus has been on the evaluation of the various Coastal Storm Risk Management and erosion control alternatives. With the buried composite seawall / dune plus beach berm being the Recommended Plan for the Atlantic Shorefront reach. Detailed design and/or analyses of access points and on and off ramps and ADA compliance has not been included at this stage as that level of design is performed during the PED Phase. Beach access designs will be completed during the PED phase and will need to be completed on a site-specific basis to account for any geometric constraints. Changes in the alignment or section of the horizontal composite seawall may be needed at certain locations to accommodate beach access, but all of this is expected to be worked out during PED. C. wind blown sand The sand placed in the dune section is stabilized by dune grass plantings which will develop extensive horizontal and vertical roots over time. The dune provides sufficient substrate for a variety of dune plants to develop. Wind-blown sand transport in landward direction has not specifically been addressed during the Feasibility Study other than acknowledging the fact that the existing conditions (FCCE Project – see also section 7.3.1 of Appendix A1) includes a dune of similar elevation. Evaluations of project measures to potentially address landward sand migration are recommended for further analysis during PED. A recommendation will be included within Section 8.4 of Appendix A1. D. See our response above for B E. The analysis referred to is discussed in response B, is referred to throughout the report, and was in fact discussed at both public meetings held on the Revised Draft General Reevaluation Report and Environmental Impact Statement— namely that additional analyses and design will be conducted in the PED Phase. This analysis is ongoing as a result of an early start to PED Phase which was granted by the Chief of Engineers in order to expedite the possible construction start of this project. Results have not been shared because the work is still ongoing.

can later be removed. One has to consider sea level rise data and length of time, say 50 years, for the future study and major protection implementation to occur. H. The Beach 149th Street groin is shown not having any improvement made. At the past New York City Council June 25th meeting, it was mentioned this groin would be enlarged or improved. 1) Sheet ID CS-101 - The Legend should not include "Sheet Pile Wall", "Buried Seawall", "Splash Apron", and "Existing Baffle Wall." If Sheet Pile Wall exists in drawing, please identify it and keep in the Legend. 2) Sheet ID CS-102 - The Legend should not include "Sheet Pile Wall", "Buried Seawall", "Splash Apron", and "Existing Baffle Wall." If Sheet Pile Wall exists in drawing, please identify it and keep in the Legend. 3) Sheet ID CS-103 - The existing groin at approximately B149th Street is not shown to be improved or enlarges as stated at previous meetings. The existing Baffle Wall beach entrances do not line up with the DOT streets. Why are there numerous Baffle Wall openings along the wall length? See Reference: e-mail dated Sept. 13, 2018 for related and additional comments. 4) Sheet ID CS-104 - The existing Baffle Wall beach entrances do not line up with the DOT streets. Why are there numerous Baffle Wall openings along the wall length? See Reference: e-mail dated Sept. 13, 2018 for related and additional comments. 5) Sheet ID CS-105 - The existing Baffle Wall beach entrances do not line up with the DOT streets. Why are there numerous Baffle Wall openings along the wall length? See Reference: e-mail dated Sept. 13, 2018 for related and additional comments. 6) Sheet ID CS-106 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." The New Groin - Reach 3, Groin 33-115th street arrow may be pointing to wrong line. 7) Sheet ID CS-107 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." The New	F. The splash apron is a rubble mound structure that provides means of dissipating wave energy beyond the sheetpile wall in the event of severe overtopping. The rubble mound structure is comprised of armor stone and bedding stone and is supported by the existing baffle wall. The structural capacity of the baffle wall and local soil condition will be assessed during the PED Phase. W50 describes the weight of the median stone. 2. the distance between the sheetpile and the baffle wall is 18 feet. 3. See our response above for C. 4. See our response above for B. G. The Jamaica Bay Planning Reach does include the areas mentioned. Small coastal storm risk features, like low floodwalls which address sea level rise and frequent flooding, were in fact analyzed for the Jamaica Bay Planning reach within the proposed storm surge barrier alignment. Those which were found to be economically justified per USACE policies have been included in the Recommended Plan. With respect to major protection implementation the following can be mentioned. Re. Comprehensive Jamaica Bay wide risk reduction features; Given the low-lying elevations of the Rockaway peninsula and developed areas around Jamaica Bay, a large-scale comprehensive risk reduction solution would be needed to be effective against all and extreme event flood risks. The proposed storm surge barrier (which is economically justified based on the preliminary analysis and is being studied under the NYNJHAT study now) would provide this comprehensive risk management and is the most cost-effective alternative for this. However, it needs to be studied further before it could be implementable and the funding in the Sandy bill would not cover the roughly $3 billion cost of this feature. Furthermore, it would need further authority and funding from Congress before it could be implemented. In the interim, the Recommended Plan presented in this report attempts to provide flood risk reduction for smaller scale events for Back-Bay communities. The Recommended Plan can be accomplished under the existing study using existing funds. The study considers sea level rise over a period of 50 years. Please see Section 4.4 of Appendix A1 and

Groin - Reach 3, Groin 34-113th street arrow may be pointing to wrong line. 8) Sheet ID CS-108 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 9) Sheet ID CS-109 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 10) Sheet ID CS-110 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 11) Sheet ID CS-111 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 12) Sheet ID CS-112 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 13) Sheet ID CS-113 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 14) Sheet ID CS-114 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 15) Sheet ID CS-115 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 16) Sheet ID CS-116 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 17) Sheet ID CS-117 - The Legend should not include "Splash Apron", and "Existing Baffle Wall." 18) Sheet ID CS-118 - The Legend should not include "Sheet Pile Wall", "Buried Seawall", "Splash Apron", and "Existing Baffle Wall."	Section 2.2 of Appendix A2 for detailed information on how sea level rise was incorporated into the analysis and design for the study. H. Beach 149th groin 1)The typical legend is used for all the site plans for the project. Call-outs for specific structures such as sheet pile wall, buried seawall, splash apron and existing baffle wall are shown on the individual site plan sheets where the structure exists or is proposed. 2)See our response above for H. 1. Re. Beach 149th Groin: The Recommended Plan does not currently include any rehabilitation to this existing coastal groin. However, during the Pre-Construction, Engineering and Design (PED) Phase additional analyses will be completed to refine the tapered groin field at the western end of the project which includes the Beach 149th groin. These analyses will inform the final design which very well may ultimately include rehabilitation (not necessarily an enlargement) of the coastal groin at Beach 149th street. For Baffle Wall entrances and openings Please note that entrances at the existing baffle wall are not currently shown on the drawing set. It is noted that some of the stationing shown on the site plans are obscuring part of the existing baffle wall. We will revise the drawings to avoid any confusion. See also our response above for B. 3) See our response above for H. 3. 4) See our response above for H. 3. 5) The typical legend is used for all the site plans for the project. The arrow is pointing to the crest of the groin. The location of the arrow will be revised for consistency. 6) The typical legend is used for all the site plans for the project. The arrow is pointing to the crest of the groin. The location of the arrow will be revised for consistency. 7) To 18) The typical legend is used for all the site plans for the project.
I am writing to communicate to you and your fellow ACE team members my perspective on the urgent need for the planned construction of groins to be extended from Beach 121st Street to Beach 148th Street in the Rockaways.	We appreciate your concern. The feasibility study is a direct result of USACE's recognition of the vulnerability of the area to flood hazards. The study investigated both the Atlantic Ocean Shorefront Reach and the Jamaica Bay

As a resident of the “beach block” on Beach 138 Street I can relay that my family and I have experienced ocean water either inside or within the vicinity of our home on a number of storm related occasions. Our most recent experience was the five (5) feet of ocean water flooded our ground floor subsequent to Hurricane Sandy. Respectfully, while I recognize the value of computer modeling , I strongly do not believe that the determinations derived from its conceptual findings should supersede the conclusions of actual experience. We are highly vulnerable to the deleterious impact from the nearby ocean with future storms given the current lack of mitigating infrastructure. This can only be ameliorated by the construction of groins in the ocean at our beaches. Hence, if ACE is going to build groins from Beach 90th to Beach 121st it should continue the construction to Beach 148th. I highly urge your positive consideration and determination to this urgent plea. It is vital for us and our fellow community members. Thank you. On the topic of ADA access to the beach from B126th to B149St, the attachment was previously sent on May 6th, 2016 to the USACE for future consideration. The proposal was also published in The Wave, Friday, May 13, 2016, page 54. The sketch #111815 depicts how we could envision the beach entrances, the traversing over the 16 to 18 foot high dunes/berms and important accessories like Bicycle Stands, Trash Containers and Flag Pole. We have a unique opportunity to develop a world class project that NYC can be proud of.	Planning Reach. The Recommended Plan is, in short, to build a buried seawall dune and beach for the Atlantic Ocean shorefront with continued periodic renourishment of beach sand for the coming 50 years. In addition, existing coastal groins will be repaired and new coastal groins will be constructed. The buried seawall and dune provide a flood risk reduction function while the coastal groins and the beach construction and periodic beach renourishment provide an erosion control function. I.e. maintain the beach (full details on the Recommended Plan are provided in Section 8 of Appendix A1). It should be noted that coastal groins do not directly contribute to a reduced risk of flooding during major coastal storm events. For the Jamaica Bay Planning Reach a series of smaller risk reduction features are prosed to reduce the risk of flooding associated with high frequency flood events (full details on the recommended plan are provided in section 7 of Appendix A2). These features do not address the risk of flooding from major coastal storm or hurricane events. Re. Comprehensive Jamaica Bay wide risk reduction features; Given the low-lying elevations of the Rockaway peninsula and developed areas around Jamaica Bay, a large-scale comprehensive risk reduction solution would be needed to be effective against all and extreme event flood risks. The proposed storm surge barrier (which is economically justified based on the preliminary analysis and is being studied under the NYNJHAT study now) would provide this comprehensive risk management and is the most cost-effective alternative for this. However, it needs to be studied further before it could be implementable and the funding in the Sandy bill would not cover the roughly $3 billion cost of this feature. Furthermore, it would need further authority and funding from Congress before it could be implemented. In the interim, the Recommended Plan presented in this report attempts to provide flood risk reduction for smaller scale events for Back-Bay communities. The Recommended Plan can be accomplished under the existing study using existing funds. Re. Beach-Entrances; The Recommended Plan is the result of a Feasibility Study and the design details presented are in line with typical feasibility design



-- (Please try printing out the colored sketch on 81/2" x 14" paper.)

From past Park's communication/ proposal there my be 4 or 5 ADA ramps installed.

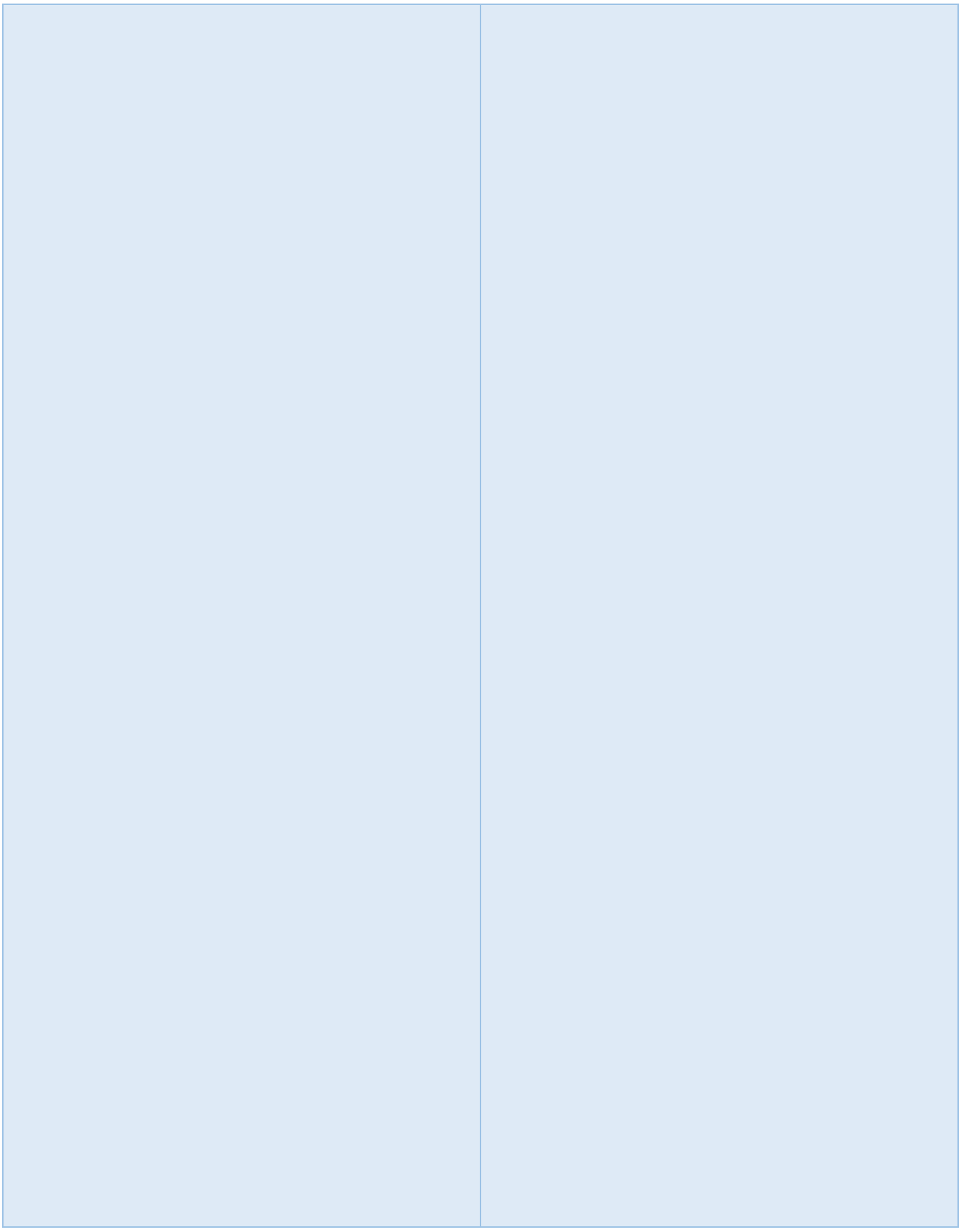
plans. The goal of a Feasibility Study is to recommend a feasible plan which meets the objectives laid out during the study and complies with the law and the policies of the USACE. The level of design and analysis performed during the Feasibility Study is geared towards reducing the amount of uncertainty about what the alternative(s) would cost to implement and what the potential impacts of the plan(s) may be in order for decision makers to feel comfortable with approving the Recommended Plan for implementation. Please note that additional design details will be worked out during the next phase—the Pre-Construction Engineering and Design (PED) Phase. During the Feasibility Study the focus has been on the evaluation of the various Coastal Storm Risk Management and erosion control alternatives. With the buried composite seawall / dune plus beach berm being the Recommended Plan for the Atlantic Shorefront reach. Detailed design and/or analyses of access points and on and off ramps and ADA compliance has not been included at this stage as that level of design is performed during the PED Phase. Beach access designs will be completed during the PED phase and will need to be completed on a site-specific basis to account for any geometric constraints. Changes in the alignment or section of the horizontal composite seawall may be needed at certain locations to accommodate beach access, but all of this is expected to be worked out during PED.

Thank you for giving your attention to this very important Quality of Life opportunity/matter.	
We live on 134th Street, Beach Block where there is massive erosion. Would you please address why the Army Corps is not building a jetty near our street? Thank you.	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined.
As a resident of the Rockaway Peninsula, residing in Belle Harbor, I'd like to express my appreciation in your release of the proposed plans for future resiliency efforts in the Rockaways. Our community has been eagerly awaiting to hear about the plans regarding protection, beach restoration and access for residents, particularly those with disabilities. In reviewing the document there are several areas I would like to get clarification, as well as, comment on.	1. beach access Re. Beach-Entrances; The Recommended Plan is the result of a Feasibility Study and the design details presented are in line with typical feasibility design plans. The goal of a Feasibility Study is to recommend a feasible plan which meets the objectives laid out during the study and complies with the law and the policies of the USACE. The level of design and analysis performed during the Feasibility Study is geared towards reducing the amount of uncertainty about what the alternative(s) would cost to implement and

1. What is the expected method in which residents will be able to access the beach? For the entrance ways, can top, side and front views be shown in exploded view manner? 2. What will be constructed to be within ADA compliance 3. Figure 6-3 on page 147 refers to beach 126-149, however, is not representative of that portion of Belle Harbor. Is that figure a misrepresentation or perhaps referring to another portion along the Peninsula? 4. All your figures of the "composite seawall" representing a splash apron and bedding stone being supported by the existing baffle wall is a concern. The wall was not constructed with the intent for such pressure to be placed upon it nor for wave pressure. It was merely constructed to limit the sand from entering the streets and sand retention. Have engineers and architects determined the feasibility of what is being represented in the drawings? 5. With the additional elevation of the sand above the baffle wall, how will that impact residents residing on beach block? It's anticipated that sand will continually be blown in the streets and become a hazard. I hope these comments will be reflected upon and addressed at your upcoming meetings.	what the potential impacts of the plan(s) may be in order for decision makers to feel comfortable with approving the Recommended Plan for implementation. Please note that additional design details will be worked out during the next phase—the Pre-Construction Engineering and Design (PED) Phase. During the Feasibility Study the focus has been on the evaluation of the various Coastal Storm Risk Management and erosion control alternatives. With the buried composite seawall / dune plus beach berm being the Recommended Plan for the Atlantic Shorefront reach. Detailed design and/or analyses of access points and on and off ramps and ADA compliance has not been included at this stage as that level of design is performed during the PED Phase. Beach access designs will be completed during the PED phase and will need to be completed on a site-specific basis to account for any geometric constraints. Changes in the alignment or section of the horizontal composite seawall may be needed at certain locations to accommodate beach access, but all of this is expected to be worked out during PED. 2. see response above 3. Figures 6-2 and 6-3 were mislabeled in the main report. The figure associated with the title of 6-2 was shown as Figure 6-3, and the figure associated with the title of 6-3 was shown as Figure 6-2. The report has been revised to correctly show the proper figures associated with the proper figure titles. Note: the figures also are shown in engineering Appendix A1 as Figures 8-2 and 8-3. 4. Wave forces are not expected to act upon the baffle wall. Wave forces will act upon the armor stone of the buried revetment and sheetpile wall which are part of the horizontal composite seawall. All these project components will be constructed such that they can take the design wave loads. Engineers have assessed the concept of including the baffle wall structure within the horizontal composite seawall (between beach 126th and 149th street) and deemed it to be feasible. Within the feasibility design as presented in the GRR the baffle wall will act as a retaining structure to retain the splash apron stones. During the PED Phase further study of this feasibility

	level design is warranted. This is recognized within the GRR document (see Section 8.4). The structural capacity of the baffle wall and local soil conditions will be assessed during PED. An engineered design will be completed at that stage to ensure that the existing baffle wall, with strengthening measures if deemed necessary, can retain the splash apron stones and handle the design loads, or the design will be modified as appropriate. Engineering strategies such as additional piles and new concrete baffle wall elements may be included within the final design. The risk and uncertainty associated with the integration of the baffle wall within the existing design is acknowledged by the engineers and the project cost risk register and cost contingency has been updated to reflect this risk and uncertainty. 5. The dune crest will be at an elevation of +18ft. The sand placed in the dune section is stabilized by dune grass plantings which will develop extensive horizontal and vertical roots over time. The dune provides sufficient substrate for a variety of dune plants to develop. Wind-blown sand transport in landward direction has not specifically been addressed during the Feasibility Study other than acknowledging the fact that the existing conditions (FCCE Project – see also section 7.3.1 of Appendix A1) includes a dune of similar elevation. Evaluations of project measures to potentially address landward sand migration are recommended for further analysis during PED. A recommendation will be included within Section 8.4 of Appendix A1.
1. The flow of sand on the Rockaway Peninsular is East to West. Large groins limit the flow of sand westward and this causes the beaches on the west side of the groin to lose sand. (Example Bay 1 Riis Park). 2. Will the absence of groins between B126 St. and B149 St. result in the depletion of sand in this area over time? If yes, what approximate time frame can the beach 126 St. to 149 St. experience major depletion of beach sand, with a ten-year average of Major Storm occurrences? 3. Can additional groins be placed in the areas of beach 126 St. through 129 St? If so is there any negative consequences in doing so?	We appreciate your comments. *Groin Placement Comments* Allow us to address your 6 comments here regarding groin placement as follows: Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide

4. Why are groins planned for below B126 St and above B149 St rather than placed along the entire shore from B 19 St to Breezy Point? If additional groins are not possible; what are the technical reasons? 5. The space between the groins planned for Riis Park is greater than the distance between the groins in Rockaway (Beach 33 St. to Beach 126 St.) Can an explanation be provided? 6. Can the space between the Rockaway groins be increased to that of Riis Park to protect the B 126/149 street area? What is the impact of doing this? Why is there a difference between spacing of the Rockaway and Riis Park groins? Berm - Berm from B 126 St to B 149 St. 1. How deep will the beach be from the seaward side of the berm to the high-water mark? Is it as deep as past beach replenishments? 2. Is the USACE responsible for beach replenishment? If not, which agency (Federal, State or City) is responsible? 3. If the beach is eroded on the seaward side of the berm, will the berm be undermined resulting in a collapse of the proposed rock dune? 4. The entrance to the beach at the seawall appears to be blocked by the landward splash apron. How will people access the beach? Please provide clear diagrams. 5. The seaward sand berm is higher than the 9 ft armor stone platform. Will this increase the amount of sand blowing landward? If yes, what is the plan to prevent this from occurring?	beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. The goal of the erosion control measures is to even out the sand losses such that erosional hotspots are reduced. For the areas west of Beach 149th Street, the goal is to ensure that the USACE project does not negatively impact or minimizes impact to the sediment budget for neighboring Riis Park. For the private community of Breezy Point beyond Gateway National Park, federal taxpayer dollars cannot be spent in the protection of shores and beaches without public access provided every quarter of a mile, whether they are privately owned or public (33 USC 426e, 33 USC 2213(d)). Additional detail with respect to the modeling performed to analyze the alternatives is documented in Sub-Appendix A1-A (A sub-Appendix to Appendix A1 of the GRR). *Berm comments* 1. Beach berm width is shown in the diagrams on sheet CS-301. The beach berm width is generally 60ft or more. The distance between the beach berm width and the MHHW line (elevation +2) is an addition 90ft.



I am looking forward to the upcoming meetings regarding your Draft Report and its proposals for the Rockaway Peninsula. I was heavily impacted by Hurricane Sandy and have great concerns with the following items in your Draft:	- The request for collaboration on dune design issues is noted. The comments have been shared with the PED team who will attempt to address the comments in future iterations of the design set to occur in early 2019. The need for further public engagement will be further assessed once additional work has been performed and shared with the public.

-- when will the USACE start to collaborate with the residents from Beach 123rd to 149th Streets on dune design issues. -- what are the plans, if any, to counter water breaching the bay side sea wall. -- what is the time table for installation of a permanent dune for the area -- most importantly, why is there no provision for installing groins from Beach 123rd to 149th Streets. I would appreciate any info you can provide on the above concerns.	- The Recommended Plan for the bay side includes improved drainage systems and pump stations which will help to drain floodwater out of the neighborhoods when the high frequency flooding risk reduction features (HFFRRFs) are overtopped. The current condition is such that floodwaters drain via gravity flow and when the bay waters are elevated due to floods, the floodwaters cannot drain out into the Bay until the Bay waters recede and the elevation is below the outfalls. The improved drainage and pump stations will allow the neighborhoods to pump water out when flood waters remain high, as long as they do not exceed the HFFRRF elevations. Re. Comprehensive Jamaica Bay wide risk reduction features; Given the low-lying elevations of the Rockaway peninsula and developed areas around Jamaica Bay, a large-scale comprehensive risk reduction solution would be needed to be effective against all and extreme event flood risks. The proposed storm surge barrier (which is economically justified based on the preliminary analysis and is being studied under the NYNJHAT study now) would provide this comprehensive risk management and is the most cost-effective alternative for this. However, it needs to be studied further before it could be implementable and the funding in the Sandy bill would not cover the roughly $3 billion cost of this feature. Furthermore, it would need further authority and funding from Congress before it could be implemented. In the interim, the Recommended Plan presented in this report attempts to provide flood risk reduction for smaller scale events for Back-Bay communities. The Recommended Plan can be accomplished under the existing study using existing funds. - Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed

	during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change. - Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined.
My husband Kevin O'Mealy and I reside at 447 Beach 139th Street, in Belle Harbor, NY 11694. I am writing to express our serious concerns with the USACE Draft Report--Projects in New York/East Rockaway Inlet to Rockaway Inlet Rockaway Beach, primarily because of the lack of attention paid to work for Beach 126th Street to Beach 149th Street, an area that is particularly vulnerable since we have no boardwalk here.	We appreciate your concerns. Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over

First, why are there no groins planned for the area between Beach 126th and Beach 149th Streets? We absolutely need groins here, like the eastern portion of Rockaway is getting, but there are no plans to build them here--six years after Superstorm Sandy!! Why?? Second, when will a permanent dune be installed in this area? We were told that the current dunes were temporary, and while they have worked to some extent in the absence of any storm, we need permanent dunes going forward. Third, what are the plans for enhancing the seawall on the bay side? The current walls are not very high and roadways and homes need to be protected from water breaching the current walls. Fourth, a review of the architectural renderings found in A1-C shows serious problems and omissions--there is no provision on these drawings for any way to enter or walk on to the beach, ADA compliance issues are not addressed, and having sand reach the top of the baffle wall means that during a severe storm that sand will blow onto the streets and into homes. We remember several feet of sand being on the beach streets after Sandy, and the sand was not even up to the top of the baffle walls then. Finally and in some ways most importantly, when will the USACE begin to collaborate with Belle Harbor residents on developing comprehensive plans to address these and other issues? The two public meetings being held are miles away from our neighborhood, and parking is limited. Our local association, Belle Harbor Property Owners' Association, has spent incredible time and energy studying these issues since Sandy, and has reviewed the plans carefully. If USACE really wants community input, you should talk to us and our leaders about our reactions, feedback, and ideas before things get set in stone. Thank you for your attention to this matter. I would appreciate a substantive response.	the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. - Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change. - The Mid-Rockaway HFFRRF includes floodwalls, berms, natural and nature based features, bulkheads, and revetments to provide a continuous line of protection which will manage the risk of flooding up to the current 10% annual chance of exceedance event from Hammels to Edgemere (see the report for

	Phase. Beach access designs will be completed during the PED phase and will need to be completed on a site-specific basis to account for any geometric constraints. Changes in the alignment or section of the horizontal composite seawall may be needed at certain locations to accommodate beach access, but all of this is expected to be worked out during PED. The sand placed in the dune section is stabilized by dune grass plantings which will develop extensive horizontal and vertical roots over time. The dune provides sufficient substrate for a variety of dune plants to develop. Wind-blown sand transport in landward direction has not specifically been addressed during the Feasibility Study other than acknowledging the fact that the existing conditions (FCCE Project – see also section 7.3.1 of Appendix A1) includes a dune of similar elevation. Evaluations of project measures to potentially address landward sand migration are recommended for further analysis during PED. A recommendation will be included within Section 8.4 of Appendix A1. -The public meetings were held to solicit input and comments on the changes to the Recommended Plan since the release of the 2016 Draft Report. The Recommended Plan for the Shorefront did not change between the two reports whereas significant additional work was performed on the Bayside. The Recommended Plan in the Revised Draft included features in Hammels, Arverne, Edgemere, and the Village of Cedarhurst. The meeting locations were chosen to be centrally located in these areas where these new features are recommended. The meeting in Far Rockaway was a 13 minute drive / 27 minute subway ride from Belle Harbor (according to GoogleMaps). In New York City, many meeting locations have expensive and/or very limited parking availability and are mostly accessed via public transit, bicycling, or walking. Comparatively, the RISE Center had what many would consider to be ample free parking, definitely compared to what is available in other parts of Brooklyn. I, for example, parked directly outside the meeting and saw ample remaining open parking across the street and on previous blocks.

	The USACE has received ample input from Belle Harbor community members and leaders and is taking this feedback into account. As noted in the above response for 'Beach Entrances', the type of design considerations your comment refers to are not necessary for feasibility level design but are addressed as designs progress in the PED Phase. The study team must balance the timing and extent of public engagement and additional meetings with the need to move forward and complete the study, which has been a consistent and repeated comment that we have heard from the public again and again. A more appropriate time to conduct engagement on the issues that Belle Harbor residents have consistently raised would be once the PED team has performed the additional analyses and has a more substantive answer to give. The designs are not set in stone until PED Phase ends and we move to the Construction Phase. Finally, waiting to perform additional engagement and design during the Feasibility Study would risk the availability of federal funding to construct the project, as this funding is allocated on a first come first serve basis once a study has been completed and the recommendation is approved.
Question. Need to take into account What effect will this work have on traffic? The area is already a traffic bottle neck and how long will the work take?	Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change. During the Pre-Construction Engineering and Design (PED) phase the USACE will also take a closer look at the construction methods and construction sequencing and the impact to local traffic. Temporary impacts on traffic are likely but efforts will be made to avoid and minimize them.
How soon can we expect to see sand being pumped onto Rockaway Beach Hot Spots?	Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently

	estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change.
Is the proposed quadrennial sand replenishment dependent on future appropriations?	Re. Beach nourishment and renourishment and cost sharing; Beach nourishment projects consist of the initial placement of sand along a beach that has experienced erosion. As the nourished beaches undergo erosion, they must be maintained through beach renourishment. The renourishment process consists of restoring the Rockaway beach to initial conditions on a 4 year cycle and has less time and cost associated with the project when compared to the initial nourishment. For the Recommended Plan the initial construction will be 100% federally funded (subject to the continued availability of funds from the Disaster Relief Appropriations Act of 2013, which are expended on a first come first serve basis). Renourishment costs are expected to be cost-shared at 50% federal and 50% non-federal, though it is possible that it is within the discretion of the Assistant Secretary for the Army for Civil Works to authorize renourishment pursuant to the existing construction authority, Section 934 of WRDA 1986, at 65/35% cost share. The exact split is still pending a final agreement between the federal and non-federal partners. As such the funding for renourishment could be subject to changes in federal appropriations and/or local laws. In short, yes the sand replenishment is dependent on future appropriations.

1 How can USACE and NYC work to have interim replenishment in areas closed this past summer? 2. Will DEC have any oppositions to seawall? 3. Will tonight's presentation be made available online?	1. USACE and NYC are in close communication regarding the observed erosion at the locations where the beach was closed in the summer of 2018. 2. USACE cannot provide a response or speak on behalf of DEC. DEC will review the GRR and EIS and will provide comments. USACE will respond such that all comments from DEC will be satisfactory resolved. 3. Presentation for public meetings can be found on following the USACE New York District Website: https://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/East-Rockaway-Inlet-to-Rockaway-inlet-Rockaway-Beach/
Who does the 4 or 5 year renourishment? Who funds? (ACOE? NY State? NYC?)	Re. Beach nourishment and renourishment and cost sharing; Beach nourishment projects consist of the initial placement of sand along a beach that has experienced erosion. As the nourished beaches undergo erosion, they must be maintained through beach renourishment. The renourishment process consists of restoring the Rockaway beach to initial conditions on a 4 year cycle and has less time and cost associated with the project when compared to the initial nourishment. For the Recommended Plan the initial construction will be 100% federally funded (subject to the continued availability of funds from the Disaster Relief Appropriations Act of 2013, which are expended on a first come first serve basis). Renourishment costs are expected to be cost-shared at 50% federal and 50% non-federal, though it is possible that it is within the discretion of the Assistant Secretary for the Army for Civil Works to authorize renourishment pursuant to the existing construction authority, Section 934 of WRDA 1986, at 65/35% cost share. The exact split is still pending a final agreement between the federal and non-federal partners. As such the funding for renourishment could be subject to changes in federal appropriations and/or local laws. The renourishment will be contracted through USACE. Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the

	buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change.
Beach replenishment – while I appreciate the enormity and scope of the project, it would appease many Rockaway residents if all the beaches were replenished (especially those which were closed – 88th St. - 102nd St.) as the first step in the project, if it needs to be done anyway, might as well do this first, regardless of the groins, at least residents can enjoy the beaches and businesses can enjoy profits from customers.	Thank you for your comment, it has been noted. The sequencing of work will factor existing erosion into account, as well as work windows required by U.S. Fish and Wildlife Service and the National Marine Fisheries Service, coordination with our partners, and other engineering consideration.
1. No emergency or interim protection after Sandy for bayside 2. What about emergency sand now? 3. What about Bay 149 and Breezy Point protection? 4. Will bayside which will take five years start first? If it did not get interm work on beach – why not start bay side? Need to start at same time, or start bayside. 5. Start construction before 2019 hurricane season. 6. Dunes and recreational area. Will the dune's beachfront have usable space? Will residents be able to use the beach? 7. Jetty – Beach 86rh St. E is sand, W is eroding. Rock jetties work. Need action to put rock jetty from 8ths forward. Need sand/groins now.	1. The USACE has no existing authority or mechanism with which to provide interim protection for the Bayside. The shorefront interim protection was only possible because there was an existing USACE project in place that could be repaired under the emergency repair program. 2. That is outside of the scope of this feasibility study. 3. It is unclear what Bay 149 Is referring to Breezy Point is outside of the proposed storm surge barrier alignment and will be assessed under the NYNJHAT study as a tie-in to the proposed barrier. 4/5. There are significant real estate requirements that must be negotiated before the bayside work can commence, whereas the Atlantic Shorefront is publically owned. For example, some private business properties must be acquired in fee or easements attained and many private residential homes will need to provide easements to allow construction and maintenance activities to occur on their property. This process can be time-consuming. Construction phasing is based on what is feasible and all elements are being expedited as much as possible. USACE has cut through significant red tape to reduce the study duration and get to a faster construction by as much as one year. 6. Yes, there will be a minimum beach berm width of usable recreational space of 60 feet, but in many parts of the study area that width is naturally much larger, sometimes as much as 300 feet wide. 7.

	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. Comments pertaining to the design have been shared with the PED team for consideration as they conduct additional analyses. Please also note that the Recommended Plan includes construction of a new beach and dune and that the plan includes periodic renourishment of the beaches such that the beaches are maintained over the project life of 50 years. It should be further noted that the coastal groins do not directly contribute to a reduced risk of flooding during major coastal storm events. The coastal groins, the beach construction and periodic beach renourishment provide an erosion control function. The buried seawall and dune provide a flood risk reduction function and are part of the Recommended Plan between Beach 17th and Beach 149th Street. When Hurricane Sandy hit, there was

	no dune in place along the Atlantic Shorefront and the beach was in an eroded condition in many places. With the Recommended Plan in place, the entire stretch of the Atlantic Shorefront, regardless of groin placement, will have an annual chance of .0067% that a storm will come which would overtop the Recommended Plan and cause flooding from the Atlantic Ocean side.
1. The proposed dune from b 126-b 149. Preliminary drawings display this 16' high dune set back against the barrier wall between homeowners properties and the beach. Please reconsider this positioning and keep the dune where the present berm is located. 2. NY post article (attached) from Sept. 29, 2018 describes a $1.45 billion project to raise East River Park 8-10 feet from Cherry St. up to 13th St. to prevent flooding in the area. How come $30 million can't be found to build a dozen rock jetties between B 125-B 149 and replenish the sand along the entire Rockaway shoreline?	1. The location of the dune and buried seawall has been designed to provide a wide beach where possible. Your input has been relayed to the design team. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. The positioning of the dune and buried seawall will then be improved to further refine the design while maintaining the intended function. 2. The Recommended Plan for the Atlantic Shorefront is estimated to cost roughly 340 million dollars and the erosion control features (groins) are intended to reduce the lifetime cost of the project by reducing the frequency and amount of sand renourishment required. Re. Beach nourishment and renourishment and cost sharing; Beach nourishment projects consist of the initial placement of sand along a beach that has experienced erosion. As the nourished beaches undergo erosion, they must be maintained through beach renourishment. The renourishment process consists of restoring the Rockaway beach to initial conditions on a 4 year cycle and has less time and cost associated with the project when compared to the initial nourishment. For the Recommended Plan the initial construction will be 100% federally funded (subject to the continued availability of funds from the Disaster Relief Appropriations Act of 2013, which are expended on a first come first serve basis). Renourishment costs are expected to be cost-shared at 50% federal and 50% non-federal, though it is possible that it is within the discretion of the Assistant Secretary for the Army for Civil Works to authorize renourishment pursuant to the existing construction authority, Section 934 of WRDA 1986, at 65/35% cost share. The exact split is still pending a final agreement

	between the federal and non-federal partners. As such the funding for renourishment could be subject to changes in federal appropriations and/or local laws.
In looking at the diagrams it appears that we need some redesign – a gully on the north side of the berm to dissipate the fury of the water. A resident who is an engineer said that this is a wave barrier (the berm) and doesn't make sense for a 4 ft. from street level step to get onto the beach. Please address the cliff from the dune/berm to the beach on the south side of berm. Can we restore the original wooden groins and reinforce the 149th St. Groin? Please revisit the plans and the beaches from 126-149th St. (On second form) We need groins throughout Neponsit. We also need an accessible beach for all.	The design of the horizontal composite seawall has been carefully thought through, analyzed and engineered and has furthermore been reviewed by qualified engineers, both internal and external to the USACE. The design is able to withstand the expected loading of the 1% Annual Exceedance Probability (AEP) Storm Event. This includes hydrostatic loads and wave loads. Re. Beach-Entrances; The Recommended Plan is the result of a Feasibility Study and the design details presented are in line with typical feasibility design plans. The goal of a Feasibility Study is to recommend a feasible plan which meets the objectives laid out during the study and complies with the law and the policies of the USACE. The level of design and analysis performed during the Feasibility Study is geared towards reducing the amount of uncertainty about what the alternative(s) would cost to implement and what the potential impacts of the plan(s) may be in order for decision makers to feel comfortable with approving the Recommended Plan for implementation. Please note that additional design details will be worked out during the next phase—the Pre-Construction Engineering and Design (PED) Phase. During the Feasibility Study the focus has been on the evaluation of the various Coastal Storm Risk Management and erosion control alternatives. With the buried composite seawall / dune plus beach berm being the Recommended Plan for the Atlantic Shorefront reach. Detailed design and/or analyses of access points and on and off ramps and ADA compliance has not been included at this stage as that level of design is performed during the PED Phase. Beach access designs will be completed during the PED phase and will need to be completed on a site-specific basis to account for any geometric constraints. Changes in the alignment or section of the horizontal composite seawall may be needed at certain locations to accommodate beach access, but all of this is expected to be worked out during PED. Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean

	Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. USACE will however not restore existing wooden groins. Re. Beach 149th Groin: The Recommended Plan does not currently include any rehabilitation to this existing coastal groin. However, during the Pre-Construction, Engineering and Design (PED) Phase additional analyses will be completed to refine the tapered groin field at the western end of the project which includes the Beach 149th groin. These analyses will inform the final design which very well may ultimately include rehabilitation (not necessarily an enlargement) of the coastal groin at Beach 149th street. The Recommended Plan does include rehabilitation of three old groins in Riis Park in order to offset any negative impact on NPS property as a result of the Recommended Plan. The final design will

	be based on further analysis being conducted in the PED Phase.
We in Belle Harbor and Neponsit are upset that the ACEO project with jetties/groins stop at Beach 121st. You need to check out the erosion on the uptown beaches. I read a summary of the latest report and it indicates that the reason jetties/groins won't be placed uptown is because you do only mitigation not recreation. What kind of thinking is this? We are at great risk/ There are many valuable homes which may be at risk. We pay very high property taxes based on NYC Dept. of Finance new Assessments. Jetties/groins would provide added protection from future storms. As a member of the Belle Harbor/Neponsit Property Owners Association, I and my fellow neighbors are outraged. Please address this issue. Additional comment submitted through email: I attended the ACOE public meeting on October 4, 2018 re: recent Draft Report (10/18). I am one of the residents of the Belle Harbor and Neponsit Property Owners Association Committee who reviewed this draft. There were many mistakes in the plan as pointed out by John Signorille, V.P. of the BHPO who is also an engineer. I am a 70 year old lifetime resident of Rockaway who has been through countless hurricanes and North Easters. Sandy was by far the deadliest in my lifetime. The beach erosion on the West End of the Peninsula is not being properly addressed. I have said over the last many decades that groins are necessary as well as sand replenishment to maintain the health and safety of our community. I take offense that your plan includes groins only up to Beach 121 Street. A reason given is that the ACOE is in the business of "mitigation" not recreation. This is an absurd idea! Those of us who live on the West End of the Peninsula pay the highest real estate taxes in Rockaway to New York City. We deserve better protection from future storms. You continue to rehash and re-do studies. This postpones the inevitable which will cause catastrophic losses to residents as well as to the tax base.	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. Subsequent comments noted.

In your final review, I implore you to space out the groins in distance so that they reach the West End up to Beach 149 Street. This can be done at no additional cost. This coming winter will bring more storms and cause further damage and erosion to our beaches and the dunes.	
Look at the rock jetty at Beach 86th St. To the east is sand. To the west is erosion. ROCK JETTIES WORK. Between 1964-1968 while I was serving in the Navy, the last jetty was put in. Once it was there the rock jetty worked. Sand renewal goes into the ocean. It is a waste of taxpayer money. Try one rock jetty now see how it works.	We appreciate your recommendation regarding rock jetties. USACE refers to these structures as groins. USACE has successfully applied groins in the past for this area and the proposed plan includes construction of new groins.
Location of Groins. I believe that they should continue to Riis Park. Although will have the West Point break in Rockaway. (where the last groin will be)	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined.

Jetties. I am a NYC sandhog and recently was part of the excavation for the East Side Access Tunnel. We drilled, blasted, and excavated enough rock for a thousand jetties. Where is that rock? Why is it not on the end of my block? Is there no foresight for such a commodity where NYC beaches are disappearing? Swamp mats are used to cross soft sandy land. Swamp mats. They will be able to bring the rock across the beaches.	The recommended plan for the Atlantic Ocean Shorefront includes construction of new coastal groins. The means of construction as well as where to source materials from will be worked out between the contractor and the USACE during the Construction Phase.
1. Need groins 2. Need access to the beach 3. Resiliency of boardwalk should be taken into account	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. Re. Beach-Entrances; The Recommended Plan is the result of a Feasibility Study and the design details presented are in line with typical feasibility design plans. The goal of a Feasibility Study is to recommend a feasible plan which meets the objectives laid out

	during the study and complies with the law and the policies of the USACE. The level of design and analysis performed during the Feasibility Study is geared towards reducing the amount of uncertainty about what the alternative(s) would cost to implement and what the potential impacts of the plan(s) may be in order for decision makers to feel comfortable with approving the Recommended Plan for implementation. Please note that additional design details will be worked out during the next phase—the Pre-Construction Engineering and Design (PED) Phase. During the Feasibility Study the focus has been on the evaluation of the various Coastal Storm Risk Management and erosion control alternatives. With the buried composite seawall / dune plus beach berm being the Recommended Plan for the Atlantic Shorefront reach. Detailed design and/or analyses of access points and on and off ramps and ADA compliance has not been included at this stage as that level of design is performed during the PED Phase. Beach access designs will be completed during the PED phase and will need to be completed on a site-specific basis to account for any geometric constraints. Changes in the alignment or section of the horizontal composite seawall may be needed at certain locations to accommodate beach access, but all of this is expected to be worked out during PED. USACE has considered the boardwalk (location and configuration) in the design. However, the boardwalk is not a part of this USACE project. The boardwalk is a project from NYC Department of Parks and Recreation. USACE will closely coordinate with NYC during the construction regarding the boardwalk.
Groins. When will the results of the new groin placement program be published? Are the results open to comment and modification?	The results of the refined sediment transport modeling will be completed during the detailed design phase in early 2019 and published when they are ready. There will not be an official public comment period as part of NEPA, but USACE with our partners New York State DEC and NYC will coordinate with stakeholders and elected officials.
Rock Jetties. Build rock jetties that you call groins from 118St and space them apart that they can reach up to Beach 149th St. Make them high and make them long and pump the sand in first before you put the rock jetties in and pump more sand to make beaches big and longer.	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective

Groin erection - What factors led to decision to only erect groins up to Beach 121st St.?	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over

	the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined.
Roxbury, Breezy Point – Why do these communities not included in Army Corp evaluation? No groins? No new sand? No jetties?	Roxbury and Breezy Point are outside of the proposed storm surge barrier alignment which has been moved to the NYNJHAT study. As such, these communities will be further analyzed in NYNJHATs as tie-ins to the barrier. If the Rockaway Reformulation were to recommend features in these areas and then the barrier is implemented, the newly built features would need to be replaced, which would be a duplicative federal expenditure.
Why is it taking so long for this project? What part of the government is responsible for the delay?	Studies of this scale, complexity and magnitude with engaged stakeholders and citizens take longer to complete. The *tentatively selected plan* received an enormous amount of critical feedback and comments requesting further analysis on the proposed storm surge barrier and more natural and nature-based features on the Bayside. The effort needed to effectively resolve these comments and incorporate changes into the recommendation took an enormous concerted effort, with outside and internal USACE coordination. Additional team members were brought on to speed up the effort and all levels of USACE have coordinated regularly to streamline reviews and get feedback early and often in order to avoid pitfalls later. The result is that this is the first USACE study to recommend policy-compliant nature-based features which are justified as coastal flood risk management features alone, something USACE is proud of. The features will work in concert with other more traditional features and create a resilient coastline that can withstand small storms. The interior drainage problems in the Bayside communities are also unusually bad, with residents experiencing sunny day and high tide flooding regularly. This issue is not an easy one to address and the analysis which led to the improved interior drainage recommendations is detailed and time-

	consuming. It also had to be done during the Feasibility Study as the cost of interior drainage can often make a project untenable, as was the case in Canarsie. Furthermore, there are many private properties along the project alignments who needed to be identified and mapped in order to assess what the real estate costs will be for acquiring adequate easements to allow construction and maintenance of the plan. This is also detailed and time consuming work for this large and densely populated study area. Finally, many of the project alignments are sited in environmentally sensitive areas and field studies had to be conducted to see how the plan could be aligned to best avoid environmental impacts, which required some back and forth with our partners and the technical team to ensure that everyone's local knowledge and priorities were incorporated.
What exactly is being done to protect the eastern most points of the Rockaways. East of Beach 9th to the Nassau boarder, Ocean, Channel and Bay??	We thank you for your concern and your comment submittal. USACE assumes that your question refers to flood protection. This area is somewhat complicated from a flooding perspective. This area floods from two sides, with the flooding from the north coming from the Nassau County bays. Since that is outside of the Rockaway project area, an augmentation of the Rockaway project area would not resolve the flooding problem in this area, due to the complex hydrology. The USACE has another study called the Nassau County Back Bay Feasibility Study which can better address the flooding risk to this area by studying the feasibility of comprehensive solutions to manage the risk from both sides. More information about the Nassau County Back Bay Study can be found at www.nan.usace.army.mil/Nassau-Back-Bays and questions can be directed to NassauBackBays@usace.army.mil.
What can be done immediately address the damage in the pictures (attached)? Bay side of 69, 72, 68, 67, 66 onward. Where was the interim plan applied? How is it that the bay side received no interim fix? Where is Jamaica Bay inlet? Where is the Back Bay? Mosquitoes?	When Hurricane Sandy hit, there was an existing USACE project along the Atlantic Shorefront. Under the USACE's emergency repair program of existing projects, the USACE was able to construct the interim beachfront measures of beach nourishment and dune construction. Since there is no existing USACE project on the Bayside, the USACE does not have authority to expend funds on the Bayside until the Chief's Report for this study is approved and the Corps with NY State

	Department of Environmental Conservation and local partners have executed a Project Partnership Agreement. Jamaica Bay Inlet is located to the West of the Rockaway Peninsula. The study addresses the Atlantic Ocean Shorefront of the Rockaway Peninsula as well as the Jamaica Bay Area. When discussing the both the shorefront and the bay area, Jamaica Bay is sometime colloquially referred to as Back-Bay. USACE will make sure that all mentions will properly address Jamaica Bay. If your question about mosquitos is referring to whether the plan will exacerbate the existing mosquito problem on the Bayside, the answer is not likely. The nature-based features will provide habitat for the natural predators to mosquitos and may in fact help to manage existing problems.
Flooding. This project work is scheduled to begin in 2019. Flooding in the very same area B. 59th St. on many days the roads are not passable. Flooding all the time. We will not last to 2019. Flooding on the Bay side – eastern end of the peninsula, Decosta, Almeida Avenues. Can anything be done to alleviate the flooding?	We thank you for your concern and your comment submittal. The Recommended Plan includes a project for Mid-Rockaway that intents to reduce damages from high frequency flooding events. This project covers the area of concern (Almeda and De Costa Avenue in the vicinity of Beach 59th Street). USACE is unable to expend federal dollars in this area until our recommendation is approved and a Project Partnership Agreement is signed. The project has been expedited as much as possible at the highest levels of USACE.
"Mid-Rockaway" Jamaica Bay Plan – Homeowners and families living on the north end peninsula of Beach 43 St. that juts out between Norton Basin and Conch Basin. We have voting citizens that have raised our children in this neighborhood for over 60 years. WE SUPPORT THE MID-ROCKAWAY PLAN that includes building protection from bay flooding. This portion of the plan that extended from Beach 49 ST, around Beach 43 ST., and extends to Beach 38th St. is direly needed! We had significant damage from Hurricane Irene, and substantial damage from Hurricane Sandy. We are here to tell you and our elected representatives that we support approval of the Revised Plan and specifically the Mid-Rockaway Section. Our questions are: 1. What is the timeline for each portion of the plan?	We thank you for your concern and your comment submittal. Funding is allocated for the entire Recommended Plan as a whole, but construction contracts may be phased and executed in sections, as real estate is acquired and plans and specifications are completed for the 100% design. The total duration for construction of the Mid-Rockaway HFFRRF Project is presently estimated at approximately 42 months

2. Will the funding be allocated as a whole or by section?	
Very much favor the Jamaica Bay Barrier. HATS timeline for Jamaica Bay Barrier?	Comment noted. This will be passed on to the NYNJHAT study team. The timeline for completion of the NYNJHAT study is Summer 2022. More information can be found at http://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/New-York-New-Jersey-Harbor-Tributaries-Focus-Area-Feasibility-Study/. You may also direct your comments to the NYNJHAT team at NYNJHarbor.TribStudy@usace.army.mil.
Subject: Protection of coastal area for the whole of Rockaway Peninsula The outline plans in conception have various measures for Rockaway Peninsula from Fort Tilden to Beach 9 Street, but does not include the Western tip of the peninsula that actually is out further and is more vulnerable than other areas. Why is that area not included, and what will the impact be since any tidal surge will now seek out this more vulnerable access point? There are sections of this area on the bayside where water is less than 30 yards from the main road which is the only road used as a hurricane exit route. What are the plans or do they exist for a barrier wall from tip of western peninsula to Sandy Hook, New Jersey?	The areas in question are not included in the Recommended Plan because these areas are under further consideration by the NYNJHAT study along with the proposed storm surge barrier that was moved as a result of the Agency Decision Milestone. These areas are outside the proposed barrier alignments and would be covered as a tie-in to the barrier. If features were proposed and constructed in those areas now under the Rockaway Reformulation, they would need to be modified or completely redone later should the Rockaway storm surge barrier move forward, which would cause duplicative federal expenditures. The Recommended Plan has been designed to ensure that no flood damages are induced outside of the project area. Without the proposed storm surge barrier now being studied under the NYNJHAT study, storm surge will continue to be a risk to the area as it can enter through Jamaica Bay and flood surrounding communities. The New York New Jersey Harbor and Tributaries focus area feasibility study, which will include a tiered Environmental Impact Statement, is evaluating five initial alternatives, which currently are comprised of measures that address severe coastal storm risks for specific geographic regions within the study area, in addition to the no action alternative. These five alternatives encompass a variety of water- and land-based measures identified throughout the estuary at areas of high projected coastal storm risk and include combinations of shoreline structures, such as beach nourishment, levees, floodwalls and seawalls, and storm-surge barriers. The storm surge barrier from Sandy Hook, NJ to Rockaway Point, NY is included

	within Alternative 2 of that study. More information can be found on the following website: https://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/New-York-New-Jersey-Harbor-Tributaries-Focus-Area-Feasibility-Study/
1. The studies that were performed in other coastal areas. Is there proof from these prior studies that the fortifying of the Rockaway Coastal Community (will) withstand another Sandy or Hurricane? Especially those of us who live closest to the beach/bay in Arverne? 2. What were the results from the survey you took on the beach? Please send results to my e-mail address above if you don't have answers now.	Without the proposed storm surge barrier component that is now being further studied under the NYNJHAT study, the area in question remains at risk for large-scale flood events. On the Bayside at Arverne the Recommended Plan will help manage flood risk from frequent smaller storms, but these features would be overtopped during large events, so risk is not eliminated by the Recommended Plan, only reduced, and two storms are never the same. During severe storm events all residents should heed the warnings and directions of local officials and agencies. If you would like to provide input to the NYNJHAT study team on the proposed measures which would address this remaining risk to the Bayside from large-scale storms, please send your comments to NYNJHarbor.TribStudy@usace.army.mil. Due to the immense public interest in this study and the NYNJHAT study, it is not practicable for the USACE to follow up directly with citizens. However, press releases are periodically put out when new information is available, our websites are updated, and the Corps updates elected officials on key matters affecting their constituents, so you can reach out to your elected officials as well. Thank you for your interest.
Why do you refer to the bayside as the back bay!? As you know the bayside faces the Manhattan skyline, sunsets, and all the beauty. Is not he back it is the bayside.	The study addresses the Atlantic Ocean Shorefront of the Rockaway Peninsula as well as the Jamaica Bay Area. When discussing both the shorefront and the bay area, Jamaica Bay is sometime colloquially referred to as Back-Bay, which is common vernacular for water bodies that are protected bays from barrier islands, like Jamaica Bay. USACE has edited the main report to refer to the Bayside instead of Back-Bay due to feedback received at the public meeting.
Zero protection around FEMA critical infrastructure. Four gas stations, new firestation, urgent case, grocery store, new medical center, ferry terminal. Why?	In order to respond fully to this question, addresses for the facilities mentioned would be needed. However, generally speaking FEMA funds and funds from the Disaster Relief Appropriations Act of 2013 have been allocated to many critical infrastructure

	projects run by various agencies after Hurricane Sandy. Retrofits to raise generators above flood levels and flood proof key facilities, like hospitals and fire stations, have been ongoing with more work planned in some areas by local and state agencies. Re. Comprehensive Jamaica Bay wide risk reduction features; Given the low-lying elevations of the Rockaway peninsula and developed areas around Jamaica Bay, a large-scale comprehensive risk reduction solution would be needed to be effective against all and extreme event flood risks. The proposed storm surge barrier (which is economically justified based on the preliminary analysis and is being studied under the NYNJHAT study now) would provide this comprehensive risk management and is the most cost-effective alternative for this. However, it needs to be studied further before it could be implementable and the funding in the Sandy bill would not cover the roughly $3 billion cost of this feature. Furthermore, it would need further authority and funding from Congress before it could be implemented. In the interim, the Recommended Plan presented in this report attempts to provide flood risk reduction for smaller scale events for Back-Bay communities. The Recommended Plan can be accomplished under the existing study using existing funds.
If the plan was approved today how long until work is completed?	Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change. Re. Construction Schedule HFFRRF Projects Jamaica Bay. The total duration for construction of the HFFRRF project for Jamaica Bay is presently estimated at approximately 46 months. This includes Pre-Construction, Engineering and Design, the time needed to acquire the necessary real estate to

	construct and operate and maintain the project, as well as the actual construction of the project. Currently the project is estimated to be substantially completed by the start of the 3rd Quarter in 2023.
We would like to know if you considered doing or starting the project at the area where homes are before moving to the green area. Also have you considered the best bulkhead material or most (modern?) for the good of the investment?	The natural and nature-based features also protect homes. Each feature is designed to function with adjacent features and reduce the risk of flooding for the neighborhoods behind the alignment up to the design elevation flood (i.e. the 10% annual chance exceedance flood for 2018). During the Pre-Construction Engineering and Design (PED) phase the USACE will take a closer look at the construction methods and construction sequencing. However, construction sequencing will also be part of the contractors' means and methods and whether certain parts of the project will be completed before is not known at this time. It should furthermore be noted that the entire project needs to be completed before flood risk reduction will effectively be in place. Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change. Bulkhead materials will be further specified during PED. The contractor will need to comply with the project specifications.
Why do US Army Corps protective measures perfectly match the new US tax code for opportunity zones? I.E. No incentives for west end a coincidence or corruption?	Comment noted.
I came for part of the presentation tonight and have looked over the report and I wanted to say I'm personally very excited about the project, specifically the Cedarhurst-Lawrence portion. The neighborhood also is very much appreciative and is looking forward to the protection is will bring.	Comment noted.

Thank you for your presentation this evening at the Cedarhurst Village Hall. Two observations before my comments. It would have been have been helpful if the paper with the site website that was handed out had your e-mail address. Also, in view if the length of the web site address, it would be helpful for those of us who are rotten typists, it would have helped if the project used a web address shortener such as goo.gl or TinyURL or bitly. More information here: https://zapier.com/blog/besturlshorteners/#bitly Flooding issues. Brookville Boulevard regularly floods between Rockaway Boulevard / NY 878 and 147 Avenue, particularly at Lat. 40.643868, Long. -73.744375. The problem could be alleviated by placing one to two feet of crushed rock over the existing roadway and repaving it at the low spot – a distance of perhaps one hundred feet. This would be an important convenience for motorists when the road is flooded as well as an important life safety feature since southbound traffic is faced with a relatively sharp left turn at the flood location. The NYC DOT has had plans to rebuild the roadway for many years, but nothing has happened. Residents of the Bayswater section of Far Rockaway would have significant benefits from raising Norton Drive between Coldspring Road and Westbourne Avenue and Westbourne Avenue between Norton Drive and Dunbar Street. This would prevent high tides and storm surges from infiltrating the low lying areas of Bayswater. Finally, all Rockaway residents would benefit from raising Beach Channel Drive from where it drops after the Horton Avenue / Hassock Street intersection to just past the Nassau County line. This is a short distance (50 feet) but the street often becomes impassible if there is a drizzle during high tide. This can be a critical safety matter because Beach Channel Drive is the primary through street in the Rockaways. It is the only street that runs from Nassau County to and past the Marine Parkway Bridge. www.BayswaterCivic.org	1. You are welcome. Comment noted. The Brookville Blvd area was analyzed and during the Phase 1 analysis (See Appendix A1) a project titled "Rosedale" with project ID 16 was identified within this area. The project however did not have a BCR larger than 1 and as a result was screened out for further evaluation during the first phase of the study. Furthermore, that specific project did not investigate raising Brookville Blvd as you suggest. The engineering team had determined that there would be too few benefits per USACE regulations (i.e. road raising would not prevent flooding of properties and homes) to justify USACE participation in a stand-alone road raising project for this area. 2. Norton Avenue – The Norton Avenue Area was analyzed during the first phase of the project identification for high frequency flood risk reduction features for Jamaica Bay and was labeled as Project 4: Norton Basin with NNBF. The project did not have a Benefit to Cost Ratio (BCR) larger than unity and was screened out. 3. Beach Channel Drive / Hassock Street– Similar to the response above. The referenced area was analyzed during the first phase of the project identification for high frequency flood risk reduction features for Jamaica Bay and was labeled as Project 6: Motts Basin South with NNBF. The project did not have a Benefit to Cost Ratio (BCR) larger than unity and was screened out.

Can there, or will there be any improvements made on the canal behind Park Lane in Cedar Bay Park during the Cedarhurst-Lawrence Phase of the project? This canal continues to be a problem with flooding during storm conditions where water levels exceed high tide by only a few feet.	The area that you mention is not part of the Cedarhurst-Lawrence project that is part of the Recommended Plan. Based on the flood extent and flooding analysis performed for the selected 20% design Annual Exceedance probability (AEP) for the year 2068 This equates to an Average Return Interval (ARI) of 5 years in the year 2068 as well as and ARI of 10 years today (2018). Based on data analysis the mentioned location did not appear to be prone to overland flooding using the design conditions stated above (see image below). As such the location was not selected to study or asses the feasibility of a flood risk reduction project. USACE however recognizes that the area is vulnerable to flood risk during more severe coastal flood conditions and these issues are planned to be addressed more comprehensively. The data displayed on this map illustrate the scale of potential flooding, not the exact location, and do not account for future, ground elevation, shoreline, or hydrological changes. Inundation was assumed to occur at a constant elevation above the NAVD88 Datum (i.e., bathtub model) as indicated on the map. All low-lying areas, shaded in color, are assumed to be hydrologically "connected". Actual flooding extents may vary due to the temporal characteristics of a coastal flooding event as well as the potential combined effects of rainfall run-off, back flow through existing stormwater infrastructure, and seepage. Re. Comprehensive Jamaica Bay wide risk reduction features; Given the low-lying elevations of the Rockaway peninsula and developed areas around Jamaica Bay, a large-scale comprehensive risk reduction solution would be needed to be effective against all and extreme event flood risks. The proposed storm surge barrier (which is economically justified based on the preliminary analysis and is being studied under the NYNJHAT study now) would provide this comprehensive risk management and is the most cost-effective alternative for this. However, it needs to be studied further before it could be implementable and the funding in the Sandy bill would not cover the roughly $3 billion cost of this feature. Furthermore, it would need further authority and funding from Congress before it could be

	implemented. In the interim, the Recommended Plan presented in this report attempts to provide flood risk reduction for smaller scale events for Back-Bay communities. The Recommended Plan can be accomplished under the existing study using existing funds.
Where is all this money coming from and how long will it take? What will be the impact and who will be impacted?	The project is 100% federally funded by the Disaster Relief Appropriations Act of 2013 passed after Hurricane Sandy. However, the beach renourishment in future years will be cost-shared with the non-federal partners and the USACE. Re. Beach nourishment and renourishment and cost sharing; Beach nourishment projects consist of the initial placement of sand along a beach that has experienced erosion. As the nourished beaches undergo erosion, they must be maintained through beach renourishment. The renourishment process consists of restoring the Rockaway beach to initial conditions on a 4 year cycle and has less time and cost associated with the project when compared to the initial nourishment. For the Recommended Plan the initial construction will be 100% federally funded (subject to the continued availability of funds from the Disaster Relief Appropriations Act of 2013, which are expended on a first come first serve basis). Renourishment costs are expected to be cost-shared at 50% federal and 50% non-federal, though it is possible that it is within the discretion of the Assistant Secretary for the Army for Civil Works to authorize renourishment pursuant to the existing construction authority, Section 934 of WRDA 1986, at 65/35% cost share. The exact split is still pending a final agreement between the federal and non-federal partners. As such the funding for renourishment could be subject to changes in federal appropriations and/or local laws. Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed

	during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change. Re. Construction Schedule HFFRRF Projects Jamaica Bay. The total duration for construction of the HFFRRF project for Jamaica Bay is presently estimated at approximately 46 months. This includes Pre-Construction, Engineering and Design, the time needed to acquire the necessary real estate to construct and operate and maintain the project, as well as the actual construction of the project. The potential impacts of the project have been analyzed and discussed in the Environmental Impact Statement (EIS) in much detail. Without knowing which types of impacts you are referring to, it is difficult to provide a detailed response. Generally speaking the impacts have been avoided and minimized wherever feasible and given the mitigation measures, to include monitoring and best management/construction practices, the project is expected to be self-mitigating. Please refer to the EIS for more information.
I am most concerned about the recent purchase of the Woodmere Club to a developer. The club is directly on the water, floods on a regular basis, and flooded almost completely during Hurricane Sandy. If they are allowed to build HUNDRES of homes there, flooding will be much worse and widespread elsewhere. What can you do to help us?	Thank you for your concern and your comment submittal. The comment is noted. Local development, zoning and permitting is outside of the purview of USACE and is generally a local and/or state matter, excepting for the regulatory capacity of USACE to manage waters of the U.S.. Recommend contacting your local and state representatives on this issue. Of note, USACE is prohibited from providing coastal storm risk management for new developments in floodplains, so any new developments are recommended to be sited either outside of the floodplain or to be elevated structures with integrated floodproofing and plans for evacuation during flood events. A statement to this effect will be added to the report.
I live in the area that seems to be the lowest actual cost and highest BCR 7.7. Does this mean we would be serviced first? What is the timeframe?	Construction sequencing is based on factors such as whether the needed real estate has been acquired, whether the designs have been permitted for construction, and the completion of the 100% designs. It is likely that multiple construction contracts will be issued and phased as appropriate based on readiness.

As a Rockaway resident, I am looking forward to the upcoming meetings regarding your proposals for the Rockaway Peninsula. My family and I were severely impacted by Hurricane Sandy. As a result we have tremendous concerns with the lack of items in your Draft report. *most importantly - Why is there no provision for installing groins from Beach 123rd to 149th Streets? These have been proven to be a necessity along our coast line. *When will the USACE start to collaborate with the residents from Beach 123rd to 149th Streets on dune design issues? *What is the time table for installation of a permanent dune for the area? *What are the plans, if any, to counter water breaching the bay side sea wall? I would appreciate any info you can provide on the these concerns.	1. Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. 2. USACE has received ample input from the residents of Beach 123rd to 149th Streets on dune designs and groin configurations. These comments will be considered during the detailed design phase of the project and additional coordination will be considered as appropriate once the results of the additional work are ready and have been shared with the public. 3. During the Pre-Construction Engineering and Design (PED) phase the USACE will take a closer look at the construction methods and construction sequencing.

I am a concerned resident of Beach 136th St. and was very upset to learn that rock jetties would not be put in place from Beach 126-149th St. We so desperately need rock jetties and replenishment of sand for all of Rockaway Park, which includes Beach 126-149th. We, as a community, feel like USACE are letting us down. Perhaps if you or a loved one lived here your outtake would be much different.	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project

	life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined.
I'm a resident of Belle Harbor for the past 26 years. 26 years ago, I was able to run, at low tide, over the wooden groins. Now at low tide, the ocean covers them and much of the sand, leaving no place to run. My point being, we need sand replenishment and rock jetties to stop the beach erosion from causing further damage.	Your concern is shared with many others and the proposed plan directly addresses you concern. The Atlantic Ocean shorefront is subject to wave attack, wave run up, and over topping along the Rockaway peninsula. The GRR presents USACE's general approach to developing Coastal Storm Risk Management (CSRM) along the Atlantic Ocean. The most cost efficient alternative life-cycle management approach for the Atlantic Ocean Shorefront Planning Reach is beach restoration with renourishment, five groin extensions and the addition of 13 new groins. This alternative would provide the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life - renourishment material would be sourced from a borrow area approximately two miles offshore, south of the Rockaway peninsula. Renourishment also provides recreation benefits to beach users, which are included in the economic evaluation of the Atlantic Ocean Shorefront Planning Reach alternatives.
Maintaining beaches – would it be cheaper to put rip-rap on beaches (not berms) with less sand? Please explain the cost-benefit rating? What do the number mean?	When beaches are maintained and/or restored the placed material needs to match the native material. Riprap is not the native material and as such cannot be considered as a material.

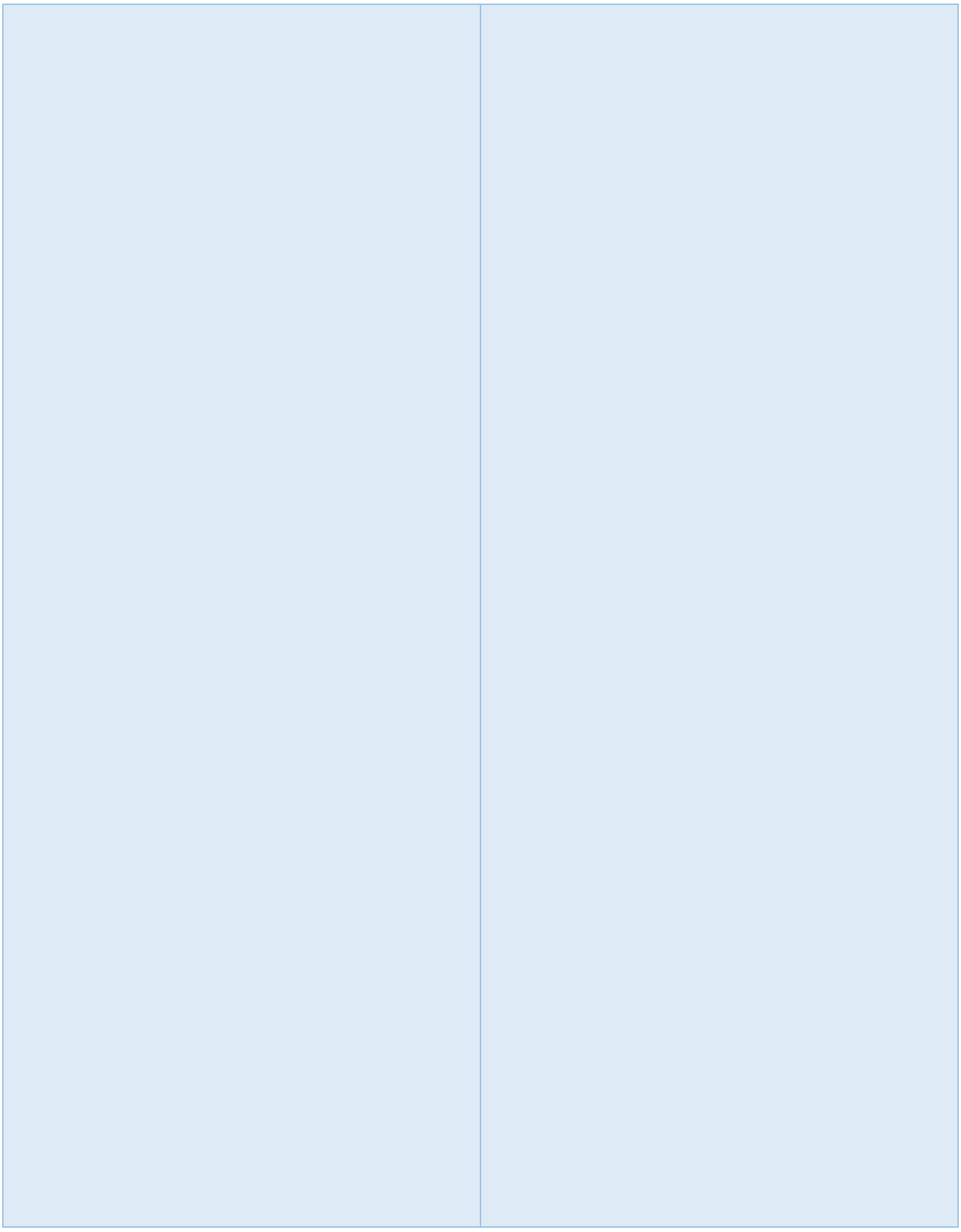
What happens if contractors don't bid? Does this affect the benefit to cost ration? How?	The cost-benefit rating (referred to as a benefit to cost ratio, or BCR) is an economic metric that measures whether or not a construction effort will be worth the cost of construction. Direct benefits (e.g., prevented damages, reduction of emergency services costs) that can be realized through the construction of a flood risk reduction measure. Typical flood risk reduction measures are the Atlantic Shorefront system of seawalls, groins, dunes, and beach nourishment and the HFFRRFs discussed in the report. Direct costs are the costs of design, construction, real estate acquisition, operations and maintenance costs, etc. In the calculation of the BCR, both benefits and costs are compared on an annualized basis. If the result of project benefits divided by project costs exceeds 1.0, the project is said to have a positive benefit-to-cost ratio (BCR). Conversely, a project that yields a BCR that does not exceed 1.0 is said to have a negative BCR. The eventuality of a contractor bid climate with low competitiveness has been accounted for in the cost contingency. However the actual bidding and price does not influence the published benefit-to-cost ratio within the GRR.
Nice to meet you in the Rockaways. Please consider giving us a bit more time to get through all the documents for the Rockaways project--I cannot tell what has been changed or not and there are so many documents....Also, I did not get notice of the new docs until October.	Unfortunately, due to our expedited schedule, we cannot extend the comment period. However, I'm happy to answer any questions you have or point out the changes if you like. The Atlantic Shorefront component, which I imagine you may be most interested in, has not changed. We did add the boardwalk to the plans and add a west and east end taper to the design at each project end, but the rest is the same. Let me know if you have any other questions.
As a Rockaway resident I am writing to express concern for what I learned at a recent Belle Harbor Association meeting. We need better protection to keep us safe from future storms and water surges. We need revised drawings for the proposed plans for 126th-149th street beach protection as well as plans for protection from flooding from Jamaica bay. We also need plans for periodical sand dredging and jetties throughout Rockaway.	We thank you for your concern and your comment submittal. Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include

The community greatly appreciates the work you're doing to keep us and our families safe.	the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. Comments pertaining to the design have been shared with the PED team for consideration as they conduct additional analyses. Please also note that the Recommended Plan includes construction of a new beach and dune and that the plan includes periodic renourishment of the beaches such that the beaches are maintained over the project life of 50 years. It should be further noted that the coastal groins do not directly contribute to a reduced risk of flooding during major coastal storm events. The coastal groins, the beach construction and periodic beach renourishment provide an erosion control function. The buried seawall and dune provide a flood risk reduction function and are part of the Recommended Plan between Beach 17th and Beach 149th Street. Re. Comprehensive Jamaica Bay wide risk reduction features; Given the low-lying elevations of the Rockaway peninsula and developed areas around Jamaica Bay, a large-scale comprehensive risk reduction solution would be needed to be effective against all and extreme event flood risks. The proposed storm surge barrier (which is economically justified based on the preliminary analysis and is

	being studied under the NYNJHAT study now) would provide this comprehensive risk management and is the most cost-effective alternative for this. However, it needs to be studied further before it could be implementable and the funding in the Sandy bill would not cover the roughly $3 billion cost of this feature. Furthermore, it would need further authority and funding from Congress before it could be implemented. In the interim, the Recommended Plan presented in this report attempts to provide flood risk reduction for smaller scale events for Back-Bay communities. The Recommended Plan can be accomplished under the existing study using existing funds.
I have a question that I am sure you have an answer to that I must just be missing. How are the beaches from west of 121st street going to be protected from erosion the constantly is occurring? Since the plan is to have no ground west of 121st street what is in the plan to compensate for these beaches to hold their sand? What was the scientific data to stop groins there at 121st street There is a lot of good in the Corps' plans but not protecting Belle Harbor and Neponsit beaches makes no sense. Those beaches do erode as pictures in the local papers have proven. Without lengthening and groins, we could have safety but closed beaches a la Beach 90-102 last summer.	We thank you for your concern and your comment submittal. Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin

Please reconsider extending the groins to be built all the way thru Neponsit. I feel you need to extend the groins in rockaway all the way into neponsit. (Sent in two emails)	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin

	design and groin placement and spacing will be improved upon such that erosion control is further refined. Comments pertaining to the design have been shared with the PED team for consideration as they conduct additional analyses. Please also note that the Recommended Plan includes construction of a new beach and dune and that the plan includes periodic renourishment of the beaches such that the beaches are maintained over the project life of 50 years. It should be further noted that the coastal groins do not directly contribute to a reduced risk of flooding during major coastal storm events. The coastal groins, the beach construction and periodic beach renourishment provide an erosion control function. The buried seawall and dune provide a flood risk reduction function and are part of the Recommended Plan between Beach 17th and Beach 149th Street.
We need the groins (rock jetties) here in Belle Harbor and Neponsit, it was proven that the rock jetties worked during Hurricane Sandy, there was less damage to the homes where the rock jetties were in place. By deciding not to build these groins (rock jetties) you are endangering my family and my home. The rock wall will cause access problems to the beach, especially for those who are handicapped. Please, please listen to us old timers and longtime residents we know our beach and what we need. The USACE has been doing this study for as long as I came remember. Sand replenishment is a band aid approach, we NEED the groins (rock jetties).	We thank you for your concern and your comment submittal. Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released



	Phase. Beach access designs will be completed during the PED phase and will need to be completed on a site-specific basis to account for any geometric constraints. Changes in the alignment or section of the horizontal composite seawall may be needed at certain locations to accommodate beach access, but all of this is expected to be worked out during PED.
1. Where are there dunes in the US similar to what is described in the revised draft? 2. When will the permanent dunes from Beach 126-149 st. be completed? 3. When will the community be able to view and comment on the revised plans for dune placement before the contract is issued? 4. How will the entry area be designed for ADA-compliant public beach access in various locations? 5. We are requesting front, side, and top view of the beach entrance areas with dimensions. 6. When will the community be briefed on the results of the preconstruction engineering analysis of the need for groins in Belle Harbor. 7. Noted attached letter from NYS elected officials. When will the elected officials be be briefed on the results of the preconstruction engineering analysis of the need for groins in Belle Harbor. 8. Will the beach replenishment be completed after the beach protection work? And will USACE be responsible for the 4-year replenishment cycle? 9. If sand replenishment is not performed prior to the completion of the beach protection work, will there be emergency plans established in the event the temporary berm fails causing flooding in the community? 10. What is the timeframe for the reinforced dune from Beach 126 to 149th St? 11. Collaboration with the community and all federal, state, and city agencies is essential. How will this be done on a regular basis through the planning, construction and completion of the project? Also attached letter from NYS elected officials to NYC mayor	1. The proposed buried Seawall for the Atlantic Ocean Shorefront is very similar to the constructed projects in Bay Head, NJ and Dam Neck, Virginia. 2. Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change. 3. Re. future updates to the public: USACE appreciates your comment and input and your input has been shared with the Pre-Construction Engineering and Design (PED) Team. USACE will share information with the public when the analyses have been substantially completed such that results can be shared with the public. 4. Re. Beach-Entrances; The Recommended Plan is the result of a Feasibility Study and the design details presented are in line with typical feasibility design plans. The goal of a Feasibility Study is to recommend a feasible plan which meets the objectives laid out during the study and complies with the law and the policies of the USACE. The level of design and analysis performed during the Feasibility Study is geared towards reducing the amount of uncertainty about what the alternative(s) would cost to implement and what the potential impacts of the

	plan(s) may be in order for decision makers to feel comfortable with approving the Recommended Plan for implementation. Please note that additional design details will be worked out during the next phase—the Pre-Construction Engineering and Design (PED) Phase. During the Feasibility Study the focus has been on the evaluation of the various Coastal Storm Risk Management and erosion control alternatives. With the buried composite seawall / dune plus beach berm being the Recommended Plan for the Atlantic Shorefront reach. Detailed design and/or analyses of access points and on and off ramps and ADA compliance has not been included at this stage as that level of design is performed during the PED Phase. Beach access designs will be completed during the PED phase and will need to be completed on a site-specific basis to account for any geometric constraints. Changes in the alignment or section of the horizontal composite seawall may be needed at certain locations to accommodate beach access, but all of this is expected to be worked out during PED. 5. Please see above comment response. The design details provided are in line with typical feasibility plan designs. Details regarding beach access are yet to be worked out. Such details can be shared once they are substantially completed. 6. Please see our response above under item 3. 7. USACE will publish the results of the PED analysis once it is completed and provide a briefing to public officials. 8. Re. Beach nourishment and renourishment and cost sharing; Beach nourishment projects consist of the initial placement of sand along a beach that has experienced erosion. As the nourished beaches undergo erosion, they must be maintained through beach renourishment. The renourishment process consists of restoring the Rockaway beach to initial conditions on a 4 year cycle and has less time and cost associated with the project when compared to the initial nourishment. For the Recommended Plan the initial construction will be 100% federally funded

	(subject to the continued availability of funds from the Disaster Relief Appropriations Act of 2013, which are expended on a first come first serve basis). Renourishment costs are expected to be cost-shared at 50% federal and 50% non-federal, though it is possible that it is within the discretion of the Assistant Secretary for the Army for Civil Works to authorize renourishment pursuant to the existing construction authority, Section 934 of WRDA 1986, at 65/35% cost share. The exact split is still pending a final agreement between the federal and non-federal partners. As such the funding for renourishment could be subject to changes in federal appropriations and/or local laws. Beach renourishment is scheduled to be on a 4 year cycle. A total beach fill quantity of 1,596,000 cy is estimated for the initial placement, including tolerance, overfill and advanced nourishment. The project includes a 4-year renourishment cycle of 1,021,00 cy, resulting in a minimum beach berm width of 60 feet. USACE will put contracts out such that contractors can bid on work. 9. Construction is estimated to start at the end of 2019 and at this point beachfill and groin work are likely to be the first elements of construction. The FCCE authority that was used to construct the existing dune on the shorefront after sand and place sand on the beach could be used in the event of an emergency to provide interim protection. However, it is likely that the USACE project will proceed to construction prior to the scenario laid out occurring. Groin construction and beachfill are likely to be the first elements of construction due to the relative simplicity of the design process. 10. Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic

	Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change. 11. USACE will publish the results of the PED analysis when it is completed. The designers performing this analysis have the comments and input from concerned community members and will consider this in the refined designs. Once the refined designs have been shared with the public, USACE will work with our partners and elected officials to determine an appropriate outreach strategy.
The Army Corps has been studying Rockaway Beach at least as long as I have lived here, almost 50 years. The only result I have seen is irregular beach replenishment with sand. Yet our beach continues to erode. Where the beach has been sustained is where there are groins. Your current projected plan shows that you have poor understanding of our area. The boulders, rocks, sand supposed reinforcement is badly designed. The winds and strong tidal water of a major storm would blow the sand and possibly even the rocks over the sea wall and into sewers, backyards, houses and streets. That would result in even more devastating damage reminiscent of Superstorm Sandy. It is essential that groins be installed between Beach 123 St. and Beach 149 St. to break the force of a storm and to divert a powerful water surge. Additionally, the project has to plan for beach access as well as for handicapped accommodations as required by law. There is a mandate to do something quickly, but merely completing a poorly designed job is totally unsatisfactory. I beg you to review your proposal and make revisions in accord with the wishes of the community who live here and are familiar with beach issues. Please visit our beach; experience the erosion. Talk with informed civic leaders and residents and make sensible, permanent adjustments so you can be	The sand placed in the dune section is stabilized by dune grass plantings which will develop extensive horizontal and vertical roots over time. The dune provides sufficient substrate for a variety of dune plants to develop. Wind-blown sand transport in landward direction has not specifically been addressed during the Feasibility Study other than acknowledging the fact that the existing conditions (FCCE Project – see also section 7.3.1 of Appendix A1) includes a dune of similar elevation. Evaluations of project measures to potentially address landward sand migration are recommended for further analysis during PED. A recommendation will be included within Section 8.4 of Appendix A1. The design of the horizontal composite seawall has been carefully thought through, analyzed and engineered and has furthermore been reviewed by qualified engineers both internal and external to the USACE. The design is able to withstand the expected loading of the 1% Annual Exceedance Probability (AEP) Storm Event. This includes hydrostatic loads and wave loads. Please note that the designs are commensurate with a feasibility study and that further analysis and engineering is needed prior to completion of the design. These engineering analyses and design work will be completed during, to what USACE refers to as, the Pre-construction Engineering and Design (PED) Phase.

proud of completing a properly done job. The lives and homes of the thousands of residents of this neighborhood can be safeguarded. The money allocated will be well spent; the project will not have to be redone.	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. Comments pertaining to the design have been shared with the PED team for consideration as they conduct additional analyses. Please also note that the Recommended Plan includes construction of a new beach and dune and that the plan includes periodic renourishment of the beaches such that the beaches are maintained over the project life of 50 years. It should be further noted that the coastal groins do not directly contribute to a reduced risk of flooding during major coastal storm events. The coastal groins, the beach construction and periodic beach renourishment provide an erosion control function. The buried seawall and dune provide a flood risk reduction function and are part of the Recommended Plan between Beach 17th and Beach 149th Street.

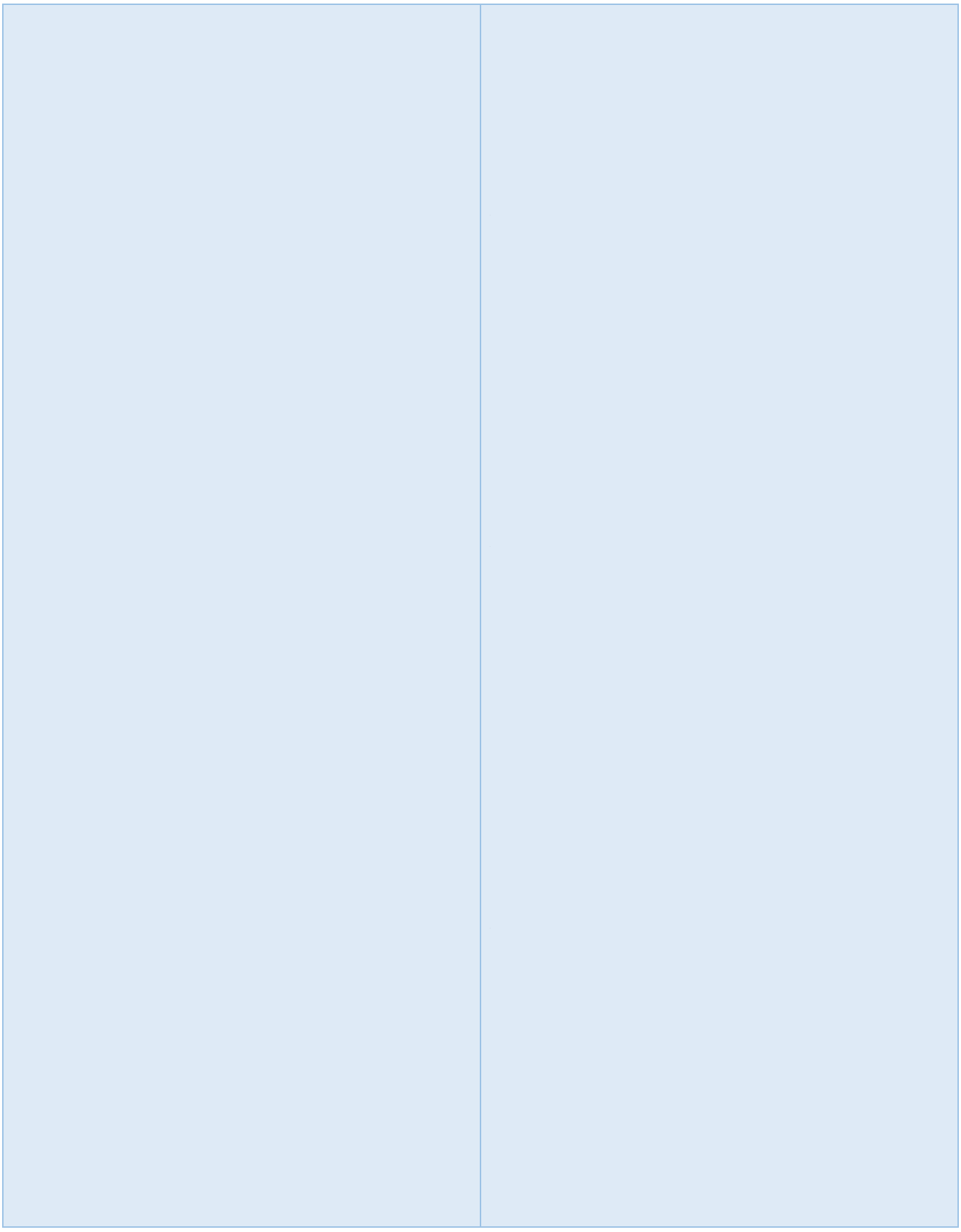
Please consider extending groins past Beach 121st Street. The entire west end is also vulnerable to storm surges. This area and neighborhood needs protection too. Thank you!	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport

	modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. Comments pertaining to the design have been shared with the PED team for consideration as they conduct additional analyses. Please also note that the Recommended Plan includes construction of a new beach and dune and that the plan includes periodic renourishment of the beaches such that the beaches are maintained over the project life of 50 years. It should be further noted that the coastal groins do not directly contribute to a reduced risk of flooding during major coastal storm events. The coastal groins, the beach construction and periodic beach renourishment provide an erosion control function. The buried seawall and dune provide a flood risk reduction function and are part of the Recommended Plan between Beach 17th and Beach 149th Street.
I have been a lifelong Rockaway Resident and have watched our shores erode over the past 60 years. I have watched as the Army Corps of Engineers began there Sand Replenishment Programs over the years. I have had to climb over giant pipes trying to enjoy at day at the beach with my family. I believe in my lifetime I have climbed over these large oversized pipes several times! The Replenishment Program has not worked for Rockaway Beach. Jetties or Groins are our only hope against storm surge. As an example the beaches on the east side of the (1) one jetty located in Rockaway Beach at 91 Street is larger due to the Jetty.	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport

I visited Long Beach, Long Island, New York which is also surrounded by the Atlantic Ocean as well and they have built Jetties (Groins) which has already shown it can be done and it works. I implore you look into Jetties (Groins) which is our only hope to keep our beaches from eroding.	modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. Comments pertaining to the design have been shared with the PED team for consideration as they conduct additional analyses. Please also note that the Recommended Plan includes construction of a new beach and dune and that the plan includes periodic renourishment of the beaches such that the beaches are maintained over the project life of 50 years. It should be further noted that the coastal groins do not directly contribute to a reduced risk of flooding during major coastal storm events. The coastal groins, the beach construction and periodic beach renourishment provide an erosion control function. The buried seawall and dune provide a flood risk reduction function and are part of the Recommended Plan between Beach 17th and Beach 149th Street.
The Corps is going to build a new stone-reinforced dune that is a little taller and wider than the current one. Current plans put the dune against the beach wall, making access a problem. If they put the dune where it belongs, we may not have much useable beach because... The Corps in not using groins (rock jetties) to retain sand west of Beach 121 Street The Corps is adding about a dozen groins points east There is no plan for storm surge protection in Riis Park and Ft. Tilden	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport

The Corps has abandoned its plan to build a storm surge gate for the Bay There is a lot of good in the Corps' plans but not protecting Belle Harbor and Neponsit beaches makes no sense. Those beaches do erode as pictures in the local papers have proven. Without lengthening and groins, we could have safety but closed beaches a la Beach 90-102 last summer. Not having protection in Gateway leaves a backdoor for the ocean to flood Breezy and Neponsit. The storm surge gate in the Bay may not have been realistic but without it a ton of work is needed all around the Bay and Broad Channel. Please make sure that Belle Harbor and Neponsit beaches are both protected and accessible. Build groins on our beaches too and build a gate for our Bay. The gate will protect us from enormous loss and property damage. Scrapping the gate plan for the possibility that you may add that as an option in a NY City Harbor gate plan that will take more than ten years just to research is a bad option and does not protect the interests of the citizens of Belle Harbor and Neponsit, not the value we bring to the City of New York.	modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. Comments pertaining to the design have been shared with the PED team for consideration as they conduct additional analyses. Please also note that the Recommended Plan includes construction of a new beach and dune and that the plan includes periodic renourishment of the beaches such that the beaches are maintained over the project life of 50 years. It should be further noted that the coastal groins do not directly contribute to a reduced risk of flooding during major coastal storm events. The coastal groins, the beach construction and periodic beach renourishment provide an erosion control function. The buried seawall and dune provide a flood risk reduction function and are part of the Recommended Plan between Beach 17th and Beach 149th Street. Re. Comprehensive Jamaica Bay wide risk reduction features; Given the low-lying elevations of the Rockaway peninsula and developed areas around Jamaica Bay, a large-scale comprehensive risk reduction solution would be needed to be effective against all and extreme event flood risks. The proposed storm surge barrier (which is economically justified based on the preliminary analysis and is being studied under the NYNJHAT study now) would provide this comprehensive risk management and is the most cost-effective alternative for this. However, it needs to be studied further before it could be implementable and the funding in the Sandy bill would not cover the roughly $3 billion cost of this feature. Furthermore, it would need further authority

	and funding from Congress before it could be implemented. In the interim, the Recommended Plan presented in this report attempts to provide flood risk reduction for smaller scale events for Back-Bay communities. The Recommended Plan can be accomplished under the existing study using existing funds.
Please look into groins (rock jetties) in the area from Beach 123 - 149 and/or all the way to Breezy Point. Look into the drawings showing that the dune and sand will be at least 1 foot higher that the sand retention wall and all that sand will be blown onto the street. Also looks like the rock and sand structure in the plans between the sand retention wall and dune could place much pressure against that sand wall. BTW: Some of the drawings seem wrong, they show what looks like a boardwalk in the area between b 127-149 and the is not... Also seems like we are going to need temporary sand to replenish the eroded sand along most of the Peninsula mostly between beaches 90-102, which was closed days before the opening of summer. There is no plan for storm surge protection in Riis Park and Ft. Tilden Also not having protection in Gateway leaves a backdoor for the ocean to flood Breezy and Neponsit. The storm surge gate in the Bay may not have been realistic but without it a ton of work is needed all around the Bay and Broad Channel.	Re. Groin placement; With respect to constructing and maintaining a beach for the Atlantic Ocean Shorefront, USACE considered various alternatives. These alternatives are referred to as the erosion control alternatives (see Section 7.2 of Appendix A1). Plan formulation of the erosion control alternatives focused on identifying the most cost effective solution to maintaining a wide beach and dune over the 50-year planning horizon. All alternatives include the initial construction of a beach such that a wide beach is present at the onset of the 50 year project life and all alternatives include periodic renourishment such that the initial constructed beach is maintained. The design of the groins and locations of the groins was based on sediment transport modeling and analyses of modeling results (showing both normal day-to-day conditions and storm conditions) to assess the alternatives' performance over the lifetime of the project. A summary of the overall life-cycle cost estimate for each alternative was then evaluated. The recommended plan is the alternative that had the lowest annualized costs over the 50-year project life and the lowest beach renourishment costs over the project life. The recommended plan does not include groins at your indicated location, but please note that the released plan is part of the Feasibility Study. Additional analysis will be completed during the Pre-Construction, Engineering and Design (PED) phase which is currently ongoing. Refinement of the groin design and groin placement and spacing will be improved upon such that erosion control is further refined. Comments pertaining to the design have been shared with the PED team for consideration as they conduct additional analyses. Please also note that the Recommended Plan includes construction of a new beach and dune and that the plan includes periodic renourishment of the beaches such that the beaches are maintained over the project life of 50 years. It should be further noted that the coastal groins do not directly contribute to a reduced risk of



	A total beach fill quantity of 1,596,000 cy is estimated for the initial placement, including tolerance, overfill and advanced nourishment. The project includes a 4-year renourishment cycle of 1,021,00 cy, resulting in a minimum beach berm width of 60 feet. Re. Construction Schedule and Sequence for Rockaway Beach. The total duration for construction of the Atlantic Ocean shorefront work is presently estimated at approximately 32 months. Currently the beach fill is expected to be the first construction activity. Construction of the coastal groins and the buried composite seawall and dune will follow and be partially executed in parallel. Construction activities for the Atlantic Ocean Shorefront work are expected to start by December 2019. Please note that additional engineering analyses will be completed during the Pre-Construction, Engineering and Design (PED) Phase, which is currently ongoing, and that the sequence and total duration may still change. Re. Comprehensive Jamaica Bay wide risk reduction features; Given the low-lying elevations of the Rockaway peninsula and developed areas around Jamaica Bay, a large-scale comprehensive risk reduction solution would be needed to be effective against all and extreme event flood risks. The proposed storm surge barrier (which is economically justified based on the preliminary analysis and is being studied under the NYNJHAT study now) would provide this comprehensive risk management and is the most cost-effective alternative for this. However, it needs to be studied further before it could be implementable and the funding in the Sandy bill would not cover the roughly $3 billion cost of this feature. Furthermore, it would need further authority and funding from Congress before it could be implemented. In the interim, the Recommended Plan presented in this report attempts to provide flood risk reduction for smaller scale events for Back-Bay communities. The Recommended Plan can be accomplished under the existing study using existing funds. The plans do not display a boardwalk between Beach 127th and Beach 149th S.

As a resident/homeowner in Rockaway Beach (Beach 91st Street), I attended the October 4, 2018 public presentation at the RISE Center in Rockaway (earlier, I attended a meeting in Queens Borough President Melinda Katz' office as a representative of Rockaway Beach Civic Association, and I recall your presentation there as well). My comments/concerns regarding the Rockaway Atlantic Ocean Shorefront measures are: 1) that the deteriorating remnants of wooden groins that extend to the WEST of the current westernmost jetty (near Beach 86th Street), be considered in the plan/final design/construction. As these sharp wooden structures (currently visible at low tide, submerged at high tide) would present a DANGER to swimmers, surfers and anyone accessing the water once the newly proposed groin field is installed, their removal should be investigated (if new rock groins will not sit directly atop the old wooden groins, which I understand they likely would not). If left in place, these wooden groins would potentially be a significant hazard (in middle of a swim/swim area between two new rock jetties -- especially as rip currents are anticipated around the new rock jetties). With sand replenishment, I understand these referenced (existing) wooden "teeth" or "sticks" might be covered by sand for a time, but as we've seen from past replenishment & subsequent erosion, they likely WILL be exposed again in the future (I believe this might be the case even as new rock jetties hold more sand in place for a longer period of time). 2) that <u>future sand replenishment</u> MUST be a priority from ACOE and its "partner organizations". If there will be rock reinforcement as part of dune structure on the beach "south" of the boardwalk (ie: between boardwalk & ocean), keeping sand atop that rock or hard structure is imperative -- for safety, beach access and environmental reasons. In the event of a significant storm (in which sand washes away exposing the hard structure beneath), <u>immediate replenishment of sand</u> would be required to keep the area safe and accessible. Additionally, keeping sand on top of any hard dune structure will be a challenge given the <u>WIND conditions</u> on the beach, if the dune is not HEAVILY PLANTED with vegetation (especially in	1. Three groins on NPS property are proposed as part of the Recommended Plan in order to offset any impacts from the Recommended Plan on the sediment transport for NPS property. Regarding additional remnant groins, it is the purview of NPS to manage / repair existing infrastructure on their property. Please direct your safety concerns to NPS as this is outside of the scope and authority of USACE. 2. Re. Beach nourishment and renourishment and cost sharing; Beach nourishment projects consist of the initial placement of sand along a beach that has experienced erosion. As the nourished beaches undergo erosion, they must be maintained through beach renourishment. The renourishment process consists of restoring the Rockaway beach to initial conditions on a 4 year cycle and has less time and cost associated with the project when compared to the initial nourishment. For the Recommended Plan the initial construction will be 100% federally funded (subject to the continued availability of funds from the Disaster Relief Appropriations Act of 2013, which are expended on a first come first serve basis). Renourishment costs are expected to be cost-shared at 50% federal and 50% non-federal, though it is possible that it is within the discretion of the Assistant Secretary for the Army for Civil Works to authorize renourishment pursuant to the existing construction authority, Section 934 of WRDA 1986, at 65/35% cost share. The exact split is still pending a final agreement between the federal and non-federal partners. As such the funding for renourishment could be subject to changes in federal appropriations and/or local laws. Re. repairs: In the eventuality of a severe storm and significant erosion or damage the USACE will be able to complete emergency repairs and repair the project to pre-storm conditions. Costs for this are included in the cost estimate for the project. Re. wind blown sand transport The sand placed in the dune section is stabilized by dune grass plantings which will develop extensive horizontal and vertical roots over time. The dune provides sufficient substrate for a variety of dune plants to develop. Wind-blown sand transport in

areas where proposed dune elevation might be HIGHER than existing boardwalk). Presently, with south winds -- a significant amount of sand is regularly lost from the dune onto the boardwalk & surrounding park/street areas -- even with the current dune elevation merely level with (or lower than) boardwalk. This issue seems like it will be exacerbated with a dune height exceeding the boardwalk elevation in some places (as proposed), so significant vegetation seems necessary to keep sand in place on dune, anchoring it from the effects of wind & water. 3) that any & all <u>construction activity be done with consideration to wildlife</u> (nesting shorebirds, marine mammals, shoreline species), to prevent injury, harm and disturbance to the maximum extent possible (with various species present at different times of year for mating, nesting, feeding, egg laying etc. -- this should be CONSIDERED as calendar/activity is approached per location) Thank you for considering these comments. I can be reached for questions, if necessary.	landward direction has not specifically been addressed during the Feasibility Study other than acknowledging the fact that the existing conditions (FCCE Project – see also section 7.3.1 of Appendix A1) includes a dune of similar elevation. Evaluations of project measures to potentially address landward sand migration are recommended for further analysis during PED. A recommendation will be included within Section 8.4 of Appendix A1. 3. re. consideration of wildlife This Draft Final Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS) includes an Environmental Impacts Statement and considerations regarding the environment were considered. Coordination with US Fish and Wildlife Service and the National Marine Fisheries Service, as well as New York State Department of Environmental Conservation is ongoing. Where impacts to nesting threatened or endangered species are of concern, work windows have been proposed and will be utilized to avoid impacts to nesting species. Monitoring is also being undertaken and buffers will be deployed if threatened and endangered species are found. You are kindly referred to the EIS and the Environmental Compliance Appendix D for more detail.

4.0 COMMENTS AND RESPONSES ON THE 2016 DRAFT GRR/EIS

4.1 Agency Comments and Responses

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Planning Division

July 19, 2018

United States Environmental Protection Agency
Region 2
290 Broadway
New York, NY 10007-1866

Attn: Ms. Judy-Ann Mitchell, Chief
Sustainability and Multimedia Programs Branch
Clean Air and Sustainability Division

Dear Ms. Mitchell:

The U.S. Army Corps of Engineers (USACE), New York District (District) is in receipt of your letter, dated 17 November 2016, submitting comments on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS).

As a result of the significance (extent and content) of agency and public comments received on the proposed project, as well as the feedback to the District resulting from the concurrent policy and technical review that was conducted by USACE Headquarters (HQUSACE), the District has determined that sufficient revision to the draft report is required in order to proceed to a final decision document. This development has prompted the decision to include, within the current schedule to finalize the report (August 2018), another 45 day public review period so as to ensure proper agency and public notification and input prior to finalizing the report and rendering a decision.

The District will be issuing a revised Notice of Availability when the Revised Draft Report is available for review. The revised draft HSGRR/EIS will reflect revisions and updates based upon some comments submitted by you, as well as other agencies, stakeholders and interested parties.

The District thanks you for your continued assistance, guidance and input to this process so as to advance the execution of this regionally-significant project. If you have any questions or concerns, please do not hesitate to contact Daria Mazey of my staff at 917-790-8726 or myself at 917-790-8634.

Sincerely,

Clifford S. Jones III
Chief, Planning Division

Enclosure

Pertinent Text and Responses to Comment Letter

EPA believes that the proposed project, on the whole, will add value by reducing future flood risk and costs associated with large-scale flood events and support the long-term sustainability of the coastal ecosystem. There are a number of ways in which the HSGRR/EIS can be enhanced as an analytical document so is to more thoroughly evaluate and communicate the potential impacts associated with the project; and ways in which the project itself can be enhanced to create more naturally resilient coastal ecosystem which are discussed below.

Financial Estimate

The document includes a number of tables including two in the Executive Summary (Without-Project Conditions Annual Damages, p. v and Alternative Plan Comparison, p. xi) which are simplified to the point at which they provide little insight into the financial impacts without the project or of the various alternatives. Further, Appendix C - Cost Estimating, is not completed. As the proposed alternatives are not finalized, it is understandable that specific costs are not known at this point, however, ball park estimates allow the public to more effectively evaluate the merits of the alternatives put forth in the document. The "Without-Project Conditions Annual Damages" should be known with more certainty, however. Providing a more detailed explanation of anticipated damages without the project, allows for a more informed assessment of the proposed alternatives. EPA believes this information should be provided in the FEIS with greater detail.

> Response: Comment Noted. Additional tables that provide more detail on the Without Project Conditions damages are available in the Economics Appendix and were not included in the main report because the study team is directed to limit the level of detail to that required for decision-making. Presentation of additional without project conditions damages detail in the main report will be reconsidered for the next draft of the HSGRR/EIS. The level of detail for the cost estimate will be more extensive in the revised Draft HSGRR/EIS being released in late August as the Recommended Plan has been further refined post the Agency Decision Milestone.

Green House Gas Emissions and Climate Change

The HSGRR/EIS references the Council on Environmental Quality's 2014 Revised Draft Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews (GHG Guidance). CEQ finalized the GHG Guidance on August 1, 2016. The Final GHG Guidance eliminates the reference point of 25,000 metric tons of C02-e annually for determining whether quantification of a project's GHG emissions is warranted. This reference point is used throughout the GHG and climate change analyses in the HSGRR/EIS.

To ensure appropriate consideration of GHG emissions and climate change in the NEPA analysis and decision-making process, we recommend removing reference to the 2014 Draft GHG Guidance and discussing the 2016 Final GHG Guidance in the FElS. Further, we recommend revising the GHG and climate change analyses to remove the 25,000 metric tons of C02-e reference point and ensure overall consistency with the 2016 Final GHG Guidance.

While the HSGRR/EIS includes estimates of GHG emissions for the preferred alternative, no estimates were given for other alternatives. NEPA requires rigorous and objective evaluation of

all alternatives, and this approach is supported for GHG emissions by the CEQ Guidance. We recommend including GHG estimates resulting from each alternative and mitigation measures in the FEIS.

> Response: The Council on Environmental Quality (CEQ) has withdrawn its final guidance for federal agencies on how to consider greenhouse gas emissions and the effects of climate change in National Environmental Policy Act (NEPA) reviews, a Notice of Availability for which was published on August 5, 2016 (81 FR 51866). As explained in the Notice of Availability, the withdrawn guidance was not a regulation. Pursuant to Executive Order 13783, "Promoting Energy Independence and Economic Growth," of March 28, 2017, the guidance has been withdrawn for further consideration.

Endangered Species and Essential Fish Habitat

The HSGRR/EIS does not effectively communicate whether or not consultation has been initiated with the U.S. Fish and Wildlife Service (USFWS) for this project. The HSGRR/EIS states on page 141 that, "Submittal of this Draft HSGRR/EIS to USFWS and the National Marine Fisheries Service (NMFS) initiates USACE's requested Section 7 consultation for the TSP." However, consultation is generally initiated with the Service(s) with an effects determination, as opposed to communication of a Biological Assessment via a NEPA document. The same is true for the Marine Mammal Protection Act. If, in this instance, alternative arrangements have been made for the initiation of consultation that should be communicated in the document. Further, it is stated on page 141 that "USACE is currently conducting informal consultation with NMFS to determine the appropriate formal consultation (i.e., Biological Assessment or Not Likely to Adversely Affect Determination)." This sentence confounds multiple aspects of consultation that should be clarified with the Services. This inconsistency with Endangered Species Act terminology can also be found in the last paragraph of page 180.

Lastly, page 141 states that coordination will occur with NMFS for ap. Essential Fish Habitat assessment. However, page 167 states that "Because adverse effects to essential fish habitat would be minor, the essential fish habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations would be satisfied." This inconsistency should be clarified in the FEIS.

> Response: Terminology used on p. 141, 167, and 180 will be revised to reflect the process and status of compliance with each of the Services under Section 7 of the ESA, the Marine Mammal Protection Act, and the Magnuson-Stevens Fishery Conservation Management Act for the Revised Draft EIS.

Water Quality

The document highlights the numerous stressors on water quality in the Bay, including combined sewer overflow (CSO), runoff from roads and the airport, leachate from landfills, windblown trash and other sources. The HSGRR/EIS cites one reference stating that as much as 240-340 million gallons per day of treated sewage effluent flow into the Bay from four wastewater treatment plants. In light of the water quality impairments in the Bay, a more detailed and refined assessment of the impacts resulting from the tidal gate on the hydrology and water quality of the Bay should have been included in the HSGRR/EIS. The impacts of alternative configurations of

the tidal gate should have also been evaluated to assess whether varying layouts could have differing impacts on the hydrology and sedimentation of the Bay.

> Response: The storm surge barrier feature (Jamaica Bay component) is now being evaluated under the New York and New Jersey Harbor and Tributaries Study (NYNJHATS) as a potential CSRM measure for the Jamaica Bay area. This includes all features previously selected for Jamaica Bay, including the Jamaica Bay shoreline CSRM components and tie-ins to the barrier along Jamaica Bay.
>
> Additional water quality modeling has been conducted to analyze a range of potential impacts up to the worst case scenario for water quality impacts of a barrier in Jamaica Bay. The NYNJHATS will describe the Jamaica Bay Eutrophication Model (JEM) that was used to analyze potential water quality impacts (JEM documentation has been revised in recent months).

EPA does not feel that the HSGRR/EIS appropriately or sufficiently communicated the range of potential impacts, either qualitatively or quantitatively, that can result from this project. Page 147 states, "A detailed discussion of each type of impact and the degree that each barrier option would have on the Jamaica Bay environment is beyond the scope given the level of the present design detail." This approach can be seen in various sections throughout the HSGRR/EIS. As detailed in the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, 40 CFR Parts 1500-1508, inherent to all EISs is the discussion of environmental consequences. It states:

> The discussion will include the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented.

This document did not meet this standard. Delaying this discussion until the release of the Final EIS is not consistent with the intended implementation of the requirements of the National Environmental Policy Act.

> Response: The storm surge barrier feature (Jamaica Bay component) is now being evaluated under the New York and New Jersey Harbor and Tributaries Study (NYNJHATS) as a potential CSRM measure for the Jamaica Bay area. The remaining components are moving forward under the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study. A detailed discussion of each type of impact and the degree that each barrier option would have on the Jamaica Bay environment will be addressed in the NHNJHATS.

Use of Natural Features

One of the stated goals of this effort is "to identify solutions that will reduce Atlantic Ocean Shoreline and Jamaica Bay vulnerability to storm damage over time, in a way that is sustainable over the long-term, both for the natural coastal ecosystem and for communities." To that end, EPA does not feel that the HSGRR/EIS sufficiently evaluated potential alternatives that could achieve this goal utilizing a more natural approach. Techniques and approaches such as

breakwaters, oyster reefs, or narrowing the inlet should be considered and discussed as possible alternatives. If there are specific reasons why these and other natural approaches weren't considered, that should be discussed in the FEIS.

> Response: The revised Draft HSGRR/EIS will include four nature-based features, i.e. living shorelines, as part of the recommended CSRM plan to address the high frequency flooding in the Back-Bay. Due to the potential positive benefit these will have on native habitats in providing intertidal wetlands that are valuable nursery habitats for many fish, the plan for these nature-based features is assumed at this time to be self-mitigating (serving to balance the needs of the community with protection of the environment). This assumption has been evaluated based upon EPW field studies, and is addressed quantitatively in the revised Draft HSGRR/EIS.

Flood Gates Impacts

In assessing the potential impacts of the tidal flood gate, it would be useful to see a schematic of what the gate would look like and how it would impact viewsheds from around the bay. There was a paucity of information regarding the operation of a flood gate including how long the gate would be opened/closed, if it would be adjusted in preparation of a storm or only during the actual event, who is responsible for decision making and manually adjusting the gate, whether it retracts within itself, etc. These details should be included in the FEIS.

> Response: The NYNJHAT Study team is performing an independent NEPA analysis. During the recent scoping meetings held for the NYNJHAT Study, photographs of some of the many types of storm surge barrier designs were presented and discussed. During analysis of the Recommended Plan, a rendering of the storm surge barrier and its potential gate type will be included in the NYNJHAT study, as well as additional photographs of other existing storm surge barriers around the world. As information becomes available within the NYNJHATS, the future analysis will also provide a discussion of operating parameters of the storm surge barrier, including closure timing (i.e., for specific anticipated storm frequencies), anticipated durations of closures, and identification of decision-makers who would initiate a storm surge barrier closure.

Hazardous, Toxic, and Radioactive Waste

EPA notes the useful inclusion of sites that may be impacted by storms with the general status of each site. However, EPA believes it is necessary for the USACE to perform a more complete analysis of the potential public health and environmental issues related to properties and storm events and should, therefore, consider the following points:

- An analysis should be performed to determine the potential chemical, radiological and biological exposures related to storm-impacted sites, properties, and nearby humans, ecosystems and the environment and how they would vary with each alternative and the no action alternative. This should include sensitive populations such as children, expecting mothers, the immunocompromised, the elderly, the impoverished, the infirmed, and any others that could be identified. Potential exposure pathways and detrimental effects should be determined. For example, contaminants may wash into surface waters, groundwater or become airborne, resulting in impacts to humans through recreational

exposure in the ocean, consumption of contaminated water or fish, inhalation of contaminants outside or via vapor intrusion in homes. Potential contamination issues and exposure pathways should also be evaluated for ecosystems and intervention strategies for these should be determined.

Response: This comment is addressed in the bullet below.

- Any additional sites of concern should be inventoried and evaluated for potential problems that could be caused by storms. Sites may include, but are not limited to, gas stations, chemical companies, tank farms, facilities with fuel tanks, sources of chemical or infectious waste (e.g., hospitals or animal farms) or those with combined sewer/storm-water systems, septic tanks or cesspools that may fail or become overloaded during extreme flooding.

  Response: The processes involved in contaminant mobilization during extreme flooding are understood, and do not need to be quantified on a location specific basis in order to demonstrate the environmental benefit of coastal storm risk reduction. General impacts will be discussed within the revised Draft HSGRR/EIS.

- If not already completed, the USACE should contact agencies that were involved in the relief work that was completed after past storms to identify problems relating to hazardous, toxic and radioactive waste that were created by past storms and how they were addressed. This information should be used to help identify precautions during the construction phase, and potential design elements, that can be integrated into the TSP to help prevent potential problems that may occur in the future.

  Response: Section 7.20.4 of the HSGRR/EIS states:

  Following Hurricane Sandy, New York DEP undertook a study to understand the impact of the storm on sites that store hazardous substances, in accordance with Local Law 26 of 1988, more commonly known as the NYC Right-to-Know Law. Of 367 facilities that had filed reports under Local Law 26, 46 facilities were severely affected by Sandy, but reported no spills and showed no evidence of spills. Only 11 facilities reported spills related to Hurricane Sandy, but the spills had been cleaned up by the facility prior to DEP inspection or spills were completely washed out by the storm. The DEP study concluded that though the lack of evidence of contamination may indicate that the impacted businesses had secured these chemicals sufficiently prior to Sandy or adequately remediated their sites post-storm, it also may reflect the particular reality of Sandy, as the high volume of water may have diluted and washed away any spills that occurred.

  As noted in the EPA-letter full paragraph above, HTRW sites for the Atlantic Shoreline and Jamaica Bay components are identified and mapped in Section 4.15 of the Environmental Appendix. Impacts on legacy HTRW sites in the Jamaica Bay portion of the study area relative to the Jamaica Bay storm surge barrier will be evaluated as part of NYNJHATS. Any impacts relative to the high frequency flooding risk reduction features

being developed as part of the TSP will be evaluated in the revised Draft HSGRR/EIS. Regarding HTRW sites located within the Atlantic Shorefront portion of the study area, project alignments will specifically avoid impinging on those sites as plans are drafted in the planning, engineering, and construction phase.

Environmental Justice

Page 145 of the document states:

> Based on a demographic analysis of the study area (presented in section 7: Environmental Consequences) and based on findings of an environmental justice review, the TSP would not have a disproportionately high and adverse impact on any low-income or minority population. USACE has determined that the TSP will provide short- and long-term benefits to disappropriated populations by protecting infrastructure resources (e.g. housing, transportation, and commercial/retail/recreational facilities) from damage caused by coastal storms.

EPA conducted an evaluation of the area using EJSCREEN, a screening tool that uses a nationally consistent dataset to identify areas of potential EJ concern. The report generated from the tool indicated that there are several potential EJ concerns within the project area. In reviewing EJ Indices at or above the 80th percentile, which likely warrant further review/investigation, EPA found that the indices for PM 2.5, Ozone, NATA Respiratory Hazard Index, Traffic Proximity and Volume, Superfund Proximity, and Water Discharger Proximity were all 80% or higher, indicating potential areas of concern.

The FEIS should include greater detail on the demographics data, the environmental data and the sources of the data that were used in reaching the determination that there will be no disproportionately high adverse impacts on any low-income or minority populations. Information should also be included concerning the geographic scope of the EJ analysis so the public can have a better idea of what is being considered in the EJ assessment. This information will allow for a more thorough evaluation of potential EJ impacts.

> Response: The revised Draft HSGRR/EIS will update Section 2.3.16 Socioeconomic Considerations to include the use of the EJSCREEN tool to identify the issues and areas of potential concern as part of the existing conditions. In addition, analyses to clarify the geographic scope of the EJ analysis, citations for the environmental data, and identification of the sources of the data that were used in reaching the determination will be added to Section 7.23 Socioeconomics and Environmental Justice in the revised Draft HSGRR/EIS.

Children's Health

EPA would like to emphasize that Executive Order 13045 on Children's Health and Safety directs each federal agency, to the extent permitted by law and appropriate, to make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children, and to ensure that its policies, programs, activities, and standards address these risks. Analysis and disclosure of these potential effects under NEP A is necessary because some physiological and behavioral traits of children render them more susceptible and vulnerable than adults to environmental health and safety risks. Children may have higher exposure levels to contaminants (through pathways such as degraded water quality or contaminants exposed during

construction) because they generally eat more food, drink more water, and have higher inhalation rates relative to their body size. Also, children's normal activities, such as putting their hands in their mouths or playing on the ground, can result in higher exposures to contaminants as compared with adults. In addition, a child's neurological, immunological, digestive, and other bodily systems are also potentially more susceptible to exposure-related health effects. It has been well established that lower levels of exposure can have negative toxicological effects in children as compared to adults, and childhood exposure to contaminants can have long-term negative health effects. The DEIS did not include a dedicated section addressing Children's Health, and only stated that "it has been determined that children in the project areas would not likely experience any adverse effects from the TSP." EPA does not question the validity of this statement, however, further detail is required. It is unclear whether the evaluation that was completed included the construction phase of this project, or evaluated aspects such as the potential for degraded water quality as a result of impacts from the proposed floodgate. A dedicated Children's Health section should be included in the FEIS and the evaluation included should be of greater scope and detail than what was included in the HSGRR/EIS.

Response: The revised HSGRR/EIS will include a dedicated section addressing the impact of TSP implementation on children's health. For example, schools and playgrounds in the vicinity of construction rights of way and lay-down areas will be identified, and avoided. The preferred alternative should not result in any adverse environmental or health impacts to children. Health and safety concerns would be primarily related to construction activities. Construction of most new facilities; however, would occur in areas where no children reside or would be present. Furthermore, appropriate barriers would be constructed and signage installed to prevent accidental incursion of children into dangerous work sites. Assuming the project as proposed meets the required federal, state and local permitting requirements outlined in the EIS, required mitigation measures should minimized the amount of criteria pollutants emitted to the environment, thereby reducing the potential for sensitive populations, such as children, to be exposed to unhealthy levels of environmental contaminants.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Planning Division

July 20, 2018

Mr. Louis A. Chiarella
United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
55 Great Republic Drive
Gloucester, Massachusetts 01930-2276

Subject: Responses to Comments on the Draft General Reevaluation Report / Environmental Impact Statement (GRR/EIS) for the East Rockaway Inlet to Rockaway Inlet Hurricane Sandy Reformulation Study

Dear Mr. Chiarella:

The U.S. Army Corps of Engineers (USACE), New York District (District) is in receipt of your letter, dated 1 December 2016, submitting comments on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS).

As a result of the significance (extent and content) of partner, agency and public comments received on the proposed project, as well as the feedback to the District resulting from the concurrent policy and technical review that was conducted by USACE Headquarters (HQUSACE), the District, in coordination with New York State Department of Environmental Conservation (NYSDEC) as our non-federal Sponsor, has determined a revised draft HSGRR/EIS is required to document the changes and USACE response to these extensive comments before proceeding to a final decision document.

The Agency Decision Milestone (ADM) resulted in the decision to move all further evaluation of the proposed storm surge barrier measure within Jamaica Bay, a significant component of the Tentatively Selected Plan (TSP), to the ongoing New York and New Jersey Harbor and Tributaries (NYNJHATs) Feasibility Study (NYSDEC and NJDEP are the non-federal sponsors, with the partnership of New York City). The NYNJHATs Study was initiated in the Summer of 2016 around the same time as the release of the Rockaway Reformulation Draft GRR/EIS. The NYNJHATs Study is evaluating large-scale regional coastal storm risk management (CSRM) strategies for the New York/New Jersey metropolitan area (which includes Jamaica Bay) extending upstream of the Hudson River to the federal lock and dam at Troy, New York, the Passaic River to the Dundee Dam, and the Hackensack River to the Oradell Dam. The NYNJHATs study is evaluating a suite of storm surge barriers, including one alignment from Breezy Point to Sandy Hook that would obviate the need for the proposed Jamaica

Bay barrier. Therefore, from a plan formulation perspective, it makes sense to evaluate the storm surge barrier, previously a component of the Rockaway Reformulation, in this newer regional study instead.

Moving the barrier component to the NYNJHATs Study has other strategic advantages as well. Namely, that more analysis is needed and that the required analysis should not delay construction of the more readily implementable Atlantic Shorefront and 'Residual Risk' measures in Jamaica Bay. Part of why more environmental analysis was deemed necessary for the barrier component is that the level of detail available to date was still largely conceptual.

The Project Delivery Team has been working with to further refine and develop the 'Residual Risk' measures in the Back-Bay, now termed *high frequency flooding risk reduction features* (HFFRRFs), in order to bring them up to full feasibility level of design and environmental analysis, and to include natural and nature-based features, as well as areas outside of New York City in Nassau County.

Thank you for the continued assistance and input to this process which helps to advance the execution of this regionally-significant project. Points of contact for the study are Planner and Biologist, Daria Mazey, at 917-790-8726 or the Project Manager, Dan Falt, at 917-790-8614.

Sincerely,

Clifford S. Jones III
Chief, Planning Division

Enclosure

cc: Marrone; NMFS
Greene; NMFS

Pertinent Text and Responses to Comment Letter

We have reviewed the integrated Draft Hurricane Sandy General Reevaluation Report and Draft Environmental Impact Statement (DHSGRR/DEIS) and the Essential Fish Habitat (EFH) assessment , both dated August 2016, for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study. The project area consists of the Atlantic coast of New York City between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, including the Coney Island section of Brooklyn.

The Tentatively Selected Plan (TSP) described in the DHSGRR/DEIS includes reinforced dune and berm construction, in conjunction with new groins and the modification of existing groins, in select locations along the Atlantic Ocean shoreline; a line of protection along Jamaica Bay and Rockaway Inlet with a storm surge barrier at one of two identified potential alignments; flood gates at Sheepshead Bay and Gerritsen Inlet; and residual risk features in locations surrounding Jamaica Bay, of which five of the identified 26 locations currently have available detail. The beach nourishment portion of the project will require approximately 804,000 cy of material for the initial placement, with a four year renourishment cycle of approximately 1,012,000 cy. The material will be dredged from an 1,830 acre offshore borrow area, two miles south of Long Island, NY and six miles east of Rockaway Inlet.

> Response: It should be noted that the storm surge barrier feature (Jamaica Bay component) is now being evaluated under the New York and New Jersey Harbor and Tributaries Study (NYNJHATS) as a potential CSRM measure for the Jamaica Bay area. This includes all features previously selected for Jamaica Bay, including the line of protection along Jamaica Bay, the storm surge barrier, and flood gates at Sheepshead Bay and Gerritsen Inlet. The remaining Atlantic shoreline components are moving forward under the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Hurricane Sandy General Reevalution Report.

The Fish and Wildlife Coordination Act (FWCA) and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) require federal agencies to consult with us on projects such as this that may adversely affect EFH and other aquatic resources. This process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments, lists the required contents of EFH assessments, and generally outlines each agency's obligations in this consultation procedure.

Aquatic Resources

Fish and Wildlife Coordination Act

Rockaway Inlet provides access to Jamaica Bay and its tributaries for many aquatic species including both state and federally managed species and their forage, such as American lobster (*Homarus americanus*), Atlantic butterfish (*Peprilus triacanthus*), Atlantic croaker (*Micropogonias undulatus*), Atlantic menhaden (*Brevoortia tyrannus*), Atlantic sea herring (*Clupea harengus*), Atlantic silverside (*Menidia menidia*), bay anchovy (*Anchoa mitchilli*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus saltatrix*), killifish (*Fundulus spp*.), little skate (*Leucoraja erinacea*), red hake (*Urophycis chuss*), scup (*Stenotomus chrysops*), spot (*Leiostomus xanthurus*), striped bass (*Marone saxatilis*), summer flounder (*Paralichthys*

dentatus), tautog (*Tautoga onitis*), weakfish (*Cyanoscion regalis*), windowpane flounder (*Scophthalmus aquosus*), winter flounder (*Pseudopleuronectes americanus*), winter skate (*Leucoraja ocellata*), and other assorted baitfishes and shrimps (e.g., *Neomysis americana, Mysidopsis bigelowi*).

Diadromous Fishes

Anadromous species such as alewife (*Alosapseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), and striped bass transit the inlet of the project area to reach spawning and nursery habitat in the freshwater portions of the system. Alewife and blueback herring, collectively known as river herring, spend most of their adult life at sea, but return to freshwater areas to spawn in the spring. Both species are believed to be repeat spawners, generally returning to their natal rivers (Collette and Klein-MacPhee 2002). In the Mid-Atlantic, landings have declined dramatically since the mid-1960s and have remained very low in recent years (ASMFC 2007). Because landing statistics and the number of fish observed on annual spawning runs indicate a drastic decline in alewife and blueback herring populations throughout much of their range since the mid-l960s, river herring have been designated as a Species of Concern by NOAA. Species of Concern are those species about which we have concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act. We wish to draw proactive attention and conservation action to these species.

Catadromous American eel (*Anguilla rostrata*) spawn in the Sargasso Sea, transit inlets as elvers and move into estuarine and freshwater habitats within coastal embayments. They inhabit these areas until they return to the sea through those inlets as adults. According to the 2012 benchmark stock assessment, the American eel population is depleted in U.S. waters. The stock is at or near historically low levels due to a combination of historical overfishing, habitat loss, food web alterations, predation, turbine mortality, environmental changes, toxins and contaminants, and disease (ASMFC 2012).

Shellfish

Shellfish occur in the nearshore portion of the project area such as hard clam (*Mercenaria mercenaria*), soft shell clam (*Mya arenaria*), blue mussel (*Mytilus edulis*), oyster (*Crassostrea virginica*), blue crab (*Callinectes sapidus*), and horseshoe crab (*Limulus polyphemus*). Surf clam (*Spisula solidissima*), razor clam (*Ensis directus*), and tellin (*Tellina agillis*) occur in the vicinity of the offshore borrow area. However, surveys conducted by the USACE in 2003 and by the NYSDEC in 2012 indicate that the borrow area itself contains very small, to no, localized populations of surf clam. It is the intent of the USACE to conduct another survey in the borrow area prior to the utilization of the borrow area and to notify NMFS prior to commencement of each dredging event, prior to the solicitation of bids, to ensure that our EFH conservation recommendations remain valid and that impacts to surf clams are minimized.

Coen and Grizzle (2007) discuss the ecological value of shellfish habitat to a variety of managed species (e.g. American lobster, American eel, and winter flounder) and have suggested its designation as EFH for federally managed species. Clams are a prey species for a number of federally managed fish including skates, bluefish, summer flounder and windowpane; siphons of hard clams provide a food source for winter flounder and scup (Steimle et al. 2000). Infaunal species such as clams filter significant volumes of water,

effectively retaining organic nutrients from the water column (Nakamura and Kerciku 2000; Forster and Zettler 2004).

Blue mussels and oysters are found along shorelines attached to hard substrates, are an important food resource for fish and birds, and as filter feeders improve water quality (Bain et al. 2007, Waldman 2008). Reef forming species such as blue mussels and oysters support an increased diversity of finfish and invertebrates, cycle material between the water column and substrate and have the potential to enhance water quality (Dewey 2000; Nakamura and Kerciku 2000; Coen and Grizzle 2007; McDermott et. al. 2008). Further, blue mussels are an important prey item for many animals in the Mid-Atlantic region (Newell 1989). Steimle et al (2000) reported that blue mussel spat were components of the diets of winter flounder, scup, black sea bass and tautog.

Although no known oyster reefs exist in the project area presently, scattered live oysters can be found in certain areas, indicating the presence of isolated populations. New York City Department of Environmental Protection, in collaboration with Cornell University's Cooperative Extension Service, constructed pilot oyster reef sites in Jamaica Bay in late 2010 by establishing a spat-on shell reef at Dubos Point and placing spat-covered reef balls in Gerritsen Creek. Both sites were monitored through 2012 and exhibited healthy oyster growth and survival, as well as a high degree of utilization by natant macrofauna (USACE 2016).

Jamaica Bay and Rockaway Inlet provide spawning, nursery, foraging, and overwintering habitat for blue crabs, which are commonly found in subtidal bottom and oyster reef habitats and are important food resources for predatory fish and birds (Bain et al. 2007, Waldman 2008). The blue crab winter dredge fishery in New York is concentrated in the lower portion of New York Harbor, including Rockaway Inlet (Briggs 1998). Horseshoe crabs use multiple habitats along the shoreline of the project area, including subtidal bottoms, intertidal mudflats, and sandy beaches. They are a key food resource for a variety of estuarine organisms, and their eggs provide food for migrating red knots, a federally endangered bird (Botton et al. 2006).

Magnuson Stevens Fisheries Management and Conservation Act (MSA)

The project area has been designated as EFH for a number of federally managed species including Atlantic butterfish, Atlantic salmon (*Salmo salar*), Atlantic sea herring, black sea bass, bluefish, cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), little skate, long-finned squid (*Loligo pealei*), monkfish (*Lophius americanus*), pollock *(Pollachius virens*), red hake, scup, Spanish mackerel (*Scomberomorus maculates*), summer flounder, whiting (*Merluccius bilinearis*), windowpane flounder, winter flounder (*Pseudopleuronectes americanus*), and winter skate.

The project area is also EFH for several highly migratory species including blue shark (*Prionace glauca*), dusky shark (*Carcharhinus obscurus*), sandbar shark (*Carcharhinusplumbeus*), and sand tiger shark (*Odontaspis taurus*). Sand tiger and dusky sharks have also been listed as Species of Concern by NOAA.

The MSA requires federal agencies to consult us on projects such as this that may affect EFH adversely. This process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments, lists the required contents of EFH assessments, and generally outlines each agency's obligations in this consultation

procedure.

The EFH final rule published in the Federal Register on January 17, 2002, defines an adverse effect as: "any impact which reduces the quality and/or quantity of EFH." The rule further states that:

> An *adverse effect may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat and other ecosystems components, if such modifications reduce the quality and/or quantity of EFH Adverse effects to EFH may result from action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.*

The EFH assessment included in the HSGRR/DEIS does not evaluate adequately all of the potential impacts to EFH that could result from implementation of the TSP. EFH for coastal locations was provided, but the assessment should be revised to include EFH for the Hudson River/Raritan Bay/Sandy Hook Bay estuary complex, such as EFH designations for larval Atlantic herring and spawning adult winter flounder and windowpane flounder.

> Response: The revised HSGRR/DEIS will consider the cumulative effects to EFH resources across the geographic range of hurricane storm risk reduction projects that includes the Hudson River/Raritan Bay/Sandy Hook Bay estuary complex.

The assessment HSGGR/DEIS lacks any discussion of the specific details of the project components including impacts to the hydrology and ecology of Jamaica Bay, Sheepshead Bay, Gerritson Creek, Mill Creek and Shellbank Creek as a result of the installation of the storm surge barrier and storm gates, and impacts to EFH from these structures and the other components of the proposed line of protection. The assessment also does not describe the areal extent of sand placement below the high tide line and the amount and extent of dredging within the inlet associated with the beach renourishment component of the project. The absence of these details prevents a full evaluation of the direct, indirect, individual and cumulative effects of all of the actions proposed.

> Response: The storm surge barrier feature (Jamaica Bay component) is now being evaluated under the New York and New Jersey Harbor and Tributaries Study (NYNJHATS) as a potential CSRM measure for the Jamaica Bay area. This includes all features previously selected for Jamaica Bay, including the Jamaica Bay shoreline CSRM components and tie-ins to the barrier along Jamaica Bay.
>
> Additional water quality modeling has been conducted to analyze a range of potential impacts up to the worst case scenario for water quality impacts of a barrier in Jamaica Bay. The NYNJHATS will describe the Jamaica Bay Eutrophication Model (JEM) that was used to analyze potential water quality impacts (JEM documentation has been revised in recent months).
>
> The revised EFH analysis will describe the areal extent of sand placement below the high tide line associated with the beach renourishment component of the project.

As a result, we must consider the assessment to be incomplete. In addition, based upon the scope of the project, including the storm surge barrier and the significant impacts to EFH and

other aquatic resources that will result from its construction, an expanded EFH consultation as described in 50 CFR 600.920 (f) is warranted. An expanded consultation process allows the maximum opportunity for us to work together to review the action's impacts on EFH, and to develop EFH consultation recommendations. Under the expanded consultation procedures, we are allowed 60 calendar days to review, comment, and respond to the information that has been provided to us.

To initiate the expanded EFH consultation, a full and complete evaluation of the direct, indirect, individual and cumulative effects of the construction and operation of all of the project components on EFH should be provided. The required components of the EFH assessment include a description of the action; an analysis of the potential adverse effects of the action on EFH and the managed species; the federal agency's conclusions regarding the effects of the action on EFH; and proposed mitigation, if applicable. As part of the expanded consultation, the assessment should also include additional information such as results of on-site inspections, views of recognized experts, a review of pertinent literature, an analysis of alternatives and any other relevant information should be included.

Response:

The District anticipates that there may be a variety of impacts to Essential Fish Habitat (EFH) as a result of the implementation of the revised TSP; some may be temporary and related to construction activities and some may be permanent due to changes in habitat types.

As project plans are further developed in the Pre-Engineering and Design Phase, the District will coordinate with NOAA Fisheries and undertake project specific EFH consultation so that the effects of the individual actions can be evaluated and site-specific EFH conservation recommendations can be developed. The District requests your review and confirmation of concurrence with this overall assessment and path forward.

Potential Project Impacts

Storm Surge Barrier and Storm Gates

Impacts to Hydrology

Rockaway Inlet provides a hydrologic connection between the Atlantic Ocean and the Jamaica Bay estuary. Tidal flushing regulates local salinity regimes, facilitates nutrient and sediment transport, and ameliorates hypoxic and anoxic conditions. Due to heavy urbanization of the Jamaica Bay watershed, industrial effluent, sewage discharges, chemical and oil spills, and storm water runoff impact water quality within the estuary. While nitrogen and phosphorus are typically limiting nutrients in estuarine ecosystems, their concentration in Jamaica Bay is exacerbated by large volumes of effluent from four wastewater treatment plants (NPS 2013); these high nutrient levels contribute to low dissolved oxygen in the estuary. A decrease in frequency or volume of tidal flushing would likely adversely impact an already fragile ecosystem.

The 3,970 ft storm surge barrier proposed in the TSP across Rockaway Inlet will have a 1,100 ft gate opening, seven 100 ft wide vertical lift gates, and two 200 ft wide sector gates. According to the DHGSRR/DEIS, preliminary modeling has been conducted on the impact of the storm surge barrier on hydrology within the Jamaica Bay system, resulting in two

alternatives for the inlet gate structure. Construction of the gate using either alternative will have both short- and long-term impacts on the inlet and estuary.

Short-term adverse effects will result from construction, while long-term impacts will include habitat loss within the footprint of the barrier, as well as changes in flow velocities, tidal amplitude and flow, sediment transport, and deposition. More detailed hydrologic modeling should be conducted to provide additional information on impacts to the system in terms of changes in tidal regime, flow velocity, scour, sedimentation rates, and current patterns, as well as the effects of the storm barrier on the ecology and water quality of Jamaica Bay.

Little information is provided on the proposed storm gates across Sheepshead Bay and Gerritson Inlet. As with the proposed storm barrier across Rockaway Inlet, the effects of the storm gates proposed for Sheepshead Bay and Gerritson Inlet on EFH and the other aquatic resources and habitat of Sheepshead Bay and Gerritson, Mill and Shellbank Creek should also be evaluated and similar modeling should be undertaken.

> Response: The storm surge barrier feature (Jamaica Bay component) is now being evaluated under the New York and New Jersey Harbor and Tributaries Study (NYNJHATS) as a potential CSRM measure for the Jamaica Bay area. This includes all features previously selected for Jamaica Bay, including the line of protection along Jamaica Bay.
>
> Additional water quality modeling has been conducted to analyze a range of potential impacts up to the worst case scenario for water quality impacts of a barrier in Jamaica Bay. The NYNJHATS will describe the Jamaica Bay Eutrophication Model (JEM) that was used to analyze potential water quality impacts.

Impacts on Fishes and EFH

Rockaway Inlet serves as the conduit for planktonic exchange and related movements ·of diadromous species, estuary dependent fishes, and invertebrates between the ocean and the estuary and its tributaries. Both temporary in-water work and permanent structures within the inlet can impede the movement of fish into and out of the estuary. A permanent structure such as a storm surge barrier can constrict flow into and out of the system and affect the circulation within the system.

Summer flounder may be impacted adversely by the in-water work and hard structure proposed for Rockaway Inlet. In a study of larval movements at Indian River Inlet, Delaware, Targett and Rhodes (2008) found that ingress of summer flounder larvae peaked bimodally in December and mid-January with collections continuing through April. Movement into the estuary may involve intermittent settling to take advantage of tidal stream transport before permanent settlement once metamorphosis is complete (Able and Fahay 1998). Residual bottom inflow, a result of more dense oceanic water intruding beneath more buoyant outflow, provides some fishes with a mechanism of ingress (Weinstein et al., 1980 in Rhodes 2008). Miller et al. (1984) proposed that to gain entry into North Carolina inlets, spot (Leiostomus xanthurus), Atlantic croaker, summer flounder, and southern flounder (Para/ichthys lethostigma) remain near the bottom (Rhodes 2008). The placement of the storm surge barrier across Rockaway Inlet will restrict fish ingress and egress through the inlet to the vertical lift and sector gates. Benthic migrations through the open gates will be further impeded by the

bottom structure of the storm surge barrier.

Winter flounder also transit inlets to reach spawning areas within mid-Atlantic estuaries when water temperatures begin to decline in the fall. Tagging studies show that most return repeatedly to the same spawning grounds (Lobell 1939, Saila 1961, Grove 1982 in Collette and Klein- MacPhee 2002). Winter flounder typically spawn in the winter and early spring, although the exact timing is temperature dependent and thus varies with latitude (Able and Fahay 1998), however movement into these spawning areas may occur earlier, generally from mid- to latei November through December (B. Phelan, personal communication 2014). Winter flounder have demersal eggs that sink and remain on the bottom until they hatch. After hatching, the larvae are initially planktonic, but following metamorphosis they assume an epibenthic existence. Winter flounder larvae are negatively buoyant (Pereira et al. 1999), and are typically more abundant near the bottom (Able and Fahay 1998). These life stages are less mobile and thus more likely to be adversely affected adversely by any impact to benthic habitat. The placement of the storm surge barrier across Rockaway Inlet will result in the permanent loss of winter flounder EFH associated with the footprint of the structure, as well as a reduction in access to the spawning areas in Jamaica Bay.

Seasonal in-water work restrictions may be necessary to protect EFH and other NOAA trust resources, particularly if a storm surge barrier is constructed. This includes a seasonal in-water work restriction from January 15 to May 31 for construction activities within EFH for winter flounder early life stages. In addition, construction activities that generate noise or turbidity may impede the migration of diadromous fishes to their upstream spawning and nursery grounds. In- water work should be avoided from March 1 to June 30 of each year to minimize adverse effects to migrating diadromous fishes. Any in-water work undertaken at other times of the year should be designed to allow movement of fish past the work site.

Further study should consider whether any solution to reduce the risk to communities and infrastructure from storms may impact species access and movements, and how such effects can be avoided or minimized. Access does not only include the ability to enter the estuary but also movements within the estuary and its tributaries.

> Response: The storm surge barrier feature (Jamaica Bay component) is now being evaluated under the New York and New Jersey Harbor and Tributaries Study (NYNJHATS) as a potential CSRM measure for the Jamaica Bay area. This includes all features previously selected for Jamaica Bay, including the line of protection along Jamaica Bay.

Wetlands

Tidal wetlands are essential for healthy fisheries, coastlines, and communities, and are an integral part of our economy and culture. Wetlands also provide essential food, refuge, and nursery habitat for federally managed and NOAA Trust species, including striped bass, alewife and blueback herring. Salt marshes provide habitat for fiddler crabs and other intertidal benthic species, and provide foraging grounds for wading birds, shorebirds, waterfowl, estuarine fishes, and blue crabs. Estuarine marsh grasses provide many ecological functions to the wetland and the adjacent waters, including a source of organic nutrients, stability of the sediments, and absorption of contaminants. The shallows provide nursery habitat for many species of fish including winter flounder and summer flounder.

Summer flounder larvae migrate inshore into estuarine nursery areas, settling to the bottom of marsh creeks to transform to their juvenile stage. These juveniles will then make extensive use of the creeks, preying on creek fauna such as Atlantic silversides and mummichogs. Juvenile summer flounder may also be found in salt marsh cord grass habitat during flood tides. Juveniles use the marsh edges for shelter, burying themselves in the muddy substrates. Keefe and Able (1992 in Packer et al. 1999) found that summer flounder juveniles that inhabit marsh creeks exhibit the fastest growth.

The primary production in wetlands forms the base of the food web that supports invertebrates and forage fish that are then prey species for larger fish such as bluefish. Surface water retention and detention and ground water recharge provides flood control services to the surrounding community. Wetlands may help to moderate global climate change through carbon storage in wetland plant communities and soil.

Jamaica Bay is regionally significant for shellfish and marine, estuarine, and anadromous fishes, as well as for its significant migratory and wintering waterfowl concentrations. The wetlands and uplands in the bay are important as fish nursery areas and foraging areas for shorebirds and waterbirds. Wetlands in the project area perform many important ecological functions including water storage, nutrient cycling and primary production, sediment retention, water filtration or purification, and groundwater recharge.

Although no wetland loss was proposed in the TSP, long-term impacts on wetlands in the Jamaica Bay estuary due to the storm surge barrier have not been identified. The estuary is subject to severe anthropogenic impacts, and has incurred a loss of 63% of wetlands between 1951 and 2003. During this time period, the rate of marsh loss increased from 17 acres lost per year during 1951 - 1974 to 33 acres lost per year during 1989 -2003 (NPS 2007). Marsh islands were lost at a rate of 47 acres per year from 1994 to 1999 (USACE 2016). The loss of wetlands as a result of this project could therefore adversely affect resources of concern to NMFS species through the loss of nursery, forage, and refuge habitat, the reduction of prey species and primary production, as well as water quality degradation from the reduction in sediment retention and pollution filtration. Vegetated wetlands are also considered to be special aquatic sites under the Clean Water Act. Because of their ecological value, impacts on these special aquatic sites should be avoided and minimized.

> Response: The storm surge barrier feature (Jamaica Bay component) is now being evaluated under the New York and New Jersey Harbor and Tributaries Study (NYNJHATS) as a potential CSRM measure for the Jamaica Bay area. This includes all features previously selected for Jamaica Bay, including the line of protection along Jamaica Bay.

Beach Nourishment and Dredging

The dredging of sand for beach nourishment has the potential to impact both the EFH of a particular species as well as the organisms themselves in a variety of ways. Dredging can result in the impingement of eggs and larvae in the dredge plant and create undesirable suspended sediment levels in the water column. Increased suspended sediment levels can reduce dissolved oxygen, mask pheromones used by migratory fishes, and smother immobile benthic organisms and newly-settled juvenile demersal fish (Auld and Schubel 1978; Breitburg 1988; Newcombe

and MacDonald 1991; Burton 1993; Nelson and Wheeler 1997). Sustained water column turbulence can reduce the feeding success of sight-feeding fish such as winter flounder and summer flounder.

Dredging can remove the substrate used by federally managed species as spawning, refuge, and forage habitat. Benthic organisms that are food sources for federally managed species may so be removed during dredging. These impacts may be temporary if the substrate returns to preconstruction condition and the benthic community recovers with the same or similar organisms. The impacts may be permanent if the substrate is altered in a way that reduces suitability as habitat, and' if the benthic community is altered in a way that reduces its suitability as forage.

As part of the borrow site screening process, the Corps has proposed to avoid dredging in sections of the borrow area identified as prominent shoal habitats such as the "Seaside Lumps" and "Fish Havens" areas. Overall, the dredging and placement of sand along the coastline will have some adverse effects on EFH and federally managed species due to the entrainment of early life stages in the dredge, alteration or loss of benthic habitat and forage species, and altered forage patterns and success due to increased, noise, turbidity and sedimentation. We agree that some effects will be temporary and others can be minimized using some of the management practices mentioned in the EFH assessment, such as dredging in the fall to avoid sensitive life stages of certain species, not dredging deep holes and leaving similar substrate in place to allow for recruitment.

Dredging in the borrow area can also affect EFH adversely through impacts to prey species. The EFH final rule states that the loss of prey may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat; the definition of EFH includes waters and substrate necessary to fish for feeding. Steimle et al. (2000) reported that winter flounder diets include the siphons of surf clams (*Spisula solidissima*). As a result, activities that adversely affect surf clams can adversely affect the EFH for winter flounder by reducing the availability of prey items. Therefore, actions that reduce the availability of prey species, either through direct harm or capture, or through adverse impacts to the prey species' habitat, may also be considered adverse effects on EFH.

According to the DHSGRR/DEIS, the offshore borrow area provides habitat for surf clams, however surveys conducted by the USACE in 2003 and by the NYSDEC in 2012 indicate that the borrow area itself contains very low to no localized populations of surf clams. Another survey is proposed prior to the use of the borrow area. It is unclear whether the intent is to survey just once prior to implementation of the entire project or before each dredging cycle. To ensure that impacts to surf clams are minimized, the borrow areas should be surveyed prior to each dredging cycle and areas of high densities should be avoided. Copies of the shellfish survey results should also be provided to us prior to any dredging in the borrow area.

> Response: The revised DHSGRR/DEIS will include a definitive survey schedule that will be used throughout project construction for each dredging cycle. After the completion of surveys, copies of the results will be provided to NMFS.

The Mid-Atlantic Fisheries Management Council (MAFMC) has developed a policy statement on beach nourishment activities that may affect federally managed species under their purview including summer flounder, scup, black sea bass, monkfish and butterfish. These policies are intended to articulate the MAFMC's position on various development activities and facilitate

the protection and restoration of fisheries habitat and ecosystem function. The MAFMC's policies on beach nourishment are:

1. Avoid sand mining in areas containing sensitive fish habitats (e.g., spawning and feeding sites, hard bottom, cobble/gravel substrate, shellfish beds).
2. Avoid mining sand from sandy ridges, lumps, shoals, and rises that are named on maps. The naming of these is often the result of the area being an important fishing ground.
3. Existing sand borrow sites should be used to the extent possible. Mining sand from new areas introduces additional impacts.
4. Conduct beach nourishment during the winter and early spring, when productivity for benthic infauna is at a minimum.
5. Seasonal restrictions and spatial buffers on sand mining should be used to limit negative impacts during fish spawning, egg development, young-of-year development, and migration periods, and to avoid secondary impacts to sensitive habitat areas such as SAV.
6. Preserve, enhance, or create beach dune and native dune vegetation in order to provide natural beach habitat and reduce the need for nourishment.
7. Each beach nourishment activity should be treated as a new activity (i.e., subject to review and comment), including those identified under a programmatic environmental assessment or environmental impact statement.
8. Bathymetric and biological monitoring should be conducted before and after beach nourishment to assess recovery in beach borrow and nourishment areas.
9. The effect of noise from mining operations on the feeding, reproduction, and migratory behavior of marine mammals and finfish should be assessed.
10. The cost effectiveness and efficacy of investments in traditional beach nourishment projects should be evaluated and consider alternative investments such as non-structural response and relocation of vulnerable infrastructure given projections of sea level rise and extreme weather events.

The MAMFC's policies should be incorporated in the final design of this project and its long-term management plan.

Response: The MAMFC's policies listed above will be incorporated in the final design and long- term management plan to the maximum extent practicable

Mitigation

Two mitigation projects, previously identified as high priority restoration projects by the Hudson-Raritan Estuary Comprehensive Restoration Plan, are tentatively proposed to offset a loss of 154 acres of fish and wildlife habitats. The two proposed projects are the Floyd Bennett Field Wetlands Habitat Creation project and the Elders Island Project. According to the information in the DHSGRR/DEIS, these two projects would provide 247 acres of habitat to mitigate for the impacts of the TSP. The Evaluation of Planned Wetlands (EPW) and the Benthic Index of Biological Integrity (B-IBI) were used to determine that these two projects would offset the loss of ecological services resulting from the implementation of the TSP. NMFS staff were not included as part of the EPW team and the results of the EPW and B-IBI

have not been provided to us. In addition, the full extent of the potential impacts of the TSP on EFH and details of the proposed mitigation are not described fully in the DHSGRR/DEIS. As a result, it is not possible determine if the proposed mitigation will offset the adverse effects of the project on aquatic resources and EFH.

As part of the expanded EFH consultation, additional information should be provided the specific element of the proposed mitigation plans. Also, any compensatory mitigation proposed should offset any loss or degradation of EFH and other impacted aquatic resources resulting from the implementation of the TSP. The Corps should coordinate with us to develop a detailed compensatory mitigation plan in accordance with the 2008 federal mitigation rules, and provide it to us for review prior to implementation. The plan should include success criteria and a long- term management plan. The site protection mechanism and long-term land steward should also be identified.

Response:

The District anticipates that there may be a variety of impacts to Essential Fish Habitat (EFH) as a result of the implementation of the revised TSP; some may be temporary and related to construction activities and some may be permanent due to changes in habitat types.

As project plans are further developed in the Pre-Engineering and Design Phase, the District will coordinate with NOAA Fisheries and undertake project specific EFH consultation so that the effects of the individual actions can be evaluated and site-specific EFH conservation recommendations can be developed. The District requests your review and confirmation of concurrence with this overall.

Endangered Species Act

Federally listed species including the threatened loggerhead (*Coretta caretta*), and the endangered Kemp's ridley (*Lepidochelys kempi*), green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles and Atlantic sturgeon (*Acipenser oxyrhynchus*) may be present in the project area. Consultation, pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, may be necessary. Our Protected Resources Division will be commenting on the DHSGRR/DEIS separately. Questions regarding the status of their review should be directed to Daniel Marrone at (978) 282-8465 or daniel.marrone@noaa.gov.

We look forward to our continued coordination with your office on this project as it moves forward. As stated above, because the EFH assessment provided lacks sufficient detail on each action proposed as part of the TSP, we cannot consider it to be complete. A comprehensive evaluation of the direct, indirect, individual and cumulative effects of all of the project components on EFH should be provided to us as part of an expanded EFH consultation. We are available to discuss the information needed in order to undertake this consultation. If you have any questions or need additional information, please do not hesitate to contact Ursula Howson at ursula.howson@noaa.gov or (732) 872-3116.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Planning Division

July 20, 2018

Ms. Jennifer T. Nersesian
United States Department of the Interior
National Park Service, Gateway National Recreation Area
210 New York Ave
Staten Island, New York 10305

Subject: Responses to Comments on the Draft General Reevaluation Report / Environmental Impact Statement (GRR/EIS) for the East Rockaway Inlet to Rockaway Inlet Hurricane Sandy Reformulation Study

Dear Ms. Nersesian:

The U.S. Army Corps of Engineers (USACE), New York District (District) is in receipt of your letter, dated 19 January 2017, submitting comments on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS).

As a result of the significance (extent and content) of partner, agency and public comments received on the proposed project, as well as the feedback to the District resulting from the concurrent policy and technical review that was conducted by USACE Headquarters (HQUSACE), the District, in coordination with New York State Department of Environmental Conservation (NYSDEC) as our non-federal Sponsor, has determined that sufficient revision to the draft report is required in order to proceed to a final decision document.

The Agency Decision Milestone (ADM) resulted in the decision to move all further evaluation of the proposed storm surge barrier measure within Jamaica Bay, a significant component of the Tentatively Selected Plan (TSP), to the ongoing New York and New Jersey Harbor and Tributaries (NYNJHATs) Feasibility Study (NYSDEC and NJDEP are the non-federal sponsors, with the partnership of New York City). The NYNJHATs Study was initiated in the Summer of 2016 around the same time as the release of the Rockaway Reformulation Draft GRR/EIS. The NYNJHATs Study is evaluating large-scale regional coastal storm risk management (CSRM) strategies for the New York/New Jersey metropolitan area (which includes Jamaica Bay) extending upstream of the Hudson River to the federal lock and dam at Troy, New York, the Passaic River to the Dundee Dam, and the Hackensack River to the Oradell Dam. The NYNJHATs study is evaluating a suite of storm surge barriers, including one alignment from Breezy Point to Sandy Hook that would obviate the need for the proposed Jamaica Bay barrier. Therefore, from a plan formulation perspective, it makes sense to evaluate

the storm surge barrier, previously a component of the Rockaway Reformulation, in this newer regional study instead.

Moving the barrier component to the NYNJHATs Study has other strategic advantages as well. Namely, that more analysis is needed and that the required analysis should not delay construction of the more readily implementable Atlantic Shorefront and 'Residual Risk' measures in Jamaica Bay. Part of why more environmental analysis was deemed necessary for the barrier component is that the level of detail available to date was still largely conceptual.

The Project Delivery Team has been working with to further refine and develop the 'Residual Risk' measures in the Back-Bay, now termed *high frequency flooding risk reduction features* (HFFRRFs), in order to bring them up to full feasibility level of design and environmental analysis, and to include natural and nature-based features, as well as areas outside of New York City in Nassau County.

Thank you for the continued assistance and input to this process which helps to advance the execution of this regionally-significant project. Points of contact for the study are Planner and Biologist, Daria Mazey, at 917-790-8726 or the Project Manager, Dan Falt, at 917-790-8614.

Sincerely,

Clifford S. Jones III
Chief, Planning Division

Enclosure

cc: Raddant-DOI

Pertinent Text and Responses to Comment Letter

Mutually Acceptable Plan

NPS appreciates that the Draft HSGRR/EIS explicitly cites future coordination with the NPS to identify a plan that is mutually acceptable. A mutually acceptable plan must be one that meets USACE project objectives, minimize adverse impacts to NPS cultural, natural and recreational resources within Gateway National Recreational Area (GATE or "park"), and mitigates for all unavoidable adverse impacts to NPS resources. Under the fundamental principles that guide the National Park Service, a mutually acceptable plan cannot result in impairment of NPS resources. In addition, the plan must be consistent with the park's enabling legislation which states "That the Secretary shall administer and protect the islands and waters within the Jamaica Bay Unit with the primary aim of conserving the natural resources, fish, and wildlife located therein and shall permit no development or use of this area which is incompatible with this purpose." The alternatives analyzed in the Draft HSGRR/EIS may have significant, persistent and irreversible adverse impacts to GATE natural, cultural and recreational resources. Potential impacts from the Tentatively Selected Plan (TSP) include the loss of coastal natural resources, alteration of natural coastal functions, alteration of the setting, feeling and association of six Historic Districts within GATE, and alteration of park visitor experiences and opportunities.

> Response: Future analyses of adverse impacts to GATE are the subject of current and ongoing coordination between the USACE and NPS. It is important to note the Jamaica Bay storm surge barrier component of the original plan presented in the Draft HSGRR/EIS is now within the scope of the NY / NJ Harbor and Tributaries Study (NYNJHATS) for further evaluation and potential recommendation. Adverse impacts cited above by NPS will be assessed within the scope of the NYNJHATS.

None of the alternatives analyzed in the plan include mitigation measures that avoid and minimize adverse impacts to NPS resources. Given the magnitude and permanence of the preferred alternative or alternative tie-in locations and the absence of identified mitigation measures, and without a full analysis of the potential impacts, the NPS can only conclude that the project as currently described in the HSGRR/EIS would result in the impairment of park resources. We consider this a starting point that can and should be rectified within the draft HSGRR/EIS, and will work with you to achieve this goal.

> Response: Planning for the avoidance and mitigation of impacts to GATE will be the subject of future coordination between the USACE and NPS. As stated above, the Jamaica Bay storm surge component of the original plan presented in the Draft HSGRR/EIS is now within the scope of the NY / NJ Harbor and Tributaries Study (NYNJHATS) for further evaluation and potential recommendation.

The draft HSGRR/EIS identifies that potential alternate tie-in alignments may be developed as part of the optimization of storm surge barrier alignment C-1E to provide flexibility for the final design to minimize effects to NPS resources and to provide for a plan that is mutually acceptable to the Secretaries of the Army and Interior. We anticipate that analysis may show that some of these alternatives, such as running the line of protection

perpendicular to the eastern edge of Riis Beach, would greatly decrease the scope and degree of impacts to park resources by avoiding the Atlantic shoreline along Riis Beach, Fort Tilden and the tip of Breezy Point. We strongly encourage you to consider these alternative alignments and analyze their relative impacts. In doing so, we would also request that there is coordination between the HSGRR/EIS and the Breezy Point and Roxbury communities' plans for protection to make sure those populations are not left vulnerable.

While we anticipate that some of the alternatives contemplated could greatly reduce impacts to park resources, we cannot formally make that determination in the absence of data and analysis. We note that alternate alignments BZ, 149, FB, and 149 & FB (listed in Table 5-18 and shown in Figures 5-13 through 5-16) were not evaluated in the Draft HSGRR/EIS. NPS will require full analysis of impacts for a mutually acceptable plan.

> Response: Alternative alignments for potential tie-in alignments for the Jamaica Bay storm surge barrier will be reassessed as part of the NYNJHATS.

It is our agency's goal to work collaboratively with USACE to arrive at a mutually acceptable plan and to implement a project that will reduce storm damage risks for NYC residents and communities; however, NPS lacks sufficient capacity to participate in the multi-year planning, design and implementation phases to the level necessary for successful development of this project. Full participation by NPS to maintain the engagement and collaboration necessary for this project will require funding for staff and technical resources that are currently not available within the NPS budget.

Impacts to Park Resources

The NPS's authority to conserve and manage park resources is derived from the Organic Act of 1916, which states that "the fundamental purpose of the said parks ...is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The NPS has discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of a park (NPS 2006 sec. 1.4.3). However, the NPS cannot allow an adverse impact that would constitute impairment of the affected resources and values (NPS 2006 sec 1.4.3). An action constitutes an impairment when its impacts “harm the integrity of Park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values” (NPS 2006 sec 1.4.5). To determine impairment, the NPS must evaluate “the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts” (NPS 2006 sec 1.4.5). The Draft HSGRR/EIS impact analysis is not currently sufficient to meet NPS policy requirements to determine if the project would impair NPS resources. In order to be mutually acceptable, the document will need to include this analysis to demonstrate that the proposed actions do not constitute impairment.

Specific areas in need of analysis are included in the sections below, and the NPS will work with the USACE to further define these needs as necessary. Overall, there is a concern that the Tentatively Selected Plan (TSP) could have significant, persistent and irreversible adverse impacts to GATE natural, cultural and recreational resources. Buried seawalls along the Atlantic coast within sections of GATE could constitute permanent, irreversible adverse ecological impacts to fundamental natural resources; an adverse effect on several aspects of integrity of

fundamental cultural resources, including association, feeling, setting, etc.; and irreversible change for the visitor experience. As an analysis of these impacts is developed and we get a better sense of the severity, duration and timing of these impacts, we can collectively work on strategies to eliminate, minimize and/or mitigate those impacts and have those changes reflected in the final analysis in the document.

Impacts to any Fundamental Resources outlined in the park's General Management Plan are of particular concern. *Fundamental resources and values are the park's attributes-its features, systems, processes, experiences, stories, scenes, sounds, smells, opportunities for visitor enjoyment, or others-that are critical to achieving the park's purpose and to maintaining its significance* (NPS 2014). The resource values of the estuary, beaches, wetlands and maritime uplands of Jamaica Bay within the proposed plan are fundamental to GATE. *These resources provide unique and surprising opportunities for experiencing the wildness of the natural world while within the city's limits, and a model for studying, managing, and restoring urban ecosystems* (NPS 2014). The habitats that compose the Jamaica Bay ecosystems are rare in such highly developed areas and support a rich biota that includes migratory birds, marine finfish and shellfish, plant communities, and rare, threatened, and endangered species. These features provide opportunities to restore, study, enhance, and experience coastal habitats and ecosystem processes. The Draft HSGRR/EIS does not provide sufficient information and analysis to fully assess the impacts of the project on these resources.

The cultural resources of the park represent tangible manifestations of humans interacting with their environment and with each other throughout time. The history of the park's defensive military fortifications and weaponry is manifested in some of the most notable cultural resources in the park. Within the project area, the history of Fort Tilden as part of the national defense network designed to protect the New York Harbor is a fundamental value. Battery Harris, Battery Kessler, Construction Battery 220 and the Nike Missile Launch Site are fundamental park resources. The civil and military aviation history resources at Floyd Bennett Field, historic landscape at Jacob Riis Park, including the beaches, boardwalk, and bathhouse; and pre-contact archeological sites, historic archeological sites related to domestic and Military occupations of park lands, and submerged resources have been identified as important park resources and values. In addition to the National Register-listed Fort Tilden, Floyd Bennett Field and Jacob Riis Park Historic Districts, the Silver Gull Beach Club, the Breezy Point Surf Club, and the Far Rockaway Coast Guard Station have been determined eligible for the National Register by the New York State Historic Preservation Office (NPS 2014). The impact analysis must describe both physical impacts and impacts on other aspects of resource integrity such as association, feeling, setting, etc. The Draft HSGRR/EIS does not adequately characterize the national and local significance of the NPS cultural resources within the project area nor evaluate the impacts of the projects on those resources.

Response: The breadth of the effects to NPS resources at GATE are acknowledged, and will be reassessed as part of the NYNJHATS. Effects to NPS resources associated with the Atlantic Shorefront portion of the project will be reexamined in coordination with the NPS and NYSHPO. However, the Corps does not agree that "*Buried seawalls along the Atlantic coast within sections of GATE could constitute permanent, irreversible adverse ecological impacts to fundamental natural resources; an adverse effect on several aspects of integrity of fundamental cultural resources, including association, feeling, setting, etc.; and irreversible change for the visitor experie*nce." The buried seawall will be a component of "Layers of protection+ - beach + dune + structure). There will be temporary construction related impacts related the seawall, but once buried it is to remain buried and the impacted area will function as before.

Agency Decision Milestone (ADM)

The Draft HSGRRIEIS identifies that a final decision for the TSP will be made at the Agency Decision Milestone (ADM) and that the TSP may be modified particularly with regard to the alignment of the Storm Surge Barrier and risk residual features. The ADM will select a plan for feasibility-level design and recommendation for implementation. NPS will require significant additional information regarding the impacts of project in general and the alternative alignments in particular to support agency agreement on a final plan. USACE has indicated that additional modeling and analysis will occur during the design and development phase of the project that could result in further refinement of the Jamaica Bay and Rockaway Inlet components of the TSP. NPS will require results of that modeling and analysis to fully evaluate the impacts of the project on NPS resources. As explained above, it is not reasonable to expect that a mutually acceptable plan can be identified without full evaluation of impacts on NPS resources. In these comments, NPS has identified some additional analysis and revisions that will be required for the Atlantic Shorefront Component of the plan. Substantial information needs and analysis is required to fully assess the impacts of the Jamaica Bay Component and residual risk measures on NPS resources. Therefore, NPS recommends that USACE develop a Supplemental EIS (SEIS) for the Jamaica Bay Component of the HGRRJEIS and that the SEIS will provide a mutually acceptable plan for the Jamaica Bay Component at the ADM milestone of the SEIS.

Response: The USACE concurs with the recommendation to separate the Jamaica Bay storm surge barrier component from the Atlantic Shoreline component of the TSP. In lieu of preparing an SEIS, as recommended by NPS, the Jamaica Bay storm surge component will be subsumed into the NYNJHATS.

Atlantic Ocean Shorefront

The Atlantic Ocean Shorefront component of the HSGRRJEIS would extend in length 5 existing groins and construct 13 new groins. The terminal groin at Beach 149th Street has and will continue to interrupt natural littoral transport mechanisms to the beach face at Jacob Riis. Expansion of the Rockaway groin field may further disrupt sediment transport processes. The sediment starved Riis beach provides protection for the Jacob Riis Park Historic District. The loss of the beach also threatens the integrity of the cultural landscape including character defining elements such as the large scale of the beach space. Loss of sand and narrowing of these beaches has also reduced the quantity and quality of habitat available for wildlife such as the

federally threatened piping plover (Charadrius melodus) and is likely to increase the risk of human-wildlife conflicts. Lastly, the loss of sand compromises the recreational experience of the hundreds of thousands of visitors that frequent the beach every summer. Interagency Agreement Number Pl4PG00287 between the NPS and USACE provided the placement of approximately 200,000 yd^3 in 2014 to restore fundamental and other important resources and values associated with recreation, cultural landscapes, and coastal habitats for wildlife at Jacob Riis Park as an interim measure until the HSGRRJEIS was completed. The Draft HSGRR/EIS does not provide for any beach nourishment at Riis Beach (reach 2) to mitigate for the impacts of the groin field on sediment transport process west of the terminal groin at Beach 149th Street. We request that this be included as a part of the plan.

Response: Coastal Storm Risk Management (CSRM) features for Atlantic Shorefront reaches 1 and 2 (which include Riis Beach) did not pass initial screening due to the small number of structures (0 residential, 7 non-residential – Depreciated Replacement Value $19,342,000). Preliminary analyses showed that the benefits of providing CSRM features would not exceed the costs of providing CSRM features, and not be economically justified. However, concur that the Recommended Plan cannot adversely affect NPS property, so sand placement and groin rehabilitation are proposed as a taper tie-in at the western end of the project past the terminal groin at Beach 149th Street. USACE is performing sediment transport modeling and will refine the western taper design in coordination with NPS during the Pre-Construction Engineering and Design Phase.

Storm Surge Barrier

The Draft HSGRRJEIS lacks sufficient information to evaluate the impacts of the storm surge barrier across the Rockaway Inlet from near Jacob Riis Park to Floyd Bennett Field (TSP Cl -E alignment) on NPS resources. The 3,970-foot barrier will directly impact Jacob Riis Park and Floyd Bennett Field Historic Districts and will be within the viewshed of other Districts managed by NPS. The open barrier will substantially reduce the area for water exchange and will impact the hydrology and hydrodynamics of the bay. Hydrologic changes may alter the sediment budget, sediment distribution, mobilization of contaminated sediments, as well as the area, distribution and long-term resilience of bay intertidal and subtidal habitats and the organisms associated with those habitats. Closing the barrier may have additional impacts, particularly with regard to water quality and sediment budget. The Draft HSGRR/EIS indicates that preliminary modeling identifies minimal impacts and that additional modeling will be conducted during the design and engineering phase of the project. NPS cannot evaluate whether it will be possible to achieve a mutually acceptable plan until the impacts of the storm surge barrier are fully evaluated and measures to reduce adverse impacts have been included to the greatest extent possible, and mitigation has been identified for adverse impacts that cannot be avoided. In addition, NPS recommends that USACE develop an external peer advisory team to provide expert input into the development of models and other tools to evaluate the impacts of the storm surge barrier on Jamaica Bay physical and ecological resources. NPS requests that scientists from the Science and Resilience Institute at Jamaica Bay and the United States Geological Survey are represented on that team.

Response: Additional water quality modeling has been conducted to analyze a range of potential impacts up to the worst case scenario for water quality impacts

of a barrier in Jamaica Bay. The NYNJHATS will describe the Jamaica Bay Eutrophication Model (JEM) that was used to analyze potential water quality impacts (JEM documentation has been revised in recent months). Independent External Peer Review is part of the Corps planning process, and will take place under the NYNJHATS for the Jamaica Bay storm surge barrier.

Storm Surge Barrier Tie-In - Rockaway Peninsula

The current TSP alignment would maximize adverse impacts on NPS cultural, natural and historic resources. The alignment will directly impact 4 historic districts and, depending upon the alignment, may directly impact contributing resources within those districts such as Shore Road and Batteries Kessler and Construction 220. The highly modified urban setting in which GATE is situated does not negate the NPS requirement to preserve the physical and biological resources. When "a truly natural system is no longer attainable," NPS policies require management to achieve the best approximation of natural conditions, to minimize impacts, to mitigate for impacts, and, when possible, to restore natural conditions.

Construction of a reinforced dune and concrete floodwall through NPS property would constitute a permanent management decision to eliminate naturally dynamic features that are formed and shaped by coastal processes and artificially fix the location of the dune and berm system. Construction and long-term maintenance of a reinforced dune would result in a permanent loss of natural conditions at Breezy Point and Fort Tilden and alteration of shoreline processes that will adversely impact the flora and fauna associated with these coastal habitats as well as recreational opportunities and experiences for park visitors. It would also result in a loss of the visitor's sense of connection with the sea and the natural environment. Breezy Point and Fort Tilden are among the only remaining natural beach and dune systems on the Rockaway Peninsula. The concrete floodwall on the north side of the Rockaway Peninsula will alter sediment transport processes and may impact the Breezy Point marsh and other bayside coastal habitats within NPS.

NPS has previously discussed with USACE alternate alignments that could reduce impacts on NPS resources. These alternate alignments were identified in the Draft HSGRR/EIS; however, no impact analysis was provided. Again, we request the consideration and analysis of these alternative alignments that would reduce or eliminate many of these impacts to park resources. In analyzing these alternative alignments, we also recommend consideration be given to the Breezy Point Marsh, particularly to understand whether this is a point of vulnerability for the adjacent road (the only means of egress for the community), and if so, what appropriate measures would be to address that situation (for instance, ecological restoration and/or sand placement).

Response: The Jamaica Bay storm surge barrier tie-ins on Rockaway Inlet presented in the Draft HSGRR/EIS is now within the scope of the NYNJHATS for further evaluation and potential recommendation. The NPS comments listed above will be addressed within the scope of NYNJHATS decision making.

Storm Surge Barrier Tie-In - Brooklyn

NPS resources will also be adversely impacted by the north-shore (Brooklyn) storm surge barrier tie-in identified in the TSP. The concrete floodwall running north along Flatbush Avenue toward the Belt Parkway will impact the Floyd Bennett Field National Historic District and may impact visitor opportunities and experiences. In addition, this alignment is expected to increase vulnerability of NPS property west of the floodwall during storm events due to reflection of

storm surge energy from the barrier and tie-in onto Dead Horse Bay, Gateway Marina and the mini-golf course. NPS property west of Flatbush Avenue was formerly a landfill and the nature and extent of sediment contamination is not known; however, significant contamination could be present. Increased erosion, due to reflection of storm surge energy from the barrier and tie-in, may result in the scouring of this material and an accompanying release of contaminants. It is essential that this is accounted for within the HSGRR/EIS.

Construction of a berm-faced elevated promenade along the waterside of the Belt Parkway, a concrete floodwall at Gerritsen Inlet, and sector gates at Gerritsen Inlet will adversely impact park resources. Reflection of storm surge energy form these barriers may increase vulnerability to NPS property, including critical habitats south of the barriers. This may result in the loss and/or degradation of horseshoe crab spawning habitat and salt marsh at Plumb Beach and changes in flora and fauna which will have adverse biological and recreational (nature watching) impacts. In addition, the elevated promenades will alter the recreational experiences and opportunities.

> Response: The Jamaica Bay storm surge barrier tie-ins on Rockaway Inlet presented in the Draft HSGRR/EIS is now within the scope of the NYNJHATS for further evaluation and potential recommendation. The NPS comments listed above will be addressed within the scope of NYNJHATS decision making.

Residual Risk Measures

The Draft HSGRR/EIS does not currently identify construction of residual risk features on NPS property or within NPS boundaries. Shoreline modifications, including the construction of 1-walls and bulkheads may alter sediment transport processes within the Bay and/or result in localized erosion that may adversely impact NPS resources. Changes in sediment transport processes that result in mobilization of sediments due to scouring adjacent to shoreline structures may also mobilize contaminated sediments. Impacts of residual risk measures on NPS resources, sediment transport processes and bio-availability of contaminants have not been analyzed in the TSP.

> Response: The environmental impact analysis of the High Frequency Flooding Risk Reduction Features (HFFRRFs – which are residual risk measures) is underway and will be included in the revised Draft Final GRR/EIS. Coordination with NPS on this issue has been undertaken and HFFRRFs are not sited within NPS property.

Nature Based Features

The restoration of over 150 acres of salt marsh island habitat within Jamaica Bay is an example of Natural and Nature Based Features (NNBF) that has been realized through the collaborative effort of USACE, NPS and other partners. Enhancement of NNBFs is one of the five planning objectives of the HSGRRJEIS. With plan components including composite seawalls, beach nourishment and groin construction, the TSP does not include any NNBFs. Softening hardened shorelines and marsh restoration in Jamaica Bay are good examples of NNBFs that can buffer storm surge and improve ecosystem resilience. The NPS encourages the evaluation and integration of more NNBFs to meet the project objectives. These may also offer alternatives that serve to avoid or minimize impacts to NPS resources as compared to the current plan components.

Jamaica Bay has experienced a long-term negative sediment budget due to the reduction of sediment input from the ocean due to westward extension of the Atlantic Ocean Shoreline, reduced sediment inputs from the watershed, and historical removal of large volumes of sediment from dredging of the bay (NPS, 2014). This has diminished the natural resilience of Jamaica Bay's marshes. The HSGRR/EIS does not evaluate how changes in tidal range, circulation, sediment budget and sediment transport under storm surge barrier open and closed conditions may impact extant and restored marsh habitat within the Bay.

Response: Where feasible, the Corps has and will continue to include green infrastructure interior drainage instead of pumps and natural and nature-based features instead of gray infrastructure. All separable elements must be incrementally justified using CSRM benefits alone and drainage infrastructure improvements are subject to Corps planning policy and guidance.

Additional water quality modeling has been conducted to analyze a range of potential impacts up to the worst case scenario for water quality impacts of a barrier in Jamaica Bay. The NYNJHATS will describe the Jamaica Bay Eutrophication Model (JEM) that was used to analyze potential water quality impacts (JEM documentation has been revised in recent months). Independent External Peer Review is part of the Corps planning process, and will take place under the NYNJHATS for the Jamaica Bay storm surge barrier.

Science and Technical Information

NPS has identified a number of information gaps that should be addressed in the Final HSGRR/EIS and/or supplemental EIS. These data and analysis are needed to assess project impacts on NPS resources, identify opportunities to minimize impacts, evaluate mitigation alternatives, and facilitate development of a mutually acceptable plan. Additional data and modeling are required to understand changes in availability and distribution of sediment within the Jamaica Bay component of the plan including: changes in flux through the Rockaway Inlet; sedimentation patterns within the bay; distribution of benthic communities, salt marsh and beaches; and, the depth and temporal development of scour along the storm surge barrier and submerged and emergent tie-in features under storm and non-storm conditions and the key parameters that determine the scour type. Additional data and modeling must also be developed to evaluate changes to hydrodynamics of the bay such as: perigean spring tides, tidal amplitude, current velocities (including peak currents), stratification and residence time within the Bay; and, tidal range outside the barrier when closed (including head of tide amplification for surrounding creeks and Dead Horse Bay). Data, model simulations and sensitivity analysis are also needed to understand how the system will perform under climate change (sea level rise, rising water tables, increased frequency/intensity of precipitation events, etc.). Hydrodynamic modeling must integrate storm surge and sea level rise. The plan also needs to provide further analysis of how surface water (precipitation) will be managed during storm barrier closed conditions. Assessment of ecological impacts will also require additional data and modeling to understand impacts of changes in hydrology and hydrodynamics on species composition, abundance and distribution in the Bay.

Response: The Jamaica Bay storm surge barrier tie-ins on Rockaway Inlet presented in the Draft HSGRR/EIS is now within the scope of the NYNJHATS for further evaluation and potential recommendation. The NPS comments listed

above will be addressed within the scope of NYNJHATS decision making.

Mitigation

The Draft HSGRR/EIS identifies that the TSP will result in permanent and temporary adverse habitat impacts of 104.5 acres and 115.7 acres, respectively. The plan does not indicate how much of that acreage is on NPS property or within NPS boundaries. On NPS property, mitigation requirements are generally greater than 2: 1. The Draft HSGRR/EIS does not discuss mitigation for adverse impacts to recreational experiences and opportunities. Mitigation for cultural resource impacts will be developed through a programmatic agreement among NY SHPO, USACE and NPS.

NPS will work with USACE to identify appropriate mitigation actions for unavoidable adverse impacts to NPS natural, cultural and recreational resources. HSGRR/EIS project costs should include support for analysis to estimate human use and ecological losses in monetary terms using established approaches applied in regulatory and natural resource damage assessment. External technical support will be needed to conduct a benefit transfer analysis to estimate the value of recreational experiences and the likely reduction associated with the plan. Habitat Equivalency Analysis or similar methodology should be used to quantify ecological losses. Impacts should be summed over time and space to identify the mitigation requirements sufficient to offset estimated losses. The mitigation should be included as a part of the impact analysis in the HSGRR/EIS, and factored appropriately into the project cost up-front.

Response: The Jamaica Bay storm surge barrier tie-ins on Rockaway Inlet presented in the Draft HSGRR/EIS is now within the scope of the NYNJHATS for further evaluation and potential recommendation. The NPS comments listed above regarding mitigation will be addressed within the scope of NYNJHATS decision making.

Impacts and Economic Benefits of Closing the Storm Surge Barrier

The Draft HSGRR/EIS does not identify a design elevation for protection for the Jamaica Bay planning reaches. Figure 3-5 illustrates the 1% annual chance (100-year return period) flood hazard; however the draft plan specifically states that no design elevation has been determined. The impacts of closing the storm surge barrier cannot be fully determined and evaluated if the frequency of closures cannot be projected based upon a design elevation for protection. It is also unclear how the economic benefits and cost-benefit ratios were calculated without a design elevation for protection. Furthermore, it is important to provide public transparency regarding the storm level for which the storm surge barrier would be closed and flood risks that will not be managed by closure of the storm surge barrier. The HSGRR/EIS must identify the level of protection and identify an approach for developing a decision matrix/closure criteria for the barrier.

Response: Economic benefits and cost-benefit ratios can be developed using risk management features designed to mitigate against a 100-year return period flood. Specific aspects of the design and operation (including timing of closings) of the Jamaica Bay storm surge component would be developed as part of the Planning, Engineering, and Design (PED) phase of the project. As stated above, the Jamaica Bay storm surge component of the original plan presented in the Draft HSGRR/EIS is now within the scope of the NY / NJ Harbor and Tributaries

Study (NYNJHATS) for further evaluation and potential recommendation.

NPS Consulting Party Status

In a July 2016 letter addressed to Mr. Clifford Jones, NPS Northeast Regional Director Michael A. Caldwell accepted the USACE New York District invitation to be a cooperating agency in the National Environmental Policy Act (NEPA) process for the HSGRR/EIS and requested consulting party status under Section 106 of the National Historic Preservation Act. The Draft HSGRR/DEIS identifies New York City as a Section 106 consulting party. The HSGRR/DEIS should also identify that NPS is a consulting party. In addition, throughout the document, references to NPS with regard to our role in the NEPA and Section 106 processes are inconsistent. One example of this is provided on page 93 where NPS is identified as an interested party for the Programmatic Agreement when NPS is actually a Section 106 consulting party and cultural resource manager. The HSGRR may have an adverse effect on NPS cultural resources and NPS must be an integral part of consultations with NYSHPO, Native American Tribes and other interested parties.

Response: The HSGRR/EIS will be corrected to state that the NPS is a Section 106 consulting party, and the Corps will include NPS in consultations with NYSHPO, Native American Tribes and other interested parties. It should be noted, however, that future consultations would occur within the scope of the NYNJHATS.

Draft HSGRR/EIS Planning Constraints - GATE 2014 General Management Plan and other GATE planning documents

The Draft HSGRR/EIS identifies that this plan will "*not negatively impact ongoing recovery, ecosystem restoration and risk management by others*". NPS has completed recovery plans for several areas in GATE that were damaged during Hurricane Sandy. The NPS is currently implementing projects at Riis Beach, Fort Tilden, West Pond and Floyd Bennett Field, all of which fall within the TSP project area. NPS recovery has emphasized increased resilience through restoration of natural processes, enhanced building resilience, and strategic retreat for cultural resources and infrastructure that cannot reasonably be made resilient.

In addition, the 2014 Gateway National Recreation Area General Management Plan (GMP) provides for the long term management of park resources that fall within the TSP project area. The GMP established most of Jamaica Bay as a natural zone with the objective of natural wetland and coastal habitat restoration in the greater Jamaica Bay area. "*Natural resource protection and restoration efforts in the Jamaica Bay Unit would focus on softening hardened coastal edges, restoring wetland and coastal habitats, and creating additional freshwater wetlands. Increased use would be balanced with additional monitoring and management of wildlife and habitats. Natural Zone Habitats would be managed to improve resilience and healthy environments as part of the larger Jamaica Bay system. The restoration of freshwater and saltwater wetland habitat would be explored in portions of the North Forty natural area and along the shoreline. The shoreline would return to natural (soft) conditions through the removal of bulkheads and other hardened structures and allow natural sediment transportation processes to occur. The Habitats would be managed to improve resilience and healthy environments as part of the larger Jamaica Bay system.*" The TSP should strive to support these goals to the extent possible and consider the specific impacts and related mitigation strategies with them in mind.

Response: The Jamaica Bay storm surge barrier tie-ins on Rockaway Inlet presented in the Draft HSGRR/EIS is now within the scope of the NYNJHATS for further evaluation and potential recommendation. The NPS comments listed above will be addressed within the scope of NYNJHATS decision making.

Draft HSGRR/EIS Planning Constraints - Endangered Species

A planning constraint identified in the Draft HSGRR/EIS is that this plan will "*not negatively affect plants, animals, or critical habitat of species that are listed under the Federal Endangered Species Act or a New York State Endangered Species Act*". GATE habitat that would be impacted by this project supports the federally listed piping plover (*Charadrius melodus* - threatened), red knot (*Calidris canutus rufa* -threatened), roseate tern (*Sterna dougallii* - endangered), and seabeach amaranth (*Amaranthuspumilus* -threatened). A quantitative analysis of the project impacts on these species within NPS boundaries is not provided. NPS requests access to the US Fish and Wildlife Service Draft Fish and Wildlife Coordination Act Report and participation in Section 7 consultation.

Response: The Corps will provide NPS with the US Fish and Wildlife Service Draft Fish and Wildlife Coordination Act Report and will engage the NPS for participation in Section 7 consultation.

Scientific Review and Documentation

NPS encourages USACE to complete a robust external technical review of the Draft HSGRR/EIS and to update and revise the science and citations supporting the plan. A key issue that has been raised during public meetings is residency time in the Bay. Citation in the Draft HSGRR/EIS for residence time is a 1997 USFWS publication. Over the past decade, significant hydrodynamic modeling has been conducted by NYC Department of Environmental Protection, researcher s affiliated with the Science and Resilience Institute at Jamaica Bay, and USGS to understand the hydrology, water quality and other physical parameters of the Bay. The Draft HSGRR/EIS must include the most recent and relevant science. In addition, citations in the document should reference the primary literature rather than summary reports or agency reports that referenced the primary literature.

Response: Additional water quality modeling has been conducted to analyze a range of potential impacts up to the worst case scenario for water quality impacts of a barrier in Jamaica Bay. The NYNJHATS will describe the Jamaica Bay Eutrophication Model (JEM) that was used to analyze potential water quality impacts (JEM documentation has been revised in recent months). Independent External Peer Review is part of the Corps planning process, and will take place under the NYNJHATS for the Jamaica Bay storm surge barrier.

Cultural Resources - Section 2.3.15

NPS defines cultural resources as historic structures, cultural landscapes, ethnographic resources, archaeological resources and museum collections. The discussion of cultural resources within the project area and impacts to those resources must be inclusive of the NPS defined cultural resources to ensure that the document is sufficient for NPS adoption. The description of the Historic Districts that occur within the project area lacks sufficient detail to fully analyze impacts to the historic context. At minimum this should include a description of the resources and the criteria under which the district was listed. Impact analysis must be broader than direct impact to

historic structures and include other aspects of integrity. The Draft HSGRRIEIS identifies that "*The on-land portion of this element overlaps the southern boundaries of the historic districts at Jacob Riis Park, Fort Tilden, Silver Gull Beach Club, and the Breezy Point Surf Club..... Construction of elements along the beach has the potential to adversely affect the historic districts.*" NPS considers the construction of an 18' buried seawall along the ocean in front of these 4 historic districts to be an adverse effect on several aspects of integrity including association, feeling, setting, etc. In addition, this section references "landmark" structures. Those resources should be identified by name as well as if the structures are NYC landmark structures or Nfil structures.

> Response: The Corps believes that the descriptions of potential impacts to cultural resources impacts documented in the HSGRR/EIS are sufficient. However, any changes to the analyses as a result of the NPS comments above will be coordinated with the NYSHPO as a part of the NYNJHATS.

Real Estate Considerations - Section 6.3.

The TSP requires extensive construction on NPS lands. As stated previously, we seek to reduce impacts to NPS resources; however, if the final alignment requires construction on NPS lands, we suggest the following process, similar to what is being considered on NPS lands for the South Shore of Staten Island Line of Protection.

6.3.3. The NPS will grant the City an easement that allows them to construct a municipal facility on lands owned by the United States. The United States will retain fee ownership of the underlying land and will retain the right to access the areas by means such as a boardwalk or other pedestrian and bicycling facilities along the top of the structure which may be needed for park purposes. The City would accept responsibility for the ownership, maintenance, and liability associated with the HSGRR; and

6.3.4. Assuming all parties agree that the type of legal instrument is sufficient to authorize the proposed use and to authorize the construction of the HSGRR, the City, the USACE, and the NPS will enter into an Agreement identifying the parties' roles and responsibilities. The Agreement will contain the terms and conditions which must be met before NPS can issue a construction permit to build the TSP. The permit will also contain conditions addressing the time, place, and manner of the construction, mitigation requirements for impacts to NPS resources, and may contain conditions for other components of the construction as necessary.

> Response: Comment noted. This information will be useful as the Jamaica Bay storm surge component is analyzed as part of the NYNJHATS implementation phase.

Operations and Maintenance - Section 6.4

The terms and conditions of the easement will specifically address the City's obligations and responsibilities for the operation, maintenance, and repair of the municipal facility, as well as liability obligations, in perpetuity. The City will be required to address corresponding funding considerations accordingly.

Jamaica Bay Sediment Budget - Section 6.7.1.7

Although a detailed sediment budget analysis has been conducted for the Atlantic Ocean Shorefront Planning Reach, a sediment budget for Jamaica Bay Planning Reach has not been

developed. Impacts to the sediment budget, sediment distribution, flux to and between emergent and submerged habitats, and mobilization of contaminated sediments have not been analyzed. Impact analysis must include open barrier condition as well as impacts of having the barrier closed during storm events.

> Response: The Jamaica Bay storm surge barrier tie-ins on Rockaway Inlet presented in the Draft HSGRR/EIS is now within the scope of the NYNJHATS for further evaluation and potential recommendation. The NPS comments listed above regarding sediment budget will be addressed within the scope of NYNJHATS decision making.

Topography - Section 7.1.1.2

Impacts of floodwalls and seawalls on Rockaway Peninsula topography associated with aeolian and flood-induced transport of sediments is not evaluated.

> Response: The Jamaica Bay storm surge barrier floodwalls and seawalls on Rockaway Inlet presented in the Draft HSGRR/EIS are now within the scope of the NYNJHATS for further evaluation and potential recommendation. The NPS comments listed above regarding aeolian and flood-induced transport of sediments will be addressed within the scope of NYNJHATS decision making.

Sediments - 7.2.1.2

The existing Rockaway groin field has not had a beneficial impact on sediment transport to Riis Beach. Expansion of the groin field, as proposed in the Draft HSGRR/EIS, is expected to further exacerbate sediment deficits at Riis Beach. In addition to the existing long-term average sediment budget, event scale erosion rates, impact of structures on sediment budget, and contribution of overwash to dune development should be analyzed.

> Response: Please see description of Seven-Cell Sediment Budget in the Engineering Appendix. The sediment budget shows that Reaches 2, 3, and 5 (Riis Beach is located within Reach 2) have been relatively stable and have about the same net longshore sediment transport entering and leaving the cells.

Cultural Resources - Section 7.22

The Draft HSGRR/EIS states that "*A Programmatic Agreement will be executed to provide a process for continuing to identify historic properties and address effects to these historic properties caused by project elements as they are developed*." A Programmatic Agreement (PA) will outline the path forward for Section 106; however the PA does not substitute for the analysis of impacts necessary to fulfill the requirements of NEPA. The Draft HSGRR/EIS considers direct physical impact to historic structures but does not evaluate impacts to other aspects of integrity such as association, feeling, setting, etc. All aspects of integrity should be evaluated for each Historic District within the project area. View sheds are noted; however, no detailed analysis of impacts on viewsheds is provided.

> Response: Agree that a rendering of the proposed barrier would need to be included to further assess the barrier's aesthetic impacts to a site-specific level to assess aspects such as association, feeling, setting, etc. The Jamaica Bay storm surge barrier is no longer part of the Recommended Plan for this study and will be further evaluated under the NYNJHATS study.

Impacts Common to Both Action Alternatives - Section 7.12.1

The Draft HSGRR/EIS concludes that "Beneficial short- and long-term direct impacts on special management areas...include: NPS Gateway National Recreation Area (Portions of Fort Tilden and Jacob Riis Park, Breezy Point, Plumb Beach). NPS finds that overall the impact analysis is insufficient to support that conclusion.

> Response: The statement regarding beneficial short- and long-term impacts to Jacob Riis Park and Breezy point will be re-evaluated as part of the current study. The determination of beneficial short- and long-term direct impacts to the GATE and Plumb Beach will be evaluated as part of the NYNJHATS.

Proposed Action Impacts - Section 7.12.2

The Draft HSGRR/DEIS concludes that "Beneficial short- and long-term direct impacts on special management areas are anticipated from implementation of the unique elements of the Proposed Action. Additional special management areas protected by the unique elements of the Proposed Action include: NPS Gateway National Recreation Area (Floyd Bennett Field)". NPS finds that overall the impact analysis is insufficient to support that conclusion.

> Response: The determination of beneficial short- and long-term direct impacts to the GATE and Floyd Bennett Field will be evaluated as part of the NYNJHATS.

Impacts Common to Both Action Alternatives - Section 7.15.1

The Draft HSGRR/EIS concludes that "Beneficial long-term direct impacts on recreation would be realized by implementation of the common project elements. Long term benefits to recreational resources described in Section 2.3.15 Cultural Resources generally result from: Protection of parks (NPS, NYC, NYSDEC) throughout the study area." NPS finds that overall the impact analysis is insufficient to support that conclusion.

> Response: The reference to cultural resources in HSGRR/EIS Section 7.15.1 is incorrect. The statement will be revised to read: Long-term benefits to recreational resources generally result from: Protection of parks (NPS, NYC, NYSDEC) throughout the study area.

Proposed Action Impacts - Section 7.15.2

The Draft HSGRR/EIS concludes that "Additional beneficial short- and long-term direct impacts on recreation would be realized from implementation of the additional shore protection actions unique to the Proposed Action. In particular, the portions of Gateway National Recreation Area on Floyd Bennett Field would be protected by the Storm Surge Barrier alternative, but not protected by implementation of the Action Alternative." NPS finds that overall the impact analysis is insufficient to support that conclusion.

> Response: The determination of beneficial short- and long-term direct impacts to recreation associated with the GATE and Floyd Bennett Field will be evaluated as part of the NYNJHATS.

Hazardous, Toxic, and Radioactive Waste - Section 7.20

Impacts on legacy hazardous, toxic and radioactive wastes within the project area have not been sufficiently evaluated. Construction of project elements may contribute to accelerated erosion of legacy landfills in areas such as Dead Horse Bay and/or bay bottom due to changes in

hydrodynamics and/or reflection of storm surge. A thorough analysis of potential impacts needs to be included in the plan.

Furthermore, NPS will need to be released from contamination liability incurred as a result of ground-disturbing activities associated with project construction, as well as long-term impacts of the project on the nature, exposure or effects of resident contaminants.

> Response: HTRW sites for the Atlantic Shoreline and Jamaica Bay components are identified and mapped in Section 4.15 of the Environmental Appendix. Impacts on legacy HTRW sites in the Jamaica Bay portion of the study area relative to the Jamaica Bay storm surge barrier will be evaluated as part of NYNJHATS. Any impacts relative to the high frequency flooding risk reduction features being developed as part of the TSP will be evaluated in the revised Draft HSGRR/EIS. Regarding HTRW sites located within the Atlantic Shorefront portion of the study area, project alignments will specifically avoid impinging on those sites as plans are drafted in the planning, engineering, and construction phase. As stated in Section 8.1 of the HSGRR/EIS, the non-federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA.

Landfills - Section 7.21

Impacts of the project on the Dead Horse Bay, a former New York City landfill, have not been evaluated. Location of the line of protection east of this landfill may increase erosion during storm events, resulting in the potential exposure of wastes or leaching of waste material into the environment.

> Response: The project alignment adjacent to Dead Horse Bay is part of the Jamaica Bay storm surge barrier, which has been removed from the recommended plan. Impacts to the former landfill will be evaluated as part of the NYNJHATS.

Aesthetics - Section 7.24

The Draft HSGRR/EIS concludes that "Beneficial long-term direct impacts on aesthetics would be realized by implementation of the common project elements." NPS does not find this conclusion consistent with the "Long-term direct impacts would include viewshed disruption for some key observation points, which would be impacted by the presence of lift gates, sector gates, floodwalls and berms" as well as impacts to Historic Districts and recreational opportunities that have not been evaluated in the plan.

> Response: A rendering of the proposed barrier would need to be included in the analysis to further assess the barrier's aesthetic impacts to a site-specific level. However, the storm surge barrier is no longer part of the Recommended Plan. The potential impacts to aesthetics will be analyzed and discussed for the features of the recommended plan in the revised draft final GRR/EIS.

Cumulative Impacts - Section 7.25

Cumulative impacts section does not include any of the on-going or planned NPS Jamaica Bay Unit Sandy Recovery projects or the Breezy Point Federal Emergency Management funded storm damage risk reduction project.

Response: Cumulative effects of the on-going or planned NPS Jamaica Bay Unit Sandy Recovery projects or the Breezy Point Federal Emergency Management funded storm damage risk reduction project are no longer part of the HSGRR/EIS, as the Jamaica Bay storm surge barrier has been moved to the NYNJHATS. Those cumulative effects listed in the NPS comment will be included in the cumulative effects discussion of the NYNJHATS.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Planning Division

July 20, 2018

Mr. Andrew L Raddant
United States Department of the Interior
Office of Environmental Policy and Compliance
15 State Street, Suite 400
Boston, Massachusetts 02109-3572

Subject: Responses to Comments on the Draft General Reevaluation Report / Environmental Impact Statement (GRR/EIS) for the East Rockaway Inlet to Rockaway Inlet Hurricane Sandy Reformulation Study

Dear Mr. Raddant:

The U.S. Army Corps of Engineers (USACE), New York District (District) is in receipt of your letter, dated 1 December 2016, submitting comments on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS).

As a result of the significance (extent and content) of partner, agency and public comments received on the proposed project, as well as the feedback to the District resulting from the concurrent policy and technical review that was conducted by USACE Headquarters (HQUSACE), the District, in coordination with New York State Department of Environmental Conservation (NYSDEC) as our non-federal Sponsor, has determined that sufficient revision to the draft report is required in order to proceed to a final decision document.

The Agency Decision Milestone (ADM) resulted in the decision to move all further evaluation of the proposed storm surge barrier measure within Jamaica Bay, a significant component of the Tentatively Selected Plan (TSP), to the ongoing New York and New Jersey Harbor and Tributaries (NYNJHATs) Feasibility Study (NYSDEC and NJDEP are the non-federal sponsors, with the partnership of New York City). The NYNJHATs Study was initiated in the Summer of 2016 around the same time as the release of the Rockaway Reformulation Draft GRR/EIS. The NYNJHATs Study is evaluating large-scale regional coastal storm risk management (CSRM) strategies for the New York/New Jersey metropolitan area (which includes Jamaica Bay) extending upstream of the Hudson River to the federal lock and dam at Troy, New York, the Passaic River to the Dundee Dam, and the Hackensack River to the Oradell Dam. The NYNJHATs study is evaluating a suite of storm surge barriers, including one alignment from Breezy Point to Sandy Hook that would obviate the need for the proposed Jamaica Bay barrier. Therefore, from a plan formulation perspective, it makes sense to evaluate

the storm surge barrier, previously a component of the Rockaway Reformulation, in this newer regional study instead.

Moving the barrier component to the NYNJHATs Study has other strategic advantages as well. Namely, that more analysis is needed and that the required analysis should not delay construction of the more readily implementable Atlantic Shorefront and 'Residual Risk' measures in Jamaica Bay. Part of why more environmental analysis was deemed necessary for the barrier component is that the level of detail available to date was still largely conceptual.

The Project Delivery Team has been working with to further refine and develop the 'Residual Risk' measures in the Back-Bay, now termed *high frequency flooding risk reduction features* (HFFRRFs), in order to bring them up to full feasibility level of design and environmental analysis, and to include natural and nature-based features, as well as areas outside of New York City in Nassau County.

Thank you for the continued assistance and input to this process which helps to advance the execution of this regionally-significant project. Points of contact for the study are Planner and Biologist, Daria Mazey, at 917-790-8726 or the Project Manager, Dan Falt, at 917-790-8614.

Sincerely,

Clifford S. Jones III
Chief, Planning Division

Enclosure

cc: Stilwell; USFWS-NYFO
Sinkevich; USFWS-LIFO
Nersesian; NPS-GATE

Pertinent Text and Responses to Comment Letter

Lack of Best Available Information for Existing Conditions/Resources
Aquatic and Terrestrial Habitats

The GRR/EIS provides a description of twelve habitat types that have been identified and mapped within the project site. These habitat types are discussed generally with little or no discussion of the functionality, prevalence or distribution of these habitats.

> Response: Section 2.3.7 Biological Communities in the Study Area identify and describe 10 different distinct aquatic and terrestrial habitats in the study area. Additional content will be added to the Revised Draft EIS to provide data indicating the extent and general locations of the habitat types within the landscape to provide the reader context to understand the extent and relative importance of the respective habitat types within the project area. In addition, Section 7.6, Environmental Consequences to the Aquatic and Terrestrial Environments erroneously referred to Section 2.3.8 Aquatic and Terrestrial Habitats, which does not exist in the DEIS. For the Revised Draft HSGRR/EIS, Section 7.6 will appropriately refer to Section 2.3.7 within the discussion of the effects to the different habitat types.

Avian

The Corps provides a description of the avian species that are known or are likely to occur within the project area within Chapter 2 and Appendix I. The information provided by the Corps is general, and to some extent incomplete and/or outdated. The Corps relied on U.S. Army Corps of Engineers 1998, 2003 and U.S. Fish and Wildlife Service 1992 to describe common species found within the project area. A table (Table 4.8-2, page 4-59 of Appendix I) is provided identifying migratory bird species of conservation concern that may be found breeding, foraging or migrating through the project area. Site specific information is available from New York City Urban Park Rangers, Breezy Point Co-Op/U.S. Fish and Wildlife Service, National Park Service, and New York City Audubon regarding breeding shorebirds and wading birds and was provided to the Corps in the Service's PAL.

In terms of specific information the Corps provided regarding breeding birds, data is limited to piping plover. The Corps provided data from 1998 to 2000 within Appendix I and from 2014 within the GRR/EIS. The piping plover is not the only breeding bird within the project area. Surveys conducted in 2016 documented least tern, common tern, American oystercatcher and black skimmers breeding along the Atlantic Coast of Rockaway Peninsula. In addition to being outdated, the information provided by the Corps is limited to the eastern portion (Sub-reaches 3-6 of the Atlantic Ocean Shorefront Planning Reach) of the peninsula and does not provide breeding data for the Breezy Point Co-Op or the National Park Service (sub-reaches 1 and 2) nor does it address recent changes to the nesting distribution of black skimmers, a New York State Species of Special Concern.

Surveys conducted by New York City Audubon, documented numerous breeding bird species within Jamaica Bay, including: black-crowned night heron (*Nycticorax nycticorax*), great egret (*Ardea alba*), snowy egret (*Egretta thula*), glossy ibis (*Plegadis falcinellus*), little blue heron (*Egretta caerulea*), and tricolored heron (*Egretta tricolor*) (Winston 2015).

> Response: As part of the existing conditions that will be updated for the Revised Draft HSGRR/EIS, the District will reference use the more recent data provided in the

Service's Planning Aid Letter and the forthcoming Draft Fish and Wildlife Coordination Act Report is to assure equal consideration and coordination of fish and wildlife resources.

Inter-jurisdictional Fish

The Corps provides a general list of finfish species which may be present within the project area with a citation for Woodhead (1992). Additional references used to describe finfish include USFWS 1989, 1995, 1997, Waldman 2008 and USACE 1995, 2009 but are not provided within the References list. While information provided by documents/reports dated from 1997 and earlier may still be relevant, the list of species generated from this reference is at least 19 years old and should not be used solely to describe the finfish present within the project area. Additionally, information regarding the seasonal distribution and abundance for these species is not provided.

Response: Content of the Revised Draft HSGRR/EIS will be updated to provide the cited primary references as the source used to characterize the finfish species within the project area. A general discussion of the seasonal patterns of species utilization of the project area will also be included.

Threatened and Endangered Species

Within the GRR, the Corps provided a description of the Federal and State listed species which may occur within the project area. Comments regarding federally-listed species will be addressed in a separate correspondence in response to the Corps' Biological Assessment in Appendix J.

Response: The District will be revising the Biological Assessment to reflect the changed project conditions within the Revised Draft HSGRR/EIS. Species to be consulted on include the red knot, seabeach amaranth and the piping plover.

Additional Terrestrial and Aquatic Species

Information regarding species like the diamondback terrapin and horseshoe crab are discussed generally with the exception of a discussion on page 4-91 and 4-92 of Appendix I regarding the abandonment of Plumb Beach as a horseshoe crab spawning site. The Corps states: "Unfortunately, horse crab populations are becoming severely threatened throughout the region. A move in the early 1990s to replenish sand to Plumb Beach severely disrupted the habitat conditions for the horseshoe crabs, and they abandoned use of the beach." Although the Environmental Appendix of the Draft GRR/EIS states that horseshoe crabs no longer spawn at Plum Beach, spawning has been documented in the eastern limits of Plumb Beach, from just west of the comfort station to the eastern limit of the beach as the shoreline turns into Plumb Beach Channel as recently as 2013, the most recent data available (Sclafani et al. 2014). Distribution of spawning data collected since 2010 indicates that Plum Beach had a total crabs/square meter value of 6 in 2011 (peak on May 30), 5 in 2012 (peak on May 20), and 7 in 2013 (peak on May 10) (Sclafani et al. 2014).

Response: Discussion of the horseshoe crab utilization of Plumb Beach for spawning will be updated with the cited information and the Sclafani et al. (2014) cite will be added to the list of references.

ENVIRONMENTAL CONSEQUENCES (Chapter 7)
Lack of Best Available Information

As discussed above, the Service finds that the GRR/EIS lacks best available information to describe the existing conditions of terrestrial and aquatic habitats and fish and wildlife resources. This information is needed in order to adequately evaluate the environmental impacts of the proposed alternatives. Additionally, the Corps' impact analysis and conclusions are not supported by the best available information. The Service recommends that the Corps conduct a comprehensive evaluation of the with/without project impacts based on current, quantitative data regarding the existing conditions.

> Response: The District will reference and use the more recent data provided in the Service's Planning Aid Letter and the forthcoming Draft Fish and Wildlife Coordination Act Report is to assure equal consideration and coordination of fish and wildlife resources.

Project Impact Analysis

Table 6-4 of the GRR (page 130 of GRR/EIS) lists the permanent and temporary habitat impacts of the TSP (Tentatively Selected Plan), the totals (129.7 acres of temporary and 128.9 acres of permanent) of which do not match with the 154 acre loss of habitat described in the text on the same page. The Service requests clarification of the total loss of habitat forecasted to result from the TSP.

The GRR references ecological modeling (page 139 of GRR/EIS) without providing a description of each of the models and how results are derived. The Service requests a description of the Benthic Index of Biotic Integrity and Evaluation of Planned Wetlands ecological modeling.

As discussed below, under the heading *Additional Concerns and Comments on the GRR/EIS,* the Service has identified numerous occasions where the Corps states that they will complete additional studies or modeling in order to determine potential impacts.

> Response: The acreage totals for the areas of impact will be reviewed and revised to ensure consistency (129.7 acres of temporary and 128.9 acres of permanent vs 154 acre loss reported elsewhere). The text of the Revised Draft HSGRR/EIS on pg. 139 will be revised to reference where the "description of each of the models and how results are derived" is addressed in the appendices. In addition, the Corps will identify all of the "additional studies or modeling" described in the EIS and include them in the Adaptive Management Plan.

MITIGATION

The Service requests detailed descriptions/plans/conceptual drawings of the four mitigation projects, Dead Horse Bay, Duck Point, Floyd Bennett Field and Elders Island, referenced in GRR (page 101). No description was provided for these projects. Additionally, if these projects were authorized and/or funded from sources other than this project (such as the Hudson Raritan Estuary Program) and are currently or planned to be implemented independent of this project, the Service questions the validity of attempting to claim credit for the benefits of these projects as
part of the ERIRIJB.

Response: The mitigation projects referenced above were considered as potential mitigation sites and if they were to be constructed as mitigation would be removed from the Hudson Raritan Estuary Ecosystem Restoration Study. The section on mitigation needs has been updated in the Revised Draft HSGRR/EIS to reflect the revised proposed action. The appropriate functional assessment methodologies have been used to evaluate and determine any required mitigation resulting from the Recommended Plan. Since the *high frequency flooding risk reduction features* (HFFRRFs) in the Back-Bay include four areas with natural and nature-based features (NNBFs), the plan is currently assumed to be self-mitigating. The NNBFs for the Back-Bay include creation/restoration of intertidal wetlands, maritime forest, and intertidal rocky habitat with oyster and ribbed mussel incorporation. The shorefront plan includes a vegetated dune with a seawall core that will remain buried, and periodic beach renourishment, as well as some groin rehabilitation and construction.

ADDITIONAL CONCERNS AND COMMENTS ON THE GRR/EIS
Coastal Processes

The Corps stresses throughout the GRR the significance of overtopping of the Rockaway peninsula and Coney Island as a source of flooding into Jamaica Bay. The Service requests a clarification/justification/data to support this position.

Response: Clarification will be provided in the revision by the addition of historic data on the relative contribution of overtopping flooding from the Rockaway Peninsula and Coney Island into Jamaica Bay.

Lack of Clarity on Project Description

Throughout the GRR/EIS the Corps refers to the project as a whole or refers to the two reaches: Jamaica Bay Planning Reach and the Atlantic Ocean Shoreline. The majority of references are made to sub-reaches 3 - 6 of the Atlantic Ocean Shoreline Reach and do not include sub-reaches 1 and 2. This was observed throughout the document including the description of the existing conditions.

Response: The completeness of the discussion of each of the six Atlantic Ocean Planning Reaches will be addressed comprehensively as a result of the splitting of the Jamaica Bay Planning Reach from the Atlantic Ocean Shoreline Reach in the subsequent EISs. The storm surge barrier feature (Jamaica Bay component) is now being studied under the New York and New Jersey Harbor and Tributaries Study (NYNJHATS). The remaining components are moving forward under the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay subject line study.

The Corps discusses separable elements in chapter 6.1.2, which are defined as “any part of a project which has separately assigned benefits and costs, and which can be implemented as a separate action (at a later date or as a separate project). The Corps identified two separable elements: the Coastal Storm Risk Management (CSRM) plan for the Atlantic Ocean Shoreline and the CSRM for the residual risk features. As such, the Corps states that they may consider a phased NEPA decision process. The Service assumes that some omission of reaches 1 and 2 is a result of the separable elements discussed in Chapter 6. However, the Service recommends that the Corps clearly identify what the proposed project is in its entirety and provide a comprehensive discussion of the existing conditions and resources found within the

project area. The Service also recommends that the Corps provide the Service with a description of how this would work from a procedural standpoint and to ensure that segmentation does not occur.

> Response: The completeness of the discussion of each of the six Atlantic Ocean Planning Reaches will be addressed comprehensively as a result of the splitting of the Jamaica Bay Planning Reach from the Atlantic Ocean Shoreline Reach. The Jamaica Bay Planning Reach will be included in the Corps' ongoing New York and New Jersey harbor and tributaries CSRM study with each of these project areas evaluated in separate EISs. Taking this approach will allow the Corps to separate the Atlantic Ocean Shoreline decisions that are ripe for decision making from the Jamaica Bay Planning Reach decisions.

Future Studies

The Corps has identified a number of studies that need to be completed before the Final GRR/EIS or during PED. The Service is concerned that the Final GRR/EIS will include a large amount of information/data and project design details that the public and regulatory agencies will not have the opportunity to comment on and assess. We request that the public and regulatory agencies be given the opportunity to review and assess the “Final” GRR/EIS prior to it being actually finalized. Additionally, the Service requests coordination meetings to allow Service input as the project design is further developed which will also assist the Service in better understanding what is being proposed.

> Response: To reflect the revised TSP, the District is preparing a revised Draft HSGRR/EIS which will be available for Service review and comment. Coordination on such has been initiated.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Planning Division

March 30, 2018

Mr. Matt Chlebus
New York State Department of
Environmental Conservation
Bureau of Flood Protection and Dam Safety
Coastal Erosion Management
625 Broadway
Albany, New York 12233-3504

Subject: Responses to New York State (NYS) and New York City (NYC) Comments on the Draft General Reevaluation Report / Environmental Impact Statement (GRR/EIS) for the East Rockaway Inlet to Rockaway Inlet Hurricane Sandy Reformulation Study

Dear Mr. Chlebus:

The U.S. Army Corps of Engineers (USACE), New York District (District) is in receipt of your letter, dated 14 December 2016, submitting comments on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS).

As a result of the significance (extent and content) of partner, agency and public comments received on the proposed project, as well as the feedback to the District resulting from the concurrent policy and technical review that was conducted by USACE Headquarters (HQUSACE), the District, in coordination with New York State Department of Environmental Conservation (NYSDEC) as our non-federal Sponsor, has determined that sufficient revision to the draft report is required in order to proceed to a final decision document.

As NYSDEC is aware, the Agency Decision Milestone (ADM) resulted in the decision to move all further evaluation of the proposed storm surge barrier measure within Jamaica Bay, a significant component of the Tentatively Selected Plan (TSP), to the ongoing New York and New Jersey Harbor and Tributaries (NYNJHATs) Feasibility Study (NYSDEC is also the non-federal sponsor, with the partnership of New York City). The NYNJ HATs Study was initiated in the Summer of 2016 around the same time as the release of the Rockaway Reformulation Draft GRR/EIS. The NYNJHATs Study is evaluating large-scale regional coastal storm risk management (CSRM) strategies for the New York metropolitan area (which included Jamaica Bay) extending upstream of the Hudson River to the federal lock and dam at Troy, New York, the Passaic River to the Dundee Dam, and the Hackensack River to the Oradell Dam. The NYNJHATs study is evaluating a suite of storm surge barriers, including one alignment from Breezy

Point to Sandy Hook that would obviate the need for the proposed Jamaica Bay barrier. Therefore, from a plan formulation perspective, it makes sense to evaluate the storm surge barrier, previously a component of the Rockaway Reformulation, in this newer regional study instead.

Moving the barrier component to the NYNJHATs Study also addresses concerns that more analysis is needed and that the required analysis should not delay construction of the more readily implementable Atlantic Shorefront and 'Residual Risk' measures in Jamaica Bay. Part of why more environmental analysis was deemed necessary for the barrier component is that the level of detail available to date was still largely conceptual.

To be responsive to NYS and NYC comments and concerns, the District has agreed to expedite the construction schedule of the least complicated elements of the Recommended Plan by initiating the development of plans and specifications (P&S) early, in conjunction with the end of the Feasibility Study.

Finally, the Project Delivery Team has been working with your agency, NYC, and the National Parks Service (as Cooperating Agency), to further refine and develop the 'Residual Risk' measures in the Back-Bay, now termed *high frequency flooding risk reduction features* (HFFRRFs), in order to bring them up to full feasibility level of design and environmental analysis, and to include natural and nature-based features, as well as areas outside of NYC in Nassau County.

Thank you for the continued partnership, assistance, and input to this process which helps to advance the execution of this regionally-significant project. Points of contact for the study are Planner and Biologist, Daria Mazey, at 917-790-8726 or the Project Manager, Dan Falt, at 917-790-8614.

Sincerely,

Cliff Jones
Chief, Planning Division

Enclosure

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water, Bureau of Flood Protection and Dam Safety
625 Broadway, Albany, New York 12233-3504
P: (518) 402-8185 | F: (518) 402-9029
www.dec.ny.gov

New York State Department of Environmental Conservation Comments on the Draft East Rockaway Inlet to Rockaway Inlet and Jamaica Bay HSGRR, EIS, and associated appendices, dated August 2016

General Comments

The Rockaway Project can be viewed as three separate components, all in different stages of development. The Atlantic Shoreline component, the Jamaica Bay component, and the Residual Risk component. In general, the Department supports the Atlantic Shoreline and Residual Risk components, however additional modeling and analysis are required to further refine the Jamaica Bay component. While the Corps has committed to conducting this additional water quality and engineering modeling/analysis prior to construction, the Department believes that there needs to be flexibility in the final selection of an alternative/alignment for the Jamaica Bay component. This analysis should be conducted in a manner that does not preclude the Atlantic Shoreline portion of the Project from moving forward.

The Department does not believe that the information in the Report provides sufficient detail or analysis for the selection of a final storm surge barrier alignment. In addition to barrier alignments C1-E and C-2, the Department asks that the Corps also evaluate other potential alignments, as far west as possible, that could eliminate the need for some of the tie-in features. Impacts to water quality, fish and wildlife species and their habitats in Jamaica Bay resulting from the installation and operation of the storm surge barrier proposed in the Report will continue to be an area of concern for the Department. Modeling and analysis to adequately identify, quantify and conclusively address any possible impacts needs to be conducted.

The Department supports splitting off the Atlantic Shoreline and Residual Risk components of the Project as soon as possible and moving them forward to construction in an expeditious fashion, and therefore suggests that the Corps include language in the Report clarifying that the final surge barrier alignment and associated tie-in features will be finalized during the Pre-construction Engineering and Design Phase (PED), and after additional analysis and modeling has been completed.

If a surge barrier alignment must be identified prior to the Report being finalized, the Department recommends that language be included in the final report to allow for flexibility in the final alignment based on the results of additional analysis during PED.

Response: Concur. This has been done and will be presented in a revised Draft General Reevaluation Report (GRR)/Environmental Impact Statement (EIS). The storm surge barrier feature (Jamaica Bay component) is now being evaluated under the New York and New Jersey Harbor and Tributaries Study (NYNJHATS) as a potential CSRM measure for the Jamaica Bay area. The remaining components are moving forward under the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay subject line study.

During the alternatives screening process the alignments west of C-2 were screened out because they were found to be less cost effective than the other alignments (i.e. not the NED plan). Alignment C-1W was screened out because it would have produced too much scour on the Gil Hodges Bridge, by the PDT's estimations. Further screening was done to differentiate between C-1E and C-2. The Corps believes that alignment C-1E is the NED alignment not only because it provides the greatest net benefits compared to other alignments and the perimeter plan (granted C-2 alignment is close to C-1E in terms of net benefits), but also due to the following factors:

- The costs for C-1E include far less uncertainty that the costs for C-2. There is no need for submerged cable and sewer line relocations for alignment C-1E. Relocating submerged utilities is a risky and uncertain endeavor and costs can quickly balloon if there is a puncture to the utility lines or unknown materials are found during excavation, such as unexploded ordinances, additional unknown utilities, submerged sea wrecks previously unknown, etc. Furthermore there is a risk of puncturing sewer lines during transfer and impacts to water quality during construction, especially if there is a spill.
- Although the real estate costs for alignment C-2 are lower than real estate costs for C-1E (Table 11), real estate costs do not account for the severe impact to water views that are imposed on a Breezy Point neighborhood by alignment C-2 (Figure 5-11), which are likely to increase real estate cost estimates at a later stage in the project were C-2 to be pursued. Many Breezy Point residents have expressed strong opposition to any impairment of their view which increases the risk of real estate costs increasing for alignment C-2. The Storm Surge Barrier Plan alignment C-1E is nearly one-half mile away from residential structures on the Rockaway peninsula and does not carry this same risk.
- Alignment C-1E provides flexibility in the determination of whether to include and to what extent to include Breezy Point and Jacob Riis Park into the project. The Rockaway peninsula terminus of alignment C-2 cannot be removed from Breezy Point in a cost effective manner. In other words, alignment C-2 requires the inclusion of and impacts to Breezy Point. The Rockaway terminus of alignment C-1E is approximately one-half mile from Breezy Point. There are numerous potential configurations of the Rockaway Bayside and the Rockaway Shorefront CSRM units that can provide alternative levels of CSRM at Breezy Point.

The evaluation and comparison of Jamaica Bay storm surge barrier alignments will be described in more detail in the revised Draft Final GRR/EIS. However, any additional modeling and analysis pertaining to the proposed Jamaica Bay storm surge barrier will be considered under the NYNJHATS study.

The Department also recommends that the Corps use the ADM as an opportunity to determine how the Atlantic Shoreline and Residual Risk components can be split from the Jamaica Bay and associated tie-in components to ensure that there are no delays to the Atlantic Shoreline component while the necessary analysis associated with the surge barrier and its tie-ins is conducted.

Response: As a result of the ADM, the barrier will be considered for further evaluation and potential recommendation under the NYNJHATS study, an option that NY DEC supported.

Impacts to water quality, fish and wildlife species and their habitats in Jamaica Bay as a result of the installation and operation of the storm surge barrier with a design as presented in this Draft HSGRR/EIS, will continue to be an area of concern with the NYS DEC, NYC ORR, NYC DEP and the NYS DOS. Modeling and analysis to adequately identify, quantify and conclusively

address any possible impacts will need to be conducted prior to the release of the Final HSGRR/EIS and/or prior to the final design of the storm surge barrier. The results of this modeling and analysis effort should be included in the Final HSGRR/EIS to better inform the public of any potential impacts to the Bay.

Response: Substantial water quality modeling has been done to analyze a range of potential impacts up to the worst case scenario for water quality impacts of a barrier in Jamaica Bay. Many of the specific comments and concerns regarding the perceived shortcomings of this modeling have been addressed in both the comment responses to NYS DOS, as well as a revised write-up describing the Jamaica Bay Eutrophication Model (JEM) that was used to analyze potential water quality impacts. The revised write-up is more detailed and explains how most of what was requested for modeling was already performed using the JEM model.

Any additional analyses pertaining to the storm surge barrier, inclusive of impacts to fish, wildlife and their habitats, will be considered under the NYNJHATS study, and is subject to that study's authorization and appropriation.

A section view, image, or artistic rendering of the vertical lift gates to illustrate the water view impacts from the storm surge barrier should be included in the Final HSGRR/EIS. A rendition showing a person on the ground and the approx. height of the gates (~50 feet) in the open position would provide the public with more of an illustration on how the proposed storm surge barrier alignments (both C-1E and C-2) would impact water views.

Response: Any rendering of the storm surge barrier and vertical lift gates will be included in the NYNJHATS study, as well as photographs of other existing storm surge barriers around the world.

Discussion of the current scarping and dune erosion issues in the in the Belle Harbor/Neponsit area should be addressed and included in the main report of the Final HSGRR/EIS and/or Appendix A1 – Rockaway, Atlantic Ocean Shoreline Engineering Appendix. Discussion of whether a re-evaluation of groin placement, number and/or size and the significance of the erosion to the overall sediment budget (Chapter 6 of Engineering Appendix) should be included.

Response: Groin field design will be confirmed and optimized during the PED phase via modeling with the two-dimensional USACE certified CMS model, which will be used to simulate the downdrift shoreline morphological response to the new proposed groin structures. Optimization adjustments may include modifications to the spacing and length of groins, tapering additional groins, or extending tapered groins westward, if modeling indicates this is warranted.

The Rockaway peninsula east of Beach 9th Street contains one of the most densely populated concentrations in the study area and serves as a vital transportation and evacuation corridor. The 8-square-block section east of Beach 9th St. is home to over 2,000 people, including a significant number of seniors. High-rise apartments line East Rockaway Inlet between Beach 9th and Beach 6th Streets, protected from the ocean by only a small, aging bulkhead. During Superstorm Sandy, apartment lobbies experienced 10 feet of surge, knocking out mechanicals, electricity, water pumps and elevators, which resulted in residents being stranded on high floors for nearly two weeks. Flood waters also entered the area from the north and east via Bridge Creek and Bannister Bay, leaving Seagirt Boulevard and the Nassau Expressway (NYS Route 878), the Rockaway's single land-based evacuation route, impassable. Emergency access was

severely restricted. Street lighting along Rte. 878 was ruined and repair began only last week (November 2016). The low-lying residential area north of Seagirt Blvd. was also flooded for up to a half-mile inland. The Report should explore addressing shoreline protection from the proposed tie-in east to Beach 1st Street.

Response: Thank you for this information and description. It is valuable background and will be used to investigate whether federal action is feasible and economically justified under the Nassau County Back Bay Study, which is poised to better address the flood risk experienced by residents in this stretch. The proposed tie-in concept for the eastern end of the Atlantic Shorefront component of the Rockaway Reformulation Recommended Plan ends at Beach 9th Street (the blue line in below figure).

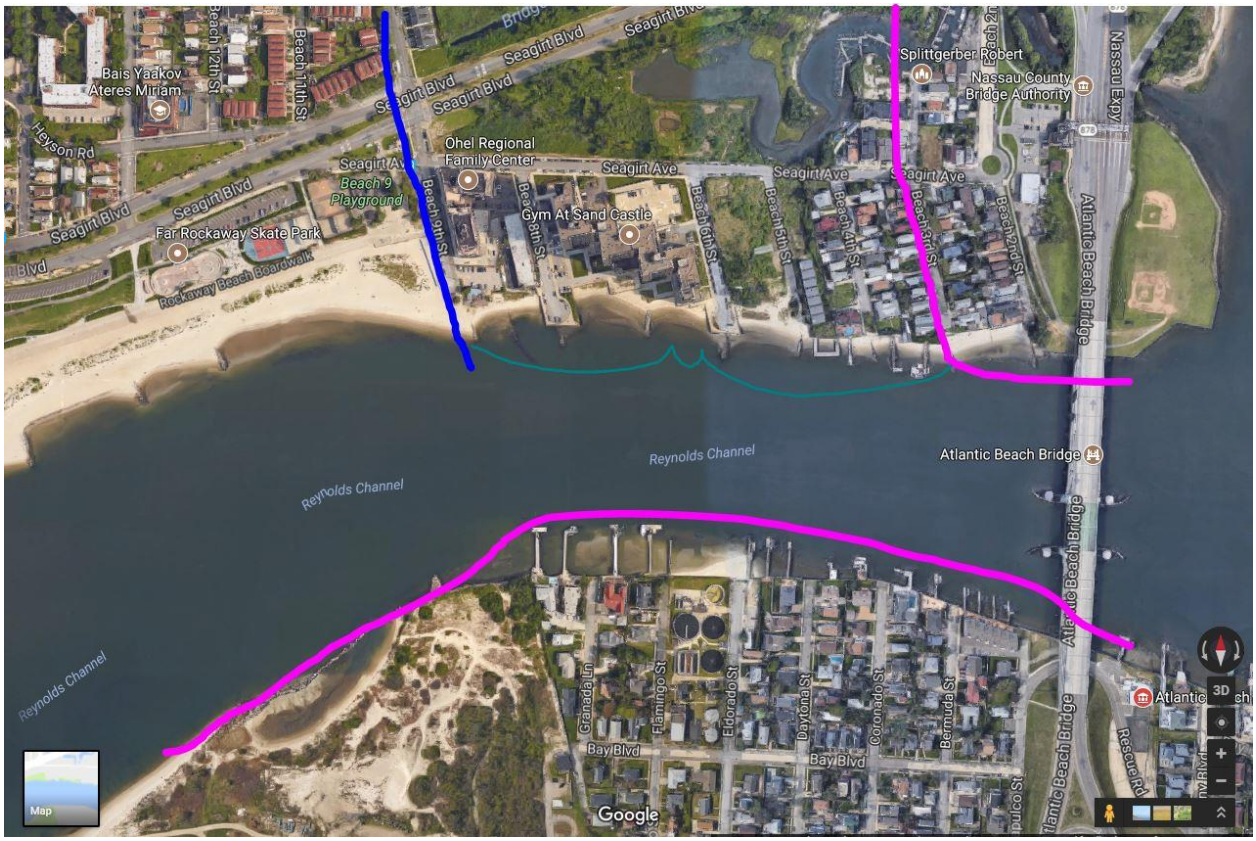


Figure 1. Rockaway Project Boundary and Tie-in*. The proposed project tie-in would end at Beach 9th (blue line) and the Nassau County Back-Bay (NCBB) study area goes to the pink line, but the .3 mile (1,585 feet) area between the projects (teal bracket) would be best addressed as a tie-in to the NCBB Study*

The .3 mile (roughly 1,585 linear feet) stretch between Beach 9th and Beach 3rd where the Nassau County Back-Bay (NCBB) focus area CSRM study begins (see pink lines in Figure 1). The NCBB study is analyzing, among other things, a potential storm surge barrier at or near the Atlantic Beach Bridge, just east of Beach 2nd Street at the inlet. Therefore, the gap area between Beach 9th and Beach 3rd would be considered under NCBB for a tie-in to the storm surge barrier, or would be protected by another proposed alignment for a storm surge barrier, which would be west of Beach 9th Street. The section between Beach 9th and 3rd gets really complex and is subject to flooding from both sides. Therefore, even if the Rockaway project were to tie-in all the way to Beach 3rd, the residents there would still be subject flooding from behind, north of their homes. Thus, this area is more appropriately addressed in the NCBB,

which is looking at the area north of this stretch as well. Additionally, from an engineering standpoint, the tie-in for Rockaway might be more appropriate north of here to high ground.

In order to proactively address the concerns of residents and businesses in this area, the planned public engagement for Rockaway will include discussion of this area and how it will be studied by NCBB, as well as include outreach to the elected representatives for this area in order to preemptively answer any questions and concerns. The team will coordinate with the NCBB study on this public outreach as well.

The Department supports the inclusion of the JEM modeling report as an Appendix to the HSGRR. It is the understanding of the Department that edits to the JEM model report based on USACE and Department comment are being undertaken by the City. These edits should be completed prior to the inclusion of the JEM Model Report in the HSGRR.

Response: Concur, edits to the JEM modeling report have been made. The report will be included in the revised Draft Final GRR/EIS as supporting information.

Mitigation

DEC considers the desktop ecosystem evaluation and EPW studies as preliminary and looks forwarding to reviewing a more detailed analysis based on actual site conditions and an evaluation of ecosystem services, types and functions.

Response: Concur, evaluation of mitigation requirements will be revised in the Draft Final integrated report for the features we are recommending for construction. Mitigation requirements will be based upon impacts to regulated habitats (i.e., water, wetlands), and utilize EPW field studies to further analyze impacts to wetland habitats in terms of ecosystem functions (i.e., functional habitat units). EPW-based analysis will be founded on field collected data, and existing site conditions. The Corps looks forward to sharing our functional habitat assessment of the Recommended Plan features with DEC.

DEC requests that the errors in the base FCU calculations be corrected and all tables, comparisons and conclusions be updated accordingly throughout the report.

Response: Concur, evaluation of mitigation requirements will be revised in the draft final integrated report as discussed above.

Jamaica Bay

More information based on the proposed location and design of the surge barrier is necessary before DEC can concur with the Corps' statements that the NED Plan will have only minor environmental impacts.

- Detailed environmental impact study showing effects by habitat type, elevation and geographic location is requested;

  Response: Concur, this analysis will be provided in the revised Draft Final GRR/EIS for the recommended plan. However, it is important to note the storm surge barrier component of this plan is being considered under the NYNJHATS study for further evaluation and potential recommendation.

- Further hydrology and hydrodynamic and water quality modeling is essential to assess

the impacts of the surge barrier and the tie-ins.

Response: Please see previous response regarding water quality modeling. Any future modeling for the storm surge barrier will be considered under the NYNJHATS study and is subject to the funding constraints of that study.

See comment for Appendix I, *Chapter 3: Summary Description of Analyzed Actions,* below for more detail on what the Department would like to see.

Residual Risk Features

Coordination with the Corps' and other agencies' proposed and in-process projects is advisable.

Response: The Corps, in close coordination with DEC and NYC, has begun coordinating with NYC DEP, DOT, and Parks, as well as NYS DOT.

Re-examination of proposed projects for opportunities to use green infrastructure rather than proposed hardened structures is requested.

Response: Where feasible, the Corps has and will continue to include green infrastructure interior drainage instead of pumps and natural and nature based features instead of gray infrastructure. All separable elements must be incrementally justified using CSRM benefits alone and drainage infrastructure improvements are subject to Corps planning policy and guidance.

Design based on current site conditions rather than historical wetland maps is requested to avoid and minimize impacts.

Concur. The alternative development will be evaluated in order to avoid or minimize impacts in that area. The Corps will continue to work closely with DEC on alignment considerations.

See comment for Appendix A3 Part 3 Rockaway Residual Risk plates, and Appendix S, Rockaway Freshwater Wetlands, for more detail.

Comments on the Rockaway Draft Integrated HSGRR and EIS

Page 55; Section 2.3.10 Water Quality, 1st paragraph: Paragraph indicates fecal coliform and E-coli data are from 1999 for the Atlantic Shorefront Reach. Is there any more recent data that can be used? Is it reasonable to assume and state that WQ is good when the geometric mean densities from 1989 through 1998 and reports from the NYC and Nassau Co. Public Health Departments from 1999 are referenced?

Response: Concur, more recent data on coliform and E-coli for the interior of Jamaica Bay is available and will be added to the Water Quality section of the report. Data covering 1997-2006 that was collected by the USEPA off Long Island will be incorporated into the analysis. The PDT will also be following up on data collected by the NYCDEP Harbor Survey. As necessary, the more recent data will be included in the revised Draft Final GRR/EIS.

Page 90; Section 5.2.1.3 Atlantic Ocean Reach Optimization: Paragraph between Table 5-5: Recommended Seawall Design Alternatives, and Figure 5-5: Dune and Berm Screening. The paragraph incorrectly references Figure 5-4 as the table that compares the costs and benefits of the beach restoration and dune alternatives. The correct figure should be Figure 5-5.

Response: Thank you, this will be corrected.

Page 101; Section 5.3.1 Habitat Impacts and Mitigation Requirements: First paragraph under Table 5-6 states that "Two mitigation projects, which have previously been identified as high priority restoration projects by the Hudson-Raritan Estuary Comprehensive Restoration Plan (HRECRP) have been selected as mitigation projects for the alternative CSRM plans." However, the text only refers to the Dead Horse Bay project. What other mitigation project is identified?

Response: Evaluation of mitigation requirements will be revised in the Draft Final GRR/EIS for the Recommended Plan. Mitigation requirements will be based upon impacts to regulated habitats (i.e., water, wetlands), and utilize EPW field studies to further analyze impacts to wetland habitats in terms of ecosystem functions (i.e., functional habitat units). EPW-based analysis will be founded on field collected data, and existing site conditions. It is important to note that the surge barrier will be further evaluated under the NYNJHATS study. In addition, the revised Draft Final GRR/EIS will include four nature-based features, i.e. living shorelines, as part of the recommended CSRM plan to address the high frequency flooding in the Back-Bay. Due to the positive benefit these will have on native habitats in providing intertidal wetlands that are valuable nursery habitats for many fish, the plan for these nature-based features is assumed at this time to be self-mitigating. This assumption will be further evaluated based upon EPW field studies, and addressed quantitatively in the Draft Final GRR/EIS for the Recommended Plan.

Page 106; Section 5.3.4 Alternative Plan Costs: In the paragraph after Table 5-10, the text states the "Mitigation costs were previously discussed in section 5.3.1 Habitat Impacts and Mitigation Requirements." However, there is no discussion of mitigation costs in section 5.3.1. The habitat impacted and the mitigation requirements for each Alternative were the only items discussed in Section 5.3.1. A discussion concerning mitigation costs should be included in Section 5.3.1 or the text in this paragraph should be changed to reflect this omission.

Response: Evaluation of mitigation requirements will be revised in the Draft GRR/EIS for the recommended plan. Mitigation requirements will be based upon impacts to regulated habitats (i.e., water, wetlands), and utilize EPW field studies to further analyze impacts to wetland habitats in terms of ecosystem functions (i.e., functional habitat units). As necessary, the Draft GRR/EIS will include a discussion of mitigation costs and referenced appropriately.

Page 110-111; Section 5.4.3 Recreation Benefits: The last paragraph on page 110 and the first paragraph on page 111 as written, make it difficult for the public to understand the methodology in computing the NED recreation benefits. One, the total number of beach visits should be discussed (7,738,500) and two, there should be more of an explanation on how the visits, corresponding costs and the final NED benefits were calculated so the public can get a better understanding.

Response: The discussion of how recreation benefits are incorporated into the evaluation will be revised for clearer understanding. It will incorporate more of the discussion from the Benefit Appendix and specifically reference the Recreation Analysis sub-Appendix.

Page 133; Section 6.3.2; 2nd paragraph: The second paragraph discusses the TSP (C- 1E) and the two large effluent sewer lines for the Coney Island WWTP. It states, "One barrier alignment crosses two large effluent sewer lines spanning between the Coney Island Wastewater Treatment Plant and the diffuser located in Rockaway Inlet." That one barrier alignment is C-2; which should be stated in the text.

Response: Concur, this change has been made. Thank you.

Page 138; Section 6.7.1.8; 2nd paragraph: The second paragraph incorrectly identifies the level of protection afforded by the residual risk features as .2% (500 year). This should be changed to 20% (5 year).

Response: Concur, this change has been made. Thank you.

Page 140; Section 6.8 Consistency with State and Federal Laws: The title of the section is Consistency with State and Federal Laws. However, the section discusses only applicable Federal laws. The section should discuss applicable New York State Environmental Laws or change the section title to, “Consistency with Federal Laws.”

Response: Concur. Section title will be revised to “Consistency with Federal Laws.”

Page 204; Section 7.25.3.1 Rockaway Boardwalk Reconstruction Project; Later in the 2nd paragraph the text states, "Between Beach 126th and Beach 149th Streets, the project includes providing structured access to the beach with stairs and ramps across the new dunes currently being constructed as part of the USACE beach renourishment project." However, the dunes and the renourishment project were completed in 2014. The last sentence states, “In addition, the project would maintain the five existing at-grade crossings through the existing dunes between Beach 9th and Beach 20th Streets.” However, the proposed project ends at Beach 19th street. This section should be updated with more accurate information and coordination with NYC Parks Department.

Response: Concur, this entire section will be updated to reflect the correct project descriptions and to indicate the timing that the boardwalk and FCCE dunes were completed.

Page 209; Section 7.25.6 Long-Term Combined Sewer Overflow (CSO) Projects; The second sentence states, “Water treatment plants are affected by heavy rain and snow storms when combined sewers receive higher than normal flows.” The word “Water” should be changed to Wastewater as a reference to wastewater treatment plants to avoid confusion with “drinking water” treatment plants.

Response: Concur, change has been made.

Page 226; Section 9.1 Public Involvement Activities: Paragraph three, second sentence states, “A Public Agency Council convened regularly to address Jamaica Bay issues of flooding, environmental quality and sustainability, and USACE.” Seems like something is missing in the sentence in the reference to USACE. Sentence should be re-written to clarify intent of the information.

Response: Thanks, this will be corrected to read: “The Public Agency Committee of the Science and Resilience Institute of Jamaica Bay convened quarterly meetings to address Jamaica Bay issues of flooding, environmental quality and sustainability, as well as to coordinate efforts between agencies. The purpose of the Public Agency Committee is to ensure all agencies are aware of each other's activities so as to not duplicate efforts, to share data and discuss priorities between agencies.”

Appendix A1 - Rockaway, Atlantic Ocean Shoreline Engineering Appendix

Chapter 6.0: Sediment Budget – See comment under General Comments regarding the current scarping and dune erosion on Rockaway Beach in Belle Harbor (Reach 3 of Sediment Budget).

See above response.

Appendix A2 - Rockaway, Jamaica Bay Planning Reach Engineering Appendix

Regarding the Coney Island Tie-in measures; on page 86 of the Jamaica Bay Engineering Appendix, the text states, "The alignment is assumed to extend west from Corbin Place with reinforced dunes along Coney Island Beach to West 37th Street and continuing the dunes as the alignment wraps around Sea Gate. Hybrid levees and floodwalls are envisioned to be integrated into Kaiser Park and Six Diamonds Park, with an in-water, non-navigable floodgate recommended near West 21st Street. Floodwalls would then follow the Belt Parkway towards high ground, which is found at Bensonhurst Park." "Preliminary costs for these CSRM measures total $410 million, accounting for CSRM measures along the entire alignment."

- Based on the proposed alignment, was there consideration given to the aesthetic value (e.g., impact on view shed) and socio-economic impacts to Coney Island Beach? What is the design height of the proposed reinforced dune?

- How will the final constructed Sea Gate project affect the proposed measures?

- These proposed measures should be shown on representative figures in the Final HSGRR/EIS for public understanding.

- Table 36: Comparison of CSRM Alternatives, (pages 89-92) does not reflect the same construction and annual O&M costs compared to Table 5-17 (page 113) of the main report. Which table and corresponding costs are correct? Why is there such a large discrepancy between the two?

Response: The Coney Island tie-in is part of the proposed barrier feature which is no longer being studied or recommended as a part of this study. The details on the Coney Island tie-in will be removed from the revised GRR/EIS. These comments will be shared with the NYNJHATS project delivery team, which is now responsible for evaluating the proposed Jamaica Bay barrier and tie-ins.

Appendix A3 Part 1 Atlantic Ocean Reach Plates and Sections

The groin field plates do not reflect a tapered design as previously proposed. DEC requests that western groins be shortened and lowered to avoid destruction of the beach leeward of the final proposed groin, currently at Beach 121st St. as well as to reduce environmental impacts.

Response: As shown in the plates, the westernmost groin is shortened, providing a minimal taper. This taper design will be optimized during the PED phase via modeling with the two-dimensional USACE certified CMS model, which will be used to simulate the downdrift shoreline morphological response to the new proposed groin field. Optimization adjustments may include tapering additional groins, or extending tapered groins westward, if modeling indicates this is warranted.

The plans do not indicate how the sheetpile and rock revetment will allow access through the corrals. It appears that the proposed wall and revetment will cut off access to the beach via the corrals. The baffle walls and corrals should be indicated on the plan cross sections.

Response: The existing Baffle wall is indicated on the cross-sections (Sheet CS301). Details with respect to access ramps and stairs (size and support configuration) that cross-over the dune and provide access to the beach will be further finalized in PED. Discussion of public access will be included.

Additional analysis should be undertaken to determine the necessity of extending the composite seawall from its current eastern end point to B 1st Street.

Response: Please see previous response pertaining to east end taper of the Atlantic Shorefront.

Appendix A3 Part 3 Rockaway Residual Risk Plates

DEC understands that the residual risk projects are in the preliminary planning stage. Looking forward, it is essential that the reformulation study:

- Coordinate with other planned initiatives in the area, such as USACE-sponsored restoration projects. Coordination is essential to avoid conflicting or duplicative projects and to optimize design effectiveness;

  Response: Concur, we have been and will continue to coordinate on this.

- conduct a detailed assessment of proposed features for effectiveness, e.g., Project #9 as presented would be flanked by routine storm tide waters;

  Response: Each proposed alignment and how it would perform under various flood events will be analyzed.

- conduct an environmental impacts analysis;

  Response: Concur, the environmental impact analysis of the High Frequency Flooding Risk Reduction Features (HFFRRFs) is underway and will be included in the revised Draft Final GRR/EIS.

- evaluate relocating or redesigning features where the proposed location of structures would have significant impacts on existing wetland features, e.g., for Project #8, moving the I-wall landward of the road;

  Response: The HFFRRF alignments are being pulled back as much as possible from existing wetlands. The features need to have enough space to site the necessary drainage, as well as space to construct and operate the features. Wherever possible, publically owned land, DOT right-aways and other real estate opportunities to move alignments away from the shore and onto City-owned lands are being pursued, as requested by NYC.

- calculate the mitigation required to account for the destruction of existing vegetated

wetland and high marsh areas and suggest appropriate mitigation projects;

Response: As part of the impact analysis, evaluation of mitigation requirements will be revised in the Draft GRR/EIS. Mitigation requirements will be based upon impacts to regulated habitats (i.e., water, wetlands), and utilize EPW field studies to further analyze impacts to wetland habitats in terms of ecosystem functions (i.e., functional habitat units). EPW-based analysis will be founded on field collected data, and existing site conditions. Due to the inclusion of natural and nature-based features, the restored or enhanced acreage of native habitats is expected to far exceed any permanent impacts to existing habitats. As discussed recently with Region 2 staff, the Corps expects the project to be self-mitigating.

- review all designs for opportunities to replace proposed hardened structures with green infrastructure;

  Response: Concur, in designing and siting our HFFRRFs, the team considered the existing shoreline condition and where natural shorelines existed and CSRM measures were warranted, the team considered NNBFs for CSRM. Other considerations for siting NNBFs included the lateral space and bathymetry, the existing habitat, and wave conditions, etc. For drainage, green infrastructure is also being considered where space allows.

- consider the long-term value of some projects, e.g., NYC DDC and NYC HPD are offering buyouts in the Edgemere area and homeowners have accepted offers, which reduces the number of people and amount and value of property protected by proposed bulkhead and berm;

  Response: The study team is coordinating with NYC HPD and has obtained parcel data maps on Edgemere buyouts in order to adjust the alignments there to better marry with the City's local plans for the area.

- review other projects requested by and supported by local communities that would achieve similar goals, and if appropriate, substitute those projects.

  Response: The study team is currently evaluating the plan for Broad Channel that was submitted by the Broad Channel Civic Association as a HFFRRF to be analyzed.

See also DEC's comment on Appendix S and use of 1974 tidal wetland maps for preliminary design purposes. It is essential that current conditions be delineated for planning purposes and to assess impacts.

Please see response for the fuller comment.

Appendix B - Rockaway, Borrow Area Engineering Appendix

Note: the dredge plan will be reviewed in detail by the R2 DEC dredge team and permits staffs when a permit application is submitted.

Noted.

Appendix B2 - Rockaway, Borrow Area Environmental

Note: the dredge plan will be reviewed in detail by the R2 DEC dredge team and permits staff when a permit application is submitted.

Noted.

Appendix I - Rockaway, Environmental Impacts Support Document

Chapter 3: Summary Description of Analyzed Actions
See comments elsewhere re: required tapering of groin field, extending study area to Beach 1st St., and need for a technical analysis of erosion and sediment transport in the Belle Harbor/Neponsit area of the Atlantic shoreline.

Please see responses to those comments.

Page 3-3: for the Tier 2 studies, in addition to further water quality studies, DEC would like to see, at a minimum, the following data:

- Quantification of acreage lost or gained by wetland type, e.g., mudflats, high marsh, intertidal marsh;

  Response: Concur, this information will be provided in the revised Draft Final GRR/EIS for the Recommended Plan. Mitigation requirements will be based upon impacts to regulated habitats (i.e., water, wetlands), as well as restoration of similar habitats associated with the four HFFRRFs. Wetland habitat to be impacted and restored can be presented in terms of wetland type as requested. In addition, mitigation requirements will utilize EPW field studies to further analyze impacts to wetland habitats in terms of ecosystem functions (i.e., functional habitat units). EPW-based analysis will be founded on field collected data, and existing site conditions.

- Determination of impacts on keystone species, e.g., horseshoe crabs, wading birds, shore birds;

  Response: Concur, this information will be provided in the revised Draft Final GRR/EIS for the Recommended Plan. Environmental impacts to noted species will be addressed, and consistent with format provided in Section 5.0 Environmental Impacts.

- Recalculation of mitigation requirements, assuming a DEC mitigation requirement of 2:1 (non-vegetated) or 3:1 (vegetated), and the confirmation or revision of assessment scoring and available acreage in report;

  Response: As noted above, the mitigation requirements will be recalculated and presented in the revised GRR/EIS for the Recommended Plan. However, the Recommended Plan is expected to be self-mitigating, with the inclusion of NNBFs at four sites. The Corps will further coordinate with DEC regarding mitigation ratios as

needed.

- Conversion of vertical data to horizontal measurements, using LIDAR and aerial change analysis, to precisely quantify habitat type changes;

  Response: Through the EPW modeling, site visits were performed at all areas to be impacted within the Back Bay. Habitat maps are based upon field mapping of vegetated communities, as well as existing habitat mapping and aerial interpretation. The Corps does not believe that additional LiDAR or aerial change analysis is warranted at this time.

- Identification of habitat types affected, e.g., plant communities;

  Response: As noted above, mitigation requirements will be based upon impacts to regulated habitats (i.e., water, wetlands, adjacent buffer areas), as well as accounting for restoration of similar habitats associated with the four HFFRRFs. Wetland habitats to be impacted and restored can be presented in terms of differing plant communities (i.e., low marsh, high marsh, mud-flat). The existing Environmental Impacts had a thorough discussion of mapped and impacted habitat types, and which will be refined as needed in the revised GRR/EIS.

- Identification of biotic communities affected, e.g., avians, horseshoe crabs, finfish, shellfish, sessile biota;

  Response: These biotic communities were addressed in Section 4 and 5 of the Environmental Impacts Support Document, and will be incorporated in the larger revised GRR/EIS.

- Determination of species impacts by changes in WQ inputs and tidal range, location, and time of year;

  Response: This comment pertains to the storm surge barrier which is no longer being evaluated as part of the Recommended Plan. As discussed above, these impacts will be evaluated within the NY/NJ HATS study.

- Summary of ecosystem impacts to enable reviewers to readily assess species viability, i.e., who are the winners and who are the losers;

  Response: The mitigation requirements will be revised as discussed above for the Recommended Plan. EPW will be utilized for wetland habitats to address functional impacts or gains. As requested, a discussion will be included relative to vegetative communities that will be impacted or restored within the revised project area.

- Calculation of Jamaica Bay–specific concerns such as the expansion of *phragmites* as the result of a decrease in tidal range and the exacerbation of *ulva* growth as a result of the changes in water quality.

  Response: This comment pertains to the storm surge barrier which is no longer

being evaluated as part of the Recommended Plan. As discussed above, these impacts will be evaluated within the NY/NJ HATS study.

Chapter 4: Affected Environment

Overall Comment: This is a thorough analysis of subject area sourcing both recent and historical studies. Distinguishing between Atlantic Oceanfront and Jamaica Bay APIs was very helpful. The distinction wasn't made in a few sections, noted below. Also, how
- or if - the Sheepshead Bay/Coney Island component was assigned wasn't always clear,

Response: Noted.

- also noted below.

- Page 4-6, Section 4.1.2.1: There is a reference to a "park," which isn't clear. "Soils found on the eolian and marine deposits within these portions of the park include Hooksan and Jamaica."

  Response: Concur. Reference will be addressed in revised GRR/EIS. The original text referred to the Gateway National Recreation Area.

- Page 4-11, Section 4.1.2.1; "Prime Farmland": There is a key word missing in the following sentence: "While the Sudsbury sandy loam and Riverhead loamy coarse sand soils at […] are classified as prime farmland…."

  Response: Concur. Text will be addressed in revised GRR/EIS.

- Page 4-16, Section 4.1.3.1, "Rockaway": For the sentence reading "From 1927- 2007, the shoreline of the Rockaways has been stable." Is it accurate to extend period to present, i.e., 2016?

  Response: FEMA 2013 is cited for this paragraph, which is where it comes from. The timeline will be edited to note from 1927-2013. Recent shoreline analysis completed since 2013 that is now available will also be added and referenced.

- Page 4-19, last paragraph: please explain the value of showing conditions in absence of an existing and just repaired retaining wall.

  Response: Text will be added to provide further clarification as part of revised GRR/EIS.

- Page 4-19: as noted elsewhere, DEC requests that the Corps and consultants conduct a technical assessment of sediment transport and erosion in this area.

  Response: GENESIS Modeling indicated that shoreline fronting Belle Harbor/Neponsit should remain relatively stable. Shoreline response to the groin field as shown in the TSP will be revisited for optimization during the PED phase via modeling with the two-dimensional USACE certified CMS model, which will be used to simulate the downdrift shoreline morphological response to the new proposed groin field. Optimization adjustments may include tapering additional groins, or extending tapered groins

westward, if modeling indicates this is warranted.

The shorefront Engineering and Design Appendix includes an evaluation of the performance of prior projects, historic erosion rates and volumetric losses. In addition it includes a sediment budget study. The reviewer is referred to Shorefront Engineering and design appendix.

- Page 4-20, 2nd paragraph; the relevance of statement about surfing beaches is not clear without there being comparative or complementary information of other types of recreational uses.

  Response: Concur, broader recreational uses will be added to the discussion either reach by reach or as a whole. This note was put in this reach to highlight a significant recreational resource.

- Page 4-21, Reach 5: first paragraph: second and fourth sentences are repetitive.

  Response: Concur, the second sentence has been deleted to remove repetition

- Page 4-22: as noted elsewhere, DEC requests that the study area be extended to Beach 1st St.

  Please see previous response.

- Page 4-31, Section 4.2.1, Bathymetry: will there be a corresponding discussion for the Atlantic Ocean shore? If it's in this section, suggest adding a cross- reference.

  Response: Concur, text will be revised to address refined project area.

- Page 4-33: cross-reference SLC.

  Response: Concur, cross reference will be added

- Page 4-36, section 4.3.2, "Tidal Currents": The intermediate SLC predictions are lower than that used by the project local sponsors (NYS CRRA; NYC CCP). Suggest adding a discussion noting and explaining the differences, if not here, somewhere in the DEIS, with a cross-reference.

  Response: Concur, a graph with the three USACE curves and local sponsor curves will be included along with a description of SLR considerations and how they relate to the various curves. Section 4.3 of the shorefront E&D appendix discusses SLR.

- Page 4-36, 5th paragraph: please verify that calculations and projections based on all three SLC scenarios will be included in the final EIS.

  Response: The design will be based on the intermediate USACE SLR curve, as noted in the Draft Report, however a sensitivity analysis will be performed to show how the project would perform under all three USACE SLR curves, as well as one additional curve which approximates the NYS/NYC curve (a mean between the USACE high and medium

curves). This has been coordinated and agreed upon between NYS DEC, NYC ORR, and USACE.

- Page 4-37, Section 4.3.2, "Tidal Currents": Please clarify if summary of tidal currents in Rockaway applies to Coney Island as well. If not, please provide that data.

  Response: The barrier and its tie-ins will be evaluated under the NYNJHATS study. Coney Island is no longer part of the current study area.

- Page 4-37 and 4-38: a wind rose showing month, speed and direction would be helpful for this discussion.

  Response: Noted. The Corps will evaluate the potential to include a wind rose as part of the revised GRR/EIS

- Page 4-42; Section 4.6.2.1, Contaminated Groundwater: If text is not quoting EPA directly, suggest adding continued use of septic systems in communities surrounding Jamaica Bay in Queens is a source of groundwater contamination.

  Response: While the text is included based upon reference from EPA, additional text relative to potential septic systems will be included in the revised GRR/EIS.

- Page 4-53; please see comment in MRF #8 regarding the error in calculating B- IBI.

  Noted.

- Page 4-57; Section 4.8.1, Invertebrate and Benthic Resources: commend action of surveying pre-dredging at borrow pit.

  Thank you.

- Page 4-64; Section 4.9.4, State Species of Concern: black skimmers are included in the table as a NYS species of concern. Suggest adding to narrative as they are nesting in habitat adjacent to plovers in Breezy and Arverne beaches.

  Response: Revised GRR/EIS will include discussion of black skimmers.

- Page 4-86; Section 4.12.1.1, Rockaway Beach and Boardwalk: expect that final report will contain updated visitation figures; there was a marked year-over-year decrease in visitors to the Rockaway beaches in 2016 despite the recently renourished beaches and re-opened boardwalk.

  Response: Additional visitation data will be included in the Report.

- Page 4-91, Section 4.12.2.2 Plumb Beach: text contains incorrect information: 1) dunes at Plumb Beach protect the Belt Parkway only - surge can readily move up Plumb Beach Channel and Shell Bank Creek; 2) Restoration of Plumb Beach was under way pre-Sandy; sand had been added before the storm.

  Response: Text will be revised accordingly.

- Page 4-97, Incorrect text Beach Channel Drive is on the northern side of the peninsula; Shore Front Parkway is on the southern side.

  Response: This will be corrected. Thank you.

Chapter 5: Environmental Impacts

Page 5-2, Section 5.0, Environmental Impacts: As indicated elsewhere in our comments, DEC requires further modeling and study before the Department can endorse the Corps' statement that no significant adverse impacts were identified.

Response: The revised Draft Final GRR/EIS which will address all the questions remaining to make this statement.

Page 5-5, Section 5.2.1, Bathymetry: down-current side effects of groins are classified as minor and long-term. The length of the terminal groin at approx. B. 121 St. has not been established but in some drawings it appears as 375 feet, approximately the same length as the groin presently at B.149th St. Based on historic conditions at B.149th St., and continual need for intervention at Beach 149th St., those long-term effects should be classified as major.

Response: Groin field design will be confirmed and optimized during final the PED phase via modeling with the two-dimensional USACE certified CMS model, which will be used to simulate the downdrift shoreline morphological response to the new proposed groin structures. Optimization adjustments may include modifications to the spacing and length of groins, tapering additional groins, or extending tapered groins westward, if modeling indicates this is warranted.

Page 5-6, Section 5.2.2, Bathymetry, and throughout section: as previously stated, detailed DEC comments will be provided pending further modeling. However, modeling so far shows that from construction of the barrier alone, and in the open position, tidal amplitude will change a maximum of 0.2 feet (2.4 inches) in Jamaica Bay. Given the limited amount of intertidal and high marsh and the limits of retreat, this is not an insignificant figure. Were the impacts of this change explored in depth?

Response: The impacts would have been explored more extensively once the barrier measure was further refined. However, the storm surge barrier is no longer part of the Recommended Plan for Rockaway. Any further analysis pertaining to the barrier will be considered under the NYNJHATS study.

Page 5-9; Section 5.3.1, Tidal currents: Rip tides resulting from the construction of groins are not mentioned as a long-term adverse impact in this section. If they are not anticipated, please give a reason for opinion.

Response: Rip tides adjacent to groins have not been examined specifically as a potential long-term adverse impact for this project. It is noted that Rockaway beaches do experience rip currents adjacent to existing groins as well as in areas without groins. It is anticipated that rip tides for the new structures will be similar to conditions created by existing structures along the project. The USACE will work with local responsible parties to educate beach users of the dangers of rip currents and how to deal with them.

Page 5-15, Aquatic and Terrestrial Environments, please see DEC comment about MRF #8 and request for recalculation and update of related text throughout the report.

Response: Noted.

Page 5-17, 5.6.2, states that the proposed action would protect shorelines and marsh islands from future erosion. However, current research indicates that significant erosion is the result of persistent, lower-energy storms, events for which the barrier would not be closed. Please substantiate the report statement.

Response: Noted. It would be helpful if you could provide citations for the current research to this effect which we can use to bolster our statement on the need for the proposed NNBFs in the HFFRRF measures. Thank you. This section is being re-worked due to the removal of the barrier from the recommended plan but discussion on erosion will be edited to reflect the nuance.

Page 5-19, Section 5.7.1, Impacts Common to Both Action Alternatives, states that oysters would flourish on the newly constructed groins. As there are no oysters growing on the existing groins, why does the Corps anticipate oyster recruitment and growth on the extended groin field?

Response: The Corps referred to recent oyster research that was occurring with the NY/NJ Harbor region. The Corps will evaluate this comment further, and address in the revised GRR/EIS. Since the Draft Report was released, the NYC DEP has undertaken an effort to establish oysters in Jamaica Bay and the USACE will monitor their progress for potential lessons learned. To date, oysters have not successfully propagated on their own, though they persist when placed in the Bay.

Page 5-22, Section 5.8.1, Fin Fish. Appendix K, EFH Assessment (pp. 16-19), lists potential impacts to finfish and recommends dredge windows. This is not consistent with statements in this section; please align findings.

Response: The revised GRR/EIS will align findings with the EFH assessment.

Page 5-32; Section 5.10.2: Suggest giving examples of barrier construction activities to help reviewers assess the impact of construction, e.g., trestles, fill, geotubes, boat docks, concrete load conveyor.

Response: The storm surge barrier is no longer part of the Recommended Plan for Rockaway. Any further analysis pertaining to the barrier will be considered under the NYNJHATS study.

Page 5-34, Section 5.11.1, Protected Species. The construction of the barrier could have potential acoustic impacts on marine mammals and finfish. Recent marine engineering advances include sound muffling technologies. Has there been an evaluation for the need for such technologies in the New York Bight area?

Response: The storm surge barrier is no longer part of the Recommended Plan for Rockaway. Any further analysis pertaining to the barrier will be considered under the NYNJHATS study.

Page 5-38, Section 5.13, Recreation. Long-term recreational impacts should include potential for riptides.

Response: Rip tides adjacent to groins have not been examined specifically as a potential long-term adverse impact for this project. It is noted that Rockaway beaches do experience rip currents adjacent to existing groins as well as in areas without groins. It is anticipated that rip tides for the new structures will be similar to conditions created by existing structures along the project. The USACE will work with local responsible parties to educate beach users of the dangers of rip currents and how to deal with them.

Chapter 6: Cumulative Impacts

Page 6-9, Section 6.4, Summary of Cumulative Impacts. As noted elsewhere, the storm surge barrier as presented in this report would not afford protection to the interior of Jamaica Bay for frequent, smaller-scale disturbance. Therefore, the stated advantage is misleading.

Response: The storm surge barrier is no longer part of the Recommended Plan for Rockaway. Any further analysis pertaining to the barrier will need to be considered under the NYNJHATS study. This section will be revised accordingly.

Page 6-11, Section 6.4.5, construction of bulkheads and seawalls has known detrimental impacts on wetland vegetation and induces scour. Please note the use of mitigation for these events.

Response: The revised back-bay features have included NNBF wetland habitats where possible and as coordinated with Region 2, are expected to be self-mitigating. The Corps recognizes these impacts due to scouring, and expect these impacts to be addressed as part of NNBF designs.

Page 6-13, Section 6.3.8, Benthic Communities. Recent research in California shows long-term impacts to polychaetes from grin construction. Please cite source of statement that impacts will be temporary.

Response: Noted. Research as referenced will be evaluated, and text revised as necessary.

Chapter 7: Summary of Potential Impacts

Page 7-1, table 6-1. As noted elsewhere, DEC would like to see detailed environmental, hydrodynamic and water quality assessments for Jamaica Bay over the long term before it can judiciously evaluate the report's quantification of impacts.

Response: The write-up on the JEM water quality modeling has been updated to better explain what went into it. Any further analysis will be considered under the NYNJHATS study and is subject to funding constraints of that study. NEPA analysis will be tiered for HATS in order to account for the development of project detail over the course of the Feasibility Study and into the Pre-Construction Engineering and Design Phase.

Chapter 8: Irreversible and Irretrievable Commitment of Resources

Page 8-1. As noted elsewhere, DEC would like to see a more refined environmental assessment that examines the proposed bayside structures over the long term before it can endorse the claim that the proposed action is sustainable over the long term "both for the natural coastal ecosystem and the communities protected."

Response: More refined environmental analysis is going into the revised Draft Final GRR/EIS for the Recommended Plan.

Chapter 9: Short- and Long-Term Productivity of the Environment

Page 9-1, Section 9, 4th para. As noted elsewhere, DEC would like to see a more refined environmental assessment that examines the proposed bayside structures over the long term before it can endorse the claim that the proposed action would "reduce vulnerability to major storms in a way that is sustainable over the long term…for the natural coastal ecosystem.…"

Response: More refined environmental analysis is going into the revised Draft Final GRR/EIS for the Recommended Plan.

Page 9-1, Section 9, last sentence: Does this assessment of long-term benefits outweighing short-term impacts extend beyond "project construction" and include operation? Please cite survey or literature review conducted of similar barrier projects that examined potential long-term, unforeseen impacts.

Response: The storm surge barrier is no longer part of the Recommended Plan for Rockaway. Any further analysis pertaining to the barrier will need to be considered under the NYNJHATS study.

Chapter 10: Unavoidable Adverse Environmental Impacts

Page 10-1; Section 10.0, Unavoidable Adverse Environmental Impacts:

- Bullet list: noise discussion should be a separate bullet
- Bullet list: 4th bullet should include dredging activities (or create separate bullet)
- Bullet list: 4th bullet: it's not clear if this describes impacts of Atlantic and Jamaica Bay actions. Does "structures" refer to groins and barrier? Please clarify.
- Bullet list, fifth bullet: suggest replacing "and loss" with "some mortality"
- Bullet list, final bullet, last sentence: long-term change to the visual landscape is outside the "construction period" stated in the lead-in sentence to the bullets.

Response: All of the above changes will be made.

MFR3 draft 09 03 14 ANocera.docx and MFR8 Ecovaluation 12111415.pdf

The study combined all 5 functions retained in the EPW portion of the study, but contrary to normal EPW protocols, they were all summed and averaged, giving each equal weight, instead of independent evaluations of each. While this approach might suffice for this preliminary screening study, a more robust analysis should be performed for future phases, to make sure that all important ecosystem functions are being replaced.

Response: A revised mitigation evaluation will be developed as described above for the

Recommended Plan.

The study is based upon desktop analysis, and the authors assume that future phases will incorporate site-specific data collection. This should definitely occur during the next phase.

Response: Site specific data has been collected and will continue to be incorporated in the evaluation of mitigation requirements for the Recommended Plan.

The study defines the Functional Capacity Unit (FCU) as the product of the Functional Capacity Index (FCI) and the impact acreage, and it states repeatedly: "FCUs are calculated by multiplying the acreage of the assessment area by the FCI score." The results of these calculations are presented in Table 6 of MFR8. However, this table is fraught with math errors, in particular for the IBI function.

Response: A revised mitigation evaluation will be developed as described above for the Recommended Plan. FCU's based only on EPW analysis will be presented for the revised project area. For reference on EPW, calculations include:

1) Multiply the FCI values for each restoration alternative by the total number of acres restored to calculate the number of FCUs gained for each of the seven wetland functions (i.e., shoreline bank erosion control, sediment stabilization, water quality, wildlife, fish, uniqueness/heritage).

2) Multiply the FCI values for the each wetland (Estuarine and Palustrine) by the number of acres of estuarine and palustrine wetlands lost in the conversion to each restoration alternative to determine the number of FCUs lost for each of the seven wetland functions, for each restoration alternatives.

3) Subtract the number of FCUs lost from the number of FCUs gained for each restoration alternative to obtain the net gain in FCUs due to restoration for each of the six wetland functions.

4) Add the FCUs for all six wetland functions together to obtain the cumulative number of FCUs produced by each restoration alternative.

While most of the calculations for the Wetland and Upland functions are off by a small amount, most of the IBI calculations seem to inflate the scores by a factor of 5, and even then the numbers are slightly off. For example, the first row of Table 6, the FCUs for the IBI, Wetland, and Upland functions are calculated at 37.50, 5.50, and 10.07 respectively. However, multiplying the FCIs by the areas of impact yields the following numbers: 7.50, 5.50, and 10.13. In row 3 (row 2 has no IBI factor), the numbers calculated are 36.67, 1.43, and 100.44. Multiplying the FCI by the acreage, however, yields: 7.33, 1.42, and 100.44. Assuming, for some reason that doesn't seem to be explained, that the IBI number is supposed to be further multiplied by 5, that would yield 36.65, not 36.67.

Response: A revised mitigation evaluation will be developed as described above. FCU's based only on EPW analysis will be presented for the revised project area. Evaluation in terms of IBI scores will not be further evaluated. See above.

The methodology states that the IBI index number was calculated by combining all 5 IBI component scores and averaging them. However, it seems as though after combining and dividing by 5 to get the composite score, the Table 6 calculations then eliminates the average

and uses the total score of the 5 IBI elements, prior to averaging, to calculate the FCU. The methodology also states that all 3 habitat types are assumed to be functionally equivalent, and are given equal weight. However, the way Table 6 calculates the FCU scores, it seems as though the IBI habitat FCU score is being weighted (approximately) 5 times that of the other habitat types. The Corps should explain why the IBI calculation is consistently increased (approximately) by a factor of 5 in all cases, and why in most cases the calculations are slightly off.

Response: A revised mitigation evaluation will be developed as described above. FCU's based only on EPW analysis will be presented for the revised project area. Evaluation in terms of IBI scores will not be further evaluated.

The tables in Appendix C calculate the Habitat Adjusted Total DSAY's, which is understood to be the product of the Total DSAYs and the Habitat Equivalency Factor. However, the calculations seem to be slightly off in most cases, even when the multiplier is 1. For example, in Table C-1, row 1 correctly multiplies 0.7 by 0.0 and yields 0.0., but row 2 multiplies 79.6 by 1.0 and gets 76.2. While this is a slight increase over the product of the Total DSAYs and the HEF, row 3 multiplies 112.5 by 0.9 and gets 103.6, not the actual product, which is 101.25, or a slight increase. The Corps should explain why these calculations seem to be in error.

Response: A revised mitigation evaluation will be developed as described above. FCU's based only on EPW analysis will be presented for the revised project area. Evaluation in terms of DSAYs will not be further evaluated.

Since the evaluation of both proposed impacts and mitigation are based upon the above calculations, it is impossible to evaluate the results and recommendations until the apparent errors cited above are either corrected or explained.

Response: Noted.

Both reports state that detailed calculations are provided in a flash drive (Attachment A); however no flash drive was provided. This should be provided.

Response: A revised mitigation evaluation will be developed as described above. FCU's based only on EPW analysis will be presented for the revised project area. EPW modeling will be available as part of the revised GRR/EIS.

Section 6.4 of MFR 8 states that, with respect to Alternative C-1E, the Spring Creek restoration site will satisfy the mitigation requirement. It then goes on to state that it is assumed that this alternative would also require a comparable level of excess mitigation to at least that proposed for Alternative D. The Corps should provide the basis for this statement.

Response: A revised mitigation evaluation will be developed as described above. FCU's based only on EPW analysis will be presented for the revised project area.

Appendix J - Rockaway, Endangered Species Act Compliance

The construction plan and schedule will be reviewed in detail by the R2 DEC fish and wildlife and permits staffs when a permit application is submitted. We expect that the final EIS will include data from 2016 surveys performed by NYCDPR.

Response: Noted.

Appendix K - Rockaway, Essential Fish Habitat

The approach to EFH assessment is consistent with Federal guidelines and appears thorough, with the following comments:

Page 2, 3rd paragraph: Authors of this EFH assessment specify that it addresses only the Atlantic Ocean, or Tier 1, phase of the TSP, and that an equivalent assessment for the interior of Jamaica Bay, Tier 2, will follow pending further analysis of the options by the COE. Given the designation of the interior of Jamaica Bay by New York State as Significant Coastal Fish Habitat, and noting that the alignments of the two barrier options are proximal to one another, DEC requests a draft EFH analysis before preliminary construction designs for the barrier are published.

Response: The storm surge barrier is no longer part of the Recommended Plan for Rockaway. The revised EFH will include the Atlantic Ocean, as well as four NNBFs within the interior of Jamaica Bay.

Page 7, paragraph above table 3: Comments re: minimal hydrodynamic impacts of barriers are premature, pending water quality modeling. Text should indicate uncertainty of impacts of with-project conditions. Also as noted by DEC elsewhere, a change in tidal amplitude of 0.2 feet is not insignificant. Detailed studies showing the horizontal impacts of this change from current conditions is necessary to assess impacts, especially to mud flats and shoals and to the upper and lower limits of intertidal marsh.

Response: The storm surge barrier is no longer part of the Recommended Plan for Rockaway. See above.

- Section 2.1: see comments for main report, especially: 1) To provide protection to the entire Rockaway peninsula, the study area should extend to the eastern edge of the peninsula at Beach 1st St.; and 2) it is important to note in Table 1 that the beachfill and renourishment amounts are calculated based on historic conditions and do not include sea level change.

  Response: Please see previous responses in terms of extension to eastern edge of the peninsula.

- Page 12; Section 3: The text following Table 5 on page 11 is not consistent with the table in cross-referencing “South Atlantic Species” (#s 30-32), “Coastal Migratory Pelagic Species” (#s 33-37) and “Highly Migratory Species” (#s 20-23).

  Response: Noted. This paragraph will be corrected.

- Page 19; last paragraph, refers to the “borrow site screening process.” It would be helpful to the reader to provide a cross-reference to the section or appendix in the EIS where this process is discussed.

  Response: Concur. Appropriate cross-reference and supporting text will be included relative to the borrow-site screening process.

- While the Introduction to Section 4 notes the possibility of temporary impacts from groin

construction, and Table 6 frequently notes a temporary disruption of benthic food prey organisms, the discussion doesn't address the long-term impacts of the structures. An assessment of the effects of groins on benthic food prey would be helpful.

Appendix L Rockaway, Cultural Resources

Note: the cultural resources plan will be reviewed in detail by the R2 DEC permits staff when a permit application is submitted. Expectation is that application will meet conditions of the East Rockaway permit. Noted.

Appendix M - Rockaway, Historic Resources

Appendix is blank in this draft; DEC will review the material in final draft.

Response: This appendix will be deleted from the revised report. It was used as a placeholder. Any information on historic properties, including any correspondence, Programmatic Agreement, Areas of Potential Effect (APE), etc., will be included in Appendix L.

Appendix N - Rockaway, Coastal Zone Management

Policy 1 states that the project will not adversely affect adjacent and upland views. Since drawings and schematics of the surge barrier have not been published, it is premature to make this statement. DEC will review any schematics of view shed when they are available and make an assessment as to impacts.

Policy 7 (3) - until further water quality and hydrodynamic modeling for the surge barrier has been done, it is premature to make this statement.

Policy 7 (4) – please expand this section to include shorebirds.

Policy 13 - it would be helpful to provide sea level change scenarios used for calculation of 50-year protection

Policy 14 –While prior presentations have referred to the groins as "tapered," the lengths given in this report of 326, 376, and 351 feet do not support that characterization. The 326-foot groin planned for Beach 121st St. will severely impact the beach on the leeward (west) side of the groin.

Policy 15 states that the "Project will also result in minor seafloor disturbance within Rockaway Inlet during piling construction of the Hurricane Barrier." The final location of the barrier has not been selected and plans have not been published. Without this information, as well as means and methods of construction, it is impossible to assess this statement. Please add qualifying language.

Policy 17 does not address the residual risk features, where there is opportunity to use non-structural means to achieve project goals.

Policy 19 references a decrease in access to and use of recreational areas "that is predicted to occur." Please cross-reference the study where this prediction is made.

Policy 22 – See comment about view shed, above (Policy 1). Policy 25 -

See comment about view shed, above (Policy 1).

Policy 44 states that the project will improve degraded tidal ecosystems and habitat for fish and wildlife. Until further water quality and hydrodynamic modeling and a detailed environmental impacts assessment for the surge barrier has been done, it is premature to make this statement.

Response: The Appendices for the new TSP will be updated to reflect the updated plans, and to incorporate or address your comments, as applicable.

Appendix O - Rockaway, Fish and Wildlife Coordination

This appendix reprints a letter from USFWS; no comment necessary other than to say that DEC has no objections to the USFWS comments.

Response: Noted.

Appendix P - Rockaway, Emissions Estimates

Note: These are draft calculations; DEC R2 air resources staff will review when barrier design is selected.

Response: Noted.

Appendix Q - Rockaway, Environmental Compliance

6.8.2, "Clean Water Act": A separate, written request to DEC is required, at which point DEC will assess the validity of the statements in this section, in particular that the alignments of the "proposed CSRM, barrier and borrow area have been located to minimize and avoid impacts to Jamaica Bay and the Atlantic Ocean."

Response: Concur.

6.8.3, 6.8.4, 6.8.5, 6.8.13, 6.8.14: deferring to USFWS, NMFS, NYS DOS, NPS, and USFWS, respectively.

Response: Noted.

6.8.11 : Please provide a basis for the determination that the "USACE has determined that the TSP does not induce direct or indirect floodplain development within the base floodplain." The conclusion is contrary to coastal real estate practices. If that justification exists elsewhere in the Draft EIS, please provide a cross-reference.

Response: The eight step assessment, presented in the Environmental Impacts section of the Environmental Appendix, concludes that all practicable alternatives have been considered in developing the TSP, and that the main federal objective of reducing coastal flood risk cannot be achieved by alternatives outside the floodplain. This will be reevaluated for the next Draft HSGRR/EIS.

6.8.12 : It is not clear how the TSP will protect wetlands from damage caused by coastal storms as the surge barrier would not close for ordinary nor-easters or coastal storms, and it is these

storms that inflict the most damage on existing wetlands. Also, the Residual Risk features have not been subjected to the requisite scrutiny to avoid, minimize or mitigate wetland impacts. (See DEC comments for Appendix A3, Part 3, "Rockaway Residual Risk Plates.")

Response: Please see earlier response.

6.8.14: EJ impacts can also be measured by exclusion, and if the study area does not extend to Beach 1st Street, and encompass a 916-unit, 2000-resident housing complex and at least two senior-citizen residences, this statement does not appear to be correct.

Response: please see earlier responses pertaining to this issue.

6.8.16: See comment about exclusion, above.

Response: Please see earlier response.

Appendix R - Rockaway, 404b1 compliance

Page 3, Project Description, b., "General Description": It is premature to conclude that "no significant adverse impacts from construction or operation of the TSP on environmental resources in the study area have been identified in the EIS." Once the alignment and design of the surge barrier is finalized, hydrology and hydrodynamic and water quality modeling will be required before DEC can make an endorsement of this statement. See general comments.

Page 4, Factual Determinations, a., "Physical Substrate Determinations, (1)": DEC looks forward to coordinating with the Corps on identifying and prioritizing additional residual risk features. For residual risk projects included in this draft EIS, see DEC comments for Appendix A3, Part 3, "Rockaway Residual Risk Plates."

Pages 8-9, (a2-a6) through (h) and "Findings of Compliance or Noncompliance: It is not clear if these assessments apply to the Atlantic Oceanside only or to the entire TSP. If the latter, the conclusions stated are premature and not substantiated by the available ecological assessment data.

Response: The Appendices for the new TSP will be updated to reflect the updated plans, and to incorporate or address your comments, as applicable.

Appendix S - Rockaway, Mapped Freshwater Wetlands

The title of the report is incorrect; the appendix shows DEC's mapped *tidal* wetlands, not freshwater wetlands.

Response: Correction will be made.

It is important to note that the tidal wetland boundaries and types may have changed since the 1974 maps and that actual drawings, plans and designs must be based on current delineated conditions.

Response: Corrections will be made based upon recent site evaluations, as well as current elevational data.

For further DEC comments on the residual risk features, please see DEC comments for Appendix A3 Part 3, “Rockaway Residual Risk Plates.”

Response: OK.

New York State Department of State Comments:

Draft HSGRR and EIS for USACE Rockaway/Jamaica Bay Project

Based on the information available to DOS at this point in project development, we have identified a number of coastal policy-based concerns, which are reflected in the following series of questions and comments:

General

- A separate section on land management and local responsibility for risk management, akin to the FIMP report Appendix H (Land and Development Management), would be a valuable addition to this report. Language noting that state and local governments are responsible for utilizing their available programs and authorities to manage risk should be included. The study area is densely populated and therefore measures to reduce the risk of flood damages is necessary. A structural solution for an area of this size and for the number of people it will help protect from damages is justifiable. However, a structural solution to protect existing property and uses should not justify more development in the study area. A structural solution is not a long-term solution, and there is always residual risk should the barrier be overtopped. Language that urges the City to consider smart land use decisions to manage risk should be included. The following (or similar) could be inserted into an appendix document to set the context for a discussion on land use and risk management recommendations:

  "*State and local governments have authorities and responsibilities for managing risk that should be utilized in coordination with federal storm risk management efforts. The Atlantic Coast of New York East Rockaway Inlet to Rockaway Inlet and Jamaica Bay project will not eliminate all flood risks so additional measures by other public sector and private interests are necessary to help achieve resilience. Mechanisms available to local interests to better understand and reduce risk include comprehensive land use plans, New York City's Waterfront revitalization Program (WRP), and local Hazard Mitigation Plans, to name a few."*

  Response: Concur that a structural solution is justifiable and that there will always be residual risk. This is why the Corps has changed our language to be one of 'risk management' not 'flood control'. The revised report will discuss the City's land use planning efforts in Edgemere. The team will also work with DOS, DEC, and NYC to include language about ongoing and potential future avenues for additional resiliency and the available mechanisms for achieving it.

Main report (Draft Integrated HSGRR and EIS)

- Executive Summary, p. iv- One of the five planning objectives listed in the report is enhancing natural storm surge buffers, also known as NNBFs, and improving coastal resilience. However, the report and selected alternative provide little detail in their discussion of these features and buffers. Most of the reference to buffers in this report relates to wetlands and maritime forest. It would appear that achieving this planning objective would require some restoration of these habitats. There is also no clear definition of living shorelines in the report, and while it is understood that living shorelines span a continuum of designs, living shorelines with a structural core would not be able to function

as natural shorelines. According to table 5-10, CSRM Structures and Associated Quantities, no living shorelines are proposed in the selected alternative (surge barrier). It appears as if this planning objective, which DOS is highly supportive of, was not met.

Response: Concur that the draft report which included the objective to include natural and nature-based features (NNBFs) did not cite potential areas for wetland and maritime forest NNBFs. However, the composite seawall/vegetated dune with rock core does meet the objective of a 'nature-based' solution. Though it does not function the same way a sand-only dune would, it is a viable and fitting solution given the restricted berm width along much of the Atlantic Shorefront reaches of the project. The minimum berm width in the TSP design is 60 feet, which would require beachfill and periodic renourishment to achieve. The study area is mostly very developed up to the coastal edge and this has limited the natural resiliency options by taking up space that could otherwise support a more natural multiple dune system. The design takes all of this into account and the rock core adds resiliency because it is not erodible and were back to back storms to hit and the first one to overtop the dune, the remaining seawall would still manage risk until the dune could be repaired.

As far as including other forms of NNBFs in the recommended plan, the team has since developed and included up to four sites where wetland/berm hybrid NNBFs are justified to help manage risk from high frequency flooding in the Back-Bay. These sites are not considered 'restoration' but integral parts of the design for managing coastal storm risk. The team is very pleased to have included them and thanks you for your involvement in the process.

Section 1

- Section 1- Please define "long-term sustainability" and how it is being achieved in the proposed project

Response: There is no single accepted definition of 'sustainability.' However, this project aims to help manage coastal flood risk for the communities in the flood area such that damages are reduced and/or prevented from future storms up to the design event, so that residents, businesses, educational institutions, public infrastructure, natural communities, etc., can continue to persist and thrive.

The recommended plan is only part of an overall system solution. The proposed storm surge barrier which will now be further studied under NYNJHATS, and will not be authorized from this study, is a key part of the system and residents in the area will remain at high risk from large storms without a storm surge barrier. Further, as DOS noted elsewhere, land use decisions and adaptive management strategies for addressing sea level rise as it occurs if it exceeds design assumptions will need to be revisited in the future. This will be discussed in the revised report.

- Section 1.5- The introduction suggests that the Corps recommended project will eliminate storm damage and understates the significant need for additional risk management actions by others as part of a comprehensive approach to risk reduction. We recommend the following observations be added to alert

readers to the fact that risk management is a broader need and involves everyone.

- The emphasis on risk management versus storm damage reduction or elimination should be more explicit.
- In accordance with effective risk management, the introduction should emphasize the need for a robust approach including additional actions by others. The project will only address a portion of storm risks and it is not guaranteed against all possible events. Similar to an investment prospectus, project reports should illuminate risks that go along with the proposed project and advocate a diversity of actions by others:
  - The project alternatives do not completely eliminate flood risks, leaving substantial continuing risk even with implementation.
  - A storm could occur that exceeds project design and overwhelms project measures.
  - There are multiple, complex components in the project and the failure of any one component could compromise the protective system.
  - The project design is predicated on certain sea level and storm behavior assumptions which may prove unreliable in the future. Project measures will not reduce sea level rise or tidal flooding.
  - The project depends on future funding and maintenance, which cannot be guaranteed with absolute certainty.

Response: Concur with all of the above recommendations.

- The reports should emphasize the use of transformative land use measures to reduce risk and maintenance of flood insurance to help address residual risk.

Response: The team will work with the City/State to include local land use measures, as agreed to by our partners.

- The reports should emphasize that continuing adaptation in surrounding communities is needed to reduce hazard impacts, even if the recommended measures are completed.

Response: Concur, especially as it pertains to Broad Channel.

Section 3

- Section 3.6 (and 6.7.2)- Sea Level Change- The low estimates of 1.3 feet from a 1992 base year to 2070 are no longer reasonable. There is near universal scientific agreement that rates have accelerated and will continue to accelerate for the foreseeable future and beyond the project life. Current research indicates that SLR effects are expected to be higher in our region than global averages, due to gravitational effects and to slowing of offshore currents. That in turn will affect the relative elevation of the peninsula, estimates of sand stability, renourishment periods, nearshore depth and wave height, and the extent of the inland flood plain. It should also affect information presented in the reports – localities need to be alerted that flood plains will get larger, flood depths will increase and storm surges

will be higher in the future since they will be on top of higher water levels. To address these issues:

- USACE project reports should emphasize that SLR is escalating and will continue to escalate well beyond the project life. Development will need to adapt to address this effect.
- Project SLR estimates should be increased to the High-Medium projection currently available through 6NYCRR Part 490 (publicly reviewed recommendation currently waiting final approval) for:
    - Areas hosting critical facilities,
    - Areas in or adjacent to FEMA-NFIP "V" zones,
    - Areas where evacuation routes are constructed (such as the Rockaway peninsula), and
    - Areas where existing land elevation is less than two feet (NY State building construction freeboard standard) above the projected water level under the 6NYCRR Part 490 High-Medium Projection.
- Actions by others including local government and property owners will be needed to address risks and impacts. Assistance from state and federal sources should be in support of local resilience initiatives.
- Avoid conveying the impression that federal flood control projects will completely and permanently manage risks. Emphasize that the federal project can only accomplish limited protective levels on a short term basis and encourage other partners to act responsibly given the known and expected mid-term and long term risks.

  Response: If you have citations of studies DOS would like included, please provide. The team can certainly include recent data and studies showing the low curve to be unlikely or surpassed in the discussion of sea level rise and climate adaptability. Nonetheless the PDT is required to show the expected performance given a continuation of historic trends. Residual risk will be discussed as well as local resilience initiatives.

Section 6

- Section 6.1.1- Please describe in greater detail the analysis used to determine to residual risk features for each of the 5 locations. All of the selected features are structural solutions- were other NNBF or non-structural features evaluated? (See comment from Appendix A2-H).

  a. It would be helpful to include upfront the storm recurrence interval that was used in the analysis for determine these 5 locations.

     Response: The plan formulation write-up in the revised GRR/EIS will include more information on this, but to summarize: the barrier was identified as the TSP over the perimeter plan shortly prior to the publication of the Draft EIS/GRR. Residual risk measure were included at a conceptual level and were taken from NYC's Raised Shorelines Report which was formulated for a current 3-year event to address SLR. These were also limited to NYC. As part of the refinement of this concept, the Residual Risk measures were further developed into the

High Frequency Flooding Risk Reduction Features (HFFRRFs).

HFFRRFs were analyzed in the whole project area, into Nassau County, and three different additional flood extents (current 5, 10, and 20 year return period events) were mapped in order to identify the appropriate "tipping point" at which a potential barrier would be likely to be operated.

Finally, a harder look was given to where NNBFs could be included since the Raised Shorelines Report did not consider NNBFs.

- Section 6.7.5- p. 140 states that "Environmental impacts from Storm Surge Barrier realignment and non-structural residual risk measures will need to be fully evaluated prior to the Final Draft HSGRR/EIS." What are these non- structural residual risk measures? There is no mention of them anywhere else in this report. This is a significant information gap.

  Response: in addition to the HFFRRF development described above, the team is looking at the potential inclusion of non-structural measures for Broad Channel, to include floodproofing and house raising. The findings of the ongoing analysis will be shared with the team (including DOS) and will be captured in the revised GRR/EIS. Discussion of how non-structural was considered elsewhere will also be included.

Section 7- Environmental Consequences

- Throughout this section, reference is made to the benefits from living shorelines under the Action Alternative. However, because it is not clear what the Corps is referring to when reference is made to living shorelines, it is difficult to assess whether the benefits will be realized. Please define the living shoreline project components.

  Response: The revised GRR/EIS will include four NNBFs to address high frequency events. The discussion of these features will be included, and will specifically address a project specific definition of living shoreline.

- Section 7.14.1- Proposed action impacts from seawalls, groins, and floodwalls will not permanently stabilize the coast. They will aid in risk reduction in the short to mid-term, increasing sediment containment on the landward and updrift side of the features (seawall and groins, respectively). However, in the longer term, these features will disconnect the barrier spit from natural coastal process functioning and formation and contribute to passive erosion in front of and downdrift from the features (parallel and perpendicular beach structures, respectively). These impacts to coastal processes were not adequately addressed, nor was an adaptive management mechanism discussed for evaluating/mitigating impacts to these processes over the life of the project.

  Response: Adaptive Management will be described in the revised Draft Final GRR/EIS. The storm surge barrier is no longer part of the Recommended Plan for this study and will be further evaluated under the NYNJHATS study.

- Section 7.14.2- A potential long-term adverse impact from this project could be increased development in hazardous areas as a result of the perceived risk reduction potential of the proposed alternative. In addition, this section refers to future land use policies, but does not discuss them as potential drivers of change in the no-action alternative impact section (7.14.4)

  Response: NYC is engaged in land use planning to prohibit further development in hazardous areas, especially at Edgemere on the Back-Bay side of the Rockaway Peninsula. Future development along the peninsula, however is already planned with or without our project and is part of the future without project condition. Some of the new developments that have been built since Sandy prior to authorization to construct for our project have raised elevations and incorporated other non-structural measures to reduce risk. The report will stress that any new development in this area should implement non-structural measures such as raised elevations, elevated utilities, etc. to any new developments to reduce risk.

- Section 7.24- More detail on visual/aesthetic impacts from the proposed alternative is needed, particularly for the Jamaica Bay barrier. This section only discusses beneficial impacts, but hardened structures are not as aesthetically pleasing as natural or nature-based features. In addition, a rendering or alternative means of displaying the visual impact is necessary for state and local government entities, as well as the general public, to fully understand how this feature will impact their viewshed and the scenic quality of Jamaica Bay.

  Response: Agree that a rendering of the proposed barrier would need to be included to further assess the barrier's aesthetic impacts to a site-specific level. However, the storm surge barrier is no longer part of the Recommended Plan. The potential impacts to aesthetics will be analyzed and discussed for the features of the recommended plan in the revised draft final GRR/EIS.

- 7.24.4- It would be incorrect to assume that a natural shoreline, such as in the no-action alternative, would present an adverse significant long-term impact. Natural shorelines are able to adapt to changes from storms. For example, beaches are able to rebuild after a storm. Structures that interrupt these natural processes would limit the ability of a natural system to adapt and recover.

  Response: Much of the shoreline in the project area is already hardened and many of these hardened features, such as bulkheads, revetments, etc., are crumbling and undermined and do not currently function as intended. The assumption is that the lack of maintenance and disrepair would continue in the no-action alternative for these hardened elements.

  Response: This lack of maintenance would have a direct effect on the aesthetics of the shoreline in certain regions. The authors comment is noted and will be further addressed with additional clarifying text. However, it should also be noted that the extent of hardened shoreline throughout this urban estuary also has a direct effect on the resilience of these natural shorelines in the inner bay.

SCFWH – Significant Coastal Fish and Wildlife Habitat – Jamaica Bay – This is a state-

designation and it is tied directly to New York State coastal management program Policy No. 7. The Corps has not evaluated the proposed measures and outcomes within the context of protecting (first avoiding and then minimizing impairments to) the functions and values of the Jamaica Bay SCFWH. This should be included as a significant discussion within the EIS as well as, ultimately, the Corps' policy analysis to the Department of State when submitting materials for a federal consistency review.

Response: Concur, this policy will be evaluated in the revised Draft Final GRR/EIS and Environmental Appendix.

Special Natural Waterfront Area (SNWA) – Jamaica Bay & Rockaway Peninsula –The focus of this New York City Local Waterfront Revitalization Program (WRP) designation is to acknowledge and protect the integrity and benefits of coastal ecosystems and their important characteristics and features, including wetlands, habitats, and buffer areas. Again, there is no discussion of the project in the context of the SNWA and its attendant values.

Response: The Corps requests that the City add in information about this program to the writeup on local efforts that was provided for inclusion in the revised report.

Redirected Storm Impacts or Collateral Damages of the Project? – No discussion or modelling is included regarding the deflection and redirection of storm surge due to presence of the closed barrier during a major storm event. It should be determined where the water & energy will actually be directed during various events and closure scenarios, who is impacted, and how risk is changed for those who may be impacted. Residual risk measures should include actions to mitigate such risks outside of the project area. In the event that real events do bear out damages to others resulting from the barrier closure, who is liable?

Response: The storm surge barrier is no longer part of the Recommended Plan. The report will be updated to reflect this. Any further analysis will be considered under the NYNJHATS study which is now looking at the Jamaica Bay barrier in a regional context.

Residual Risk Measures – A more comprehensive description and review of the residual risk measures is necessary. Through what process and analyses did the Corps arrive at the five measures included in the TSP? How will residual risk measures be funded? Is any land acquisition required? What are the consequences if measures cannot be implemented due to funding or real estate constraints? Are the five measures presented the only ones that will be considered going forward or will other measures be developed as the project progresses.

Response: The Residual Risk measures have been expanded upon and further refined in this next stage of the study. Please see earlier response to similar comment on this.

Best Available Data – PFIRMs – Sec. 2.3.3 and other places within the document should acknowledge and reflect the PFIRM data/ maps rather than prior FEMA maps.

Response: The effort, time and cost to redo the modeling based on the updated maps is not warranted and would not change the results of the screening. A discussion of how the maps relate to one another can be included. PFRIM data is recognized in the shorefront engineering appendix, Section 4.2.

Real Estate – This section is not sufficiently developed. It should be detailed as to which properties will be affected, both private and public, and how conflicts will be handled. What properties are affected? How have/ will property owners be notified? Will eminent domain be considered? Will there be government buy-outs? Will lands be acquired for permanent open space, etc.?

Response: The Real Estate Plan is being developed as the project detail is refined and will be included in the revised Draft Final GRR/EIS.

Mitigation Elements, (6.1.3.2); Environmental Operating Principles (8.5.2) – What will final mitigation elements be? There is no detail provided. Appendix O – USFWS – also references a need for this information – ecological modelling used to determine impacts to habitat, including acreage and quantity of each habitat impacted, and descriptions and engineered drawings of proposed mitigations. In addition to direct disturbance impacts, both temporary and permanent, investigations and development of mitigation elements should integrate those impacts to species, biodiversity, and habitats that may result from effects on water quality and circulation.

Response: Evaluation of mitigation requirements will be revised in the Draft Final integrated report for the Recommended Plan. Mitigation requirements will be based upon impacts to regulated habitats (i.e., water, wetlands), and utilize EPW field studies to further analyze impacts to wetland habitats in terms of ecosystem functions (i.e., functional habitat units). EPW-based analysis will be founded on field collected data, and existing site conditions.

TSP – preferred barrier alignment – The analysis of the barrier alignments resulting in the TSP of C1E should be expanded and reevaluated. The report indicates that C3 was found to have the lowest environmental impact and would likely protect more people and property and require less of a structural footprint elsewhere. Additionally, the economic costs are said to be comparable in light of the latter consideration. It is not clear why the USACE selected C1E as the TSP except for the need to make modifications to locations of utility lines. What were the deciding factors?

Response: Please see earlier response on this comment.

Analysis of social and economic impacts – NFIP impacts should be discussed. Would there be changes to requirements for flood insurance? Would the mapped flood risk areas be altered?

Response: The PDT does not anticipate that the project, as designed, would change flood insurance requirements.

Water Quality – Potential water quality impacts (and consequent impacts on the ecology of Jamaica Bay) of the proposed storm surge barrier remain one of the major concerns with the Jamaica Bay part of the project. Modelling has been minimal and voluntary on the part of the City's environmental agency. Selection of the most appropriate (least impact) alternative should necessarily follow more thorough and detailed modelling efforts under a wider scope of circumstances – storms, period of closure, upland influences, etc. Modelling should also include an analysis of impacts on water quality at inlets, bays, and mouths of tidal creeks, etc. in order to make an intelligent assessment.

Response: The JEM modeling that was done to assess potential water quality impacts was detailed and aimed to assess a worst case scenario. USACE has provided an updated more detailed write-up describing what was done as well as responses to DOS detailed comments about the water quality modeling, most of which were addressed in the existing modeling which is now better explained. Any further analysis would be considered under the NYNJHATS study. Furthermore, SMART Planning, the Corps' new planning paradigm, directs the team to only develop a level of detailed analysis sufficient to make the decision at hand. If alternatives can be screened out in early phases, limiting the modeling and analysis needed for the full feasibility design and impact analysis, then the team is directed to do so. This is intended to reduce cost and duration of Corps studies, something that many non-federal partners have advocated for.

Ecosystem and Bay Health Effects – Detail is needed as to how the Corps intends to approach evaluating effects of implementing the TSP on the functions, restoration, and sustainability of Jamaica Bay's wetland systems and the critical habitats they support, on the hydrology including tidal creek systems, bay circulation and tidal flushing of pollutants. This evaluation should be discussed in the context of both the near term effects and the long term sustainability of living and non-living resources and natural processes including changing climate and sea level.

Response: First, it is important to note the storm surge barrier component of this plan has been moved to the NYNJHATS study for further evaluation and potential recommendation. Second, the mitigation evaluation will be revised based upon the revised project area and approach described above.

Wetlands/ Marsh Islands – The report (p. 76) discusses environmental degradation and historic loss of wetlands as a problem and presents the opportunity of restoration of natural coastal features including wetlands, reefs, beaches, dunes, and transitional upland features. Section 3.3 projects a future net loss of Jamaica Bay wetlands (and ocean beaches) in the FWOP condition. The USACE does not present how the project is anticipated to offset this historic trend of wetland loss and fails to acknowledge that losses will not be overcome by the future "with project" condition, i.e. there will still be a net loss with the project in place unless restoration measures are sufficient to overcome it and/ or wetlands are provided room to migrate landward. The USACE also fails to acknowledge that there may be benefits to wetlands and water quality through storms and storm surge events that would be impeded by the presence of surge barriers. The Corps should greatly expand the background discussion and scientific analysis pertaining to wetlands and potential impacts of this project on wetland resources for each planning reach. There should also be a discussion focused on current projects which are attempting to restore Jamaica Bay wetlands and how the project may affect (positively or negatively) the success of these and future efforts to improve bay health. It should be further considered, as an integral part of the TSP, to include such measures.

Response: This section will be revised to address the revised project area that is inclusive of four NNBFs designed for high frequency storm events, and the exclusion of the storm surge barrier. The revised text will take into consideration these considerations as it relates historic and project loss of wetlands in Jamaica Bay. The storm surge barrier is no longer part of the Recommended Plan.

CRBS – Designated CBRA areas – Sec. 2.3.5.5 -- All of Jamaica Bay and the western portion of the Rockaway Peninsula are CBRA areas. The purpose of the CBRA is to conserve coastal barrier resources through dis-incentivizing federal expenditures and

financial assistance that encourage development in these areas. P. 34 of the HSGRR/EIS states, without qualification, "The project area meets with the exemptions identified below …" and then lists the CBRA exemptions or circumstances under which federal investment is not contrary to the CBRA. The report fails to establish and sufficiently demonstrate, applying the purpose and legislative intent of the CBRA and its language, that the project actually meets CBRA exemption criteria.

Response: The CBRA area associated with the Jamaica Bay and the Rockaway Peninsula is NY60P which is per CBRA an "otherwise protected area" which the only restriction is not allowing the purchase of flood insurance by entities. The Draft HSGRR/EIS will be revised to reflect this determination.

7.26 – *Any Adverse Environmental Impacts that cannot be avoided* – "Permanent impacts will be fully mitigated by the creation of 247 acres of natural habitat. No other long-term environmental impacts are expected to occur as a result of the TSP." – see table 6-2.

Response: The mitigation evaluation will be revised as noted above and included as part of the revised GRR/EIS.

Regarding these sections and the associated tables presenting habitat impacts, there is no distinction or indication of which impacts are attributed to implementation of the surge barrier versus implementation of the Atlantic Ocean shoreline measures. There is also no background on what analysis led to the data presented in the tables and thus no way to verify or qualify anything presented.

Response: The mitigation evaluation will be revised as noted above and included as part of the revised GRR/EIS. Any identified impacts will be related to Atlantic Ocean shoreline measures in revised GRR/EIS, or the four NNBFs.

10.1 *Recommendations, Overview* - States "environmental resource concerns were addressed early in the study process to assure that adverse impacts were avoided to the maximum extent practicable". While there has been dialogue among agencies, important environmental resource concerns expressed by DOS in commentary provided in January 2016 and by other agencies including the DEC and NYC DEP involving water quality, long term ecological health of the bay, and impacts to bay wetlands have not been comprehensively addressed within the HSGRR/EIS to a point where the conclusion that "adverse impacts were avoided to the maximum extent practicable" is a reasonable one.

Response: The mitigation evaluation will be revised as noted above and included as part of the revised GRR/EIS.

Re: Decommissioning – This topic is missing from the report. Please discuss economic costs associated with decommissioning and removing the surge barriers in the future. Discuss when and under what circumstances and conditions the surge barrier would become ineffective and/ or non-operational to perform its intended functions.

Response: the storm surge barrier is no longer part of the Recommended Plan.

Re: Plan Recommendation - TSP – C1-E – May be refined or altered at the Agency Decision Milestone (ADM) based on public, policy, tech. reviews of draft HSGRR/EIS – Specifically for the alignment of the SSB, NPS land features, and residual risk features.

Response: Noted. The storm surge barrier is no longer part of the Recommended Plan for this study as a result of the ADM.

Re: Alternatives Development – Alternatives analysis appears to have been done as an assessment of alternative proposed alignments of the SSB – resulting in selection of C1E. Where is there reference to prior analyses of full array of alternatives including the No action alternative, evaluation of AO measures with and without the SSB, and the various alternatives including the Jamaica Bay perimeter plan? How were these evaluated and compared with the TSP.

Response: The plan formulation to date will be revised in the revised Draft Final GRR/EIS in an attempt to better explain the process and screening. The storm surge barrier is no longer part of the Recommended Plan.

Re: Modelling/ Tributaries – Modelling of potential impacts at individual tributary gates should be conducted before the preferred plan is authorized in order to protect bay health and ecology.

Response: The tributary gates were part of the Perimeter Plan, which was not the TSP, except for the measures proposed in Sheepshead Bay, Gerritsen Inlet, and Coney Island. These features are considered to be part of the proposed storm surge barrier tie-in plan and will be further evaluated under the NYNJHATS study. Since they have been screened out, no further analysis will be conducted on tributary gates.

Re: Post-project monitoring/ reporting – The Corps should include an outline of its plan to monitor and report on post-project recovery of ecological communities to pre-project levels or better – e.g. beach infauna, shorebird presence and foraging, and recovery of benthic communities in the borrow areas.

Response: The District and NYSDEC presently engaged in multiple coastal storm risk management projects to protect communities along the South Shore of Long Island (including New York City). Concern about ecological impacts due to these dredging and placement operations has been focused on potential detrimental effects on infaunal benthos, a major source of forage for commercially important coastal fish and invertebrate species. Previous studies of beach nourishment (e.g., Nelson 1993, Burlas, M., Ray. G. L. & Clarke, D. 2001) concluded that, in most cases, impacts from beach nourishment are minor. Impacts such as short-term reductions in standing stock biomass (an indicator of secondary production) are outweighed by benefits (e.g., medium- to long-term increases in flood protection and recreation), making such projects clearly in the public interest. However, because most previous studies were constructed in beach environments geographically distant from New York (e.g., New Jersey and southeastern U.S., questions have been raised as to the applicability of results reported elsewhere. As a result, the District has been sampling affected borrow areas the last 2 years sharing the results with Bureau of Marine Habitat (East Setauket). Findings from this study shall be intended not only to assess impacts associated with the immediate dredging and filling operations, but also to confirm the potential for impacts from subsequent renourishment operations and similar projects in the New York-New Jersey area.

Environmental impacts from beach nourishment are typically confined to the immediate

borrow (dredge) and beach (fill) areas and include reduced abundance of infauna, altered infaunal community structure, altered feeding habits among fish, crabs, and other commercially important species (due to changes in the availability of prey items), and increased turbidity. The overall objective of monitoring applicable to the South Shore of Long Island program is to determine if these impacts are severe and long-term and allow for resource managers to make better informed decisions on future projects.

There are no standard sampling programs for collecting this type of information; however, Cochran (1963), Morrisey et al. (1992), and Nelson (1993) provide useful guidelines, Saila et al. (1976), Cohen (1988), and Underwood (1992) provide specific advice for applying these principles to environmental impact studies. Each borrow area will have one year of pre sampling and three years of post-sampling events.

Detection of changes in benthos at both the borrow areas is the major focus of the monitoring program. Although the Program addresses general concerns associated with beach nourishment, certain aspects were tailored to fill specific gaps in knowledge relevant to the specific project area.

Purpose of monitoring program is to assess the potential impacts of offshore dredging activities and to identify ways in which dredging operations can be conducted so as to minimize or preclude long-term adverse biological and physical impacts to the environment. The primary study elements are: 1) characterize benthic ecological conditions, using existing data sets and data collected from field work, in and around the proposed sand borrow sites; 2) evaluate benthic infauna present in the proposed sand resource areas, and assess the potential effects of offshore sand dredging on these organisms; 3) develop a schedule of best and worst times for offshore sand dredging in relation to transitory pelagic species; 4) evaluate the potential impact of offshore dredging and consequent beach replenishment on sediment transport patterns, sedimentary environments, and impacts to local shoreline processes.

Re: Real Estate considerations –p.132

What is the plan if the non-federal sponsors cannot acquire, furnish, fund or otherwise provide the lands, easements, rights-of-way, and utility relocations necessary to implement the project? Is the federally funded project going to move forward ahead of all of these things being secured?

Response: If the required lands, easements, rights-of-way, and utility relocations necessary to implement the project cannot be provided, then the separable portions pertaining to that real estate will not be built. The project can move forward into the Pre-construction, Engineering, and Design (PED) Phase as the non-federal sponsors work to secure real estate. However, necessary real estate instruments, such as rights of entry for surveys and boring work, may be required during PED Phase. Construction Phase will begin once Real Estate is acquired and not prior.

Re: Navigation – 7.16 – Concludes that “no adverse impact on navigation is anticipated from the closed barrier as navigation during a storm is unlikely” –

The report fails to address problems related to the barrier closure during a large event, potential for debris, vessels, and sediment deposition in and around the structure which may have impacts for navigation in coming weeks following a major event.

The report should address, in narrative form, the types and sizes of vessels currently

using and anticipated to continue using this passage. [See also infrastructure, as the channel itself can be considered "navigational infrastructure" and its capacity should be considered in this report.] Does the restricted channel due to the structure narrowing the passage, have any impact on these vessels/ uses? What sort of guidance will be available for navigators in "being more careful regarding safe passage"?

Response: the storm surge barrier is no longer part of the Recommended Plan. The report will be revised to reflect this and the EIS will discuss navigation impacts for the Recommended Plan and the No Action plan. Discussion of above would need to be addressed in the NYNJHATS study which is currently analyzing the proposed Jamaica Bay storm surge barrier in a tiered NEPA approach.

Appendix A-2H – Residual Risk for Jamaica Bay

- P. 1 states that site specific factors will dictate the choice of inundation protection measures, but that it was not practical to account for all of the local, site-specific conditions to determine which measure was most appropriate at each location. Therefore, generic measures were selected. The recognition that these protection measures should consider local and site-specific factors is accurate, and we believe that more analysis could have been done, exploring an array of different measures beyond just structural or retrofit solutions. Please explain why there is no discussion of NNBF or non-structural solutions, if or if not they were considered at all, and if they were, why were they eliminated? We could not find any alternatives analysis for these features in the other reports. We believe that these residual risk features present a great opportunity to explore alternative options, such as NNBF. As it relates to the Corps planning objectives, this would be an opportunity to achieve the project objective of enhancing buffers and implementing NNBF.

  Response: Concur. Please see previous response about the development of the Residual Risk measures and subsequent and ongoing refinement into the HFFRRFs, which include up to four NNBFs and are examining potential non-structural measures for Broad Channel, based on the site specific conditions.

- If the 5-year return interval was chosen for analysis of low-lying, "at-risk" shorelines, does that mean that the surge barrier will be closed for any event that is larger than a 5-year level? Please clarify if there is any residual risk that was not addressed due to discrepancies between the level at which the gate would close and the interior residual risk factors that were discussed.

  Response: At the time the Draft Integrated Report was published, the Residual Risk measures and closure triggering event were still conceptual and uncertain. During subsequent analysis, the team has mapped three additional 'high frequency' flooding events in order to identify an appropriate closure trigger. This event is what the HFFRRFs are designed to. The flood extents for the current 3, 5, 10, and 20 year events were all mapped. It became clear with the mapping that once you went to a 20 year event the inundation was widespread and that in order to manage flood risk from such an event you would basically need something more akin to the Perimeter Plan. Since the Perimeter Plan was already deemed less economically

efficient and more environmentally impactful than the proposed storm surge barrier, the team decided to design the HFFRRFs to a current 10 year, future 5 year flood event level (using the USACE Intermediate SLR curve). This operational parameter would minimize wear and tear and maintenance for the proposed storm surge barrier, as well as any impacts to navigation or the environment from closures of the barrier.

Since HFFRRFs were not economically justified in all of the areas where flooding is frequently experienced, the Recommended Plan still has residual risk for residents from both smaller and larger events, but would substantially reduce the frequency that residents in the areas of the HFFRRFs would experience flooding. Residual risk will be discussed in the report, similar to many of DOS' previous comments.

Appendix D - Economic Benefits

General comments:

1. Subdivision of Project Area: Two planning reaches are subject to distinct risk mechanisms (p. *i*) so evaluation of with and without project damages requires a different model. Appendix D-2 Jamaica Bay Planning Reach Benefits is identified on p. 2, but no copy of that document was provided for review.

   Response: Appendix D-2 is part of Appendix D (available on the CENAN website), and begins on PDF page 132 of 155.

   a. Specific information in 131 of 155 pages of the appendix relates only to the Atlantic Shoreline Planning Reach which is at risk from erosion, wave attack and inundation. Are we able to rely on the benefits estimate for the Atlantic shore components if the bay and inlet components don't advance?

Response: Yes, the benefits estimate for the Atlantic shore components are independent of the bay and inlet components. As such, the benefits estimate for the Atlantic shore components remain viable without the bay and inlet components going forward as part of the recommended plan.

   b. If the proposed surge barrier doesn't advance, can an alternative plan be extracted for the bay communities that would provide Corps program eligible measures to be coordinated with actions by other federal, state, local and private concerns?

   Response: The barrier has been moved to a different study and we have developed HFFRRFs as eligible measures to try and provide some protection for Back-Bay communities that could be stand-alone yet also complement a potential future storm surge barrier. These measures are being coordinated with other state and local efforts.

2. Risk definition and ecosystem health: The "risks" described are natural events for

which the ecological community is well adapted. Changes in landforms associated with these events are necessary for the health of the ecological community. As a result, we recommend emphasizing that the "risks" are potential negative effects to development and human uses, rather than environmental forces, ie., the "risks" are not waves, surge and erosion, but negative effects to development. This is an important distinction because many, if not all of the management measures proposed by the USACE will have detrimental risks for the natural community, which will have to be addressed elsewhere.

Response: Discussion of risk in the context of a coastal storm risk management (CSRM) study centers around risk to human life and safety, as well as to development, infrastructure and human uses, as assessed in NED benefits. Flood risk, though adapted to the ecological community, poses risk to human life and development and communicating that risk is a key part of a successful CSRM planning effort. Especially since our plan, as DOS points out, will still leave residual risk and we need people to understand this as it impacts their decisions regarding development, evacuation during storms, etc. Therefore it is appropriate to talk about the key elements of flooding (waves, surge, and erosion) as risks in the context of a CSRM study.

3. Non-standard Benefits and Recreation Benefits: We commend the Corps for estimating recreation values. The inclusion of these non-standard benefits is valuable for understanding uses and opportunities in the region. However, several issues with respect to how the project is understood by decision makers and the public are raised that should be addressed. Lack of examination of the full spectrum of existing and potential recreation opportunities weakens the objectivity of the report and undermines the ability of state and local interests to fully consider the effect of recommended measures. It's important that the best estimates of potential non-standard costs and benefits be presented for a comprehensive and realistic description of regional conditions and the effects of the project.
   a. Other recreation effects – The economic analysis used only represents current visitation practices under an assumption existing beach uses will continue with the project. Construction of project features may foreclose other recreation benefits.

      Response: This is referring to the storm surge barrier which is no longer part of the Recommended Plan.

   b. Residual Risks – The economic analysis does not describe the scale and frequency of damages to infrastructure and development that may accompany the proposed project, for example:
      i. The project does not eliminate inundation in low lying areas due to sea level rise;
      ii. Some storms may occur that exceed project design level of protection;
      iii. The project may not function as intended during a storm event;
      iv. The project may not be maintained to perform adequately;

v. There could be flaws in project construction materials or installation;
vi. Sea level rise may exceed the amount used as a basis for estimating benefits, which would reduce project benefits and/or project features could be compromised by accelerated sea level rise.

Response: Annualized residual damages are included in the tables which present with-project damages, which by definition includes events that exceed the design level of protection. The PDT is not aware of any specific methodologies that account for flaws in design, construction or operation of flood protection structures when analyzing benefits.

c. Potential losses are not described or quantified - The list of benefits estimated does not include the benefit gained by a variety of reduced losses, such as lost business operations, school closings, increased travel time, reduced need for temporary shelter, reduced debris disposal, etc. While these types of costs are difficult to estimate and may not be part of standard Corps procedures, they are important factors to consider and should be included in regional strategic management plans.
    i. If possible, a list of these costs should be included somewhere with an indication of how others might address them.
    ii. If included, guidance should point to the importance of estimating changes in these costs over time due to changes in development patterns and recommended project actions. The effects of storms, erosion and natural processes on community values, including project-related investments, should be addressed in a comprehensive review of alternatives.
    iii. NYC should be apprised of the costs the city will bear under alternative management strategies.

Response: The text can be revised to include a list of potential benefits not evaluated for this study, and could include a brief discussion of their likely impact / their expected magnitude compared to the benefits that have been evaluated, based on previous studies.

4. Characterization of project area: In general, there is insufficient information on the natural features and processes in the project area. As a result, it is difficult to determine how compatible proposed actions are with the landscape and regional hydrological and sediment processes, and whether impairments due to human actions in the study area or adjacent areas are having detrimental effects that could be addressed to help manage risks. Addressing the following general points would greatly facilitate project evaluation and efforts by others:
    a. Wind, waves, storms, surges and erosion are natural processes and can be expected to occur during the project life and foreseeable future. Land uses should be compatible with these events. To the extent that land uses are incompatible, information on which areas are most at risk and the reasons for those risks (what is in jeopardy and what environmental events would cause damage) would be helpful.

Response: Noted.

b. The nature of the landforms, barrier peninsula, inlets, marshes and floodplains should be described. How did these forms originate, how would they tend to evolve over time absent human intervention, and what human activities have taken place to modify these landforms?

Response: This should be addressed in the 'affected environment' section, the geological existing conditions, and the future without project section. Those sections will be revised to include this discussion where it is missing.

c. If sea level rise accelerates to high levels estimated by the Corps or New York City, what are the expected effects on landforms in the project area, and what development will be at risk? It would be helpful to identify areas that could be inundated during the project life, and areas that could be inundated 100 years from the start of the project, using highest estimated sea level rise projections.

Response: A sensitivity analysis describing what would happen and potential adaptive responses were the high levels of SLR to occur will be included in the revised report.

Specific Comments:

1. Physical Setting, p. 5 and Description of the Problem, p. 13: Rates of erosion and building exposure are well described, but the nature of the peninsula as a natural feature is insufficiently discussed. We suggest at least one paragraph be added that describes the rates at which the peninsula accumulated over time, the elevation of the peninsula and particularly developed areas relative to MHHW, the general patterns and rate of sand movement characteristic of the peninsula, the height and distribution of natural dune features, and how the peninsula might be expected to evolve under environmental conditions over time absent human intervention. This information is essential to effective regional land use planning and risk management efforts. Comparable information should be provided for the bay interior shoreline and floodplain areas.

   Response: Noted. These additional facts will be considered. The team will need to rely on existing information to include them. If DOS has any resources they can cite, that would be helpful. The PDT will see if information about land use and physical changes over time can be included in the revised report.

5. Description of the Problem, p. 13: The occurrence of storms and natural sediment movement processes is not the root cause of damages because absent at-risk development these damages would not occur. It is the placement of vulnerable development in locations subject to these forces leads to risk. This should be emphasized so that land use planners and other risk managers in the region are fully aware of the consequences of their decisions. To the extent that development is placed in locations where floods, storm surges and erosion are prone to occur,

defensive measures will be permanently required, risks will increase in the future, and the likelihood of damages is increased relative to inland areas. We suggest emphasizing these points in sections describing risks and natural processes.

Response: Concur, that developing in high risk areas is unadvisable and interrupts natural processes and the natural resiliency of an undeveloped shoreline. The revised report can emphasize this more. However, this area is highly developed already and has been identified by NYC as an area for further in-fill development irrespective of a federal CSRM project, in order to meet the unmet housing needs of NYC.

If there is any way to differentiate geographic areas or neighborhoods on the basis of different levels of risk, or different natural processes that could cause damages, it would be helpful to planners to know that. Are certain areas more susceptible to flooding, surge or erosion that others? Where is erosion significantly elevated in comparison to average rates elsewhere in the project area?

Response: The flood extent mapping that was done in the Back-Bay for the HFFRRFs will be a useful tool for this. The shorefront engineering appendix includes an evaluation of shoreline erosion rates along the Atlantic shorefront. Additionally, the FEMA flood risk maps (FIRM and PFIRM), as well as the CEHA maps are useful sources of information/tools to address the reviewer's questions.

The report can be revised to show in broad detail which shorefront reaches currently have greater or lesser background erosion rates, based on inputs to the Beach-fx model. Other than that the published flood mapping for the shorefront could be discussed, which would define areas vulnerable to wave action.

2. Without Project Future Conditions, p. 18: Rates of expected erosion are provided but there should also be an explanation of why the peninsula accumulated sand over the course of the 19th and early 20th century, but is eroding now. What is the reason sediment inputs to the peninsula are not maintaining continuing the historic growth of the peninsula? This may be largely due to construction of the jetty at East Rockaway Inlet, other intervening structures, dredging practices, or other factors changing sediment supplies. A general description of the reasons the peninsula accumulated and why it is eroding now should be provided. A project designed to counteract natural processes cannot be properly designed without comprehending the causes of the problem, nor can other regional managers make informed decisions. This information would be greatly helpful.

   Response: Please see the Shorefront Engineering and Design Appendix A-1 which documents shoreline changes and human activities in Section 2.2 Shoreline History and Section 2.3 Engineering Activities.

3. Paragraph 54, p. 20, beginning "In order to evaluate damages…". A sentence later in the paragraph states: "The alternative plans offer full protection up to the easternmost project limit at Beach 19th Street." We interpret this to be a Corps guarantee that no flood damages will occur during the project life with the recommended measures. If that is not the case, please revise the sentence to explain what is and is not provided

by the proposed measures.

Response: Sentence will be revised.

4. Economic Benefits Appendix, Jamaica Bay Planning Reach p. 2 (136/155): The shape of the project study area does not seem to relate to any geo-political or floodplain boundary. Please provide some explanation of how the project area was determined.

   Response: Figure 1 of the Jamaica Bay Planning Reach discussion referred to in the comment is based on the 500-year water surface elevation of +15 feet NAVD88, which includes the high estimate of sea level rise expected by 2070. Figure 1 of Appendix D also shows in the main document as Figure 1-1. Comparison of these figures to Figure 1-5 of the main document verifies the general boundaries shown on Figure 1 of Appendix D (part 2) follow the +15 feet NAVD88 contour. Figure 1 does not specifically follow the contours of the +15 feet NAVD88 contour, as the study area boundary shown in Figure 1 Appendix D (part 2) were drawn up-gradient to the nearest road. Clarifying text will be added to the revised document.

5. Structure Values, p. 24: The text states "All calculated values were adjusted for location using RS Means location factors and for depreciation using standard depreciation factors as applied in previous flood risk management projects for USACE-NYD." A better explanation of depreciated values is needed. Could some example depreciated value be inserted to help readers understand the estimating procedure? What is the construction cost estimate and what depreciated values are used in the model going forward in time? Do depreciated values reach a minimum as time goes forward, and if so what is that value? Readers do not know and should not be expected to know how the Corps applied depreciation in other projects.

   Response: The text will be revised to clarify the methodology by which depreciation factors are applied to structure values for the purposes of the benefit analysis, and to include a brief discussion of the rationale for use of depreciated values in studies of this nature.

   a. Does the model estimate depreciated replacement cost for future events? Some explanation of how the economic model accrues damages for modeled storm events over time is needed.

   Response: The report will be edited to explain how the economic model accrues damages for modeled storm events. The HEC-FDA model has the capacity to include a future year where the hydrologic engineering and/or economic data would have changed from the base year. Within the model the expected annual damage is assumed to be constant beyond the most likely future condition. The expected annual damage for each year in the period of analysis is computed, discounted back to present value at the beginning of the base year and then annualized to get the equivalent value over the analysis period.

6. SBEACH modeling, p. 37: The description of modelling indicates post-storm conditions

are reported for various features. It is routine for beaches to recover sediment naturally following storms. Do the models account for this recovery, or do the models assume continuous consumption of beach features over time, absent beach construction?

Response: SBEACH models the beach profile response to storms and does not include beach profile recovery. However, Beach-fx does account for beach recovery. Typically a berm width recovery factor of 90% to 95% is applied in Beach-fx. So if the berm erodes 100 feet during a storm event, 90 to 95 feet of berm width is recovered in the weeks/months after the storm event.

7. Non-shore Reaches, p. 37: Flood stage/frequency curves are used to estimate damages. Are the stage/frequency curves adjusted upward over the life of the project to account for sea level rise? The maximum estimated sea level rise damages should be reported, with and without recommended measures. How much continuing damages occur with recommended measures, and where are those damages expected to occur?

   Response: Stage frequency curves are adjusted upward to reflect future sea level conditions and average annual damages are calculated at different points in time to reflect changes in risks. Detailed tables of annual damage in current and future years will be updated in the Report Appendix and will quantify damages in each project reach.

   a. Estimates of effects without the surge barrier should be provided, in case the ocean front portion of the project goes forward separately. The surge barrier concept could be modified, replaced or abandoned in the future, and the state and local interests should know what those effects could be.

      Response: Since the barrier is no longer part of the recommended plan, the estimated effects without the barrier will be discussed in the revised report.

   b. A projection of damages 100 years in the future, with high estimate sea level rise, would be valuable for planning. The locations affected should be identified, and effects with and without project measures should be estimated.

      Response: Please see earlier response.

OFFICE OF THE MAYOR

253 Broadway - 14th Floor New York, New York 10007 www.nyc.gov/resiliency

Date: December 2, 2016

Subject: ***USACE East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Sandy General Reevaluation Report (Report) and Environmental Impact Statement (DEIS) – New York City Comments***

I. Top-Level Comments:

- The proposed buried seawall along the Atlantic shoreline in the Rockaways (section 6.1 and elsewhere) will protect New York City (City) communities that were among the most devastated during Sandy. The United States Army Corps of Engineers (USACE or Corps) should move expeditiously to construct this separable element of the project with funds appropriated in the wake of Hurricane Sandy while continuing to pursue additional funds to realize the full project.

  Response: The Corps has agreed to initiate P&S concurrently with the final stages of the Feasibility Study in order to address this concern/comment. The storm surge barrier, will be further studied under the NJHATS study.

- The Corps identifies a preferred alignment for Rockaway Inlet tide barrier in proximity of the Gil Hodges Bridge over two more westerly alignments (C-1E over C-2 and C-3) due to potential impacts to underwater cables and higher costs, respectively.

  The City prefers a more westerly alignment that avoids additional in-water construction and associated environmental impacts at Sheepshead Bay and Gerritsen Inlet and minimizes visual and environmental impacts of upland coastal defenses. Before moving forward with an alignment that will necessitate additional tide barriers in Sheepshead Bay and Gerritsen Inlet, such as C1-E, the Corps should produce more detailed analysis of the costs and environmental impacts associated with C-1E and C-1W compared with C-2 or an alignment west of C-2.

  Response: C-1W was screened out because it would have produced too much scour on the Gil Hodges Bridge, by the PDT's estimations. Please see earlier response on why C-1E was chosen as the TSP alignment. Not only does it maximize net benefits compared to C-2 and the perimeter plan, but there is less risk for costs to balloon during utility relocation, which is not required for C-1E. Any other alignments further west than C-2 were screened out as less cost effective alignments (i.e. not the NED plan).

- The USACE must ensure that the City is able to coordinate and comment on any forthcoming Corps EIS documents and plans as detailed designs are further developed. In order to fulfill its own environmental review obligations pursuant the New York State Environmental Quality Review Act, set forth in the New York State Environmental Conservation Law Sections

3- 0301(1)(b), 3-0301(2)(m) and 8-0113, additional detail regarding Corps actions, affected properties, and necessary local actions are necessary. Therefore, the Corps should conduct site- specific environmental review of project components that sets forth additional specificity and should issue draft versions of such documents for public comment. The City should be notified as the Corps develops a timeline that sets forth milestones for future design, analysis, and construction as well as projected dates for the release of related environmental review, design, and planning documents for public comment.

Response: Noted/concur. The Corps will continue to involve NYC in the regular PDT meetings of the study team. A member from ORR and NYC Parks regularly participate and meeting agendas and minutes are sent out every two weeks to a larger distribution list of NYC team members, which should help them to identify when added participation may be warranted. The Corps relies on the NYC representative/liaison to involve additional technical experts at the City at the appropriate times and works with the City to facilitate this.

General Comments:

- The Corps should recognize the City's successful appeal to the Federal Emergency Management Agency (FEMA) to revise the flood risk calculations and corresponding flood maps when discussing the 2013 preliminary Flood Insurance Rate Maps (PFIRMs) (in Section 2.3.3 and elsewhere) and provide context on the process for establishing new flood maps.

  Response: Concur, this should be noted. Could the City please provide a write-up on the context for inclusion? Thank you.

- This project will include significant operation and maintenance (O&M) obligations for the City.
  - As design progresses, the USACE should coordinate with the City and its operational agencies on any decisions that may impact O&M costs.

    Response: Concur. This is underway.

  - USACEs should make clear what reporting requirements will be imposed on the City.

    Response: Noted.

  - USACE should identify any training, support, and guidance that will be provided to the City in order to meet these O&M and reporting requirements.

    Response: Noted

- Assumptions for future sea level rise projections vary within the Report and DEIS. For example on page v the projection is 1 foot, and on page 71 the projection ranges from 1 to 5.4 feet. Sea level rise projections should be consistent throughout.

  Response: Concur, the report will be checked and revised for consistency.

- The final design of any engineered structures that may impact New York City Department of Parks and Recreation (NYCDPR) parklands should be completed in coordination with NYCDPR. In addition, the USACE should coordinate potential betterment projects with NYCDPR to ensure that funds are

used efficiently to provide New York City residents with the greatest benefits to open space and natural resources.

Response: USACE is fully coordinating with NYCDPR.

- Many of the proposed elements have the potential to impact existing sewer and water infrastructure in the project area. USACE should work in close coordination with the New York City Department of Environmental Protection (NYCDEP) to ensure that impacts are minimized and City sewer and water infrastructure is not compromised.

  Response: USACE is fully coordinating with NYCDEP.

- Specifically:
  - Any portion of the Tentatively Selected Plan (TSP) crossing existing water and sewer infrastructures should either (1) span or bridge over NYCDEP infrastructure so there will be no additional loading to the existing infrastructure or (2) USACE must demonstrate that the system foundation will not undermine existing water and sewer infrastructure.

  - USACE should demonstrate that the existing water and sewer infrastructure can withstand the additional soil fills.

  - TSP structures should not impede access and maintenance of existing DEP water and sewer infrastructure.

  - Effects on the effluent discharge capacity of the Coney Island WWTP (which is within the protected area but has an outfall outside the barrier) must be evaluated in coordination with NYCDEP.

  Response: Noted. USACE will continue to coordinate with the DEP.

- Many of the proposed elements have the potential to impact existing roadway infrastructure and traffic patterns in the project area. USACE should work in close coordination with NYCDOT to ensure that impacts are minimized and City roadway infrastructure and traffic patterns are not compromised. Specifically:

  - Raising of roads will require full-depth reconstruction of roadways and sidewalks; as part of reconstruction, traffic signals and lighting and all associated conduits need to be removed, redesigned, and reinstalled. Impacts to and redesign of this infrastructure should be coordinated with NYCDOT and other appropriate entities. City standard details and specifications should be used for the roadway design.

    Response: Concur. The team will continue to coordinate with NYCDOT.

  - Please identify whether USACE or NYCDOT will be responsible for the design and/or construction of street geometry changes.

    Response: USACE will be the responsible party, in partnership with and NYC. However, USACE can take lead on design and construction, in coordination with DOT.

- There should be a section that illustrates how storm surge barriers may affect current study streets (i.e., Flatbush Avenue and its gas pipelines) and provides related quantitative traffic/pedestrian/parking analyses.

  Response: Response: the storm surge barrier never reached the level of design to assess this. The storm surge barrier will now studied under the NYNJHATS study and any traffic impact analysis will considered as part of that study.

  - As design plans are developed USACE should provide travel demand assumptions on construction workers, trucks, and relevant Maintenance and Protection of Traffic (MPT) plans during construction period.

    Response: Please see above.

  - The TSP will have significant impacts on the Jamaica Bay Greenway, a 28-mile network of bike and pedestrian paths that will form a loop around Jamaica Bay when complete (10 miles have been completed to date). USACE should coordinate with NYCDOT on the project design to ensure adequate replacement of Greenway facilities and to minimize impediments to future Greenway construction. During construction, impacts to Greenway access should be avoided or mitigated with alternate routes. See appendix II for a list of areas where USACE TSP overlaps with the Jamaica Bay Greenway.

    Response: Thank you for providing this list. Our team will review to see if there are any unaccounted for intersections with our Recommended Plan. We have already begun incorporating boardwalk as-builts into our design. Now that the barrier is out and the HFFRRFs have changed, we will look again to see if there are overlaps and reach out to NYCDOT for as-builts or design plans in order to consider them in our designs. Thanks.

II. **Project Features:**

Rockaway Atlantic Side

- USACE should work with NYCDPR and NYCDOT to ensure appropriate in-kind replacement for existing recreation infrastructure, including but not limited to the Jamaica Bay Greenway, shoreline and boardwalk features impacted by construction.

  Response: Concur.

- USACE should work with NYCDPR to determine the design of the recreational access over the buried seawall, and address features including but not limited to:
  - The number, location, and design of all access points over the buried seawall, including access for maintenance vehicles and pedestrian access
  - The selection of surface material and finishes
  - The siting of construction staging areas
  - The alignment of permanent access over the new composite seawall to the beach at Belle Harbor and Neponsit that will maintain its current ADA accessibility

  Response: Concur.

- Removal of recently built ramps and stairs on the Rockaway boardwalk necessary to build the

stone revetment discussed in section 5.2.1 of the Report has the potential to significantly impact the project's costs. The USACE should provide additional information regarding:

- Whether the estimated cost for the reinforced dune factors in the removal of the king piles and reinstallation afterwards

Response: Costs for removal and reconstruction of ramps or stairs associated with the boardwalk was not accounted for in the original cost estimate. These costs will be included in the updated cost estimate for the project. The USACE will include additional narrative regarding any major work items and construction sequencing that relate to modifications of existing stairs and ramps to accommodate the new buried seawall design.

- Because the ramps will have to rest on top of the stone revetment once reinstalled, Whether there has been consideration to the weight of the ramps on the stone revetment and whether the pile configuration will be changed

Response: Details with respect to access ramps and stairs (size and support configuration) that cross-over the dune and provide access to the beach will be further finalized in the PED phase.

- Whether the stone revetment will have any impact on the stairs which were built down to the scour line

Response: Details with respect to access ramps and stairs (size and support configuration) that cross-over the dune and provide access to the beach will be further finalized in the PED phase.

- At the community meeting held on 10/13/October 13, 2016, the community responded very positively to the extension of the current groin field west to Beach 121st Street and many community members requested the groins be extended even farther west. Has the Corps considered adding groins in Belle Harbor / Neponsit where the City has experienced significant erosion following Hurricane Sandy?

  Response: GENESIS Modeling indicates that shoreline fronting Belle Harbor/Neponsit is relatively stable and may not need an extension of the groin field westward. The Tentatively Selected Plan groin field east of Belle Harbor will allow sediment transport westward to those communities from the new groins. A planned two-dimensional USACE certified CMS model will be used to simulate the downdrift shoreline morphological response to the new proposed groin field during the PED phase. Further extension of the taper groin field westward will be considered if modeling results warrant.

- USACE should set forth expectations for maintenance for the new reinforced dune and groins

  Response: Agreed. General maintenance expectations will be established and discussed during Feasibility, particularly regarding the proposed pump stations and road closure gates, which the team is currently seeing if those features can be replaced by less-maintenance intensive measures such as ponding and road ramps. If those are not possible given the space limitations, USACE will work closely with NYC and DEC to determine whether the proposed plan with the

maintenance involved is acceptable or not. The Operations & Maintenance Manual is prepared during subsequent to the Feasibility Study as the design is finalized.

- Does "suitable beach fill material" meet the New York State Department of Environmental Conservation's (NYSDEC) recommended soil clean up objectives for publicly accessible land? Any feature of the proposed project that will incorporate public access should be evaluated for contaminated materials at a later date to ensure there would be no significant hazardous materials impacts.

  Response: USACE does not consider soil clean up objectives when screened. Suitable sediment-sand with a grain size equivalent to or slightly coarser than sand found naturally on the beach-must be used (U.S. Army Corps of Engineers 2002[1]). In this study, beaches throughout the U.S. were examined to determine both natural grain size distributions and the sediment size that is stable under natural conditions. Sand within proposed borrow areas off the coast of Rockaway (i.e. out to 60 ft water depth) were sampled to determine their natural conditions. No assessment for Hazardous, Toxic, Radioactive Waste (HTRW) was required, since the borrow areas were not a concern of the U.S. EPA or NY State, nor are they part of the National Priority List under, Comprehensive Environmental Response, Compensation, Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA). Sand from the borrow areas is predominantly quartzose sand (>90%), which lacks the affinity for binding of contaminants. In addition, the extremely low organic carbon and clay content of the borrow area sediments makes the presence of contaminants highly unlikely other than at trace levels. (USEPA/USACE, 1991[2]).

Rockaway Inlet Tide Barrier

Response: The storm surge barrier is no longer part of the Recommended Plan and will be further studied under the NYNJHATS study.

- What level of risk is acceptable for water quality degradation, habitat, and tidal range effects in Jamaica Bay and other water-bodies that may be impacted by construction of the TSP (i.e. Gerritsen Inlet and Sheepshead Bay)? Is this accounted for in the mitigation requirements?
- Additional water quality modelling will need to be completed to evaluate impacts of a Rockaway Inlet tide barrier. Any modeling and analysis performed by USACE should be in consultation with DEP. Additional modeling should also be conducted on barriers across the Gerritsen Inlet and Sheepsehead Bay.
- The DEIS analysis indicates that the Storm Surge Barrier Plan results in a tidal amplitude change of 0.2 feet during the tide cycle. The Corps should evaluate the impact of this tidal pattern change on existing DEP outfalls in Jamaica Bay.
- The effects of tidal fluctuation on wetland restoration projects in Jamaica Bay should be

[1] U.S. Army Corps of Engineers (2002). Chapter 4: Beach Fill Design. In Coastal Engineering Manual-Part V. Vicksburg, Mississippi. 113 p.

[2] U.S. Environmental Protection Agency/U.S. Army Corps of Engineers. 1991. Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual. EPA-503/8-91/001. February 1991. USEPA, Office of Water/Department of the Army, USACE.

investigated.

- The wetlands at the greatest distance from the barrier and those with small inlets due to past modifications would experience reduced flushing. A 10% to 20% reduction for a 6 foot tidal range during average tides would result in a .06 to 1.2 foot difference, which could be significant.
- If storm surge barriers cross waterways that DEP vessels traverse (as depicted in Figures 5-12 and 6-2), DEP will need to be included as stakeholders during discussions of design so DEP vessel dimensions can be calculated into the design.

Roadway Floodgates

- The type of floodgate should be specified (swing, roller, etc.) and specifications should be provided for all materials, machines, and equipment, including overall quantities, costs per unit, and operation specifications.
- It is important that the City understands the resources required for deployment and operation of proposed road gates before gate designs are finalized.

  Response: During Feasibility, the design is developed to a roughly 50% level, enough to reasonably calculate costs and impacts. Detailed design will be done during the Pre-Construction Engineering and Design (PED) Phase. The Corps will work with DEP to fully define the resources required.

- Many proposed flood gates cross important evacuation routes. The USACE will need to coordinate with the City and its emergency services providers, New York City Emergency Management and NYCDOT, on alignment and an operational plan for street closures. A note in the design drawings should reference this forthcoming coordination.

  Response: Concur.

- The information pertaining to "Operations and Maintenance" in section 6.4 of the Report should provide specific details pertaining to the proposed roadway flood gates. These details should include a schedule and operating procedure for when gates will be deployed in the case of an anticipated event.

  Response: Operations and Maintenance details for roadway flood gates for any HFFRRFs will be developed during the PED phase concurrent with detailed design of the gates.

Residual Risk Projects

- The Corps should set forth the level of protection the residual risk features are designed to provide, how the Corps selected this level of protection, and how sea level rise will impact this level of protection?

  Response: Concur, this will be included in the revised Draft Final GRR/EIS.

- The Corps should set forth why the five initial measures included in the TSP were prioritized, how the remaining seventeen measures will be advanced, and the implications that a measure's inclusion or exclusion will have on its funding and implementation.

  Response: please see previous response on the development of HFFRRFs.

- Many of the residual risk projects overlap with planned City capital projects, including some coastal resilience projects with similar goals. The City and Corps should coordinate to ensure projects are not duplicative as planning progresses.

  Response: Concur, coordination is underway.

- The USACE's plan to raise Brookville Boulevard will continue to restrict natural tidal flows to the adjacent wetland. Phase I of the City's Raised Shorelines Citywide project also identified the raising of Brookville Boulevard as a high benefit project and evaluated alternatives that could enhance inter-tidal wetland exchange while also increasing the Boulevard's resiliency. The USACE should consider a design that improves tidal exchange as the passage of these waters is important for the protection and nourishment of the wetlands and for the function of the wetlands as a water retaining body. The Idlewild Watershed Communities Reconstruction Plan, produced by the Governor's Office of Storm Recovery (GOSR) through its New York Rising program, also identifies the elevation of Brookville Boulevard as a featured project.

  Response: Brookville Boulevard is landward of the floodprone structures in the Rosedale area, it was screened out because it would not provide any significant flood risk reduction benefits.

  Above image shows the houses which experience frequent flooding west of Brookville Boulevard, which would not receive significant flood risk reduction benefits were it to be raised.

- The raising of Brookeville Boulevard would likely exacerbate negative impacts to water quality in Idlewild marsh due to CSO discharges. This could potentially cause marsh loss and erosion in an already degraded habitat area. The USACE should analyze these impacts, which were not included in the DEIS, before finalizing any designs.

  Response: please see above.

- Impacts to coastal areas caused by the construction of residual risk features such as walls and

berms include loss of habitat, erosion, loss of public access, and general condition of the shoreline areas. In particular, construction of seawalls at the shoreline often accelerates erosion. These impacts must analyzed and mitigated.

Response: Potential impacts from the HFFRRFs will be analyzed in the EIS. The HFFRRFs now include four NNBF areas and the plan as a whole is expected to be self-mitigating because of this.

III. Report Sections:

Section 2 - Existing Conditions

- Section 2.3.3.7
    - Fauna are omitted from description of biological communities; some connection to the broad class of animals listed in section 2.3.8 should be made in this section.

Response: Will be revised to include appropriate references.

- Section 2.3.5.2
    - The U.S. Department of Commerce approved the revisions to New York City Waterfront Revitalization Program on June 9, 2016. The revised policies, available at www.nyc.gov/wrp, should be used for the review of consistency of this project.

Response: Team will review and update as needed. Thank you.

    - There is also a revised Coastal Zone Boundary available online that should be used to update Figure 2-11.

Response: Will be revised to include the most recent Coastal Zone Boundary.

- Section 2.3.75
    - The high marsh areas noted as invaded by common reed in paragraph 2 are undervalued because the full range of function of these areas is not assessed. Very little high marsh remains within parkland – most has been converted to low marsh. These remaining high marsh areas serve multiple purposes: they are the only areas available for low marsh migration and they are extremely valuable habitat for obligate salt marsh nesting ground birds. These functions should be considered highly valuable and factor into the analysis, which focuses solely on the value of habitat services and functions of this area, and not its use for marsh migration.

      Response: While the mitigation evaluation will be revised, the project team recognizes the high value of native high marsh habitats; especially within Jamaica Bay. The text will be evaluated and revised as necessary to ensure the value of high marsh habitats is not understated.

    - The Report does not comment of the causes of the invasion of phragmites into high marsh areas. It should be noted that this largely occurs on the fringes of marshland where there has been fill introduced in to the high marsh, and thus elevations are increased in adjacent areas, and at the freshwater interface of wetlands, where there are likely high nutrient sources.

Response: Due to the highly urbanized nature of Jamaica Bay, phragmites has invaded the majority of high marsh habitats and even at sites where fill has not been introduced. However, it's recognized that it most frequently the result of some form of anthropogenic disturbance. The text will be revised to address this comment.

- There is no mention of the biota/fauna that are dependent on the high marsh areas within the section titled "Biological Communities."

Response: Appropriate link to species that utilize high marsh areas will be included.

Section 3 - Future Without Project

- NYCDEP's 26th Ward, Coney Island, and Jamaica waste water treatment plants (WWTPs) should be shown on Figure 3.3 Map of Critical infrastructure (which appears to only indicate Rockaway WWTP).

  Response: Thank you. These wastewater treatment plants will be added.

Section 4 – Formulation and Evaluation of Alternative Plans

- USACE should incorporate an assessment of all impacts and benefits of the TSP on NYCDEP infrastructure into the more detailed cost estimate that will be developed.

  Response: It is beyond the scope of the study to provide that quantitative analysis. However, USACE will continue to coordinate with NYCDEP to help with common understanding of what would be required of NYCDEP and what USACE can construct in terms of interior drainage improvement.

Section 7 - Environmental Impact Statement

Additional environmental analysis is necessary as the design of the project progresses or as separable elements of the project progress.

Response: The environmental analysis will be revised based upon the new project area.

- Additional environmental review must also identify any actions that the City, its agencies, and non-City stakeholders must take to facilitate the completion of this project.

  Response: the team is actively coordinating with the City on this during regular PDT meetings, bi-weekly higher level coordination meetings, and other meetings, as needed. The Project Partnership Agreement (PPA) clearly lays out all of this and is signed prior to construction.

- Though the DEIS is necessarily generic due to the conceptual nature of the current plan, USACE should consider adding discussion that further explains the anticipated framework for additional review that the Corps will conduct, especially for the Rockaway Inlet barrier, including a description of the additional studies that are expected and at what point in the process those details will be presented publicly.

  Response: The barrier is no longer part of the Recommended Plan but is being evaluated under the NYNJHATS study. The NYNJHATS study will use a tiered NEPA strategy and will lay out what types of analyses are planned and when in the process they will occur.

- The City and its agencies, as well as non-City stakeholders, must be provided an opportunity to comment on forthcoming environmental analysis undertaken as design progresses on the project or separable elements of the project, and the Corps should set forth the process for facilitating such comments.

  Response: Noted.

- The literature review is based primarily on only one study Fugro, 2016)[1] which is inadequate for a project of this magnitude. The USACE should review additional sources, including Pater (2012) [2], which was referenced in the Fugro study.

  Response: Additional references were included in Appendix I. However, the GRR/EIS will be revised to include a more thorough discussion of these impacts and draw upon a diversity of literature sources.

- The USACE should provide a noise analysis for the construction period.

  Response: Noted. Noise will be discussed in the revised Draft Final EIS.

- 7.4 Air Quality: For Air Quality Construction analysis, projects lasting more than two years are not considered temporary. Discrete stages of construction should be described and potentially analyzed in further detail.

  Response: A General Conformity analysis and Determination was completed for the project and a Statement of Conformity was signed. The project will be in full compliance with the Clean Air Act and Amendments. In so far as the project is a construction project with a specific duration (start-finish) and not the establishment of a permanent facility, the potential for impacts would be temporary, i.e. to occur only during the construction of the project, and not be sustained beyond that duration.

- 7.7 Invertebrate and Benthic Resources, 7.8 Finfish, 7.9 Reptiles and Amphibians, 7.10 Birds, 7.11 Mammals: The no action analysis assumes a greater level of damage to coastal ecological habitat by high energy storms than the City has observed in past weather events. The USACE should consider additional analysis to validate these claims.

  Response: The GRR/EIS will be revised to specifically address high frequency storms and includes four NNBFs.

- 7.13 Protected Species: "USACE is engaged with the USFWS to ensure the latest reasonable and prudent measures for piping plovers and standard BMPs are incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected species under their jurisdiction." Please describe or provide example of these types of measures.

  Response: The Conservation Measures would consist of, but not be limited to:

1) The USACE will conduct surveys during the spring/summer, and prior to construction activities, to identify nesting plover in the Project Area and to document all known locations of plover. In addition, the USACE will document any other Federal or state-listed wildlife species observed in the Project Area during survey and will initiate consultation with appropriate state and Federal agencies.

2) Symbolic fence and signs will be placed around all plover nests and brood rearing areas located in the construction area to deter use of the area and to protect sites from incidental disturbance from construction activities.

3) The USACE will conduct construction activities near active plover nesting areas from September 2 through April 14 to avoid the key shorebird nesting period.

4) Construction activities will avoid all delineated locations of the species during the breeding season and will undertake all practicable measures to avoid incidental taking of the species.

5) The USACE will reinitiate consultation with the USFWS to identify acceptable alternatives should any plover nest sites be identified within the direct construction footprint.

6) The USACE will monitor the Project Area before, during and after construction.

7) The USACE will educate residents, landowners, beach visitors and beach managers on piping plover.

8) The USACE will encourage local agencies to place time restrictions on beach use by vehicles to avoid key nesting and fledging periods.

9) The USACE will conduct follow-up surveys of plover habitat within the Project Area. Surveys will be conducted for three consecutive nesting seasons post-construction and a summary report regarding habitat use and nesting will be provided annually to the USFWS.

- 7.15 Recreation: The USACE should provide additional justification for the conclusion that "negligible short-term direct impacts are anticipated from disruption of access to recreation resources during project construction (e.g., beaches, parks, historic sites)" and a description of recreation facilities that will be displaced.

  Response: The GRR/EIS will be revised to further detail rationale that led to this determination.

- 7.24 Aesthetics: the USACE should provide more specific detail regarding viewsheds (including renderings or cross-sections if possible) to justify its claim that, despite viewshed disruption, "beneficial long-term direct impacts on aesthetics would be realized by implementation of the common project elements."

  Response: please see previous response regarding viewshed/aesthetic impacts of proposed

storm surge barrier which is no longer part of the Recommended Plan.

[1] Fugro. (2016) Lafayette River Tidal Protection Alternatives Evaluation, City of Norfolk, City-wide Coastal Flooding Project, Work Order No. 7, January 2016.
[2] Pater, P.D. (2012) Effect of the Removal of the Oosterschelde Storm Surge Barrier, Delft University of Technology, June 2012.

Appendix F – Real Estate Plan

- The City would not be able to complete a ULURP and environmental review findings to prepare real estate with the real estate plan provided. A more detailed real estate plan that specifies blocks/lots and roads to be acquired, eased, or otherwise affected by construction or drainage should be prepared in future reports. The Corps should provide more detailed environmental review to accompany future real estate plans should environmental review and provided to stakeholders for public comment.

  Response: A complete Real Estate Plan will be included in the revised Draft Final GRR/EIS. This plan will be released for a second 45-day review period.

Appendix G – Public Access Plan

- Plan should address the preservation of existing Greenway uses for both bicycle users and pedestrians during construction as well as in the built design.

  Response: The Public Access Plan is prepared by the Non-Federal Sponsors. This comment will be passed to the points of contact at DEC and NYC Parks, respectively.

Appendix M – Historic Resources

- In order for the New York City Landmarks Preservation Commission (LPC) to complete its review of historic resources, the USACE should provide the following information:
  - A figure consisting of a map of the cultural resources in the Area of Potential Effect (APE), including all listed and eligible resources. The map should include street names and a key containing districts and addresses of individually listed or eligible properties.

    Response: A map as described above will be included in the revised report.

  - The bibliography of previous reports/surveys used to complete the Cultural Resources section and Programmatic Agreement (PA) should be provided.

    Response: The references section of the main report includes citations of the reports, websites, etc., used to prepare the cultural resources section. It will be to ensure all citations used in the Cultural Resources section are included. The Programmatic Agreement will have an appendix that includes any reference material used in its preparation.

  - The USACE should provide information regarding the location of archaeology surveys referenced in Appendix I.

    Response: In the references section of Appendix I, each cultural resources citation will identify the location of the archaeological surveys used – which may be the location of the report (ex. New York District) or web address if found online.

  - A copy of the SHPO comments should be included in the DEIS.

    Response: Concur. Some of the correspondence was located in the Pertinent Correspondence appendix. For the revised report, the chronology of SHPO, NYCLPC and

other coordination will be included in Appendix L.

Appendix N –Rockaway Coastal Zone Management

- There is a new Consistency Assessment Form available at www.nyc.gov/wrp that should be filled out. The analysis of consistency should refer to the updated policies also available on that site.

Response: Concur. The new form will be used in the next draft.

- The new policy 6.2 requires analysis of how the project is designed to consider future sea level rise projections. This analysis should refer to the New York City Panel on Climate Change's sea level rise scenarios and projections for future 100-year storm events and future high tides. Please see attached draft guidelines.

Response: the Corps has coordinated with NYS and NYC on this and agreed that a sensitivity analysis will be done using the Corps' low and high level SLR curves, as well as a mid-point between the Corps' medium and high curves. Comparisons between the Corps' projections and the NYS and NYC projections, taken from the Corps' sea level change curve calculator (2017.55) show that, though these aren't perfect fits by any measure, if we aim to approximate NYS's medium projections under CRRA Part 490 and the 50th percentile under NYCC, we'll meet the state's and city's objectives. The mean of the Corps' medium and high curves appears to do so and will provide the City and State the added information requested to help in long-term planning and understanding how the project would perform under varying SLR curve projections.

Appendix I – Planned NYCDOT Capital Projects in Study Area:

Reconstruction of Beach Channel Dr – Phase B

- Phase: Pre-Scoping
- Construction Registration: FY 20

Beach 108th Streetscape Improvements

- Phase: Design Procurement
- Construction Registration: FY 20

Beach 84th St Reconstruction

- Phase: Pre-Scoping
- Construction Registration: FY 22

Somerville Area – Phase II

- Phase: Design Procurement
- Construction Registration: FY 20

Westbourne – Norton

- Phase: Preliminary Design
- Construction Registration: FY 18

Gerristen Beach – Street Reconstruction

- Phase: Final Design
- Construction Registration: FY 16

Reconstruction of Bergen Avenue Area, Bklyn

- Phase: Final Design
- Construction Registration: None

Jamaica Bay Greenway – Canarsie Pier Connector

- Phase: Planning/Scope Development
- Construction Registration: FY 20

South Brooklyn Crosstown SBS

- Phase: Planning/Scope Development
- Construction Registration: FY 20

Woodhaven Blvd SBS, Segment A

- Phase: Planning/Scope Development
- Construction Registration: FY 18

Broad Channel Bulkheads – Phase II

- Phase: Final Design
- Construction Registration: FY 18

Median Reconstruction on Cross Bay Blvd

- Phase: Pre-Scoping
- Construction Registration: FY 20

Downtown Far Rockaway Urban Design and Streetscape Reconstruction Project

- Phase: Final Design
- Construction Registration: FY 17

Brookville Edgewood

- Phase: Final Design
- Construction Registration: FY 17

Southeast Queens (Merrick or Guy Brewer) SBS

- Phase: Null
- Construction Registration: FY 20

Springfield Gardens Phase 5

- Phase: Design Procurement
- Construction Registration: FY 15

Appendix II – Jamaica Bay Greenway overlaps with USACE TSP:

Plumb Beach Network Link

- Currently, this segment of the Jamaica Bay Greenway, beginning at the intersection of Brigham St. and Emmons Ave in Sheepshead Bay, exists as a separated two-way path located on the southern side of the Belt Pkwy/Shore Pkwy right-of-way.
- The HSGRR&EIS proposes in the Tentatively Selected Plan (TSP) at this location an elevated promenade (partially vertical-faced, partially berm-faced).

Flatbush Ave/Floyd Bennett Field

- The existing Greenway facility at this location (Flatbush Ave from Shore Pkwy exit ramp to the

Marine Pkwy Bridge) includes a separated two-way path on the East side of Flatbush Ave. At the southern end of this segment, at Aviation Rd, Greenway users are routed across Flatbush Ave to the East side of the street before continuing south through the toll plaza and over the Marine Pkwy Bridge to the Rockaway Peninsula.

- The HSGRR&EIS proposes in the Tentatively Selected Plan (TSP) at this location a concrete floodwall (land).

Marine Parkway Esplanade (Jacob Riis Park / Beach Channel Drive)

- This segment of the Greenway extends approximately 0.9 miles from the Marine Pkwy Bridge towards the east, along the north shore of Rockaway Peninsula. The two-way Greenway path is located approximately midway between Beach Channel Drive and Jamaica Bay, in a 90'-wide strip of parkland.
- The HSGRR&EIS proposes in the Tentatively Selected Plan (TSP) at this location a concrete floodwall (bulkhead).

Riis Boardwalk

- The Greenway path connects Beach 169th St to Rockaway Beach Blvd, following the Jacob Riis Park Promenade path on the south (Atlantic Ocean-facing) beach of the Rockaway peninsula.
- The HSGRR&EIS proposes in the Tentatively Selected Plan (TSP) at this location beach restoration and an 18-foot reinforced dune-composite seawall.

Shorefront Parkway

- This segment of the Greenway extends approximately 1.6 miles on Shorefront Pkwy from Beach 108th St. to Beach 73rd St. The facilities for this portion of the Greenway include on- street bicycle lanes.
- The HSGRR&EIS proposes in the Tentatively Selected Plan (TSP) at this location beach restoration and an 18-foot reinforced dune-composite seawall. Though not directly overlapping, the Greenway facilities are immediately adjacent to the planned seawall and as such must be considered in the development of its design.

Rockaway Beach Boardwalk

- The Rockaway Beach Boardwalk is a multi-use path, providing facilities for both pedestrians and cyclists alike. The Jamaica Bay Greenway includes the Boardwalk as part of its route for 5.5 miles, from Beach 126th St to Beach 9th St/Seagirt Avenue in Far Rockaway.
- The HSGRR&EIS proposes in the Tentatively Selected Plan (TSP) at this location beach restoration and an 18-foot reinforced dune-composite seawall.

4.2 Stakeholder Comments and Reponses

Comment	USACE Response
"extend the public comment period on the above-referenced proposed Draft Report and Environmental Impact Statement by a minimum of thirty (30) days beyond the currently scheduled public comment deadline. The Draft outlines complex plans for a $2.6 billion-dollar long-term coastal storm management strategy for Jamaica Bay. The current 60 days does not provide adequate time for the communities and stakeholders to review the lengthy report and provide comprehensive recommendations that have the potential to strengthen the project. The ACOE is providing a potential roadmap for flood risk reduction in coastal Brooklyn and queens with the Draft and the public should play a major role in shaping the future of the project. Extending the public comment period allows the public to make better long-term decisions that will impact their communities.	Public comment period was extended in response. No additional comments received.
"formally request that the U.S. Army Corps of Engineers extend the public comment period on its Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay. Due to the scope and complexity of the proposed project, the Army Corps' recent extension of the Environmental Impact Statement's public comment period from November 2, 2016 to November 17, 2016 is inadequate to foster meaningful public comments. Specifically, we request the Army Corps to approve a 90-day extension to the draft Environmental Impact Statement's original 60-day open comment period. The purpose of the National Environmental Policy Act is to "insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken." NEPA clarifies that this "information must be of high quality." and that both "[a]ccurate scientific analysis, and public scrutiny are essential...." The Environmental Impact Statement's absence of accurate scientific analysis both renders it insufficient for a draft EIS and forecloses the public's ability to properly and fully analyze its true environmental impacts. The public must not be limited to commenting on a plan's merely hypothetical and speculative impacts. Based upon these and other deficiencies, we request that the Army Corps, at the	Public comment period was extended to 2 December 2016 in response. No additional comments received. Based partially on the comments received, which were considered as part of the Agency Decision Milestone, the TSP was amended to move all further consideration and evaluation of the proposed storm surge barrier to another CSRM study that is looking at regional CSRM, namely the New York and New Jersey Harbor and Tributaries Study. A Revised Draft GRR/EIS was prepared for the updated Recommended Plan and released for a second public comment period. Specific comments regarding the analysis in the Draft GRR/EIS are addressed further down in this comment and response table.

very least, provide the public with a greater extension to the Draft Environmental Impact Statement comment period. A seventy-five day public comment period does not provide the public with enough time to develop and submit helpful comments. See 33 C.F.R. 230 .19(a). The DRAFT ENVIRONMENTAL IMPACT STATEMENT The Draft Environmental Impact Statement is a lengthy 270-page document that outlines the Army Corps tentatively selected Coastal Storm Risk Management plan for the Atlantic Coast of New York. The tentatively selected plan involves a large project area that spans multiple Boroughs of New York City (King and Queens Counties) and Nassau County. Specifically, the project area "consists of the Atlantic Coast of NYC between East Rockaway Inlet and Rockaway Inlet, the water and lands within and surrounding Jamaica Bay, New York," and "the low lying Coney Island section of Brooklyn...." This massive project is estimated to cost over $3.7-billion-dollars, result in the loss of 154 acres of natural habitat, and potentially impact the project area's "[m]ore than 850,000 residents, 48,000 residential and commercial structures, and scores of critical infrastructure features such as hospitals, nursing homes, wastewater treatment facilities, subway, railroad, and schools...." The Draft Environmental Impact Statement reveals that the tentatively selected plan has the potential to negatively affect Jamaica Bay's tidal range, water quality (e.g., dissolved oxygen, temperature, nutrient concentrations, etc.), ecological "habitat in the interior tribal tributaries and shallow areas of the Bay," as well as its neighboring coastal communities' real estate values. An initial review of the draft Environmental Impact Statement reveals numerous potential environmental issues, including but not limited to: (i) the Corps' use of outdated water quality geometric means for Fecal Coliform and Enterococci; (ii) the determination that only 240-340 million gallons of treated sewage will be discharged into Jamaica Bay per day (from WWTPs) without accounting for additional sources of discharges (e.g., CSOs, MS4s, illegal and elicit discharges, and direct discharges); (iii.) its unfounded determination that the project will not adversely affect marine mammals and sea turtles; and (iv) its complete failure to consider whether the Storm Barrier will exacerbate the Bay's already existent chlorine and heavy metal pollution, its nutrient load problems and inability to maintain Dissolved Oxygen	

levels at the water quality criteria threshold for fish survival; and, (v) whether the barrier will further restrict the flow of sediment into and out of the Bay, potentially creating new, or compound existing water quality problems (e.g., affecting the sediment's legacy contamination bioaccumulation). Indeed, the draft document does not even include a determination of exactly how the proposed gate will be constructed, admitting that additional modeling and analysis is required "to identify, quantify and conclusively address any possible impacts to water quality and fish and wildlife species and their habitats in the Bay." The funding for this massive multi-billion dollar project is not yet in place and a timeline for funding is indefinite. The draft Environmental Impact Statement may be intended to secure such funding, with the actual project not commencing until some uncertain future date. Thus, absent a true planned action, an analysis of the environmental impacts is entirely premature as it cannot possibly contemplate what conditions will exist when the project is actually constructed. CONCLUSION The potential impacts to Jamaica Bay's aquatic and terrestrial ecosystem, as well as its surrounding coastal communities, are significant. We request that the general public be provided with at least a 90-day extension to the original public comment period. If granted, this extension will enable interested parties and local residents to comprehensively review the draft Environmental Impact Statement and submit thoughtful comments. "…a minimum of 150 days is required to facilitate any meaningful public participation, it is our firm belief that the Corps' decision to merely extend the public comment period from November 2, 2016 to November 17, 2016 was clearly insufficient.	
	Public comment period was extended in response. No additional comments received.

Thank you for your attention to this matter, and we look forward to your prompt response.	
The Draft Report and EIS identifies overall project features, but acknowledges that aspects of the project, including some major components, have not been finalized. These details need to be worked out in order for an EIS to thoroughly assess environmental impacts. A process for reviewing and commenting on the components of the plan that are not yet finalized must be provided prior to finalization of the plan.	Corps is separating the Atlantic Ocean Shoreline decisions--that are ripe for decision making--from the Jamaica Bay Planning Reach decisions. As a stand-alone EIS, the Atlantic Ocean Shoreline decisions do not require additional planning studies or analyses. The Jamaica Bay Planning Reach will be included in the Corps' ongoing New York and New Jersey Harbor and Tributaries CSRM Study affording the Corps in order to "*...work out the details to thoroughly assess the environmental impacts...*"
A large component of this project is constructing additional or enhancing existing hardened structures along the shoreline, e.g., groins, which are known to alter sand transport and can actually increase erosion in areas, which would degrade and destroy existing beach habitat. A-NY would like to see agreements and financial commitments in place between USACE, the NY State government, and local sponsors to monitor any habitat loss as a result of this project and then respond and address issues relating to habitat loss, in particular beach and wetland loss.	Monitoring of changes in habitat will be discussed in the Jamaica Bay Planning Reach segment of the New York and New Jersey Harbor and Tributaries CSRM Study.
This project needs to include a more thorough assessment of managed retreat from the coast. Strategies such as voluntary buyouts, converting flood zone properties into natural areas that serve as buffers during future storm events, living shorelines, and preventing further development of flood zones should be considered. Managed retreat is the only strategy that will reduce direct impacts to communities and reduce long-term economic impacts from storm damage. Studies comparing managed retreat over armoring have found managed retreat to be a better option. For example, the City of Imperial Beach in California conducted a long-term assessment of managed retreat over armoring and concluded that by 2100 the City would spend nearly five times as much on continued maintenance and new armoring compared to managed retreat.	Managed retreat was eliminated as a comprehensive measure during plan formulation. However, NYC's "Build it Back" program offered buyouts/relocation to residents with high coastal storm risk and where these buyouts were voluntarily accepted, homes were removed from the floodplain.

We feel additional evaluation on the impacts to Saltmarsh Sparrows and their preferred "high" saltmarsh habitat need to be conducted in consultation with biologists who are experienced with this species and their habitat requirements in order to adequately assess impacts to this highly at-risk species.	Monitoring of changes in habitat will be reassessed and discussed in the Jamaica Bay Planning Reach segment of the New York and New Jersey Harbor and Tributaries CSRM Study.
The Draft Report and EIS state that the impacts of the Alternatives on erosion and deposition within Jamaica Bay and, therefore, on the wetlands within the Jamaica Bay ecosystem, have not been evaluated. Those are some of the most notable habitats within the project area and not understanding how the alternatives, including the preferred alternative, will impact erosion and deposition within Jamaica Bay is a significant flaw in the project. Also, listing "0" acres impacted in Table 7.4 for wetlands is misleading, because the potential of this project to alter erosion and deposition within the bay has not been evaluated.	Monitoring of changes in habitat will be reassessed and discussed in the Jamaica Bay Planning Reach segment of the New York and New Jersey Harbor and Tributaries CSRM Study.
The proposed mitigation does not appear to compensate for the loss of beach habitat, which is estimated to be 13 acres (Tables 6.4 and 7.4).	The EIS provided a conservative approach to quantifying the effects on habitat by assuming a 15-foot right-of-way (ROW) width on both sides of the entire alignment for permanent loss of habitat. The 13 acres of beach habitat reported as permanently lost are summed from the area of this ROW intersecting beach habitat across the entire alignment. From Beach 19th Street to Beach 126th Street, the alignment would be buried seawall and composite seawall for more than eight miles in length. The Buried Seawall would be overtopped with sand, resulting in no permanent loss of beach habitat. The Buried Seawall would be overtopped for a large portion of the structure with a thin ribbon of exposed structure immediately adjacent to the existing boardwalk or surface roadway. The USACE does not consider the loss of a total of 13 acres of beach habitat--in this configuration and position in the landscape--to be a significant loss of habitat and its loss does not require mitigation.
The Draft Report and EIS states that the project would benefit federal and state listed species like the Piping Plover because it will protect vegetated areas. Piping Plovers typically nest in un-vegetated areas.	Text revised.
We commend the USACE for working with the U.S. Fish and Wildlife Service on implementing Best Management Practices (BMPs) to reduce impacts to federally listed species, but even if BMPs are implemented (e.g., restricting construction to the nonbreeding season) there will still be impacts and,	As a result of consultation with the Service, compensatory mitigation is not required for the species listed. Benefits to these species from enhanced or improved habitat or the implementation of BMPs during implementation are identified in the EIS.

therefore, A-NY would like to see mitigation to offset impacts to Piping Plovers, Red Knots, Common and Least Terns, Saltmarsh Sparrows, and other at-risk species. Mitigation for those species needs to consider the specific needs of those species, not just the general habitat that they prefer.	
This is a massive project that is likely to have unforeseen impacts post-construction. As such, a comprehensive monitoring program must accompany it, and the funding and commitment necessary to implement the monitoring program and respond to information gathered via the monitoring program must be secured before any iteration of this project is approved.	The Monitoring Plan will be based upon the results of the ongoing coordination with resource agencies as part of complying with environmental laws for this project.
"… supports a balanced approach to storm recovery and coastal risk reduction that includes long-term strategies that benefit the region's communities and coastal ecosystems. Our primary interest in this project is on how it impacts at-risk species like the federally threatened Piping Plover and priority coastal habitats such as beaches and salt marshes, and we believe that these and other birds will be harmed severely by the proposed changes to these areas."	An updated Biological Assessment has been prepared for the Recommended Plan and is included in Appendix D: Environmental Compliance. Impacts to federally threatened Piping Plover are discussed in the BA and area being coordinated with the US FWS, who is preparing a Draft FWCAR. The FEIS will re-examine the habitat classifications that are predicted to have changes in their habitat.
The beach habitat on the southern coast of Long Island is one of the most significant stretches of habitat to numerous priority shorebirds, including the federally and state-listed Piping Plover, Red Knot, and Roseate Tern, as well as the stated-listed Common Tern and Least Tern, and the state species of special concern Black Skimmer. It is clear from our review of the Report that this project will reduce the availability of that habitat in New York. The Report overstates the threat that overwash and breaches contribute to storm risk and damage, and the project will prevent the creation of overwash habitat, which provides optimal habitat for Piping Plovers. The Report does not outline how the project will mitigate for that. Further, the Report states that the project would benefit federal and state listed species like the Piping Plover because it will protect vegetated areas, but Piping Plovers typically nest in areas without vegetation.	As a result of ongoing consultation with the USFWS, the Service will be providing a Fish and Wildlife Coordination Act Report and has provided comment to the Corps on the effects determinations for listed species. The FEIS will reflect the status of the consultation process as well as update the basis for the effects determination for each of the listed species.

ESA Compliance section of the EIS acknowledges that the prey base for Piping Plovers will be reduced due to destruction of the wrack line, and that additional beach habitat may result in increased predator populations and increased recreational use, reducing the population of Piping Plovers. The EIS dismisses the impact on the Common Tern, Least Tern, Roseate Tern, and Black Skimmer by stating essentially that what is good for the Piping Plover will be good for other birds. The EIS not only contradicts itself, but ignores the very different nesting habits of Piping Plovers, the various terns, and Black Skimmers. Overall, the EIS downplays the impacts to shorebirds and does not fully evaluate impacts to shorebird habitat. Although we commend USACE for working with USFWS on implementing Best Management Practices to reduce impacts to federally listed species, the BMPs do not provide sufficient mitigation.	The contradiction will be addressed in the revision. In addition, as a result of ongoing consultation with the USFWS, the Service will be providing a Fish and Wildlife Coordination Act Report and has provided comment to the Corps on the effects determinations for listed species. The FEIS will reflect the status of the consultation process as well as update the basis for the effects determination for each of the listed species.
In addition to beach habitat, the project area includes impressive areas of salt marsh habitat, which supports the at-risk Salt Marsh Sparrow. The Salt Marsh Sparrow is found across the Atlantic Coast, but only breeds on a thin sliver of coastline between Maine and Virginia. The Salt Marsh Sparrow is on many state watch lists and is considered "vulnerable" on the International Union for the Conservation of Nature's (IUCN) list of threatened species. Following our review of the Rockaway Report, we concluded that additional assessment on the impacts to Saltmarsh Sparrows and their preferred, “high” saltmarsh habitat need to be conducted in consultation with biologists who are experiences with this species and their habitat requirements. At present, the impacts on erosion and deposition within Jamaica Bay and, therefore, on the wetlands within the Jamaica Bay ecosystem, have not been evaluated. In particular, it should be considered that the preferred alternative reduces overwash, but overwash provides storm protection benefits by accumulating sand and contributing to barrier island development and marsh creation	The interrelationship between the accretion and erosion processes from changes to the overwash process in the Rockaway shoreline and the potential long-term changes in high saltmarsh and wetlands habitat will be re-examined in light of potential effects to salt marsh sparrow.

A large component of this project is constructing additional or enhancing existing hardened structures along the shoreline, such as groins, which are known to alter sand transport and can actually increase erosion in areas, which would degrade and destroy existing beach habitat. The Report does not indicate that agreements, monitoring mechanisms, and financial projections between the New York State government and local sponsors are in place to monitor and address the issue of potential beach loss as a result of the project.	For Civil Works project such as this, the long-term role of the non-federal sponsor is articulated in Section 8.1 Division of Plan Responsibilities and Cost Sharing Requirements. Therein, the ninth bullet states "*For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal Government;" and "Hold and save the U.S. free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the U.S. or its contractors."*
Managed retreat from the coast needs to be considered. Strategies such as voluntary buyouts, converting flood zone properties into natural areas that serve as buffers during future storm events, living shorelines, and preventing further development of flood zones should be evaluated. Managed retreat is the only strategy that will reduce direct impacts to communities and reduce long-term economic impacts from storm damage	Managed retreat was eliminated as a comprehensive measure during plan formulation.
Finally, we strongly believe that further study is needed to consider how the storm surge gate will alter flow, water quality and habitat for fish and other wildlife. The Draft Report itself acknowledges that specific aspects of the project have not been finalized and is therefore incomplete. The proposed mitigation does not compensate for the loss of beach habitat.	Comment acknowledged.
We believe that a broad-scale structural solution is only one component of a risk reduction strategy. Even after the surge barrier, seawall/dune, and wetlands are constructed there will still be flooding and property damage due to storm events larger than the design standard or the failure of the engineered solutions. Therefore, we urge the Corps to work closely with the City of New York to implement additional local solutions to reduce flood risk. These measures include strategies such as flood proofing, raising homes, and voluntary buy-outs.	Managed retreat was eliminated as a comprehensive measure during plan formulation.

We understand that according to the EIS, the Tentatively Selected Plan (TSP) must be “engineeringly feasible, economically justified, and environmentally acceptable.” To that end we urge the Corps to use Nature and Nature-Based Features (NNBF) to the greatest extent possible to create ecosystem resilience and flood protection. We also urge the Corps to value the full suite of ecosystem services that will be lost or gained with the TSP, especially in the design of compensatory mitigation for the surge barrier.	During plan formulation, the Corps did "*use Nature and Nature-Based Features (NNBF) to the greatest extent possible to create ecosystem resilience and flood protection.*"
We understand that preliminary water quality modeling on the various surge barrier alignments has been conducted using the Jamaica Bay Eutrophication Model and will be repeated again after the final design is selected. However, we urge the Corps to assess a more comprehensive suite of models at this time because it is not possible to quantify and mitigate the impacts of the surge barrier without this work. There will likely be indirect, ecosystem-level effects that result from construction and operation of a surge barrier for large storm events (and for regular operation and maintenance). Dissolved oxygen, pH, nitrogen, and fecal indicator bacteria will be influenced by changes in normal tidal fluctuations, as predicted by the hydrodynamic modeling conducted to date, even when the gates are open. When the gates are closed in large storm events, heavy rainfall will cause Combined Sewer Overflow events and the surge barrier could cause water quality, based on the aforementioned metrics, to drop below critical biological thresholds, with fish, diamondback terrapins, and crustaceans trapped in the Bay by the barrier. Given these potential impacts of the surge barrier, we would like to advise that the Corps ensure that sufficient ecosystem service mitigation (beyond the acreage of footprint of the surge barrier) is considered in the TSP. The current mitigation proposed for Dead Horse Bay, Elders East, and Floyd Bennett t Field Wetlands are based on the number of acres impacted by the footprint of the proposed surge barrier (Tables 5-6 and 5-7). Mitigation should also occur to offset the loss of functions and services that the wall will cause to the water quality and connectivity of aquatic organisms when the gates are shut. Salt marshes, oyster reefs, and ribbed mussel beds will provide juvenile fish and crustacean habitat and denitrification	The need for, and appropriate use of, additional water quality modeling to identify ecosystem-level effects will be included in the Jamaica Bay Planning Reach segment of the New York and New Jersey Harbor and Tributaries CSRM Study.

ecosystem services to the bay, helping to offset the impacts of the surge barrier.	
Low-income and vulnerable communities such as East/Far Rockaway, Edgemere, Coney Island, Broad Channel, and Bay View/Canarsie stand to be disproportionately affected by flooding, storms, and sea-level rise. These communities deserve protection from the more frequent, low-intensity storms that affect the region and cause nuisance flooding, erosion, and limit safe outdoor access. We urge the Corps to consider using NNBF to create greater resilience for these communities that will enable them to recover from future storms. Wetlands, oyster reefs, and dunes can provide wave attenuation and flood control during the storm events when the surge barrier is not operational. These NNBF should include safe public access to the greatest extent possible (e.g., fishing piers, picnic areas).	Additional evaluation of the potential disproportionate effects to low-income and vulnerable communities based on the revised Recommended Plan was performed and included in the Revised Draft EIS.
Barrier islands are transient environments that change shape and size with incoming tidal wave action and the longshore transport of sediments. The construction of groins along the Atlantic Ocean Shorefront will affect these natural depositional processes and over time the system may become sediment deficient. The permanent seawall along the Rockaway Peninsula will require costly sand renourishment and maintenance over the 50-year life cycle of the project. In the future, we urge the Corps to consider the long-term benefits of raising homes or leveraging the buyouts that occurred in Oakwood Beach, Staten Island after Hurricane Sandy.	The benefits of non-structural solutions (e.g., raising homes or buyouts) were considered, but were not economically justifiable (i.e., they are too expensive).
We understand that the Corps uses Benefit Cost Ratios to select the TSP. However, these dollar-to-dollar ratios do not account for the full suite of ecosystem functions and services that the surge barrier will impact because ecosystem services cannot always be accurately monetized.	Comment acknowledged.
We recognize and compliment the Corps on the use of functional assessments (Evaluation for Planned Wetlands and Index of Biological Integrity) to determine the current ecological value of existing ecosystems. However, these analyses did not translate to a full accounting of ecosystem functions and services affected by the TSP (Table 5-6, 5-7). There will undoubtedly be indirect effects of the surge barrier and they extend beyond the footprint of the constructed features. We urge the Corps to use	The appropriate use of functional assessments to inform plan formulation and will be reassessed and discussed in the Jamaica Bay Planning Reach segment of the New York and New Jersey Harbor and Tributaries CSRM Study.

ecosystem service accounting methods, such as functional assessments, and complimentary tools, such as Habitat Equivalency Analysis, to evaluate the Alternatives and use this information to complement Benefit Cost Ratio. The Nature Conservancy demonstrated the use of functional assessments and Habitat Equivalency Analysis in our Urban Coastal Resilience Report: A Case Study in Howard Beach, Queens.3 We illustrate that hybrid infrastructure strategies integrating tidal gates, salt marshes, and shellfish can provide sufficient, cost-effective flood protection and superior ecosystem services to gray-only alternatives.	
The TSP presents two surge barrier alignments (C-1E and C-2). The EIS states that these alignments had a lower impact to the tidal amplitude than the other option(s) given the existing hydrodynamic modeling. Although impacts to water quality are still not well understood, we believe that alternative C-2 may be preferable to C-1E, due to its lesser impact to the properties of Gateway National Recreation Area. Construction of alternative C-1E would alter the visitor experience and change the character of Fort Tilden, Jacob Riis Park, and Floyd Bennett Field. In addition, given that open space and natural areas are limited in New York City, these NPS properties provide important bird nesting habitat that would be disrupted during construction. We also encourage the Corps to include the Coney Island tie-in as part of the final flood protection solution in order to ensure that the communities of Coney Island and Sheepshead Bay do not experience additional damages from flooding.	The barrier alignment selected and the Coney Island Tie-in will be reconsidered as the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study.
The Community Risk and Resiliency Act (CRRA) signed by Governor Cuomo in September 2014 requires that permittees and funding programs demonstrate consideration of sea-level rise projections, storm surge, and flooding. There are various references to sea-level rise projections in the EIS, including references to New York City sea level (Orton et al. 2014) as well as historic and accelerated sea-level rise rates consistent with current USACE guidance (EC 1165-211) but it is unclear whether they have expressly incorporated the requirements of CRRA. "…the Corps use a future projection that is higher than the 10th percentile of the ClimAid sea-level rise	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the requirements of the Community Risk and Resiliency Act (CRRA) from 2014 will be reconsidered.

models, or that map onto the "Medium" or "Medium-High" estimates articulated by CRRA"	
Our concern with the Plan is not that it seeks to protect humans and human infrastructure, but that it proposes to create structures that may or may not protect human settlements from storm events while at the same time causing damage and degradation to habitat important to bird species of state and federal conservation need (e.g. Piping Plover, Red Knot, Common Tern, Black Skimmer). There will undoubtedly be damage to ecosystem function of natural areas enjoyed by both wildlife and humans. How that damage is measured, valued, and mitigated? What is acceptable?	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the evaluation of the anticipated effects to listed species will be coordinated with the USFWS (federal protection) and the NYSDEC (NYS-listed species).
According to the report, the overall project features have been identified as a Tentatively Selected Plan (TSP). "Specific dimensions of the plan have not been finalized." It is difficult to assess environmental impact when the details of some of the major components have not been finalized.	Because the Jamaica Bay Planning Reach segment is being integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the dimensions of the TSP for the Jamaica Bay Planning Reach will be refined and presented within the larger CSRM Study.
"…concern is about habitat protection, including maintaining or improving water quality in the Bay. Construction or enhancement of hardened shorelines, installation or enhancement of 18 groins, installation of a 6.6 mile sea wall, and installation of one or more surge barriers at the mouth of the Bay would alter the movement of sand, constrain the movement of saltmarsh, and impact water quality in the Bay by limiting tidal flow and flushing effects. • How will these variables be measured? What will be done to restore habitat function and water quality if they are negatively impacted?	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the effects of the surge barrier on tidal processes (salt wedge, tidal amplitude, etc.) and water quality (e.g., residence time, DO, salinity, etc.) will be reconsidered as part of the CSRM Study. The long-term monitoring as well as adaptive management responses in the event that unacceptable effects are identified will be discussed in the CSRM Study.

*By providing incentives for people to not build close to the shoreline, buying property in the 100-year flood zone at fair market value and converting it to natural areas, and by installing living shorelines rather than armored structures, future severe storms will be buffered by the natural environment. This approach has been used in the UK with positive results, i.e. Northey Island in Essex (flooding in 1991) and Tollesbury and Orplands (flooding in 1995). Great Wigborough in the Blackwater Estuary is one of the largest managed retreat schemes in Europe. The program was started by the RSPB - The Royal Society for the Protection of Birds. They intentionally breached the original old sea wall to allow the held-back sea to flood through to create salt marshland. The marshland reverted to its original state and has become a great site for migratory and breeding birds. • Has the alternative of 'managed retreat' been thoroughly considered and taken into account?	NYC has engaged in an extensive buyout program which has purchased and removed a number of homes from the floodplain, called "Build it Back". In fact, the Jamaica Bay communities were all approached and offered buyouts that would be fully paid for by NYC. Where this has occurred, our plan returns to floodplain, as feasible, particularly in Edgemere. The Recommended Plan also includes natural and nature-based features, or living shorelines, in the several parts of the Mid-Rockaway design. Many of the communities and residents in this area have been there their whole lives or for generations and have strong ties to the area and no desire to leave.
*The NYC Department of Environmental Protection (NYCDEP) has described impacts to water quality of Jamaica Bay as having been plagued with high nitrogen levels from combined sewer overflow, increasing population, increasing human populations, disruption of tidal circulation patterns from landfill operations. The 2016 update on NYCDEP's Jamaica Bay Watershed Protection Plan describes how shoreline hardening, channelization, dredging, loss of sediment inputs from tributaries, and accumulation of particulates have affected historic flow patterns in the Bay, "eradicated natural habitat, impacted water quality, and modified the rich ecosystem that was present prior to the extensive urban development of the watershed." They further state "Yet great progress has been made, and studies show that water quality is recorded as the cleanest it's been in the past 100 years in the New York Harbor. • How will restricting the mouth of the Bay by installing storm surge gates effect water quality? Even when the gates are open, the supporting structures will extend into the inlet. We support "…that the width of the opened gates, if gates are installed, needs to be as wide as possible. The Plan suggests that the preliminary data from modelling the gates would impact water quality (p. x). Additional models need to be run, to examine the benefits from storm surge protection versus the costs to water	The sufficiency of the existing water quality modeling will be reconsidered as the Jamaica Bay Planning Reach planning is further refined and the effects analyses for that segment are integrated into the larger New York and New Jersey Harbor and Tributaries CSRM Study.

quality, water transfer, and aquatic animal movement."	
NYC lies within the Atlantic Flyway, a migratory route especially used by shorebirds and other waterbirds. Migratory stopover sites are as critical to sustaining the population of this species as are breeding sites and wintering grounds. As sea levels rise, stopover habitat will shrink, making those existing sites become even more important. (https://www.fws.gov/northeast/redknot/). When assessing mitigation opportunities, loss of stopover habitat must be considered in addition to loss of nesting habitat.	Comment acknowledged.
The list of State Threatened bird species needs to include Common Tern.	The common tern has been added to the list of NYS-listed birds.
The Plan states that the project would only minimally impact beach-nesting shorebirds when nests occasionally would over wash (p. 72). • Nest flooding is a major cause of early egg mortality and failed nesting in American Oystercatchers as well as in Saltmarsh Sparrows. This issue requires further evaluation by trained biologists. • A mitigation plan that will benefit bird populations impacted during migration or breeding needs to be described. • A monitoring plan for migratory and breeding birds needs to be in place, and the funds to support that work need to be identified	As a result of ongoing consultation with the USFWS, the Service will be providing a Fish and Wildlife Coordination Act Report and has provided comment to the Corps on the effects determinations for listed species. The FEIS will reflect the status of the consultation process as well as update the basis for the effects determination for each of the listed species. If the USFWS requires compensatory mitigation and a monitoring plan for listed species, such plans will be developed.
I propose a separate EIS to elucidate more clearly as to what the Coney Island tie-in will involve. My understanding is that the New York City EDC is currently conducting a study to evaluate Coney Island coastal storm risk management features. However, the draft EIS indicates that the structure of the tie-in will	Comment acknowledged.

utilize components drawn from the tentatively scheduled plan (TSP). For this reason, USACE should conduct the study of the Coney Island tie-in.	
I also believe that it is vastly important that the USACE takes a stand against development in unprotected shoreline communities that will result in a higher density population. In gathering information for this study, the USACE researched and examined the impacts that Sandy left upon the community. This situates your agency uniquely in a position to caution against increasing the number of residents that live directly in the path of a potential storm surge. I would greatly appreciate the USACE's insight and support in my efforts to severely restrict development along the waterfront until a proper plan for shoreline protection is put into place	Comment acknowledged.
The analysis of impacts to surfing and other types of recreation are inadequate in the document. The "Existing Conditions" section that starts on page 17 does not consider any human uses of the project area. Page 110 discusses "Recreation Benefits" but only mentions the economic implications of beach visits, nothing about impacts to recreational users. It is commonly known and widely agreed that after beach nourishment projects in the Rockaways the surfing is significantly negatively affected. How can the effects of the proposed project on recreational use be analyzed if there is not a baseline to compare with? Page 184 similarly does not cover negative impacts from beach nourishment, or the economic impacts of reduced surfer trips to the Rockaways because of negatively affected surfing conditions.	Section 2.3 Environmental and Historic Resources will be updated to include a new section describing the existing conditions relative to recreation.

"…cannot support adding additional hard structures into the surf zone or on the beach. Groins are a swimming hazard both for the risk of collision and also because they increase the power of the wave and will, by the Corps own estimates, only slow down but not prevent, loss of sand from Rockaway beach. …would also like to highlight that groins are not meant to function as storm protection barriers. Many Rockaway residents claim that groins will protect against future storm surges and impacts but this is not how they function. "… cannot support placing hardened structures such as the "composite seawall" on the beach. When waves hit a seawall, the wave is reflected back towards the ocean taking beach sand with it.4 Both the beach and the surf may disappear. If unexpectedly high erosion or lack of funding allows the composite seawall to be uncovered, the structure will lead to the disappearance of the public beach in The Rockaways.5 This will severely affect the economy and culture of the community "…groin project (in NJ) along their coastline has not performed as per the site's proposal projections. In fact, plans to remove or notch the groins were introduced to improve the situation. While we do not support additional hard structures in the ocean, we are curious why there is no mention of investigating methods to increase groin permeability such as nothing, shortening and reducing offshore crest elevation, all methods that have been shown to increase the longevity of beach fill. In one study, notching postponed renourishment for up to a year.	Comment acknowledged.
"…would like to see the agreements and financial projections between NY State government and local municipalities for the continued maintenance of this project. There is a serious financial responsibility for local governments attached to this project; we would like to be certain that this project is financially and legally sound.	Section 8.1 of the main report specifies the division of plan responsibilities and cost sharing requirements. Financial responsibilities of the non-Federal sponsor are discussed therein.
"…advocates that living shoreline structures be utilized in bays and other low energy areas where such practices would be possible, including Jamaica Bay. The Corps recently released Proposed Nationwide Permit B to streamline the process of implementing living shorelines.7 It would be remiss of the Corps to overlook such an important tool for erosion control….	Comment acknowledged.

These methods must be considered in order to protect the valuable habitat located in Jamaica Bay.	
Surfrider is concerned that the sea level rise (SLR) estimates used by the USACE are overly conservative. The table on page 70 shows only 5.36 feet of SLR by 2100 (in a "high" scenario), while the New York Department of Environmental Conservation estimate is 6.25 feet.9 New models by scientists that include larger Antarctic ice melting scenarios estimate that sea levels could rise as much as 6 feet by 2100.10 Due to the conservative SLR estimates, we believe that the beach fill quantities required to maintain this project need to be reconsidered. The USACE must use the best available science in estimating SLR to ensure that the millions of dollars of funds put into the proposed project are not wasted on an inadequately built project. Using realistic SLR estimates may add costs to the proposed project but they will pay off in less damage in the future. Basing this project on such conservative SLR levels, calls into question whether the projected benefits and intended protection USACE is presenting with this project will be achievable when SLR proves itself to align with the above predictions provided by the New York Department of Environmental Conservation.	The approach to quantifying the effect of estimated sea level change (SLC) on plan formulation is consistent with USACE policy.
Beach nourishment can negatively affect beach and ocean ecosystems in many ways. Starting offshore, important habitat areas can be negatively affected by so called "borrow" sites if they do not fill back in with sand. One study estimated that it took three years for borrow areas to fully recover, meaning that these areas could be left in a permanently decimated state with new beach nourishments scheduled every four years. Other borrow sites have filled in with mud or silt and have become anoxic areas after sand mining for beach nourishment projects has occurred. Once the sand is on the beach negative effects can occur to the beach ecology. Studies have shown that the tiny animals that live in the surf zone, which form the base of the food chain in those areas, can be severely depleted for 6---24 months after nourishment activities. This document does not adequately discuss those impacts or examine their effects to other trophic	The sufficiency of the analyses of effects to important fish species is being coordinated with the National Marine Fishery Service (NMFS).

levels including commercially and recreationally important fish species that might be affected.	
The type of sand can also significantly affect the beach ecosystem and the enjoyment of beach goers. If incorrect grain sizes are used they can harm beach organisms that are accustomed to a specific size. Grain size and coarseness of the deposited sand can accelerate erosion leading to steep beaches, which can result in dangerous shore breaks for beach goers.15 Steeper beaches lead to greater wave energy and a propensity for a type of breaking wave known as a "plunging wave", which is not only dangerous for recreational users but also perpetuates the erosion problem. Steep beaches and plunging waves create stronger rip currents and feeder currents and there are numerous reports of beach nourishment projects aligning with a series of serious injuries to recreational users. Additionally, if poor sand with shells, dark or foul smelling material, or rocks is used, this can affect beach goer attendance, which could lead to severe economic consequences for beach communities. Rockaway locals reported that after the beach fills following Sandy, there was a bad smell associated with the sand that was brought in and they opted to stay away from the beach until this subsided from fear of getting sick. It was also visible to residents that the most recent beach fill projects in Rockaway did not last as long as initially planned. Much of the sand was washed away with the first big storm. Surfrider is concerned that more frequent nourishments than proposed will be required, leading to further environmental degradation and negative effects to recreational use.	Comment acknowledged.
As residents and frequent visitors to Rockaway, we are aware of the efforts that are required to ensure the protection of the piping plover and other endangered species such as the red knot and humpback whale. We are concerned that a project of this scale will negatively affect these species despite assurances by	Effects to listed species are coordinated with the National Marine Fisheries Service as well as the US Fish and Wildlife Service (i.e., the Services) and the effects determinations will be made in consultation with the Services. Feasibility of construction and maintenance have been demonstrated in the FS.

the USACE. The Corps proposes seasonal and temporal limits on construction and maintenance of the proposed project to negate impacts to mating seasons of endangered species. However, this seems unfeasible given the large geographic and temporal size of the project.	
"…requests that the Corps evaluate a sand moving system as part of the proposed project, perhaps in conjunction with the composite seawall structure. There is considerable sand accretion at Breezy Point and erosion along the Rockaways and East Rockaway Inlet. Sand moved between those two points through a permanent system could be cheaper, less environmentally damaging, and result in better sand quality than large beach fill projects every four years. A similar system was proposed and implemented for Sandy Hook, New Jersey, but was destroyed by super storm Sandy before it was finalized	Alternative methods of moving sand for beach nourishment were considered in the alternatives formulation process. Finalization of design parameters and construction methods will be addressed during the Planning, Engineering, and Design (PED) phase of the project.
Managed retreat can be more economical in the long run. For example, the City of Imperial Beach in California conducted a long---term assessment of focusing on managed retreat instead of armoring. The study concluded that by 2100 the City will spend nearly five times as much on continued maintenance and new armoring compared to managed retreat. The proposed Corps plan does not include a buyback or retrofit option. We realize that the large amount of private residents in the 100---year flood zone makes these types of adaptations economically difficult. However, it would be irresponsible to not allow residents the option of having local governments buy back their property to begin the process of depopulating these low lying areas. These areas can be converted to community green spaces or gardens for the immediate future. To use super storm Sandy appropriated federal funds to solely focus on coastal armoring is a misuse of taxpayer funds.	The benefits of non-structural solutions (e.g., managed retreat including raising homes or buyouts) were considered, but were not economically justifiable (i.e., they are too expensive).

"…concerned about future use of the proposed seagate and the effects on the Jamaica Bay environment. The proposal states that the gate would only be closed for extremely high sea levels during storm events. But once it is in place, what mechanism keeps it from being closed more frequently? We envision a situation where political pressure leads to the gate being closed a few times a month or more during high tides Surfrider requests that local communities sign legal documentation stating that the seagate only be used during extreme storm events and not routine tide cycles. Jamaica Bay is a very valuable wildlife and recreational area and closing the bay off to the usual tidal cycle would have serious negative effects to the ecosystem. Many aquatic species rely on the daily tidal flushing to achieve their reproduction cycles and food location. Tidal flushing is also critical for water quality and oxygen levels. "…against placing hardened structures like the seagate into our coastal ecosystem, but in this case we believe the impacts from the seagate will be less than the impacts from hardening a significant portion of Jamaica Bay.	As the Jamaica Bay Planning Reach segment is being integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the effects of the surge barrier on tidal processes (residence time, salt wedge, tidal amplitude, etc.) and water quality (e.g., nutrients, DO, salinity, etc.) will be reconsidered as part of the CSRM Study.
There is little doubt that the proposed Breezy Point Risk Mitigation project to be undertaken pursuant to FEMA's HMGP was designed by the City in partnership with the BPC community specifically for coastal protection around the BPC community. The first phase (the soft costs) of the project have been approved by FEMA. The estimate for the total project is about $58 million. How could it not be considered in its entirety (or portions to be integrated into the USACE project) as a viable, cost-effective alternative for "coastal storm risk management" ("CSRM") which is the stated purpose of the USACE's project? We have provided materials on this alternative approach with this comment letter. It must be studied along with the other alternatives proposed in order for the HSGRR and EIS to be considered complete. Failing to consider the adequacy, environmental impacts and cost of the FEMA project is a significant omission under NEPA requirements on the part of the USACE.	The design, placement, and the extent of CSRM provided to Breezy Point by the Atlantic Ocean Shoreline will be refined during analyses to be conducted prior to the Final HSGRR/EIS. At that time, the status of the Hazard Mitigation Grant Program planning for Breezy Point will be considered.

There are other alternatives that also should be identified and evaluated as part of the HSGRR and EIS. The BPC is looking into various alternatives to complement the FEMA project. For example, raising roads has been a successful flood protection measure. It is our understanding that the USACE is considering raising roads as part of its Fire Island to Montauk Point project. Several low lying, vulnerable communities along Great South Bay, Moriches Bay and Shinnecock Bay have local roads raised to protect the communities against high frequency flooding. BPC urges the USACE to look at the alternative of raising Rockaway Point Boulevard, along with other reasonable alternatives.	Road raising was considered as a non-structural risk reduction measure as shown in Table 5-10. It will be added to Table 5-1.
The biggest difference between C-1 E and C-2, and its adverse impact on the BPC community, is critical to understand. The USACE says that a surge barrier at C-2 will impose a "severe impact to water views" on the BPC community. Maybe that is true but there is no analysis of that statement contained in the HSGRR and EIS; no view shed modeling; no simulations; no Visual Resources Assessment as required for USACE environmental reviews. The BPC believes that impact on the view shed will be mitigated by moving the surge barrier past Beach 222nd Street. This modified C-2 location should be studied in the HSGRR and EIS. Additionally, there was a location alternative C-3 which was summarily screened out because of increased construction costs due to a greater in-water footprint. The diagrams included in Chapter 5 fail to show where C-3 was located. Without more information, neither the USACE nor the public can make a fair assessment of any of the alternative locations for the surge barrier. Moreover, as further discussed below, what comes with the USACE's choice of C- 1E will have even greater adverse impacts on the BPC community	As the Jamaica Bay Planning Reach segment is being integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the effects of the surge barrier on tidal processes (residence time, salt wedge, tidal amplitude, etc.) and water quality (e.g., nutrients, DO, salinity, etc.) will be reconsidered as part of the CSRM Study.
It is extremely difficult to understand what elements of the bayside alternatives in addition to the surge barrier were identified and evaluated. There is no discussion of such elements in Chapter 5, the alternative analysis. They appear to be listed as potentially selected structures in Table 6-1 without discussion. In fact, in Section 6. 1.1 in which the proposed selected alternative is described, the USACE states that "the extent of CSRM provided to Breezy Point by the [tentatively selected plan] will be refined during analyses to be conducted prior to the Final HSGRR/EIS." This very sentence renders the HSGRR and EIS inadequate. NEPA requires that the draft EIS	As the Jamaica Bay Planning Reach segment is being integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the effects of the surge barrier on tidal processes (residence time, salt wedge, tidal amplitude, etc.) and water quality (e.g., nutrients, DO, salinity, etc.) will be reconsidered as part of the CSRM Study.

sufficiently inform the public so that meaningful comments may be made. Under NEPA regulations at 40 C.F.R. § 1502.9, "[i]f a draft statement is so inadequate as to preclude meaningful analysis, the agency shall prepare and circulate a revised draft ....”	
At the public outreach and NEPA meeting held by USA CE on October 20, 2016, which many BPC residents attended, USACE indicated, in its presentation, that the choice of C-1 E by the USACE somehow led to the conclusion that a concrete flood wall should be built on the bayside along the entire length of the BPC community. Is this because of back flooding from the surge barrier located at Cl -E? There are significant, potentially, unavoidable community and individual impacts associated with the construction of such a wall, including a plan to "take" by eminent domain or otherwise acquire a significant amount of private property in order to build the wall. This wall is also shown on Figure 8 on page xii of the executive summary yet there is absolutely no discussion of its impacts in the HSGRR and EIS.	The final detailed design selection for how Alternative C1-E has not been chosen. There are a number of designs under consideration, as depicted in Section 5.7, Figures 5-13 through 5-16, and Table 5-18. The effects on habitat from alignment construction of Alternative C-1E are listed in Section 6.1.3.1 Summary of Environmental Impacts and also in Section 7, Environmental Consequences. Specifically, construction of sea walls in the area of Breezy Point are addressed in Section 7.6.1 Impacts Common to Both Action Alternatives.
Of great concern to the BPC community is the loss of the Bayfront from construction of the flood wall. The beach on the bayside is very narrow. The wall will run the entire length of the BPC Bayfront thus eliminating or severely restricting all recreational activity in and by the bay including swimming, boating, kayaking, walking, and other forms of exercise as well as picnicking, family gatherings and community events. Bayfront access is not a mere amenity to the BPC community but an integral component of the lives of its residents. In addition, this mammoth structure will seriously reduce the value of BPC homeowners' property, especially with respect to every home along the Bayfront. The USACE's proposed selected alternative will tear the fabric of the historically tight-knit and vibrant BPC community. Interestingly, the executive summary of the HSGRR at page xiv states that the proposed selected alternative includes a levee along the bayside "eastward from B222nd St. to B201st St.," not a wall, conflicting with what is presented on page xii. But even the levee will have significant impacts on the BPC community. In Appendix I to the HSGRR and EIS, the Environmental	Comment acknowledged.

Appendix G of the HSGRR and EIS is the Public Access Plan prepared by the DEC which discusses beach access along Rockaway Beach from Beach 19th Street to Beach 149th Street. The plan says "the scope may extend west along the beach from Beach 149th Street to Beach 193rd Street and from Beach 193rd Street to the tip of the Rockaway Peninsula." There is no further discussion or analysis of potential community impacts associated with such a public access plan and there certainly was not any outreach to discuss the plan with the various communities affected. The potential impacts of any Public Access Plan must be considered under NEPA. NEPA regulations require that the EIS include a discussion of "historic and cultural resources, and the design of the built environment" and evaluate "aesthetic, historic, cultural, economic, social, or health [impacts], whether direct, indirect or cumulative." 40 C.F.R. §§ 1502.1 6(g) and 1508.8(b). Furthermore, as DEC is a State agency, it may not ignore the principles of the State Environmental Quality Review Act, N.Y. Envtl. Conserv. Law §§8-0101 et seq. ("SEQRA"). SEQRA requires that the DEC "act and choose alternatives which, consistent with social, economic and other essential considerations, to the maximum extent practicable, minimize or avoid adverse environmental effects." N.Y. Envtl. Conserv. Law §8-0109(1). The definition of "environment" in SEQRA is broad. It includes, "physical conditions which will be	The potential impacts to aesthetics of a storm surge barrier will be further analyzed under the NYNJHAT study as this feature is no longer part of the Recommended Plan for Rockaway. Section 7.24 Aesthetics summarizes the effects to visual resources within the project area. The Revised Draft GRR/EIS analyzes aesthetic, historic, cultural, economic, social, etc. impacts, both direct, indirect, and cumulative. Area referenced in the comment will not be impacted by the current scope of the project. Breezey Point was included as part of the Jamaica Bay barrier plan, and will be fully re-examined as part of the New York New Jersey Harbor and Tributaries CSRM.

affected by a proposed action, including land, air, water, minerals, flora, fauna, noise, objects of historic or aesthetic significance, existing patterns of population concentration, distribution, or growth, and existing community or neighborhood character." N.Y. Envtl. Conserv. Law §8-0105(6). Judicial decisions have denied projects on the basis of adverse impact to community character as well as visual impact. See, e.g., Wal-Mart Stores v. Planning Board of the Town of North Elba, 238 A.D.2d 93 (3d Dept. 1998). Discussion of these important land use and community impacts is either woefully inadequate or non-existent in the HSGRR and EIS.	
… we believe that a FEMA certifiable project that maximizes and employs *enhanced and expanded wetlands*, *green infrastructure strategies* and "living *shoreline*" technologies for the fullest reach of interventions is possible and best for our community. If more drastic flood mitigation measures are required to protect our community and achieve FEMA certification, then the "Six Diamonds Alignment" or "Shoreline Perimeter" options from the NYCEDC study should be considered	Comment acknowledged.
Any flood protection measures should *provide secondary benefits to our community and the natural habitat*. We hope to see *ferry service become available to our community* to enhance connectivity with other boroughs such as Manhattan, and we do not want flood protection interventions to prevent this development. Other secondary benefits such as *increased access to the waterfront*, *walking and bike paths*, and *connectivity between the parks* are desired. Further, the use of *outdoor classrooms for environmental learning2* among community members and school groups has been an excellent and regular practice here. Interventions and adaptations to the open space areas surrounding the creek should consider this key community practice and help to improve and enhance this for our community.	Comment acknowledged.
While much of the NYCEDC Coney Island Creek Resiliency Study captures community values and concerns adequately, we need to restate we are opposed to either of the far western alignment interventions. After careful study, we believe that either the "Barrage" option, or the "Calvert Vaux Alignment" option, would have drastic harmful effects on tidal flow and water quality in Coney Island Creek. It is perhaps because of continued and steady	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the issues associated with the Coney Island Creek Resiliency Study will be reconsidered.

community opposition to these options that other measures were studied and included in this study. We remain highly opposed to either option.	
Water Quality: We do not believe that there was enough attention paid to water quality issues as the NYCEDC study was conducted. That study was conducted for 2 years and then released quietly on August 18th, 2016. Community members were told that water quality testing was conducted throughout the study and helped inform flood mitigation options that were being presented to the community. However, only several weeks later, our members, through ongoing participation in a volunteer water quality testing at the creek, found out that the DEP discovered massive sewage dumping into Coney Island Creek on September 7th. 2016. The illegal and illicit discharges have been ongoing and seemingly unreported, despite the DEP's own data going back to 2014, which shows Coney Island Creek as having the highest counts of fecal coliform in any New York City body of water. How this ongoing sewage problem went undetected and unreported during the entirety of the NYCEDC study is a big question and concern for us. Further, in the Key Findings section of the report, #4 reads: An in-water barrier with a wide opening does not negatively impact tidal circulation or water quality in the Creek. Again, we challenge the assumptions this statement was made upon if the massive sewage discharges were missed during the entirety of this study.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the effects of the surge barrier on tidal processes (salt wedge, tidal amplitude, etc.) and water quality (e.g., residence time, DO, salinity, etc.) will be reconsidered as part of the CSRM Study.
How will the NYCEDC Coney Island Creek Resiliency Study be incorporated into the Army Corps study? Our members were highly active in the NYCEDC study and community engagement process. When we participated in the Army Corps presentations about the Jamaica Bay reformulation plan in October and November of 2016, there were no details or slides available about the Coney Island Tie-In. We respectfully *request that you take further time and consideration with this aspect of the Coney Island Tie-In project*, and engage our community further for input and reactions as you develop this piece further.	The barrier alignment selected and the Coney Island Tie-in will be reconsidered as the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study.

The plan describes the construction of groins and other beach stabilization structures and describes the effect on topography of these hard structures in a sand---dominated environment as minor (Section 7.1.12). These structures will have a significant unaddressed effect in halting the natural topographic forcing factors of wave--- deposited sediments and wind---induced dune formation, thereby significantly altering the patterns of sand deposition and erosion.	Comment acknowledged.
The stabilizing influences of groins, seawalls and floodgates are described as positive influences "that retain and capture littoral materials native to the beach communities and/or limit the effects of wave and storm surge erosion" (Section 7.1.1.3). However, it is well known that the effects of groins, for example, are to accumulate sediment on the up current side of the structure and to starve the down current side of sediment, creating a characteristic "cupping" structure to the beach that must be periodically remediated. Arguably letting nature distribute sediment naturally is a more adaptive way to maintain the ecological integrity of the beach and the natural processes of soil formation...It is recommended that additional study be conducted on the appropriate length, height and number of groins to minimize impacts on sediment movement.	The USACE acknowledges the concern. As stated in the Executive Summary, "*Final design and selection of the...alignment and associated tie-ins are deferred until additional analyses and design refinements can be conducted. Final...design will be made in the future based on responses from public, policy, and technical reviews of this Draft HSGRR/EIS and additional investigations conducted for that purpose".*
Beach nourishment attempts to address shoreline displacement by adding sediment to balance the sediment budget. That involves finding and transporting suitable (i.e. clean) sediment that is compatible with wave energy around the site. Because the beach/dune profile will be displaced as relative sea level rises there will be a need for greater volumes of material per unit time to maintain the beach/system in place. And, as the rate of sea---level rise increases, the need for additional sediment to maintain shoreline position will increase. Sediment will need to be secured and deposited continually so as to maintain the sediment budget balance to maintain the current shoreline. Cost is a factor in sediment procurement because, as the more accessible material is consumed, cost per unit will increase. The plan should address more explicitly the expense and energy required to replace natural cycles of sediment movement with artificial ones.	Section 5.2.1.1 Life-Cycle Cost Optimization: Beach Fill compares costs to select the feature that "...had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life." The evaluation did consider the effects of SLC consistent with USACE policy.

if beach nourishment will happen on the Rockaway beaches as part of the plan, an analysis should be given of the environmental impacts of removing sediment from elsewhere. Stipulations should be included and incorporated into the cost estimates that the sediments should not be polluted or toxic.	Information regarding the chemical characteristics of borrow materials that could be used will be added to both the Environmental and Historic Resources (Hazardous, Toxic, and Radioactive Waste (HTRW)) and the Environmental Consequences Sections (7.20 Hazardous, Toxic, and Radioactive Waste) of the report.
Exacerbating sediment starvation As the plan acknowledges (section 7.2.1.2) the bay may be sediment "starved." That is, insufficient sediments may be reaching tidal wetlands and other ecosystems already, because of anthropogenic changes to the system including beach stabilization structures and jetties, bulkheading, dredging of navigation channels and for borrow pits, and the long entrance and counter---current orientation of the Rockaway Inlet. It is possible that the tidal floodgates will exacerbate these effects by reducing sediment carried with storm surge. It is critical that these effects be better understood before deciding to implement the plan.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the effects of the surge barrier on sediment transport will be reconsidered as part of the CSRM Study.
Engineering of the barrier given the loose sediments of the two tie-in points The plan should address how the tidal floodgates will be engineered given that Floyd Bennett t Field is composed of land fill over tidal salt marshes (Black 1981) and the Rockaway Peninsula is a sandy barrier island (Sanderson 2016; Psuty 2010). The depth to bedrock in this part of the city is over 1000 feet. Both of these sediment types are subject to erosion on the edges that might influence the overall sustainability of the project given storm surge and severe storms in the future. Specifically, since there is no bedrock to tie into, how will the gates be made secure against extreme forces associated with tides and storm surge?	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, design of and the need for the Storm Surge Barrier alignment and associated tie-ins would be reconsidered as part of the CSRM Study.

The plan does not address the natural disturbance and successional patterns associated with extreme flood events on aquatic and terrestrial environments. Disturbance events, which reduce ecological structure and/or biomass, and the successional sequences that follow disturbances are essential characteristic features of coastal ecosystems. These ecosystems have assembled through processes of tidal flooding and storm surge, which this plan seeks to alter. For example, as sea levels rise, extreme flooding events inundate coastal upland systems with salt water, killing sensitive plant life, and creating the opportunities for landward migration of salt marsh ecosystems. Storm surges also serve to redistribute and in some cases remove wrack and garbage from tidal marsh ecosystems, unleashing the ability of tidal marshes to recover from burial. At the same time storm surges can bring in fine and coarse sediments that otherwise would be unavailable to salt marshes. These sediments may be of particular importance in Jamaica Bay because, as described above, the system may be sediment starved. The plan will have dramatic effects on the oceanographic distribution and delivery of marine---derived sediments to near---shore and upland environments during storm surges. Section 7.1.1.2 makes reference to how seaward structures protect upland soils however the soils of the Rockaway Peninsula are derived from marine materials. On the margins of Jamaica Bay, the historic soil type (absent anthropogenic landfill) were peaty substrates supporting tidal marshes. These ecosystems and the soils beneath them benefit from periodic infusions of marine sediments to maintain their height in the tidal range. For the interior of Jamaica Bay, the removal of the highest tides associated with storm surge will also remove the sediment depositing effects of those storm surges, and therefore potentially interfere with the long---term natural formation processes creating tidal marsh ecosystems.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the effects of the surge barrier on sediment transport, deposition, and the associated ecological succession in the transitional areas between aquatic and terrestrial environments will be reconsidered as part of the CSRM Study.

The plan does not design for protection under scenarios of accelerated sea level rise, nor does it address the cumulative effects of development on the Rockaway Peninsula and around Jamaica Bay that have been facilitated by coastal protection measures like this one. One of the biggest uncertainties in the US coastal zone is how economic development patterns will respond to the increasing risk caused by sea level rise and coastal flooding. In other coastal urban areas, flood protection has led to a false perception of lowered risk, increasing pressure for economic development even as the rate and magnitude of projected sea level rise and coastal flooding hazards have increased (Smits et al 2006). The current expected design life of the project is ~50 years, precisely when a vast majority of the projections of sea level rise show a pronounced departure – specifically a potential acceleration – from the observed rate of sea level rise over 1993 to the present. The current choice of an intermediate sea level rise scenario amounts to tolerating the additional risk of potentially 1 – 2 feet of sea level rise by mid---century, resulting in a design elevation of approximately 18 – 19 feet. A risk---averse approach would suggest basing the design elevation on 90th percentile sea level rise projections instead of 50th percentile sea level rise projections to accommodate future risk. The expected increase in flood risk beyond the 50---year time horizon warrants consideration of how the structure can be gradually adapted or phased out in favor of more flexible pathways that support resilience in Jamaica Bay, as recognized by the New York City Panel on Climate Change and the Mayor's office (NPCC 2010, Chapter 1). Historically, development in the study area led to ecosystem degradation and habitat loss in aquatic and terrestrial environments (Black 1981; Waldman 2008; Sanderson et al. 2016). The environmental impacts addressed in the plan only address the direct effects of this plan and do not provide appropriate context for the cumulative effects of this plan on top of all of the previous impacts on aquatic and terrestrial environments (Cocklin et al. 1992; Lindenmayer and Laurance 2012).	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the effects of a surge barrier on tidal processes (salt wedge, tidal amplitude, etc.) and water quality (e.g., residence time, DO, salinity, etc.) will be reconsidered as part of the CSRM Study.

As design development is furthered for the residual risk shoreline components, further consideration should be given to alternative shoreline design strategies that include a combination of green (natural and nature---based features) and grey strategies and are responsive to local environmental conditions. In the TSP, the residual risk features are primarily grey (bulkheads, crown, I and T walls, and revetments) in areas where softer shoreline design would be preferable, given the importance of Jamaica Bay as a Special Natural Waterfront Area and the negative historical impacts of hardened shorelines on the ecology of the bay. The plan notes that increased hard structures will increase attachment areas for organisms that prefer hard substrates like rockweed and barnacles. It should be noted however that historically Jamaica Bay had very little hard geological substrate. In effect increasing hard substrate in Jamaica Bay is introducing a novel ecosystem type on a large scale to the environment. These new environments should be considered in the context of the cumulative effects of seawalls and bulkheads and other forms of anthropogenic hard surfaces already in the bay.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the effects--including cumulative effects will be reconsidered as part of the CSRM Study.
One of the stated study objectives (p. iv) is to "improve community resiliency." As the project advances into design development, outreach should be used as an opportunity to engage communities in resilience discussions more broadly about the environment, climate change and community resilience. Extensive outreach conducted equitably through the region and using a range of engagement strategies (in person, digital, traditional media) would give a more comprehensive understanding of community concerns to be prioritized and addressed. Discussions with affected communities about the design and construction implications of the plan, the risk reduction implications, and the flood insurance implications should be prioritized. Additionally, any outreach should consider the demographic characteristics of the neighborhood (such as language access, accessibility for elderly and disabled, etc.) to ensure broad community participation.	As stated in Section 9.1 Public Involvement Activities, "Following public release of the document, additional public meetings will provide more detailed analysis of the alternative plans, feature plans, and identification of impacts." Recommended approach to community engagement will be taken into consideration in planning and conducting further public involvement.

A major issue for the plan is how the configuration of the tidal gates and the length of their closure during a storm will affect water quality in Jamaica Bay. Four sewage treatment plants currently deliver on average 26,000 lbs. of nitrogen per day to Jamaica Bay, orders of magnitude above levels in 1900 (Misut and Voss 2007). The only way for this nitrogen to leave Jamaica Bay is through natural processes of denitrification or through export via the Rockaway Inlet to the open ocean. The high levels of nitrogen have been implicated in algal blooms, anoxic conditions, and fish die---offs in the past. On---going scientific work suggests that marsh chemistry is strong influenced by the high nitrogen loadings. The New York City Department of Environmental Protection has worked to reduce nitrogen loadings, but some of that work may be reversed depending on how the storm gates are operated. The plan should address not only the length of closure of the tidal gates to address storm surge, but also the potential for more frequent closures. Several communities around Jamaica Bay, notably parts of Howard Beach, Broad Channel and Edgemere, are likely to be flooded on monthly high tides in the future because of sea level rise. As these monthly tides begin to impinge, even more regularly than they do today, on buildings and other infrastructure, there may be pressure to close the gates more often, as a flood prevention strategy. The plan should address the full range of potential operations strategies, in the context of sea level rise scenarios, and their effects on water quality. Water quality studies should consider both nitrogen reduction strategies as well as climate---induced changes in stratification patterns that can affect the development of hypoxia as well as alter biogeochemical fluxes. These affects may be larger than any affect the project might have on water quality via changes in residence time. Further study and consideration should be given to gate configuration impacts on the movement of fish and plankton into and out of the bay during extreme storm events and the influence of those movements on fish populations. Also, section 5.2.2.1 states “Both alignments C---1E and C---2 result in a maximum tidal amplitude change of 0.2 feet, which occurs only during the highest tides of a tidal cycle.” What might the	The storm surge barrier will be further studied and potentially implemented under the NYNJHAT study. However, to address some of your comments, the JEM model was run to assess a potential range of impacts to water quality. The JEM is comprised of a coupled hydrodynamic model and a water quality model, which is capable of simulating eutrophication (nutrients, phytoplankton biomass and dissolved oxygen) and pathogenic bacteria. The original JEM model has undergone several revisions in recent years to improve its spatial resolution and to add functionality that allowed them to expand the capabilities of the water quality to model to forecast the impacts to the how additional biological communities that utilize nutrients in the Bay, including macroalgae (Ulva) and benthic algae. Also available for use with the JEM modeling system is a watershed or sewershed model, which relates rainfall that falls over the upland drainage basin to determine the pollutant loadings of nutrients and pathogens delivered to the Bay via combined sewer overflows (CSOs), separate sewer overflows (SWOs) and direct runoff to the Bay. The Recommended Plan acknowledges the frequent flooding that occurs in parts of Jamaica Bay and has evaluated and recommended some High Frequency Flooding Risk Reduction Features to address this frequent flooding, where feasible and justified. This would limit the closure frequency of a potential storm surge barrier as well as any associated impacts related to more frequent closure. The alternatives are indeed considered in the context of varying potential sea level rise conditions. Now that the storm surge barrier will be studied under a different study potential impacts to marshes based on any changes to tidal range would need to be assessed in that study. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the surge barrier construction and operation on tidal processes (salt wedge, tidal amplitude, etc.) and water quality (e.g., residence time, DO, salinity, etc.) will be reconsidered as part of the CSRM Study.

impact of the change in tidal range have on marsh loss?	
Hydrodynamic models have shown that flooding will increase outside the barrier over a large region (Orton et al. 2016). Preliminary results suggest a 1.0---1.5 inch increase in the 100---year flood through the rest of NY/NJ Harbor, which is a small increase but non---negligible. The Corps should quantify this and the increased damages in their benefit---cost analysis. Also, reflection of floods will raise flood heights by 6---10 inches just outside the barrier (Manhattan Beach, Roxbury, Sheepshead Bay). If the level of protection isn't higher for those areas then those neighborhoods are at greater risk of catastrophic flooding of the type that occurred in New Orleans during Katrina – abrupt overtopping of levees into small volumes of space with a large population. This is a very serious problem if not addressed.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the analyses of flood risk reduction and will be reconsidered as part of the CSRM Study.
...we request the Army Corps to approve a 90-day extension to the draft Environmental Impact Statement's original 60-day open comment period... The Environmental Impact Statement's absence of accurate scientific analysis both renders it insufficient for a Draft EIS and forecloses the public's ability to properly and fully analyze its true environmental impacts. The public must not be limited to commenting on a plan's merely hypothetical and speculative affects. Based upon these and other deficiencies, we request that the Army Corps, at the very least, provide the public with a greater extension to the draft Environmental Impact Statement comment period. A seventy-five day public comment period does not provide the public with enough time to develop and submit helpful comments. See 33 C.F.R. § 230.19(a).	The public comment period was extended to 2 December 2016, as opposed to the 45 day period required by NEPA.

Potential environmental issue: the Corps' use of outdated water quality geometric means for Fecal Coliform and Enterococci;	In order to assess the potential impact of a barrier closure on water quality within the Bay, a modeling study was conducted using the Jamaica Bay Eutrophication Modeling system, known as JEM. JEM is comprised of a coupled hydrodynamic model and a water quality model, which is capable of simulating eutrophication (nutrients, phytoplankton biomass and dissolved oxygen) and pathogenic bacteria. The original JEM model has undergone several revisions in recent years to improve its spatial resolution and to add functionality that allowed them to expand the capabilities of the water quality to model to forecast the impacts to the how additional biological communities that utilize nutrients in the Bay, including macroalgae (Ulva) and benthic algae. Also available for use with the JEM modeling system is a watershed or sewershed model, which relates rainfall that falls over the upland drainage basin to determine the pollutant loadings of nutrients and pathogens delivered to the Bay via combined sewer overflows (CSOs), separate sewer overflows (SWOs) and direct runoff to the Bay. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the surge barrier construction and operation on water quality will be reconsidered as part of the CSRM Study.
Potential environmental issue: the determination that only 240-340 million gallons of treated sewage will be discharged into Jamaica Bay per day (from WWTPs) without accounting for additional sources of discharges (e.g., CS Os, MS4s, illegal and illicit discharges, 12 and direct discharges)	All available data was used for the water quality modeling, including CSO data. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the surge barrier construction and operation on water quality will be reconsidered as part of the CSRM Study.
Potential environmental issue: unfounded determination that the project will not adversely affect marine mammals and sea turtles	Effects to listed species are coordinated with the National Marine Fisheries Service as well as the US Fish and Wildlife Service (i.e., the Services) and the effects determinations will be made in consultation with the Services. Please see the Revised GRR/EIS and Environmental Compliance Appendix D for detailed impact assessments of the Recommended Plan, which no longer includes the proposed storm surge barrier.

Potential environmental issue: complete failure to consider whether the Storm Barrier will exacerbate the Bay's already existent chlorine and heavy metal pollution, its nutrient load problems and inability to maintain Dissolved Oxygen levels at the water quality criteria threshold for fish survival	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the surge barrier construction and operation on tidal processes and water quality (e.g., residence time, DO, salinity, etc.) will be reconsidered as part of the CSRM Study.
Potential environmental issue: whether the barrier will further restrict the flow of sediment into and out of the Bay, potentially creating new, or compound existing water quality problems (e.g., affecting the sediment's legacy contamination bioaccumulation).	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the surge barrier construction and operation on tidal processes, including sediment processes, will be reconsidered as part of the CSRM Study.
...the draft document does not even include a determination of exactly how the proposed gate will be constructed, admitting that additional modeling and analysis is required "to identify, quantify and conclusively address any possible impacts to water quality and fish and wildlife species and their habitats in the Bay."	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, evaluation of the surge barrier construction and operation on tidal processes (salt wedge, tidal amplitude, etc.) and water quality (e.g., residence time, DO, salinity, etc.) will be reconsidered as part of the CSRM Study.
The funding for this massive multi-billion dollar project is not yet in place and a timeline for funding is indefinite. The draft Environmental Impact Statement may be intended to secure such funding, with the actual project not commencing until some uncertain future date. Thus, absent a true planned action, an analysis of the environmental impacts is entirely premature as it cannot possibly contemplate what conditions will exist when the project is actually constructed.	Comment acknowledged.
The scale and scope of such a project necessitates public input and we feel that the current November 17, 2016 deadline for commentary does not provide enough time for adequate review by civic groups, community stakeholders and residents. We are requesting that the deadline be extended to no earlier than December 31, 2016 so that our constituents can voice their support or concern for a project that will permanently change our communities.	A series of public scoping meetings were held in the study area after the Alternatives Milestone meeting, but prior to the TSP Milestone Meeting. The meeting format included a presentation of the study purpose, alternatives considered and analyses of performance and cost of alternative plans. Posters highlighting pertinent analyses and findings of the study were available before and after the presentation to allow the attendees to circulate from area to area and pose questions and express concerns to technical staff.
Will project affect entrance to beach area?	A public access plan is part of the documentation package (originally published as Appendix G. Please refer to the public access plan.

Would the project block the ocean view?	A public access plan is part of the documentation package (originally published as Appendix G. Please refer to the public access plan.
Would it block the ocean breeze?	A public access plan is part of the documentation package (originally published as Appendix G. Please refer to the public access plan.
How will this affect real estate prices for lower floor apartments	Analyses of changes in real estate values is beyond the scope of the study.
Damage sustained during Sandy to our building was caused by winds but not water	Comment Noted.
Draft EIS provides no details about specific plans for Coney Island tie-in. Requesting a separate EIS for the Coney Island tie-in similar to what has been done for the Rockaway peninsula	The barrier alignment selected and the Coney Island Tie-in will be reconsidered as the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study.
Will a shorefront walkway be created above any levees or seawalls planned for this area (Manhattan Beach Esplanade, from Corbin Place to Ocean Avenue, Brooklyn)	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, public access will be reexamined as part of the CSRM Study.
The use of natural flood barriers such as vegetated dunes and mud flats should be used wherever feasible.	Comment acknowledged. Vegetated dunes and wetland NNBFs are included in the Recommended Plan where feasible.
Changes to depth of the Sheepshead Bay Inlet should be evaluated before flood control measures are implemented	Comment acknowledged.
Interim flood protection measures should be included in the EIS. At the very minimum, vegetated dunes should be provided as interim measures for the beaches of southern Brooklyn (Manhattan Beach, Brighton Beach, Coney Island)…	Federal action can only be taken where there is existing or special authority and must follow the USACE policies and guidelines. An interim FCCE project, including a vegetated dune was built along the Atlantic Shorefront since the USACE had an existing project there, it had authority to do so. The other areas in Southern Brooklyn mentioned would need authority in order to construct CSRM measures. This authority would be granted with an approved Chief's Report which is the conclusion of a Feasibility Study.

...it appears that all of the modeling is based on a "fact" about Jamaica Bay that was proven to be incorrect: That water moves so slowly in Jamaica Bay that residence time has increased to an average of 33 days (Section 2, "Existing Conditions", page 17). In fact, water moves much, much faster through Jamaica Bay and it "flushes" roughly every 7 days. The "flushing time" of Jamaica Bay was a very contentious issue that was hotly debated at numerous meetings attended by representatives of the Army Corps, NYCDEP and the New York State Department of Environmental Conservation (NYSDEC). Therefore it is astonishing that the consultants for this project were unaware of this discrepancy. ... the modeling for the Jamaica Bay portion of the DEIS was based upon in-formation that is outdated and inaccurate and may therefore result in significant adverse impacts. This is a very serious matter that needs to be remedied. A full environmental assessment based on accurate data under the National Environmental Policy Act (NEPA) is absolutely required.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the hydrodynamics of Jamaica Bay and the potential environmental consequences of risk reduction construction and operation will be reexamined as part of the CSRM Study.
The EIS mentions the numerous benefits of oyster reefs, but to date, despite substantially improved water quality and sizable efforts, reefs have not been established. Suitable substrate was provided and studies have shown that oysters will grow, thrive and even reproduce, but they are unable to establish reefs. Perhaps the spat does not settle out because tidal flow is so swift in Jamaica Bay that the spat is carried out through Rockaway Inlet. The hydraulics of Jamaica Bay were investigated in the JABERRT and need to be looked at.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the hydrodynamics of Jamaica Bay and the potential environmental consequences of risk reduction construction and operation will be reexamined as part of the CSRM Study.
The Preferred Alternative includes construction of a storm surge barrier across Rockaway Inlet near Floyd Bennett Field. However tidal flow in this area is already very swift. Any construction will narrow it even further, increasing the velocity of water flow. This requires a thorough investigation to avoid adverse impacts.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the hydrodynamics of Jamaica Bay and the potential environmental consequences of risk reduction measure construction and operation will be reexamined as part of the CSRM Study.
EIS mentions HTRW in vicinity of Floyd Bennett Field - should be investigated and remediated.	Comment acknowledged.
The US Army Corp of Engineers beach erosion and hurricane protection initiatives, and the continuous identification of Jamaica Bay as a potential site for	Comment acknowledged.

disposal of contaminated dredged spoils into subaqueous borrow pits, have continued to use "a tidal flushing time for waters of Jamaica Bay taking 30 days for flushing channels and inlets along the periphery of the Bay". This tidal prism has been shown to be exaggerated, disproven and from a purely engineering perspective, wrong. (See attached JABERRT Research Publication) Marsh loss has been shown to be, in the majority, caused by the significant hydraulic draw and tidal flushing exchange of the Bay with Atlantic Ocean waters rapidly flowing through the Rockaway Inlet on every tidal cycle. This tidal cycle is at such a velocity, fine sediment accumulations establishing *Spartina alterniflora* marshes, cannot and have not, been able to accumulate thus contributing to the marsh losses to the interior islands of Jamaica Bay. This steep flushing cycle of Jamaica Bay waters does not allow fine particles to adhere to existing fringe marsh islands thus preventing sediments contributing to S. alternaflora germination and growth.	
In response to several GIS investigations conducted on marsh boundary photos reviewed by NYSDEC in the mid 1990's, and an estimate established at 60 acres of marsh loss on average annually, a Blue Ribbon Panel to explore causes of marsh loss to Jamaica Bay, was established inl998 with world renowned ecologists, natural resource scientists, and coastal geomorphologists. This Blue Ribbon Panel Rep01t on Jamaica Bay, prompted the 2 year study of Jamaica Bay entitled, "The JABERRT Report", completed by the NPS for the Corps of Engineers in 2001. (copy of literature published recently on these results) The full 3 -volume JABERRT Report for Jamaica Bay has been ignored.	This report was consulted and information from it was incorporated into the water quality modeling and other analysis that was performed (see citations for the JEM write-up) in future publications of information on the Rockaway Inlet storm surge barrier. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the hydrodynamics of Jamaica Bay and the potential environmental consequences of risk reduction measure construction and operation will be reexamined as part of the CSRM Study.
The entire Jamaica Bay Project Proposal, part of the entire East Rockaway Inlet to Rockaway Inlet Storm Protection Management Plan is ill conceived, misinformed as to significant environmental impacts to the natural resource of the Jamaica Bay ecosystem, fails to consider and include considerable research pertinent to this proposed action, and is intolerably expensive. This proposed action, in any of its alternative forms, should be totally abandoned.	Comment noted. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the hydrodynamics of Jamaica Bay and the potential environmental consequences of risk reduction construction and operation will be reexamined as part of the CSRM Study.
NYCEDC Study assumptions are incorrect - flooding came from both ocean and creek but study assumes flooding is solely from creek. Focus of the study appears to be on amenities associated with floodgate/pedestrian bridge across creek rather than flood control	NYCEDC Study not within the scope of this EIS.

1) An aniline dye factory, (the Brooklyn Yarn Dye Co.) that operated on the southern shoreline of the Creek (Neptune Ave. between West 22nd & West 23rd) until the 1970's. Neighborhood residents remember seeing the water of the Creek colored with various dyes. The site is very close to the location for the proposed flood gate and the impacts from the dye factory were never remediated.	Comment acknowledged. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study.
2) Coney Island Creek and Sheepshead Bay may still be partially connected by an old culvert. In the early twentieth century, filling of the tidal inlet between the Creek and the Bay began and a culvert was constructed to maintain a connection between them.	Comment acknowledged.
3) There is a long history of illegal dumping into the Creek. There are overturned, sunken cars, supermarket shopping carts, tires and other debris in the water at the eastern end of the Creek. Some of the cars have been in there for decades, and occasionally, bubbles of oil still rise from them.	Comment acknowledged. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study.
4) The land portion of an old manufactured gas plant (MGP) and a small section of the Creek's adjacent shoreline was remediated. But there was no remediation of the contamination from the MGP that spread to other areas of the Creek.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study.
5) Several businesses that dismantled ships and barges were located along the Creek in the early to mid-twentieth century. The impacts from these activities have never been addressed.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study.
6) The NYCEDC study notes "There are approximately 50 permitted and unpermitted discharge pipes and outfalls throughout the Creek." The New York City Department of Environmental Protection (NYCDEP) has admitted that its mapping of these pipes may not be completed until 2020. There-fore, the modeling for NYCEDC's proposed flood gate for the Creek was done without knowing how much water is entering the Creek, whether or not it is contaminated, etc. It is essential to know what discharges into the Creek and where before any work begins.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study.

7) The private gated community of Sea Gate, at the western end of the Coney Island peninsula, may have combined sewer lines. Both the New York State Department of Environmental Conservation (NYSDEC) and NYCDEP have admitted that they know nothing about this private sewer system, what condition the lines are in, where they connect to or if they discharge into either the Creek or the ocean. Sea Gate was hit badly by Hurricane Sandy and their antiquated sewer lines are in very poor condition.	Comment acknowledged. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study.
8) Several of NYCDEP's prior studies provide conflicting information about the drainage areas and outfalls that enter Coney Island Creek.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study.
9) Properties along the Creek include a cement plant, scrap metal business, boat yard, gas station, several auto body shops, school bus depots and various other industrial uses. Some or all of these may discharge contaminated storm water directly into the Creek.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study. Cleanup of contaminated sites would be outside of the scope of this study and would need to occur prior to the implementation of the Corps project.
10) The Metropolitan Transportation Authority's Coney Island Yard, the largest railyard in the world, is located on the shore of the Creek and has been in continuous use since 1926. All run off from this 75 acre property went into the Creek. Therefore, it is likely that sediments adjacent to this property are contaminated with heavy metals, PAHs and other toxins. A filtration system for the existing outfall and construction of a new outfall are planned, but there is no mention of how contaminated sediments near this property will be addressed.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study. Cleanup of contaminated sites would be outside of the scope of this study and would need to occur prior to the implementation of the Corps project.
A clean-up of the entire length of the Creek is badly needed. It may be so contaminated that it meets the guidelines for a Superfund site. A clean up should be done as mitigation for the future flood control project.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the history of contaminants within the footprint of construction for alternatives for the Jamaica Bay Planning Reach will be reexamined as part of the CSRM Study. Clean up of contaminated sites is the mission of the Environmental Protection Agency and would need to occur prior to the implementation of a Recommended Plan.

Draft EIS omits key information to make it legally sufficient as a draft EIS - TSP is underdeveloped with no details about construction, function, or funding; conclusions are unsubstantiated; document contains contradictory information; document is incomplete and based on insufficient modeling and analysis	The Draft GRR/EIS has been revised to include more details, remove inconsistencies, and incorporate comments received on the 2016 draft. Due to the significance of the changes to the Recommended Plan (mainly the removal of the storm surge barrier from the recommendation), the Revised GRR/EIS has been released for a second public review period.
NEPA standards are not met - fails to support claims that EFH will be unaffected, fails to discuss possible exacerbation of environmental issues; water quality data used is outdated.	The sufficiency of the analyses of effects to important fish species is being coordinated with the National Marine Fishery Service (NMFS). The EFH Assessment has been revised to reflect the updates to the Recommended Plan and is included as part of the Environmental Compliance Appendix D. The latest available data was used for this analysis. If you are in possession of newer data, please provide.
Lack of information about TSP - incomplete design makes it impossible to estimate impacts of that design. Funding and real estate plans are undeveloped. Environmental impacts are therefore impossible to estimate. No discussion is included about possible consequences of closing the gate for periods of time longer than planned.	In accordance with SMART Planning, conceptual designs are further developed as the study progresses. The Revised Draft GRR/EIS includes a more detailed level of Feasibility Design. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, barrier design and operations as well as the potential environmental consequences of barrier construction and operation will be reexamined as part of the CSRM Study.
No specific proposal as to how Sandy funding should be utilized. In effect, a plan for the use of those appropriated funds (if we assume that this figure of $500 million is generally correct) would represent the highest priority features for the Corps, the State, the City of New York and all other interested parties. Sandy funds should be first used for CSRM along Atlantic shorefront	Comment acknowledged.
Prioritize NNBF; some Sandy funds should be diverted for use to develop NNBF. We would propose that one or more coastal and/or maritime wetland forest restoration projects should be included in a near-term Plan to be funded with Sandy dollars. Allocating some Sandy dollars for this purpose is consistent with PL 113-2 Chapter 4 Department of the Army Corps of Engineers Civil Investigations provisions related to the consequences of Hurricane Sandy to this effect: "...Provided, that $2,902,000,000 of the funds provided under this heading shall be used to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks	Comment acknowledged. NNBFs have been developed and are part of the Recommended Plan.

associated with large-scale flood and storm events…." (emphasis added). This provision clearly dictates that these funds can and should be used to support coastal ecosystem sustainability. The inclusion of some coastal and marine forest NNBFs that have risk reduction features is the most effective way to comply with this statutory requirement.	
Nonstructural Measures. Nonstructural measures need to be better developed for higher frequency events; plan in draft FIMP report is used as a model.	Nonstructural measures (e.g., buy outs) were considered in the analysis.
1. Please include a full analysis of the impact of combined sewer overflows and separate storm sewer discharges on the water quality of Jamaica Bay during the time the gate is closed. Please also include an analysis of these overflows and discharges given the anticipated reduced tidal exchange caused by the gates immovable infrastructure (even when open).	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, barrier design and operations as well as the potential environmental consequences of barrier construction and operation will be reexamined as part of the CSRM Study.
2. Please include an operations plan, or anticipated use plan, describing how, when, and whether the gate will be closed. Will it be engaged only for large storms, leading to some areas continuing to be flooded during smaller storms, or will it be closed under some other circumstances? For each of the circumstances the gate will be closed, the Corps should include modeled impact assessments - across all Draft EIS issue areas (including but not limited to water quality, fisheries, oyster reef productivity, human health, access, and navigation).	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, barrier design and operations as well as the potential environmental consequences of barrier construction and operation will be reexamined as part of the CSRM Study.
3. Please describe where, if anywhere, flooding in the action area will continue to occur, whether during small or large storms, and under a variety of sea level rise and storm surge scenarios. Please also include the Corps' modeled costs associated with recovery from such flooding events.	Please see the Revised GRR/EIS released on August 31, 2018 which describes the residual risk associated with the Recommended Plan, discusses sea level rise and sensitivity analysis of how the Recommended Plan would perform under various scenarios. The Benefits Appendix addresses recovery costs avoided as well as residual risk.
4. Please include an assessment of where water outside the barrier - in the immediate vicinity of the barrier - will travel if the barrier is closed (please provide maps).	Further development of the Jamaica Bay storm surge barrier plan has been deferred and will be fully analyzed in the New York & New Jersey Harbor and Tributaries Coastal Storm Risk Management Focus Area Study

5. Please describe in more detail the impacts of the permanent fixtures installed as part of the gate on the water exchange between the Bay and the ocean, on the ability of fisheries, marine mammals, and sea turtles to transit through the gate's permanent structure.	Further development of the Jamaica Bay storm surge barrier plan has been deferred and will be fully analyzed in the New York & New Jersey Harbor and Tributaries Coastal Storm Risk Management Focus Area Study
6. Please describe the impact of the gate on endangered sturgeon.	Further development of the Jamaica Bay storm surge barrier plan has been deferred and will be fully analyzed in the New York & New Jersey Harbor and Tributaries Coastal Storm Risk Management Focus Area Study
7. Please describe what will happen to migrating (or simply swimming) fish trapped on the inside of the gate when the barrier is shut.	Further development of the Jamaica Bay storm surge barrier plan has been deferred and will be fully analyzed in the New York & New Jersey Harbor and Tributaries Coastal Storm Risk Management Focus Area Study. However, it is not anticipated that storm surge barrier closures would exceed 48 hours and would likely be shorter in duration. The majority of the time, a proposed barrier would remain open.
8. Please describe the impact of altered hydrology on water quality, habitat, and sediment flux within the Bay. Please specifically examine impacts to restoration projects completed, planned, funded, and approved (including by the Corps) within Jamaica Bay over the past ten years - from oyster restoration pilot programs to seagrass restoration and borrow pit remediation projects.	The level of detail in the storm surge barrier design was conceptual for the Draft GRR, consistent with SMART Planning principles of only including the level of detail necessary to support a decision. It was the intention of the Corps to refine the design to full Feasibility level for the Final Report. However, the volume of comments concerning the potential impacts of the proposed storm surge barrier contributed to the agency decision to postpone the recommendation to construct the storm surge barrier until it can be studied further under another ongoing study looking at residual risk and a suite of storm surge barriers across the region. USACE has decided to recommend further study of the storm surge barrier and its potential impacts under another ongoing study, The New York and New Jersey Harbor and Tributaries Coastal Storm Risk Management Study, which is looking at a suite of storm surge barriers, among other measures, across the region. Please see the Revised GRR/EIS for a full impact analysis of the Recommended Plan.

No proposed size, shape, form, or use specifics for the storm barrier.	The level of detail in the storm surge barrier design was conceptual for the Draft GRR, consistent with SMART Planning principles of only including the level of detail necessary to support a decision. It was the intention of the Corps to refine the design to full Feasibility level for the Final Report. However, the volume of comments concerning the potential impacts of the proposed storm surge barrier contributed to the agency decision to postpone the recommendation to construct the storm surge barrier until it can be studied further under another ongoing study looking at residual risk and a suite of storm surge barriers across the region. USACE has decided to recommend further study of the storm surge barrier and its potential impacts under another ongoing study, The New York and New Jersey Harbor and Tributaries Coastal Storm Risk Management Study, which is looking at a suite of storm surge barriers, among other measures, across the region.
No identified engineering analysis of the barrier.	The level of detail in the storm surge barrier design was conceptual for the Draft GRR, consistent with SMART Planning principles of only including the level of detail necessary to support a decision. It was the intention of the Corps to refine the design to full Feasibility level for the Final Report. However, the volume of comments concerning the potential impacts of the proposed storm surge barrier contributed to the agency decision to postpone the recommendation to construct the storm surge barrier until it can be studied further under another ongoing study looking at residual risk and a suite of storm surge barriers across the region. USACE has decided to recommend further study of the storm surge barrier and its potential impacts under another ongoing study, The New York and New Jersey Harbor and Tributaries Coastal Storm Risk Management Study, which is looking at a suite of storm surge barriers, among other measures, across the region.

No water quality impact assessment of Jamaica Bay under closed-gate conditions.	The level of detail in the storm surge barrier design was conceptual for the Draft GRR, consistent with SMART Planning principles of only including the level of detail necessary to support a decision. It was the intention of the Corps to refine the design to full Feasibility level for the Final Report. However, the volume of comments concerning the potential impacts of the proposed storm surge barrier contributed to the agency decision to postpone the recommendation to construct the storm surge barrier until it can be studied further under another ongoing study looking at residual risk and a suite of storm surge barriers across the region. USACE has decided to recommend further study of the storm surge barrier and its potential impacts under another ongoing study, The New York and New Jersey Harbor and Tributaries Coastal Storm Risk Management Study, which is looking at a suite of storm surge barriers, among other measures, across the region.
No assessment (and only minimal identification) of endangered species, fisheries, and marine mammal impacts and issues.	Effects to listed species are coordinated with the National Marine Fisheries Service as well as the US Fish and Wildlife Service (i.e., the Services) and the final effects determinations will be made in consultation with the Services. Please see the Environmental Compliance Appendix and EIS portion of the Revised GRR/EIS released on August 31, 2018.
No review (or even cataloguing of) past, present, and pending future remediation and restoration activities within the Bay, let alone any analysis of the impacts the barrier may have (open or closed) on the hundreds of millions of dollars of work that has been leveraged by the Corps, other federal agencies, state and local government, and community organizations for the benefit of the Bay and its resilience.	The level of detail in the storm surge barrier design was conceptual for the Draft GRR, consistent with SMART Planning principles of only including the level of detail necessary to support a decision. It was the intention of the Corps to refine the design to full Feasibility level for the Final Report. However, the volume of comments concerning the potential impacts of the proposed storm surge barrier contributed to the agency decision to postpone the recommendation to construct the storm surge barrier until it can be studied further under another ongoing study looking at residual risk and a suite of storm surge barriers across the region. USACE has decided to recommend further study of the storm surge barrier and its potential impacts under another ongoing study, The New York and New Jersey Harbor and Tributaries Coastal Storm Risk Management Study, which is looking at a suite of storm surge barriers, among other measures, across the region.

No assessment of any natural or enhanced-ecosystem resilience planning alternatives.	Natural and enhanced-ecosystem resilience planning alternatives are currently being developed during the current phase of study to address high frequency flooding and are included in the Recommended Plan as presented in the Revised Draft GRR/EIS, released to the public on August 31, 2018.
We also urge the Army Corps of Engineers to expand the Natural/Nature Based Features (NNBFs) particularly as part of the residual risk projects and the perimeter plan for Jamaica Bay. Civil engineering solutions only accomplish one goal for which the structure is designed. On the other hand NNBFs accomplish multiple goals, including but not limited to water quality improvements, habitat enhancement, and public amenities. Furthermore NNBFs should be developed and implemented at the neighborhood scale (rather than larger regional scale) to ensure needs of the local communities and the local habitats are taken into consideration and in full partnership with the other public agencies such as the NYC Department of Environmental Protection, NYC Parks, and National Park Service and others. In addition there is a great deal of expertise and local knowledge within the private sector that should be tapped as a resource in developing a more robust NNBF plans.	Natural and enhanced-ecosystem resilience planning alternatives are currently being developed during the current phase of study to address high frequency flooding and are included in the Recommended Plan as presented in the Revised Draft GRR/EIS, released to the public on August 31, 2018.
We urge the Army Corps of Engineers to provide more opportunities for the public to review and comment on every phase of this project. In fact there are models for effective public outreach and engagement, such as the New York Rising Citizens Advisory Committee and the EPA's Superfund Community Advisory Groups.	As stated in Section 9.1 Public Involvement Activities, "*Following public release of the document, additional public meetings will provide more detailed analysis of the alternative plans, feature plans, and identification of impacts.*"
Finally given the projections on sea level rise and frequency of severe weather events, we must give coastal retreat and buy-out as serious and viable alternatives. New York State has already implemented a buy-out program in Staten Island. Such non-capital (i.e., programmatic) solutions may not exactly align with the Army Corps of Engineers' expertise but with appropriate partnerships this type of programmatic solutions can be further developed and might be the most prudent action in some areas.	Managed retreat allows natural shoreline erosion to occur and incrementally removing or relocating shoreline structures and infrastructure as they eventually become unsafe for intended use. This measure (also referred to as floodplain buy-out) was not carried forward as a measure which would be implemented on a large scale due to anticipated economic inefficiency.
Our first choice would be Plan B, utilizing only natural and nature-based features (NNBF). However, we understand that that alternative would not fully mitigate future storm damage, is economically unfeasible and is not a current option	Noted

We are vehemently opposed to Plan D. Building 44 miles of 18-foot seawalls all the way around the bay would destroy access to the shore for recreational boats and destroy land-based access to the bay. The 20 storm gates would significantly affect recreational navigation in every corner of the bay, including Paerdegat, Mill Basin, Gerritsen Inlet, Spring Creek and all the parks in Far Rockaway and Arverne. The seawalls would uproot sensitive shorelines with their protective vegetation and destroy the majority of nesting grounds for fish and turtles. The whole plan does nothing to protect the community of Broad Channel and does nothing to protect the cordgrass marshes that filter the water and protect the shorelines against storm surges, the same marshes that USACE and the American Littoral Society have been rebuilding for the past two years. This plan would destroy the historic and continuous relationship between shorefront communities and the water that is the reason they exist. This is an ill-conceived, heavy-handed approach that destroys what it is intended to protect.	Interior Plan D was not selected as an element of the recommended plan.
	Comment acknowledged.

The Army Corps of Engineers recently released the "Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement" (Draft HSGRR/EIS) and General Conformity (GC) Determination for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet, and Jamaica Bay Reformulation Study for review and submission of comments. As recognized, the Rockaway peninsula was one of the most heavily impacted areas by and during Hurricane Sandy. The draft studies have been reviewed and the following feedback/comments are made to be fully considered during the final preparation of the final EIS: 1. The recommendations throughout the various studies are based on reduction of risk from two sources of storm damage: inundation, wave attack with overtopping along the Atlantic Ocean shorefront of the rockaway peninsula and flood waters amassing within Jamaica Bay via the Rockaway Inlet. In addressing "coastal resiliency" and "long term resiliency" a number of factors have not been stated and considered to identify best solutions to prepare for, and reduce or eliminate vulnerability to storm damage. 2. In reference to #1 above, the principle water factors stated in the studies were wave attack, wave run up, overtopping and erosion. It is also noted the bay shoreline retaining wall (Beach 149th Street to Beach 109th Street) has a top elevation of approximately 3 to 4 feet above grade (roughly +10 ft. NAVD). 3. In reference to #2 above, no mention is made that water rises from storm sewers (backflow) into the streets, basements and garages during small storms. This large amount of water (possibly over a foot+ high at several street points) is not from wave	In developing the comprehensive plan, "wave attack, wave run-up, overtopping, and erosion" included consideration of (a) wind, tides, and precipitation; (b) interior flooding from rainfall or backflow from sewers; (c) and predicted sea level change from all factors. As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, barrier design or other solutions will be reexamined as part of the CSRM Study. The approach to addressing climate change and sea level rise is consistent with Corps policy.

attack, wave run up, overtopping and erosion. 4. In reference to #3 above, for the purpose of the Reformulation Study, the year of reconstruction is assumed to be 2020, with a design life of 50 years. Also, Projected flood heights at Howard Beach will increase by 2.9 feet from 1983-2001 to the 2050's. 6. In reference to #5 above, a number of Sandy Storm factors were not mentioned nor facts shown in the studies, i.e., Duration of storm, Rainfall Rate (# of inches), Horizontal Rain, Full Moon, Full Moon Closeness to the Earth Effects, Wind Velocity, Wind Gusts Velocity, and Wind Direction. These factors, in combination to "sea level rise, high tide, Northeaster, colliding with a second storm (blast of arctic air from the North)" require further study and possibly new recommendations. 7. In reference to #6 above, factors that attribute to sea level rise in the future is the installation of an underwater 26 inch diameter gas pipeline by Williams Co. that equates to submerging a 10 story building with a 4,000 square foot footprint. 8. In reference to #7 above, what is the underwater footprint of the possible installation of a Montauk 90 MW facility project planned in the ocean that can contribute to sea level rise? Relate this calculation to a building size. 10. In reference to #8 &#9 above, include the effect of all the windmill's underwater electric cable runs (in the ocean) that can contribute to sea level rise. 11. With the protections proposed, it would appear that a bathtub effect can or may occur. The Rate of Rainfall, Duration of the Storm, Wind Velocity, etc. will contribute to water entering the bathtub without a manner for the captured water's exit. Thus, it's important that these factors be stated and included to the study for furthering the analysis. It's believed with the above factors considered for additional study, a number of recommendations may be changed, such as the Bay Wall Height (Beach 149th Street to Beach 109th Street), Height of Flood Gates, Sea Level Rise, etc. In addition, for the purpose of the Reformulation Study, the stated year of reconstruction being assumed to be 2020, with a design life of 50 years doesn't appear realistic.	
1. The recommendations throughout the various studies are based on reduction of risk from two sources of storm damage: inundation, wave attack with overtopping along the Atlantic Ocean shorefront of the Rockaway peninsula and flood waters amassing within Jamaica Bay via the Rockaway Inlet. In	Comment Noted.

addressing “coastal resiliency” and “long term sustainability” a number of factors have not been stated and considered to identify best solutions to prepare for, and reduce or eliminate vulnerability to storm damage.	
2. In reference to #1 above, the principle water factors stated in the studies were wave attack, wave run up, overtopping and erosion. It is also noted the bay shoreline retaining wall (Beach 149th Street to Beach 109th Street) has a top elevation of approximately 3 to 4 feet above grade (roughly +10 ft. NAVD).	Comment Noted.
3. In reference to #2 above, no mention is made that water rises from storm sewers (backflow) into the streets, basements and garages during small storms. This large amount of water (possibly over a foot+ high at several street points) is not from wave attack, wave run up, overtopping and erosion.	Comment Noted.
4. In reference to #3 above, projected future climate changes are expected to exacerbate existing problems. Projected future climate changes, including sea level rise, precipitation increase, temperature increases, and changes in extreme weather events’ frequency and/or intensity will increase coastal storm flooding, erosion and wetland loss.	Comment Noted.
5. In reference to #4 above, for the purpose of the Reformulation Study, the year of reconstruction is assumed to be 2020, with a design life of 50 years. Also, Projected flood heights at Howard Beach will increase by 2.9 feet from 1983-2001 to the 2050’s.	Comment Noted.
6. In reference to #5 above, a number of Sandy Storm factors were not mentioned nor facts shown in the studies ,i.e., Duration of storm, Rainfall Rate (# of Inches), Horizontal Rain, Full Moon, Full Moon Closeness to the Earth effects, Wind Velocity, Wind Gusts Velocity, and Wind Direction. These factors, in combination to “sea level rise, high tide, Northeaster, colliding with a second storm (blast of artic air from the North)” require further study and possibly new recommendations.	Comment Noted.
7. In reference to #6 above, factors that attribute to sea level rise in the future is the installation of an underwater 26 inch diameter gas pipeline by Williams Co. that equates to submerging a 10 story building with a 4,000 square foot footprint.	Comment Noted.

8. In reference to #7 above, what is the underwater footprint of the possible installation of approximately 200 windmill towers and substation(s) that can contribute to sea level rise? Relate this calculation to a building size.	Comment Noted.
9. In reference to #8 above, what is the underwater footprint of the possible installation of a Montauk 90 MW facility project planned in the ocean that can contribute to sea level rise? Relate this calculation to a building size.	Comment Noted.
10. In reference to #8 & #9 above, include the effect of all the windmill's underwater electric cable runs (in the ocean) that can contribute to sea level rise.	Comment Noted.
11. With the protections proposed, it would appear that a bathtub effect can or may occur. The Rate of Rainfall, Duration of the Storm, Wind Velocity, etc. will contribute to water entering the bathtub without a manner for the captured water's exit. Thus, it's important that these factors be stated and included to the study for furthering the analysis.	Comment Noted.
12. With reference to the above September letter, Comment #8, factors that attribute to sea level rise in the future is the proposed Multi-Purpose Levees (MPL) installation along a portion of Southern Manhattan's East River waterfront. This high and wide standard river embankment roughly comprises a 1.3 mile long section of Southern Manhattan. The proposed 500' land reclamation will require structural fill inbound of the proposed perimeter structures. Therefore, what is the complete underwater footprint planned in the East River that can contribute to sea level rise (approximate Depth, Length and Width)? Relate this calculation to a building size.	Comment Noted.
13. In reference to Sea Level Rise and associated effects by the other factors, project the future installation of structures in the Ocean and Rivers elsewhere that can elevate these waters. These man-made structures should be factored into the drafted designs proposed for safeguarding the Rockaway peninsula.	Comment Noted.
14. The Bay Wall's height from Beach 149th Street to Beach 109th Street should be increased by approximately "more than 2 feet" to significantly	Comment Noted.

reduce water overtopping caused by many factors stated in comment #6 and potential overflowing.	
MAINTENANCE: A floodgate barrier used only in rare emergency situations will wind up at the bottom of the City's list for upkeep. How often would it be tested and inspected? Coney Island's infrastructure has persistent problems with vandalism and scavenging. Unless there is a constant security presence, the structure would be extremely vulnerable to damage.	Comment Noted.
SHOALING AND CLOGGING: The floodgate illustration shown in the Resiliency Study has multiple support columns and gates rather than one wide gate. These supports would stop normal flushing action, allowing silt and floatables from storm sewer runoff to block the gates and slow tidal action. Floating marine debris from Gravesend Bay, including large broken pilings and tree trunks, would also create a hazardous condition and interfere with operation of the gates. Past experience shows that the City is not quick to remove this sort of debris from the creek.	Comment Noted.
ICE FLOWS: In winter the gates could be jammed by ice flows. Coney Island Creek freezes over in winter. If the gates were clogged with ice, it could dam the creek, and then melting snow runoff from the streets would backflow through the storm sewers into surrounding neighborhoods.	Comment Noted.
PLASTIC FLOATABLES: DEP skimmers would be unable to access the creek to collect the refuse that's now removed from the floating barrier at Cropsey Avenue. Plastic and other debris are a constant hazard. How often would the gates be cleaned? My guess is "not often enough."	Comment Noted.
BACKDOOR FLOODING: Hurricanes and nor'easters can dump as much as 14 inches of rain in a short period of time. Three thousand acres of runoff would be trapped in the creek without an outlet. If the gates were closed in anticipation of a storm, the creek would back up through the storm sewers and flood the surrounding neighborhood. There are no tide gates on storm sewers to prevent backflow.	Comment Noted.
LIABILITY: If the barrier includes a public access bridge, it will become a diving board for young people and a platform for anglers to set illegal fishing nets at the gates. If anyone is swimming around the structure during an incoming tide or if the gates are clogged with debris, current could cause them to be pinned	Comment Noted.

underwater, resulting in deaths by drowning. Many young people have drowned in Coney Island Creek over the years, and the proposed dam would prove to be an irresistible attraction for kids to explore. This structure would be a liability problem for the City.	
EMERGENCY OPERATION: How would a floodgate be powered? Power outages accompany hurricanes. Will there be generators? Is it possible to manually operate such a large structure?	Comment Noted.
WATER QUALITY AND POLLUTION: Coney Island Creek is an estuary that has a history of contamination from manufacturing, coal gasification facilities, illegal dumping and filling with material of unknown origin, auto junkyards, petroleum contamination, auto repair shops, scrap metal recycling, illegal shipbreaking, sunken vessels, underground and aboveground storage tanks, metals, and spills of hazardous materials.	Comment Noted.
There is an error in the EDC's Resiliency Study. The KeySpan mitigation of the former coal gasification site at Shell Road did not extend to Stillwell Avenue as claimed in the study. The creek was only cleaned to the gas site's property line at the MTA Bridge at West 12 Street. The creek west of the bridge has never been mitigated, and "black mayonnaise" toxic sediment was never removed or capped and has most likely migrated to the western site of the creek. Any construction along the creek's banks will require a massive cleanup. Heavy industry once lined the creek's shoreline and most sites have never been mitigated.	Comment Noted.
THREATS TO WILDLIFE: A floodgate that traps sewage spills or other toxic materials would seriously degrade quality of life in the neighborhood much more than the occasional flooding that now occurs.	Comment Noted.
RECOMMENDATION: Use living shorelines, reefs, gabions, wetlands, raised habitat-enhanced bulkheads constructed along private property. Use a passive system instead of a mechanical one.	Comment Noted.
1. I do not believe the main storm gate planned parallel to the Gil Hodges Memorial Bridge, from Flatbush Ave. Brooklyn to the Rockaways, is sufficiently wide in the "open" position to allow adequate water flow through Jamaica Bay. According to page 94 of the plan, the total width of the gates is 1100 feet. The width of the current opening is about 3800 feet. Therefore, the opening will be decreased to 30% of the existing opening. The water quality in	Comment Noted.

Jamaica Bay is adversely affected by sewage outflow, fertilizer runoff, industrial pollution, and other human activities. If the amount of water flushing the bay is significantly decreased, what will happen when this pollution accumulates? What will happen to the oxygen levels, to the organisms that live in the bay, and to the birds and other wildlife that feed on fish and other marine organisms?	
2. There are also planned “sector gates” to Sheepshead Bay, Gerritsen Inlet, and Coney island Creek. These last two affect natural areas with wetlands. Are these gates of an adequate size to have no negative impact on these natural areas?	Comment Noted.
3. There are miles of other features: Reinforced dunes, beach berms, levees, concrete floodwalls, elevated promenades. Will these negatively impact beach-nesting birds? 4. What will happen to the areas outside (west) of the main storm gate: Plumb Beach, southwest Barren Island, and the bay side of the Rockaway Peninsula from Roxbury to Breezy Point? Will the “bathtub effect” of waves bouncing off the main storm gate and sector gates, even when open, cause an increase in erosion? And during a storm when the gates are closed, won’t this effect be even more pronounced?	Comment Noted.
Surge barrier needs to be funded - Surge barrier needs to incorporate lazy open - modelling needs to be more complete	Additional engineering and modeling will be undertaken during design phase as funding is available
Island of Broad Channel is... the most at risk community in the study area and one that sees the most instances of periodic tidal flooding from events that do not rise to the level of major storm instances and the one where RRM's would see the greatest benefit.	Comment acknowledged.
Include Waver Break Oyster Reef-to be constructed off west side of Broad Channel on the shallow mud flat that exists. This would reduce wave force energy approaching the homes and infrastructure on the west side of the island. (noted in the governors NY rising plan as a goal for storm protection)	Comment acknowledged.
(No comments written)	Comment missing from transmittal.
We need groins in Neponsit.	Groins have worked in the past Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only

	recommended for construction in areas where this is the case.

4.3 Public Comments and Reponses

Public Comment (2016 Draft Report)	Response
Flooding comes from underneath our homes (groundwater?). Hard structures will cause water to be retained behind them. The water will flood both sides of the gate and cause Roxbury to be flooded first. Recommend building "some sort of moveable structures that could direct the current depending on which way is needed".	Comment Noted.
TLDR: The communities know the risks and want to stay anyway. Utilize buyouts instead of building for the people that want to leave I believe much of your extremely costly proposals will change much of the current beauty and opportunities the communities presently enjoy. Ecosystems will be changed forever as will the quality of life. Just now when Jamaica Bay waters have improved tremendously your intended project will change that for the worse. Undoubtedly or eventually the cost of maintenance will filter down to homeowners and renters perhaps even forcing them to relocate. The problem of living in flood prone areas in not unique to our area. Up and down the east coast and adjacent to inland rivers people choose to live in such locations knowing the risks. Time and again people rebuild their homes knowing that their area is prone to hurricanes and flooding, yet they remain. I propose that the monies allocated to these projects be better spent in purchasing the homes of those who choose to relocate and then reselling to those who will take the risk of flooding for a chance to live near the shore as millions of others have chosen to do in our country. This could be a cost neutral proposal, a profit making one, or at the very least save an enormous amount of money for the taxpayers involved. I realize that this idea is not part of what your department does and that there are other concerns such as the cost of flood insurance and FEMA's involvement in the aftermath of a major storm, but I feel strongly that your current proposals would be extremely disruptive to our present way of life.	NYC's *Build it Back* program, which did extensive outreach in the project area, included a buyout program to move people out of the floodplain, and raise homes where people did not want to leave. A USACE program to further this goal is unlikely to have good participation rates since it would require more cost-sharing on the part of homeowners in many cases, whereas the recently offered City program was 100% paid for.

18ft walls are excessively high. No hard structures - expand the beach to accommodate a dune, repair existing groins and jetties, add groins, nourish the beach, build bulkheads, elevate homes, build mini floodwalls for each home.	Comment Noted.
TLDR: How will project affect horseshoe crabs? interested in your research as to the structures beings built i.e. gates and how will this affect the Atlantic Limulus Polyphemus in that it is one of their mating areas.	Please see the Revised Draft EIS and Appendix D for analysis of potential impacts to horseshoe crabs from the Recommended Plan.
With regard to the proposed floodgate to be built into a new/renovated Marine Parkway - Gil Hodges Memorial Bridge, I have some concerns. How much flow will be affected, even in an open position? The Jamaica Bay estuary, spotlighted by the Jamaica Bay Wildlife Refuge, is a world famous site for birds in all seasons, most notably shorebirds during the southbound fall migration. They currently use the East Pond for feeding, but much activity takes place all over the bay along the periphery and on the numerous internal islands. Will salinity be negatively affected by the placement of this device? There is only the one small outlet from the bay, and many fish and marine arthropods, such as horseshoe crabs, exist as they do because the current environment suits their needs. Do we know what changes may affect them, and the upstream impacts in the food chain on the birds? Also, isn't there the real threat, with a monster storm, of a total wash-over at Riis Park right behind the gate? There is no elevation there.	The water quality modeling that was performed for the Draft GRR/EIS did not show a significant affect to salinity from the storm surge barrier in the open or closed position, even for the worst case scenario extended closure that was modeled. Regarding overwash, the storm surge barrier would need tie-in structures to tie-into high ground and ensure that the barrier is not flanked, inducing flooding on either end. Further analysis pertaining to potential impacts from the storm surge barrier will be conducted under the NYNJHAT study which is now studying this feature for potential implementation.
I want to discuss the rock jetty on beach 149 street to repair the jetty make it bigger and stronger is left out and the community wants to know why	Comment Noted.

Summary: generally support. C2 is probably an easier alternative to execute than C1E. Models are inaccurate based on my personal observations while living in the area. West of Beach 124-125 sees more erosion until 130-131. 131 to mid-130s sees worse erosion. Extend the groins further west to mitigate erosion	Comment Noted.
TLDR: seawall should be higher than the boardwalk. Has USACE included the existing dips in the boardwalk in their design? My understanding is the proposed beach protection includes adding a sea wall and rocks covered with sand against the boardwalk. Currently the boardwalk dips at the concession stands which forms a gully and would funnel the ocean water if the ocean breaches the current dunes. I believe the proposed sea wall protection should not follow the height of the boardwalk, the sea wall should be higher. If the sea wall follows the height of the boardwalk the same funneling of ocean water will exist. Creating a sea wall higher than the boardwalk will remove the funneling affects if the ocean breaches the sea wall. Has/Is the army Corps of Engineers including the dips in the boardwalk when designing the Sea wall and rock protection?	Comment Noted.
Summary: nature should dictate how you construct; any project will be a failure if it does not take natural forces into account. Wildlife and nature must not be harmed for the benefit of humans.	The team has considered the existing natural conditions in our designs and the Recommended Plan includes nature-based features. The team has also, in compliance with NEPA, sought to avoid, minimize and mitigate for any impacts to the environment.
TLDR: My community has preserved our beaches - you're going to destroy our dunes. Based upon my readings and the discussions I've had with other residents of Cherry Grove, the opinions are varied; however, the conclusion that I have drawn is that I am adamantly against the plans to dredge/remove sand from our community beach front area only to be relocated to other areas along this barrier beach. Doing so, will destroy our dunes! The members of this community have assiduously	This comment appears to be for a different project. Please direct your comment to the FIMP and FIMI teams.

maintained our dunes for the past forty some odd years by yearly planting beach grass and have supervised the installation of snow fences along the entire length of the Grove. We have preserved our dunes! Dredging and relocating sand from our area will undo what we have done!!! Though my property is located mid-island, I support every and all efforts made by my friends and neighbors in their stated objections to your current and continuing FIMI and FIMP plans.	
Around the world cities are now using inflatable/deflatable barriers to protect their harbors and coastlines. Have you investigated these inflatable/deflatable barriers in the Rockaway Inlet?	The storm surge barrier component of the TSP will be further analyzed and potentially implemented under a separate study, the NYNJHAT study. The NYNJHATs team is considering inflatable barriers.
Which of the following are more effective lift gates, sector gates and swing gates? Also what are the cost of each?	Please refer to Appendix A2 for discussion of cost and purpose of selected gate alternatives. The NYNJHAT team is investigating the pros and cons of various gate types.
Storm gate. Call on me	Comment Noted.
Question regarding eminent domain concerning buildings along baywall. I own bungalow Bay on Bay 92 St	Since the perimeter plan was not selected as the TSP, no real estate issues are expected at this location of Jamaica Bay.
Could you please explain about co-payment city and state money? What are the phases of construction? Jetties first? Or sheet piling?	Sandy funded elements of this plan are 100% federally funded. Phasing of construction will be determined during design phase.
What will happen to the residential piers in Historic Arverne? What will the bulkheads in Historic Arverne look like? What is the schedule for new storm sewer infrastructure to prevent sewer seepage/backflow during storms? When will work start in Historic Arverne? I request clarification/details for proposed work in Historic Arverne coast. I request a US Army Corps of Engineers planning meeting for the Historic Arverne community. I request emergency mitigation to the flooding areas in Historic Arverne.	While no work in this area has been identified as a primary alternative, this area may be the target for High Frequency Flood Risk Measures.
Surfrider Foundation is a group of beach lovers, so we are very interested in this plan.	Comment Noted.
What was the cost of this study to date	Approximately $6M
ALL	Comment Noted.

(No comments written)	Comment missing from transmittal.
Five years ago after Hurricane Irene the Rockaway community had a demonstration by Beach 91st street on the boardwalk with Senator Schumer and looked down and saw water not on a sandy beach. Fast forward to today, after the boardwalk, berm and sand replenishment was done that area has a beach. The Belle Harbor and Neponsit community is losing its sand at an alarming rate. Question: Has the USACE reviewed/revised their models to better understand why this is happening?	Erosion is occurring at rates confirmed by historic research and computer modeling. While the current TSP recommends erosion control measures, the location of Rockaway Beach and the location of existing infrastructure will still require additional renourishment activities to maintain the existing shoreline.
ARC was committed to the big build hard solution from the start. Why should we believe this just happened to turn out the "best" solution?	Please refer the HSGRREIS and Appendix 2 to understand the USACE planning process.
Question timing of these projects.	Comment Noted.
Can you please consider constructing a storm surge gate from Breezy Point Rockaway to Sandy Hook NJ? It seem simpler in terms of purchasing private property and it would protect all of NY Harbor + NJ, Raritan Bay+ Staten Island etc. Thank you	This is currently being studied under the NYNJHATS, which is underway.
Water movement	This comment is incomplete.
I live in Canarsie, I would like to know if you will hold a public session in Canarsie, if so when?	Public sessions were held with within the study area during the comment period associated with the release of the Revised Draft HSGRR/EIS.
Does the Army Corp do assessment if City of NY can operate barrier?	Any barrier that is built will be operated and maintained by the State of NY, in partnership with the City. They will need to demonstrate their capability to do so as part of the requirements for signing the Project Partnership Agreement at the outset of preconstruction engineering and design, as well as the construction phase.
How does your project compare to the New Orleans wall? How will it protect Brighton Beach and how tall will it be? Can you build on sand and make it high enough?	Please refer to Appendix 2. Further analysis of the storm surge barrier is being conducted by the NYNJHAT study.

1. No models of Dutch water abatement presented. 2. Sheepshead Bay not addressed nor the Brighton Beach area. 3. Are you still using Katrina style levees? (they did not work in New Orleans.) 4. What is a Project Biologist?	Please refer to the subject report.
Has the possibility of an artificial barrier island extending from Breezy Point Northwest, an area of natural accretion, been considered? Recycled materials and pumped sand should be inexpensive and simple to construct. A gate system could be built in to allow total surge and vessel traffic.	This kind of alternative is under consideration by the NYNJHATS, which is underway
If construction starts in 2019. How long will it take to complete construction for the protective wall with flood gates?	Construction of the Atlantic Shoreline portions of the TSP are anticipated to begin in 2020 and will be complete by 2023
Where has there been done in Brighton Beach since Sandy?	Brighton Beach area was renourished immediately after Sandy as part of the FCCE emergency sand placement
Where would be if Hurricane Matthew did not turn East out the ocean - We have no protection since hurricane Sandy destroyed us four years ago.	FCCE emergency project was implemented. Combined with the NYC funded dune betterment, Rockaway Beach has a greater level of protection than has ever existed.
What percentage of people have to vote this plan down so it's not constructed?	Public acceptability is one of the evaluation accounts that the USACE uses to evaluate plans. Due to the significant amount of comments received raising concerns about the proposed storm surge barrier, this feature will be further evaluated under a separate study before it can be recommended for construction.
If money runs out, the walls that are built will stop water from running in, but the water will then rush into the community where barriers are missing!	Any plan recommended for construction will need to tie-in to high ground at each end to avoid the scenario you lay out. This is part of our tentatively selected plan.
What is the 1st phase of construction on the ocean side? Would the groins (jetties) come before the dune reinforcement?	Construction phasing will be determined in the design phase of this project.
The recent storm surge from Hurricane Matthew has washed away our beach. There is currently a three foot drop from the mats to the sand. These mats are	The Recommended Plan for this project includes beachfill and periodic renourishment. Without knowing which stretch of beach you are referring to,

more in the water at high tide. How can you solve this problem?	please review the Revised GRR/EIS for details on what is included in the recommendation for your area.
Why is NPS being permitted to not participate in this project? The lack of protective measures on NPS property seriously compromises and jeopardizes the safety and resiliency of the surrounding communities of Breezy Point, Neponsit and Belle Harbor as well as the property and facilities of Gateway Recreation Area. The plan must include protection against breach of State Rd. due to the continued erosion of the Cove area at Beach 193rd street.	NPS is a cooperating agency on this study and we are in regular communication and coordination with them. Much of the TSP would occur on or near their property and we must achieve mutual acceptability before any project can be constructed for this study.
I do not want to lose my home to eminent domain.	Comment Noted. No eminent domain to occupied homes is included in the Recommended Plan.
Please explain how the topography of the ocean bottom affects beach erosion.	Please refer to the Appendix A1 for a discussion of ocean topography and wave energy.
For maintenance - what funding guarantees would Corps require from City and State	The non-federal partners enter into a binding contract with the federal government.
Why not use the same program as Venice, Italy and build a retractable concrete wall from tip of Breezy Point to Coney Island	The TSP identified the gate option with the best benefit to cost ratio. Other potential alternatives, like the Venice gates were considered and ruled out. Please refer to Appendix A2.
This is a bad idea	Comment Noted.
Please provide a timeline for the planning process and implementation	Please refer to subject document.
Is this formulation proposal fully funded?	No, the storm surge barrier and associated tie-ins do not have funding and would need future appropriations in order to build them.
Once reefs are in place what is the cost of maintenance?	Reefs are not a component of the TSP.
Quite simply: Residents want groins, reinforced dunes, reefs and sand replenishment. Without additional protection, the dollars spent of sand replenishment are wasted because storms remove sand. Try to get it right and take action beyond the 40+ years of study that I have been hearing about. Again the experience of Sandy, wouldn't it be were to	Comment Noted. The Recommended Plan includes groins, reinforced dunes, beachfill (sand replenishment), nature-based features on the bayside and low floodwalls, bulkheads and revetments on the bayside. The study team is working on an expedited schedule to recommend and implement a plan that would reduce coastal storm flood risk while

eliminate most of the barriers that have to be overcome before any works begins - 2017 npt acceptable. Already 4 years - only a draft. FOR SHAME	complying with USACE policies and meeting our review and environmental compliance requirements. A study of this scope and scale has higher scrutiny for required reviews, public engagement, and complexity for the design, all of which add to the timeline for execution. Nonetheless, the team is working hard to serve the needs of the community in the interest of the nation. The Chief of Engineers has agreed to allow the concurrent and early start of Plans and Specifications and negotiate the terms of the Pre-Construction Engineering and Design Phase early to facilitate a seamless and quick transition once a Recommended Plan is approved for implementation. This is all aimed at being able to start construction as soon as possible without adding delays of ramp up time, etc.
Is Rockaway really protected? - Jetties are not in place - Sand dunes are not reinforced with steel bulkheads - Seawalls have shallow foundations - Riis Park has no dunes on ocean or bayside - Ft Tilden and area west of Ft Tilden are exposed the same way Riis Park is	There is significant coastal storm flood risk in the area which this Feasibility study aims to manage. The FCCE project that was built by the USACE after Hurricane Sandy for portions of the Atlantic shorefront included a dune and extended the beach. In these areas the communities behind this FCCE project have reduced risk, however the Recommended Plan would further reduce this risk and would add risk reduction features for parts of the bayside communities in the form of the High Frequency Flooding Risk Reduction features at Mid-Rockaway, Motts Basin North, and Cedarhurst-Lawrence. For Fort Tilden and Riis Park, the west end taper design on NPS property would include beachfill and groin rehabilitation. See the Revised GRR/EIS for more information. Any part of the recommendation needs to meet Corps policies, including that the benefit to the nation exceeds the cost.
Can somebody consult the system to avoid flooding in Holland?	Comment Noted. Please refer to Appendix A2. The NYNJHATs team which is responsible for further analysis of the storm surge barrier has been in communication with risk managers in Holland and other parts of the world to glean information and lessons learned on storm surge barriers.
Please explain the differences in cost effectiveness (protection of property, sacrificed properties) in building flood gates C2, C1W, C1E? Also the differences in community options with each gate?	Comment Noted. Please refer to Appendix A2.

What was the cost for Breezy Point scope of work? So for 11691 omit 11692 is 1:8. How much for 11693 and 11697?	Comment Noted. Please refer to Appendix A2.
I have a boat ramp on my property and do not want to lose it for a new bulkhead.	Comment Noted.
Of the $3 Billion dollar project proposal how much would be invested in infrastructure jobs and employment opportunities for people who live in the immediate area?	Limited funding is available to implement this project.
How secure will the residents living close to Jamaica Bay and Norton Ave be after the project is completed?	Please refer to the subject report for detailed discussion of risk reduction measures.
In spite of the massive construction that went on in 2016 in raising the street we still have flooding of our homes. Before this street raising there was no flood in my house. - Want our homes to be restored (with the BIG project, those of us in the program to have quality work done).	Comment noted.
I would like to know if there are any type of forecast models in place that might give insight of coming event. Here on Rockaway, due to its historical records of weather relative events.	Please refer to Appendix A1 for a detailed description the wave climate and historical information
When is the expected start date? End date? - Is there only the (1) one designated location for the tidal gate? - Would there be consideration to have the tidal gate built in another location - further out of the bay?	Funding is not currently available for the hurricane barrier alternative. Please refer to the subject report for information concerning gate location formulation.
How will the ramps to beach be affected when installing stone revetment? Will the horseshoe crabs in Jamaica Bay be negatively affected from any part of the project?	Beach access will be provided when the project is constructed. Horseshoe crabs are considered in the EIS, please refer to the subject document.
Impact on Animals/Nature/Environment? Standards used to evaluate this impact? (only government or private/not for profit Animal/Environmental Groups?)	Please refer to the subject document.
I would like to see on a few Rockaway beaches a breakwater to reduce the force of the waves so old people, children and somewhat disabled people can	Breakwaters were considered and screened out as a viable alternative. Please refer to Appendix A1 for additional discussion.

enjoy the ocean without the full force of the waves. - On the North shore of Puerto Rico they have groins to reduce waves.	
The governor said "some places belong to nature" after Hurricane Sandy. Is it impractical to limit development in Jamaica Bay? Jamaica Bay is a wetland its natural function is to flood and absorb storm surge.	Comment Noted.
I am concerned that these plans will be detrimental to the wildlife that inhabits Jamaica Bay.	Comment Noted. Please review the Revised Draft EIS which analyses the potential impact to the environment from the Recommended Plan and discusses how impacts have been avoided and minimized and how best management practices will be utilized. In particular, the Recommended Plan includes natural and nature-based features which will provide new and enhanced habitat and help serve as a self-mitigating feature of the project for the areas where some unavoidable impacts are otherwise expected.
I think spending so much money on this plan is not justifiable and may be bad for the three hundred plus species of birds that have been recorded in this important bird area along the Atlantic flyway. Greener alternatives should be looked into.	Comment Noted. The benefits to the national economy have been estimated and are shown to exceed the cost of the project which justifies the federal expenditure. The benefits are based on future damages avoided due to flooding and the cost to repair. The EIS analyzes potential impacts to bird and the natural and nature based features which are included in the Recommended Plan will provide the added benefit of habitat for birds and other flora and fauna.
We came to Queens especially to visit Jamaica Bay for its diverse wildlife. I do not think the environmental ramifications have been sufficiently addressed in this situation. Other solutions which incorporate living shorelines would be cheaper and made sustainable.	Comment Noted. Living shorelines have been included in the Revised Recommended Plan, where feasible.
I think the TSP is too reliant on hard structures which may disrupt the ecosystems in a very important wildlife area. I do not think "modeling" can possibly determine all of the environmental impacts that the implementation of this plan may create and I hope that before this plan is implemented there will be further exhaustive environmental review.	Comment Noted. Nature-based features have been included in the Revised Recommend Plan, where feasible on both the bayside and the Atlantic Shorefront.

Although I want people to be protected from the elements, I am afraid that the tentatively selected plan will be dangerous to the many birds and fish that exist in Jamaica Bay. I hope that you go back to the drawing board.	Comment Noted. The revised Recommended Plan includes nature-based features, where feasible, which will provide habitat for birds and fish and contribute to the resiliency of the plan and the communities it aims to protect.
Please place reefs as a barrier to protect the Rockaways. Think long term and not just a temporary fix.	Breakwaters and reefs were considered and screened out as a viable alternative. Please refer to Appendix A1 for additional discussion.
We're grateful to have received congressional authorization for these much needed improvements. Did congress require any reporting of the effectiveness of this project after its completion and what room will these be to make necessary adjustments in the future?	No such requirements were made by congress but a Monitoring Plan will be prepared based on the results of the ongoing coordination with resource agencies and the Operations and Maintenance Manual will address adaptive management.
Wall and groins will create an unstable erosion area. Kill wildlife already we have islands forming the Army Corps DID NOT MINTAIN THE last dredge, sand filled the channels and they will not take responsibility for it. I swim, sail a study Marine Biology this is a bad idea. MYC hasn't even removed dead trees will not maintain	Comment Noted.
How much protection does this plan offer the shorefront west of C-2?	This area will be addressed now with the NYNJHAT study as the storm surge barrier with tie-ins has been moved to that study which is looking at regional coastal storm risk management.
C2 is a much better alternative to C1 plan. - Much less disruptive to thousands of families. - Minimum additional cost. - Actually saves money over same respect with greater protection.	Comment acknowledged.
C2 is a much more viable plan than C1E with much less impact on the lives of many. NO WALL in Roxbury	Comment acknowledged.
How can Dan Falk state that it is too expensive to install groins and jetties to protect us - where has the money gone	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
I have lived in Belle Harbor since 1975 when we purchased our home. My husband and I have lived through three (at least) sand replenishments.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin

Everytime the sand washes away after a few years and is deposited in Breezy Point. The only thing that seems to work is the rock jetties or groins. Why are these stopping at Beach 121 St? We no longer have a Beach 133rd!	construction. They are only recommended for construction in areas where this is the case.
Why are the groins not being placed all the way to 149th street? We are taxpayers and deserve to have protection from storms and flooding.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
Why keep pumping sand - 3.5 million cu. Yd - when it just washes down to Breezy Point? Where are the rock jetties?	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
I have many questions, but a simple, immediate one to start: will new stone groins align exactly over the existing wooden remnants or will the old wooden groins present hazards to swimmers and surfers in the fields between the new groins?	No, the new stone groins will be placed in the same spacing as the existing stone groins. Your comment about the existing wooded groins is noted.
The community wants groins on every block, reinforced dunes and reefs and beach replenishment on a regular basis. Can we expect these proposals?	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
Would it not be cheaper to just raise/elevate all the homes in Roxbury? Wall devastates Roxbury. Avoid wall from Marine Park Bridge up to Breezy. Can keep Fort Tilden and Riis Park "as is" in Natural State. This savings plus the benefit to Roxbury make this a better alternative. How much would be sand? Put walls only along Beach Channel Drive and west to Beach 141st street and then overland to ocean. Also put around Breezy Point.	Please refer to the subject document to understand the USACE formulation process and how it relates to the Roxbury area.
Ending the groins at B. 122 could be disastrous for those beaches west of that point. Look at B. 88 and B. 149 just west of those groins. If no more than 12 groins can be built, why not place them further apart so as to reach at least Beach 147th? Thanks.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
We need groins in Belle Harbor & Neponsit! How much beach where there be between the dune hill in	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future

Belle Harbor and the high tide line? In other words, how much usable beach? Wouldn't C2 allow Roxbury, etc. to be protected without invasive walls?	renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
Why are the groins not being built all the way west? Why are they stopping at B. 121 St?	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
Why are the groins (jetties) not continuing to Beach 149th Street? Have you looked at our beaches since the dunes were installed WE HAVE NONE LEFT!	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
1. Why are groins not scheduled to be provided between Beach 123rd and 149th streets? (erosion is already happening on Belle Harbor and Neponsit Beaches). A. How many groins would be required to cover these beaches? B. What is the approximate distance between groins? c. Is it possible to spread groins out to cover these beaches? 2. What is the length, width and elevation of the proposed groins? a. How high will they be constructed above the mean high tide mark? b. Will the National Hurricane Center Consensus Model (average of all models) be used?	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
If the rock jetties work from B. 9th to B. 86 st. knowing that you are going to Bch 122, why are they stopping there? Leaving Belle Harbor and Neponsit completely at risk you refurbished not even 3 years ago and we have so much beach erosion yesterday on a beautiful beach day I took my grandchildren to beach 120 need for beach chairs we will sit on the grass	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
Why do groins stop at 121? They need to construct thru Belle Harbor and Neponsit. Sand replenishment needs to be ongoing.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
Would like to see groins throughout Belle Harbor and Neponsit, reinforced dunes and reefs to hold sand. We have lost a tremendous amount of sand since the last replenishment and have no room for more sand	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.

loss with the winter coming, a time for nor'easters which steal our sand!	
Why no groins/jetties from Beach 122 to Beach 149?	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
1. Since most of the water came from the ocean (Sandy) why not have sand piles like on Beach 9th street all the way down to Arverne?	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
1. We need erection of jetties (groins) through Beach 149th Street 2. Sand replenishment 3. Reinforcement of the present dunes with rock material 4. Installation of man-made reefs	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
I am concerned that the last groin on 121 St. will create a scouring effect on the west side of it. This is also a location where the boardwalk lowers. To me this seems like a recipe for the water to seek a low point, the lowered boardwalk and funnel down the street. Please place the groins down the whole beach to Gateway. This is only one of my concerns.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
Groins ---Rockaway Park- Belle Harbor - Neponsit - Groins, we love them, we need them - essential for preserving our beaches. Do you agree? Berms - The preliminary design for reinforcing the berm from 126th Street to 149th Street is at best confusing. When can the impacted communities see a more through design that best meets our storm protection needs? Elevation, width, density and placement from baffle wall? Accessd to the beach from the street on each block is important - it is hard to see how that is accomp0lished looking at the preliminary designs. Sand Replenishment - How much sand is anticipated for the next replenishment project for the Rockaway Shore? What is the approximate cost? Reefs - Has the Army Corps ever installed along the eastern seaboard reefs to prevent Beach erosion? Hurricane Gonzalo recently hit Bermuda. It was a category two hurricane. The reefs surrounding Bermuda were	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.

reported to have saved homes along the coast by lessening the wave surge. Why aren't we building more reefs to do the same in the Rockaways? General Questions - In the event the communities from 123rd to 149th street were to receive groins, a reinforced berm, additional sand and reefs what would be the logical order for each item to be installed?	
AS owners of a home in Belle Harbor since 1991 a few houses from the beach we have survived several major storms with varying amounts of damage to our property. The narrow width of our peninsula is easy to see when you watch the water from the Atlantic Ocean meet the water from Jamaica Bay somewhere in the middle of our 5-block expanse of land between these major bodies of water. To say Rockaway is a NARROW peninsula is an understatement ! So . . . . what to do to protect lives and property? Quite a few times over the 25 years we've watched the Army Corps of Engineers pipe sand from some distance offshore to replenish the sand on the beach. The results were always promising and welcome. . . . but most always short lived. Strong storms with strong wave action managed to return most of the sand from whence it came! Time and again we were left with a narrow beach as all the expensive piped sand went back out to sea. The COST of each piping of offshore sand to replenish sand on the beach again and again is staggering. Surely there is a better solution. After our own research and seeing the long-lasting, positive results in beach areas where GROINS/JETTIES are in place gives us what is hands-down better, more effective, more permanent solution. Yes, it's an expensive solution. However, if the cost of the offshore piping of sand over and over again is added up as a total, doesn't it make more sense to invest that kind of money in a permanent solution?? Jetties or groins are needed. We've tried other solutions. Now we should go with one that has been proven to work and to last.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
The area East of Beach 9th St has not been included in these plans, why?	

The Belle Harbor and Neponsit Communities need Reefs and Groins to protect and reinforced Rock Berms to safeguard our communities from Hurricane Storms and to safeguard our beaches. It is vital and necessary that these projects be instituted now to protect and safeguard our communities.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
76 Form Letters - groins, dunes, reefs, sand replenishment This letter is being written in response to the comments made relating to the proposals presented during the most meeting of the Army Corps of Engineers held at PS 114 in Queens, New York on October 20, 2016. As a Belle Harbor homeowner and tax payer of record, I respectfully request that the proposal for protecting the Rockaway peninsula be reexamined based on comments voiced, and suggestions posed, by the many residents residing in Belle Harbor and Neponsit in particular, and responses from the Army Corps of Engineers. As a survivor of Super Storm Sandy I have attended various meetings, spoken with more than a few individuals, including engineers, who have suggested the best solutions designed to keep us safe from future storms. I am in support of the following measures: a) groins (jetties) be continued from 123rd to 149th Street. b) reinforced dunes (whichj are required to assist in erosion) c) reefs (which prevented great damage in Bermuda during most recent storm) d) sand replenishment (which would be required much less often after above measures are implemented) The aforementioned measures, in the long run, will prevent loss of life and billions of dollars in property damage. If all these elements are properly included they will have long term benefits and be cost effective. Thank you for your consideration to include said measures as it relates to the overall plan to protect individuals residing, not only in the Rockaways, but throughout various portions of New York City and environs.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
TLDR: Building floodgate from tip of Breezy Pt to Kingsborough College would eliminate need for other walls around Jamaica Bay and result in cost savings. I am writing this attachment as the owner of a property located at 932 Bayside, Breezy Point NY	The major factors which affect the cost of storm surge barriers are the number of openings and the length and height of the barrier. Preliminary analysis of an alignment from the tip of Breezy Point to the opposite shore in Brooklyn indicated that this would be more expensive than any of the shorter alignments considered, even when you consider less

11697 to request the movement of the proposed flood gate. The presentation I attended in October by the Army Corps of Engineers at PS114 in Belle Harbor had the recommended location of the gate on the east side of the Marine Parkway Bridge. This location required building walls on the bayside of areas west of the wall. The proposed walls would be devastating to the communities surrounding Jamaica Bay. Building the flood gate from the tip of Breezy Point to Kingsboro College would eliminate the need for these walls. The cost savings obtained by eliminating the walls could be used to offset the cost of longer flood gate. The western option would allow the communities surrounding the bay to enjoy this special body of water. Thank you for your consideration in this matter.	extensive tie-in walls around Jamaica Bay. Furthermore, the tip of Breezy Point is in Gateway National Park and includes sensitive environmental habitat which would be adversely impacted, including federally threatened piping plover habitat. The National Environmental Policy Act and the Endangered Species Act require the government to avoid, minimize, and mitigate for adverse impacts. This combined with the additional cost led to the decision to consider Alternative C-2 as the westernmost alignment for the proposed storm surge barrier.
Refer to letter.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
20 October 2016 meeting with the Army Corps of Engineers 6:00 p.m. in Belle Harbor=, New York As owners of a home in Belle Harbor since 1991 a few houses from the beach we have survived several major storms with varying amounts of damage to our property. The narrow width of our peninsula is easy to see when you watch the water from the Atlantic Ocean meet the water from Jamaica Bay somewhere in the middle of our 5-block expanse of land between these major bodies of water. To say Rockaway is a NARROW peninsula is an understatement ! So . . . . what to do to protect lives and property? Quite a few times over the 25 years we've watched the Army Corps of Engineers pipe sand from some distance offshore to replenish the sand on the beach. The results were always promising and welcome . . . . but most always short lived. Strong storms with strong wave action managed to return most of the sand from whence it came! Time and again we were left with a narrow beach as all the expensive piped sand went back out to sea. The COST of each piping of offshore sand to replenish sand on the beach again and again is staggering. Surely there is a better solution. After our own research and seeing the long-lasting, positive results in beach areas where	Comment acknowledged. Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.

GROINS/JETTIES are in place gives us what is hands-down better, more ffective, more permanent solution. Yes, it's an expensive solution. However, if the cost of the offshore piping of sand over and over again is added up as a total, doesn't it make more sense to invest that kind of money in a permanent solution>> Jetties or groins are needed. We;ve tried other solutions. Now we should go with one that has been proven to work and to last.	
Refer to letter.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
Refer to letter.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
P.S. The team that presented their proposals at the recent heighborhood meeting in Rockaway were extremely professional and did a very impressive job representing the corps. I commend them for doing their jobs well and calmly in a sometimes angry environment. Congratulations on your team.	Comment acknowledged. Thank you.
34 Additional comment to above letter.	Groins and "jetties" are only deemed cost effective if the amount of sand they save in future renourishments exceeds the initial cost of groin construction. They are only recommended for construction in areas where this is the case.
How can we make sure that FEMA (& other agencies) timely send out forms necessary for re-imbursement (settlement) to insurance company for payment to flood insurance insured. 6 mos. Passed insurance company never got documents. From FEMA (ex: proof of loss). Would still be in limbo if I did not contact insurance company involved. Would like to speak (Briefly).	Comment out of scope.
1. What is the time frame that the water gate will be installed. 2. Will we be guaranteed that if there is a storm surge that the residents will be protected. 3,	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, barrier design and operations as well as the potential environmental

How will this project impact the premium in our flood insurance?	consequences of barrier construction and operation will be reexamined as part of the CSRM Study.
What impact will the hard solution have on flood insurance rates? If construction does not meet NFIP specifications, will it be redone?	The Corps planning process aims to maximize net benefits irrespective of flood insurance rates. There may be some benefit to local homeowners flood insurance rates going down as a result of a Corps CSRM project, but this is not a project goal or metric that we use.
For Dan Falt - Interested in Corps info on SLR/SLC for Radio program podcast	Comment out of scope.
Did NYS ever wonder why the islands in the Caribbean & Bermuda can handle extremely large hurricane surf or the winter swells that push down to the Caribbean producing the 20-30 foot waves and after storms such as these, their beaches remain relatively unaffected? The answer is the natural reefs harness the wave energy and minimize the erosion of the beaches. The bottom line is sea level is rising, and the beaches will continue to be eroded. Placing sand and producing a flat beach face only accelerates the lateral transport of sand thus making a need to maintain and increase ongoing dredging operations in NYC Harbor Entrance. By harnessing and controlling the wave energy along our shorelines we can slow the erosion and lateral transport of sand. There are two parts to this equation. 1) Sea level rise verse land elevation 2) Harnessing and directing wave energy. The coves in Montauk are an example of harnessing wave energy, nature wants to make new inlets and the beaches are migrating towards the mainland over geologic time. It has been brought to my attention that Mr. Glenn Walton a NYS Employee as a Parks Engineer with decades of erosion mitigation design experience and a lifetime of life experience with coastal geology and barrier beach dynamics has ideas which encompass both rising sea level and harnessing of wave energy are not being acknowledged by authorities in higher rankings than him. WHY IS THIS? Mr. Walton has reef designs that in the long run will save the residents from absorbing wasted finances produced by New York State with ineffective techniques. Why are we not working with nature, and acting like the man animal that pretends	Comment acknowledged.

we can control nature? I also ponder the questions as to why I am writing to a biologist, not a coastal geologist. Why is this and how long will New York State waste both federal and taxpayers money? Please acknowledge and listen to Mr. Glenn Walton's ideas on coastal erosion and harnessing wave energy to minimize beach erosion, lateral transport of sand and in the end save tax payers money. I believe we are all trying to find the same end result.	
	The approach to quantifying the effect of estimated sea level change (SLC) on plan formulation is consistent with USACE policy.

Did NYS ever wonder why the islands in the Caribbean & Bermuda can handle extremely large hurricane surf or the winter swells that push down to the Caribbean producing the 20-30 foot waves and after storms such as these, their beaches remain relatively unaffected? The answer is the natural reefs harness the wave energy and minimize the erosion of the beaches. The bottom line is sea level is rising, and the beaches will continue to be eroded. Placing sand and producing a flat beach face only accelerates the lateral transport of sand thus making a need to maintain and increase ongoing dredging operations in NYC Harbor Entrance. By harnessing and controlling the wave energy along our shorelines we can slow the erosion and lateral transport of sand. There are two parts to this equation. 1) Sea level rise verse land elevation 2) Harnessing and directing wave energy. The coves in Montauk are an example of harnessing wave energy, nature wants to make new inlets and the beaches are migrating towards the mainland over geologic time. It has been brought to my attention that Mr. Glenn Walton a NYS Employee as a Parks Engineer with decades of erosion mitigation design experience and a lifetime of life experience with coastal geology and barrier beach dynamics has ideas which encompass both a rising sea level and harnessing of wave energy are not being acknowledged by authorities in higher rankings than him. WHY IS THIS? Mr. Walton has reef designs that in the long run will save the residents from absorbing wasted finances produced by New York State with ineffective techniques. Why are we not working with nature, and acting like the man animal that pretends we can control nature? I also ponder the questions as to why I am writing to a biologist, not a coastal geologist. Why is this and how long will New York State waste both federal and taxpayers money? Please acknowledge and listen to Mr. Glenn	Comments are addressed to the project Biologist because they are responsible for NEPA compliance, which relates to public engagement. Comments are read and considered by the whole project delivery team, including the geologist. Nearshore coastal (shore parallel) breakwaters for the Atlantic Ocean shorefront (reefs) were considered (see the list of Management Measures for the Atlantic Ocean Shorefront Planning reach in the report) and were screened out early on for a variety of issues: 1) Based on the changes to the habitat and the use of the area by native species (and recreational users), environmental resource agencies (including the project partners) do not tend to support these features or find them to be acceptable. 2) The cost is substantial compared to sand renourishment. 3) Breakwaters don't significantly reduce the risk of storm surge. 4) Breakwaters and t-groins are useful in very specific circumstances where there are no other good options to keep sand in place, like in Plum Beach and Sea Gate. Breakwaters, or reefs, can be used as shoreline stabilization measures to locally reduce long shore transport capacity and retain sand behind these structures. Reefs certainly do reduce wave energy behind them, but they also change the nature of the beach and the habitat. High energy beaches also need a constant source of sand along the littoral chain so reducing energy with reefs may not necessarily solve eroding beaches problems and could change the characteristics of the beach itself. If you remove

Walton's ideas on coastal erosion and harnessing wave energy to minimize beach erosion, lateral transport of sand and in the end save tax payers money. I believe we are all trying to find the same end result.	enough energy, you may develop a marsh. Also, while wave energy is one aspect, sand supply along the littoral chain is another. A disadvantage of breakwaters is that they offer no high water protection and thus are not effective in providing coastal storm risk management benefits for this project, especially when their high cost is factored in. In short, though breakwaters can reduce the force of wave action and sand may accrete, erosion control is only one aspect of our project and recommendations are made to maximize net benefits.
1. The assumed sea level rise since 1970 seriously understates the probable rise - latest projections are from 205 ft. why use such a small rise? 2. In addition to use of ocean what is the wave height assumed a Sandy category storm in 2170?	The approach to quantifying the effect of estimated sea level change (SLC) on plan formulation is consistent with USACE policy.
Please discuss public access of it is not available at present.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the real estate issues will be reexamined as part of the CSRM Study.
The proposed projects are located on federal land and on private property - please confirm that the NPS or private landowners can "opt out" of this project if they desire to do. You mentioned that Public Access is a requirement when ACOE places sand. Is P.A. also required for a project where no sand is involved?	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the real estate issues will be reexamined as part of the CSRM Study.
As part of the non-fed sponsor responsibilities can they initiate a Community Advisory Committee to be a local task force lending local knowledge to every feature of the study? This could be the public sounding board for what is working and what isn't working day by day. EX: Living Breakwaters, Rebuild by Design @ Tottenville Staten Island - RPA's Regional Plan #4. What is the plan to involve area residents beyond the EIS process? The community will need a platform before, during, after construction.	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the real estate issues will be reexamined as part of the CSRM Study.
The residual risk features should be expanded top include more areas than the 5-7 locations already identified (Norton Basin, Mott Basin, Brookville Blvd, Canarsie, etc.). They should be stand-alone features that can exist with or without the gate, other flood walls, etc. They should be localized, green and gray features. * Why isn't green infrastructure like reef	As the Jamaica Bay Planning Reach segment is integrated into the New York and New Jersey Harbor and Tributaries CSRM Study, the real estate issues will be reexamined as part of the CSRM Study.

streets, living breakwaters considered for the RRF's? Can you build on/next to the JB Greenway? * What is your plan for mitigation for historic districts managed by NPS? * The NPS has to make difficult decisions about what (i.e. Ft. Tilden, Floyd Bennett Field and Dead Horse Bay) Structures they need to invest in vs what they will let go in the changing environment and SLR. How does this study compliment NPS's plan for the future?	
Historic Arverne Community wants to participate in the detailed planning of USACE CSRM features and infrastructure to support it - - how do we make this happen?	Please come to our public meetings October 4th & 10th at 6 pm at the Rockaway Waterfront Alliance and Cedarhurst Village Hall, respectively. More information on our website: http://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/East-Rockaway-Inlet-to-Rockaway-inlet-Rockaway-Beach/
What does Residual Risk Mean? Why is Historic Arverne Considered Residual?	The Residual Risk measures (now called High Frequency Flooding Risk Reduction Features) related to the idea that even with a storm surge barrier, there would still be some residual, or remaining flood risk. This is due to the fact that you would not close a storm surge barrier for every small event that causes flooding. The reason being that in some parts of Rockaway, such as Arverne, the areas are so low lying that they experience rainy day flooding or high tide flooding and it would be very expensive to operate and maintain a barrier that is closed that frequently, not to mention the added impact to transportation ann the environment. Hence the idea that smaller coastal storm risk management features could be (and have been) developed to address this frequent flooding without needed to close the barrier twice a day at high tide, etc.
Seawall along Jamaica Bay side of Peninsula	Comment incomplete.
In Manhattan Beach where will the "new" sea wall be built? The Promenade/Esplanade which once was the furthest Southern strip of land is uncompromised structurally and in portions, has been privately and built upon. Also a private citizen on Amherst Street, has built a fence across the street - another example of privatization.	Manhattan Beach is not included in the Recommended Plan but will be addressed as part of the New York and New Jersey Harbor and Tributaries Study.

If there is a wall along the bay how high? Will we still have a beach on the other side?	The Mid-Rockaway, Motts Basin North and Cedarhurst-Lawrence HFFRRFs include some floodwalls, bulkheads, revetments, and natural and nature-based features. The elevations of the floodwalls vary by site based on the elevation at grade. Please see the Revised GRR/EIS for more detail. Beach access to the Atlantic Shorefront will still be provided. Please see the Public Access Plan.
How high will the wall be in bayfront Roxbury in relation to the sidewalk? Or mean high water? How is the 18' measured from where will there be a beach in front of the wall? Will there be access to the beach? How far apart will the beach access points be?	The requested information can all be found in the subject report, including changes to the Recommended Plan.
Are you planning I walls or T walls around Roxbury? Building walls around Roxbury is risky. This is not consistent - some areas are past marsh with a low lier strength. The sand is unproductable also - can easily sink one foot when along shoreline. Conditions similar to bayou in New Orleans where levees failed. Roxbury walls will also fail. Look at the map of the area grew from the 1880s to today. They were marshes alternating with sand.	Comment Noted. The tie-in structures to the proposed storm surge barrier will be further analyzed in the NYNJHAT study. Geologic samples and analysis will be undertaken to ensure structural stability and appropriate design.
The wall is not acceptable for Roxbury. It would destroy the nature of our community. We live here to enjoy our beach during every season of the year. Walking on the beach, fishing, kayaking, swimming, paddle boarding, boating and quiet enjoyment of nature's beauty will be taken away by the wall.	Comment Noted.
The engineer said that they might elevate every house in Roxbury and not build a wall. The costs might be similar. This could be combined with dunes and groins to help with nuisance flooding.	House Raising was determined to not be cost effected in comparison with the gate alternative.
If seawall along Breezy/Rox voted down can they still install gates across the bay? This will cause a back flow and destroy Breezy.	Comment Noted.
No wall in Roxbury. It destroys the beautiful beach community that has existed for many years. It will destroy property value. Groins and dredging have helped this community for many years. That is the plan that should be in place. No WALL. C2 is a more viable plan than C1E.	Comment Noted.

I reside on the Rockaway Bayfront. I do not want my wall in front of my house. I just paid a lot of money to raise and repair my home. This is a beach community. We expect beach and water access. This is why we paid a premium for our house.	Comment Noted.
A wall NAVD + 18.0 is 13 feet above the sidewalk in Roxbury. The wall would take away access to the beach, completely eliminate the scenic views and destroy the natural beauty of our community. Why is the wall so high when Sandy's surge was NAVD + 11.0 (6 feet above the sidewalk).	Comment Noted.
I live in Roxbury NO to the wall	Comment Noted.
No wall or gate by bridge @ Roxbury/Breezy. Need more sand and groins.	Comment Noted.
No wall for Roxbury	Comment Noted.
Will public access be required? Why are groins excluded from Roxbury? The wall is 13 feet above - that is not acceptable. No access, no aesthetic value and beauty of our community.	Comment Noted.
1- Why have we been told for years we cannot disrupt the environment with groins but now this can be done. 2. Why not protect the bay front with dredging and groins and dunes other than a wall.	Comment Noted.
We live on the bayside of Roxbury and do not want the wall and would like to know alternative ways to protect the community.	Comment Noted.
I truly object to this wall it woill devalue our property.	Comment Noted.
Roxbury does not need a WALL. A wall will not protect Roxbury. In fact a wall will destroy Roxbury.	Comment Noted.
I do not want a wall on Bayside Beaches my home is in Roxbury and this is unacceptable.	Comment Noted.

I live in Roxbury and I don't want the 18 foot wall. I love going to the beach every summer. We won't be able to see the beach or go boating, have swimming races etc.	Comment Noted.
I live in Roxbury on the bayside. I do not want a sea wall on the bay in front of my house. I have lived there 63 years. Build out our groins add more groins. You will destroy this community that has been there forever. A wall will render our homes worthless. We want access to swimming and boating and our beaches.	Comment Noted.
I do not want a gate that does not protect Roxbury and I do not want a wall that takes away my beach and boating activity thereby causing my home to have a value of 0. Groins, jetties and dredging periodically always worked.	Comment Noted.
I object to the wall I live in Roxbury on Bayside Ave.	Comment Noted.
I live in roxbury and I am totally opposed to the seawall! Breezy Point is a beautiful community that has a rich history and this will destroy it. It will also totally disvalue our homes.	Comment Noted.
1. As a resident and homeowner in the Rockaways I would like to know what will be done regarding the very badly deteriorated bulkheads on the waterfront by the bay from Beach 72nd Street onwards to Beach 65th Street in Arverne. Seems all work is being done on the shorefront but all homeowners on the bayside are having no repairs or improvements to protect their homes from any form of flooding in any respect.	Please see the Description of the Recommended Plan for the Mid-Rockaway High Frequency Flooding Risk Reduction Features, which include an extensive design for Arverne which should replace deteriorated CSRM features where appropriate and construct new features as well, to include some natural and nature-based features.
How will the bulkhead affect bayfront property owners access to the bay for water access will they lose it? Also will the street get elevated?	Bulkheads are designed to maintain access to the water compared to other CSRM features. Street elevations are not included in the Recommended Plan.
1. What reason for wall being 8 ft high if the beach is already being built, it makes better science that the seawall be high and the bay be science.	Comment noted.

How will the 30 day flushing time issue for Jamaica Bay be corrected?	This is outside of the scope of this study.
How does this plan deal with rising of water taken inside the walls - where does that water go?	Please see the Interior Drainage sub-appendix to the Engineering & Design Appendix A for a detailed discussion of the interior drainage plan.
Bathtub Effect	Comment incomplete.
1. Cleanup Sheepshead Bay canal? 2. Oyster Beds in Manhattan Beach Ocean and Bay? 3. Shut-off values for entire community. 4. How to improve water drainage in Shore Blvd? 5. Sand dunes for Coney Island and Manhattan Beach?	Comment noted.
1. If the waves get higher than anticipated for the heights of the concrete wall, how the water will back up to the ocean and how long will it take for the water to recede? 2. Why can we have walls that are built in the water and raised above the water instead of concrete dune walls?	Please see the Engineering and Design Appendix and the Benefits Appendix for more information on how the Recommended Plan would perform. How long water takes to recede is highly dependent on the specifics of a given storm, the water elevations, rainfall, etc.
1. When will the city do the 69th bulkhead. 2. Will they also do the sewer on Bayfield Ave 3. Bay Street on 72nd St.	This is outside of the scope of this study. This question should be directed to the appropriate local entities.
I would like to see peninsula Hospital back. What is going to happen to the flooding doing a heavy rain storms?	Comment noted. The project would reduce flood risk during heavy rain storms.
1. What are the plans to mitigate the flooding areas now? 2. The City intends to move more than 150 million federal funds originally earmarked for flood protection programs. And $152 Million set aside for a raised shoreline program. How will this impact your task?	The USACE team has worked hand in hand with the City and State and is coordinating between local and federal efforts to ensure there is no conflict. The USACE study/project is funded through the Sandy bill and separately from City-led efforts.
How will this project affect localized flooding that is generated by high tide surges, water comes up through the sewer lines	Local drainage is managed locally and is outside the scope of this study. However, this project includes interior drainage designs for the CSRM features which may help to address this problem as an incidental benefit.
What about the sewer system. How are they going to create a system that will enhance our sewer system?	The sewer system is managed by NYC Department of Environmental Protection and is outside of the scope

	of this study. Where the stormwater and sewer systems are combined, it is possible that the Rockaway project will improve overall capacity of the system by helping to drain stormwater quicker, but this would be an incidental benefit of the project.
TLDR: Beach access is critical. Access ramps should be provided. We would support a long term project that is designed to protect the area from coastal storm floods such as a wall being built in the ocean as opposed to being erected adjacent to Boardwalk. When the plans are detailed for the Brighton Beach Coney Island area please keep in mind that access to the beach is critical for our beach community. Access Ramps should be provided where we presently have access to the beach (steps). However, at this time we need more information before we can make and further comments.	Comment acknowledged.
As a Rockaway resident please consider putting in more and longer jetties	Comment acknowledged.
TLDR: More jetties I am writing this email to request information as well as ask for more rock jetties in Rockaway Beach. I am a proud resident of Rockaway Beach and struggled during the catastrophe of hurricane Sandy. For many years sand has been put down to stop the ocean from destroying the land but this does not work and is a waste of time and money because within months the ocean takes the sand. The option of rock jetties seems the most logical way to keep the water from rushing into the land. The proof is that Sandy destroyed the majority of the land that is not protected by rock jetties from 90 street up. Please respect and respond to my request for more rock jetties. Thank you for your help and support.	Comment acknowledged.
TLDR: Build more jetties in the Rockaways I am writing to request the addition of more jetties in Rockaway, Queens, New York. Obviously, the jetties are a useful tool for reducing erosion for the compact urban community, but they are also a huge improvement to the recreation of the area for bird	Comment acknowledged.

and fish habitat, surfing, swimming safety, and more. Many members of the community support this.	
More jetties	Comment acknowledged.
I am writing to express my sincere hope that more jetties can be installed at Rockaway beaches.	Comment acknowledged.
TLDR: build more jetties in the Rockaways Please grant the Rockaway's more jetties. After the recent storm we have unfortunately seen most of the sand replenishment program that was successful post-Sandy go to waste as the beaches west of the 90th St jetty have eroded so quickly again while those east of it have seem to trap the sand. Please build us more jetties so the replenishment program does not wash away again.	Comment acknowledged.
TLDR: More groins and jetties. Lifeguards, swimmers, and surfers will benefit Hello, I am writing this as a resident of Rockaway beach. Sandy showed us clearly that we need to build more groins and jetties within our beaches, It was apparent to anyone that the beaches with jetties provided both protection during the storm and helped stop erosion both during and after Sandy. We have spent so much money replenishing our beaches, why stop half way through the process? Add some more jetties. The jetties also help lifeguards control and protect swimmers and provide surfers with better waves. The rebirth of Rockaway's popularity is based on its ocean. Please consider more jetties before moving all of your funding and effort to the bay.	Comment acknowledged.
Refer to letter.	Comment acknowledged.
TLDR: Favor the floodgate over the perimeter plan. Environmentalists have no reason for concern. I am very much in favor of the storm surge gate	Comment acknowledged.

proposal, with the storm gate tied into the high ground on the "mainland" to the north at Brooklyn, and to the south at the ocean barrier on the Rockaway peninsula. In my opinion it is far superior to the "perimeter" plan, which would be more expensive both to implement and maintain, as well as being less environmentally friendly, with waves bouncing off bulkheads. Perhaps most importantly, the surge gate plan is also the most politically viable. Only the surge gate plan protects ALL of Jamaica Bay, and thus would unite all communities within the Jamaica Bay flood zone behind a common goal. The perimeter plan would pit one community against another, in a competition for dwindling funds to secure their own little section of the bay. In fact, this is already happening in the planning stage, as the D.E.I.S states, “The community at Broad Channel, which is effectively within Jamaica Bay - as opposed to being a community on the fringe of Jamaica Bay - would not benefit from the perimeter plan, as site specific features for Broad Channel were not cost-effective and eliminated from consideration in the screening." For environmentalists who are horrified at the idea of a massive storm gate at the mouth of the bay, it will be open most of the time. According to this study, the effect on tidal flow with the gate open are almost too small to measure. There's also no reason for ongoing marsh replenishment projects to not continue concurrently, and they may even be able to allow the gate to be kept open for lesser flood events of short duration.	
Thanks for forwarding public meeting info.	Comment acknowledged.

US Army Corps of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix H

Support from Non-Federal Sponsor, Partners, and Cooperating Agencies

December 2018

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water, Bureau of Flood Protection and Dam Safety
625 Broadway, Albany, New York 12233-3504
P: (518) 402-8185 | F: (518) 402-9029
www.dec.ny.gov

November 30, 2018

Colonel Thomas D. Asbery
Commander and District Engineer
US Army Corps of Engineers
New York District
26 Federal Plaza, Room 2119
New York, NY 10278-0090

Dear Colonel Asbery:

The purpose of this letter is to confirm the New York State Department of Environmental Conservation's (DEC) interest in participating in the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Coastal Storm Risk Management Project (Project) as the Non-Federal Sponsor with the United States Army Corps of Engineers (Corps) for the construction of the Project. Furthermore, the DEC supports the recommendations contained in the Project's Final Integrated Hurricane Sandy General Re-evaluation Report/and Environmental Impact Statement (GRR/EIS), dated December 2018.

In order for the DEC to take on the role of the Non-Federal Sponsor, the DEC's authority (Chapter 7 of Title 4 of the New York State Unconsolidated Laws) to participate in a project to arrest erosion and alleviate or prevent damage resulting from storms requires the DEC to have a local sponsor that will share in the Non-Federal Sponsor's costs and obligations. The City of New York (City) and the Village of Cedarhurst (Village) have agreed to be the DEC's local sponsors. Letters of support from both the City and Village are enclosed.

The DEC understands that to the extent that the Disaster Relief Appropriations Act of 2013, Public Law 113-2 enacted January 29, 2013 (DRAA 13), funds appropriated by Congress are available, the Corps will construct the Project at 100 percent Federal expense. In the event that there are insufficient DRAA 13 funds to complete construction of the Project, the proposed Project Partnership Agreement (PPA) will need to be amended and the remaining work will be subject to cost-sharing.

This letter does not constitute a binding agreement for the DEC to serve as Non-Federal Sponsor, nor is this letter a commitment for the funding of any portion of the Project. These commitments can only be made when the proposed PPA with the Corps for the Project is executed by the Office of the New York State Comptroller. DEC maintains that it is interested in being the Non-Federal Sponsor; however, the DEC's participation will depend upon successful execution of a formal agreement with the local sponsors.

The DEC recognizes that additional analysis will be required during the Pre-Construction Engineering Design (PED) phase of the Project, and that based on the refinements that

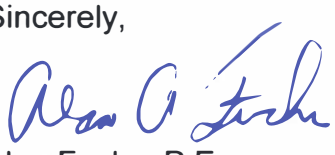
occur during PED, the final design may differ from the designs outlined in the GRR/EIS. The Corps will need to continue to coordinate with New York State, New York City, and the Village of Cedarhurst throughout PED as the plan, real estate needs, and Project elements are further refined, including the design and siting of the rock sills and associated fill, groins, dune crossing structures, and the items noted in the enclosed letter of support from New York City.

The DEC recognizes that the bayside features have been developed to a feasibility-level of detail. We expect that further design of these features will occur during PED and we expect that opportunities for minimizing impacts to existing wetlands and water access will be incorporated.

The DEC awaits the Corps' submittal of their Water Quality Certification (WQC) application. Based on the DEC's review of the Hurricane Sandy GRR/EIS, DEC does not foresee any problems that would preclude the issuance of the WQC, providing that the previous DEC comments on the GRR/EIS are adequately addressed in the Corps' initial WQC application or subsequent requests for authorization. The DEC will initiate the formal review process of the WQC once the Corps' application is submitted. The DEC acknowledges that the Corps application will ask for an Umbrella WQC with individual authorizations to be processed during each individual construction contract. Please note that there is no authorization for the Corps to move forward in the construction of each contracted reach of the Project until each contract's review process is completed and each WQC Authorization to Proceed is issued.

The DEC will continue working with the Corps to move the Project forward as expeditiously as possible. If you have any questions, please contact me by email at alan.fuchs@dec.ny.gov, or by telephone at (518) 402-8185.

Sincerely,



Alan Fuchs, P.E
Director
Bureau of Flood Protection and Dam Safety

Enclosures

cc w/ Encl.: Stephen Couch, USACE
Dan Falt, USACE
Steve Zahn, NYSDEC
Susan McCormick, NYSDEC
Matt Chlebus, NYSDEC
Jainey Bavishi, NYC ORR
Sam Hersh, NYC ORR

November 30, 2018

Colonel Tom Asbery
Commander and District Engineer
United States Army Corps of Engineers
New York District
26 Federal Plaza
New York, New York 10278

Dear Col. Asbery:

The City of New York strongly supports efforts to make communities in the Rockaways and Jamaica Bay more resilient to the impacts of coastal storms and nuisance flooding, and we thank the U.S. Army Corps of Engineers (USACE) for their efforts to advance protections for the beachfront and bayside of the Rockaway peninsula.

Please allow this letter to serve as formal support of the plan outlined in the East Rockaway Inlet to Rockaway Inlet Hurricane Sandy General Reevaluation Report, dated December 2018. This letter confirms New York City's interest in serving as the Local Sponsor to the Non-Federal Sponsor, New York State Department of Environmental Conservation (DEC), on the East Rockaway to Rockaway Inlet and Jamaica Bay Storm Damage Reduction Project (Project).

This letter does *not* constitute a binding agreement to serve as Local Sponsor nor does it constitute a commitment of funding for any portion of the project, both of which can only be effectuated through the execution of a project partnership agreement (PPA).

The City strongly supports the USACE's recommendations for the Atlantic Beach and reaffirms our belief that beachfront projects should not be delayed as analysis and design and any required acquisitions on the bayside continues. The City also supports the recommended bayside interventions and recognizes that that additional analysis will be required during PED, prior to construction. The City also recognizes that the final design may differ from the designs outlined in the report, based on the outcomes of the Pre-Construction, Engineering, and Design (PED) phase.

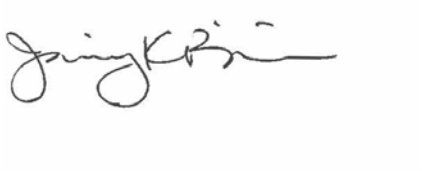
In particular, we expect that the Corps will coordinate with the City on the following tasks during the PED phase in order to complete necessary refinements on bayside designs:

- We recognize the design of pump stations for these sites was conducted to a feasibility-level of detail. We understand the Corps will apply the design considerations in EM 1110-2-3102 during the PED phase. Consistent with this guidance, we expect NYCDEP to be involved and consulted with in the analysis to finalize design details pertaining to operations & maintenance, redundancy of pumps, automated trash racks, and pump station siting.

- We recognize the plan includes feasibility-level design of road closure gates and road raisings. We expect that during PED the final design of these features will be coordinated with NYCDOT, for compliance with applicable standards.
- As additional details are developed during the PED phase, we expect continued and regular involvement and engagement with the affected communities to communicate these design details.
- We recognize that the bayside features have been developed to a feasibility-level of detail. We expect that during PED, further design of these features will occur, and we expect that during this design process, opportunities for minimizing impacts to existing wetlands will be considered.

We are pleased to see this important milestone being met and we remain committed to advancing the important project components deferred to the New York New Jersey Harbor and Tributaries study, namely the Jamaica Bay barrier and Coney Island tie-off. These federal investments are crucial to a comprehensive solution for the long-term resilience of low-lying communities in South Brooklyn and Southeast Queens.

Should you have any questions or concerns on these matters, please contact the undersigned at,



Jainey Bavishi
Director, New York City Mayor's Office of Recovery and Resiliency

Mitchell Silver
Commissioner, New York City Department of Parks and Recreation

Vincent Sapienza
Commissioner, New York City Department of Environmental Protection

RECEIVED
BUREAU OF
JUL 27 2018
FLOOD PROTECTION
AND DAM SAFETY

Village of Cedarhurst

NASSAU COUNTY, NEW YORK

MAYOR
BENJAMIN WEINSTOCK

BOARD OF TRUSTEES
RONALD LANZILOTTA, SR.
ARI BROWN
MYRNA ZISMAN
ISRAEL WASSER

200 CEDARHURST AVENUE
CEDARHURST, NY 11516
516-295-5770
FAX 516-295-1077

www.cedarhurst.gov
E-MAIL:village@cedarhurst.gov

July 3, 2018

Alan Fuchs, P.E.
Director
Bureau of Flood Protection and Dam Safety
625 Broadway, 4th Floor
Albany, NY 12233-3504

Re: Rockaway Reformulation

This is to confirm that the Village of Cedarhurst ("Village") formally supports the recommendations contained in the Hurricane Sandy General Reevaluation Report dated August 2018. This will also confirm the Village's interest in participating in the Lawrence/Cedarhurst portion of the East Rockaway to Rockaway Inlet and Jamaica Bay Storm Damage Reduction Project (Project) as the Local Sponsor of the Non-Federal Sponsor with the New York State Department of Environmental Conservation (DEC) for the construction of the Project.

The Village of Cedarhurst understands that to the extent that the Disaster Relief Appropriation Act of 2013, Public Law 113-2 enacted January 29, 2013 (DRAA 13) funds appropriated by Congress are available, the United States Army Corps of Engineer (Corps) will construct the Project at 100 percent Federal expense. If there are insufficient DRAA 13 funds to complete construction of the Project, the proposed Project Partnership Agreement (PPA) will need to be amended and the remaining work will be subject to cost-sharing.

This letter is not a commitment for the funding of any portion of the Project. That commitment can only be made when the proposed PPA with the DEC for the Project is executed and the Village enters into a formal written agreement with DEC. The Village maintains that it is interested in being the Non-Federal Sponsor. However, the Village's participation will depend upon successful execution of said formal agreements.

The Village would like to see the completion of the Project's implementation as quickly as possible. To that end the Village supports the release of the draft Report for public and agency review.

Sincerely,

Benjamin Weinstock
Mayor

cc: Salvatore Evola
Board of Trustees
Frank Parise
Wayne Yarnell

776055

United States Department of the Interior
NATIONAL PARK SERVICE
Gateway National Recreation Area
210 New York Avenue
Staten Island, New York 10305

November 16, 2018

Colonel Thomas D. Asbery
Commander and District Engineer
Department of the Army
U.S. Army Corps of Engineers
New York District
Jacob K. Javits Federal Building
26 Federal Plaza
New York, NY 10279-0090

Dear Colonel Asbery:

The purpose of this letter is to confirm the National Park Service's (NPS) interest in participating with the United States Army Corps of Engineers (USACE), New York State Department of Environmental Conservation, and The City of New York for the successful implementation of the Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement for the East Rockaway Inlet to Jamaica Bay (HSGRR/EIS) Coastal Risk Management Project. The NPS mission is to manage our lands for the preservation of and access to natural, cultural and recreational resources in perpetuity. Understanding that this Project is necessary for the protection of the adjacent communities, and that construction of the risk reduction features will not occur on NPS property, NPS is committed to working to avoid and minimize adverse impacts on our resources while advancing the goals of the Project.

This letter is not a commitment for construction of any portion of the Project on NPS lands. Construction of the project on Gateway National Recreation Area's (GATE) land is contingent upon: an appropriate legal authority or instrumentation to authorize construction on NPS property; commitment of a non-federal sponsor for long-term maintenance obligations and liability and risk considerations for the project on NPS lands; and, appropriate off-sets for unavoidable Project impacts to GATE natural, cultural and recreational resources. In addition, any portion of the project that may be constructed on or impact NPS resources must be mutually acceptable to the Secretary of the Interior and the Secretary of the Army and consistent with GATE enabling legislation (16 U.S. Code Subchapter LXXXVII).

NPS will continue to work with USACE and other partners to implement this project. If you have any questions, please contact me by email at jennifer_nersesian@nps.gov or by telephone (718-354-4665).

Sincerely,

Jennifer T. Nersesian
Superintendent

Cc: Cliff Jones, USACE
Dan Falt, USACE
Daria Mazey, USACE
Joshua Laird, NPS
Patti Rafferty, NPS

US Army Corps
of Engineers®
New York District

FINAL

Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Appendix I

Pertinent Correspondence

December 2018, amended as of May 2019

to include USFWS transmittal letter of Biological Opinion and USACE response

CORRESPONDENCE FROM:

Hon. Charles E. Schumer
United States Senate
dated 23 May 2018
and 25 May 2018

RESPONSE BY:

Thomas D. Asbery
Colonel, U.S. Army
dated 22 June 2018

CHARLES E. SCHUMER
NEW YORK

WASHINGTON, DC 20510-3203

United States Senate

May 23, 2018

Dear Colonel Asbery,

In light of the recent announcement by the NYC Parks Department that Beaches 91 to 102 in Rockaway will be closed to the public this summer, I write to urge the Army Corps of Engineers New York District to schedule public meetings as soon as possible to discuss with the community a detailed timeline with hard deadlines for the construction of permanent beach protections.

After Hurricane Sandy devastated Rockaway and the communities surrounding Jamaica Bay, I worked very hard to lead a bipartisan push to pass a $63 billion relief package. Following that, we worked together to remove debris, make homeowners whole, build a new state-of-the-art boardwalk, repair playgrounds and schools and roads, and place 3.5 million cubic yards of sand to replenish beaches and protect the area from future storm surge, but the pace of erosion in Rockaway is now threatening the public's safe access to the beach and the livelihood of local business owners, while leaving homeowners too vulnerable to the next storm.

With each day that passes, Rockaway stands to lose even more. More aggressive action is needed to begin building more permanent and effective protections against beach erosion and storm surges.

I appreciate that your District is grappling with extremely complex engineering and environmental questions as you make progress on the Jamaica Bay-Rockaway Reformulation Project, but the community is in need of more immediate answers. Therefore, I urge you to schedule meetings with the public so that you can update residents specifically on when construction will begin on hard protective features – such as a sea wall, jetties, and groins – to protect their fragile beachfront.

Earlier this year, I was proud to secure $730 million in additional federal funding to support critical resiliency and mitigation work by the Corps in New York, as we worked together to expedite the timeline of the Jamaica Bay-Rockaway Reformulation Project.

Thanks to these efforts, we have the resources, know-how, and forward momentum we need to protect this precious natural resource. I urge your District to now update local stakeholders on when these advantages will lead to shovels in the ground.

Thank you for your attention to this pressing matter. Should you have any questions, please do not hesitate to contact my office.

Sincerely,

Charles Schumer

Charles E. Schumer
United States Senator

CHARLES E. SCHUMER
NEW YORK

WASHINGTON, DC 20510-3203

United States Senate

May 25, 2018

Dear Colonel Asbery,

In the wake of the NYC Parks Department's closure of Beaches 91 to 102 in Rockaway, I write again to request a comprehensive list of emergency options that the Army Corps New York District could undertake to renourish the affected areas with sand as soon as possible.

I am thankful that we have been able to expedite progress of the Jamaica Bay-Rockaway Reformulation Project, which will provide long-term, permanent beach protections for the community against future storms, but there is an urgent need to address the erosion that is endangering Rockaway's residents and visitors right now.

In the spirit of our ongoing effort to cut through the red tape of the Army Corps' internal processes and bureaucracy, I encourage your engineers to think as creatively as possible as you consider what can be done to replenish sand in Beaches 91 to 102.

Earlier this year, I worked hard to secure $730 million in additional federal funding to equip the New York District with the resources you need to protect this vulnerable part of Queens. I am hopeful that we can now employ those resources to rapidly respond to the dire situation in Rockaway.

Thank you for your attention to this issue. Should you have any questions, please do not hesitate to contact my office.

Sincerely,

Charles Schumer

Charles E. Schumer
United States Senator

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

JUN 22 2018

The Honorable Charles E. Schumer
Minority Leader
United States Senate
322 Hart Senate Office Building
Washington, D.C. 20510

Dear Senator Schumer:

Thank you for your recent letters dated May 23 and 25, 2018 regarding beach erosion and long-term coastal storm risk reduction in Rockaway and Jamaica Bay. As the issues you have raised in the letters are closely linked, I am replying to both letters on short and long-term strategies with regard to the current concerns.

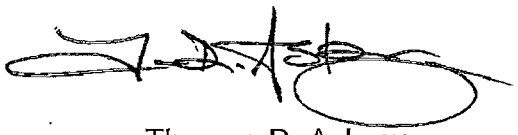
I am pleased to report to you that we are moving forward with good momentum on the long-term comprehensive resiliency features for the Rockaway oceanfront and Jamaica Bay high risk back-bay areas. We are in senior leader level coordination with New York State and New York City on the remaining technical issues, and we hope to resolve them before the scheduled public release of the Draft Final Report by the end of this summer. Between the release of the Draft Report and the release of the Final Report before the end 2018, we will conduct a series of public meetings and outreach sessions with local constituencies to describe the proposed features and timelines for construction. Concurrently, we will strive to acquire the necessary approvals to be able to initiate construction as early as possible in late 2019 using 100% federal funding under Public Law 113-2.

We are also directly engaged in discussions on possible options for short-term measures to address erosion impacts along Rockaway Beach between Beach 91st Street to Beach 102nd Street. Four significant coastal storms this past March eroded the beach to near the base of a dune constructed after Superstorm Sandy, leading New York City Parks to close this section of beach. After participating in two recent meetings with city, state and Federal elected officials, it has become apparent that a viable funding source, regulatory permitting, and lack of a contractual process to execute work in a timely manner are limiting factors in executing a project on the aggressive timeline envisioned. Nonetheless, our New York District team recently held a planning session to develop options that might address the immediate concerns. These ranged from a 100% city solution, a 50/50 solution (Federal/city), and 100% Federal solution. We further explored our authorities, possible sources of funding (Federal and private), and possible procurement methods. Possible procurement methods included sole source, letter contract, urgent and compelling need, and also traditional procurement methods.

Unfortunately, no funding source has been identified to date, and thus there is no viable option available for the New York District to provide assistance at this time. Even if a source of funding did come available in the near future, our most aggressive estimate would be approximately 8 to 10 weeks to complete sand placement on the beach. Under that assumption, sand could not be delivered to the beach for this summer season. Given these constraints, we are aware that New York City is exploring a number of measures to reduce the impacts to the local community and businesses this summer while we gear up to construct the long-term resiliency solutions on the oceanfront and back bay. I do want to highlight the fact that although the beach is closed for recreation, the remaining dune in place is wider and more elevated than prior conditions, and is still providing risk reduction to the Rockaway communities.

The Corps of Engineers is committed to working collaboratively with all parties and to maintaining transparent and open communication as we move forward with our partners in the city and state to deliver robust and long-term resiliency to the shorelines on the oceanfront and back-bay of Rockaway and Jamaica Bay. If you have any questions please do not hesitate to contact me, or Mr. Daniel Falt at 917-790-8614.

Sincerely,



Thomas D. Asbery
Colonel, U.S. Army
Commander and District Engineer

CORRESPONDENCE FROM:

Hon. Mitchell J. Silver
Commissioner, City of New York Parks & Recreation
dated 08 November 2017

RESPONSE BY:

Thomas D. Asbery
Colonel, U.S. Army
dated 02 January 2018

Suspense #0119

NYC Parks

Mitchell J. Silver, FAICP
Commissioner

City of New York
Parks & Recreation

The Arsenal
Central Park
New York, NY 10065
www.nyc.gov/parks

Wednesday, Nov 1, 2017

NOV 0 8 2017

Dan Falt
Frank

Colonel Thomas D. Asbery
Commander and District Engineer
U.S. Army Corps of Engineers
New York District
26 Federal Plaza
New York, NY 10278

Re: U.S. Army Corps of Engineers & NYC Parks Coordination on Coastal Protection Projects

Dear Colonel Asbery,

I want to send a sincere thank you to yourself and your staff at the New York District for visiting with NYC Parks and the Mayor's Office of Recovery and Resiliency on October 12th here at the Arsenal. Our conversation made clear many of the complex aspects of the Corps of Engineers' process and how we can work together in advancing projects.

As discussed at our meeting, advancing the Rockaway Shorefront component of the Rockaway Reformulation Study is a top priority for the City. You mentioned that it was one of your top priorities as well, so I do feel confident that the City, State, and Corps will continue working diligently on the remaining tasks. However, we remain concerned about the schedule and urge you to continue exploring ways to deliver the Rockaway Shorefront project as quickly as possible. For example, my staff indicated the continuing analysis and design of the High Frequency Flood Risk Reduction Features (HFFRRF) as a component that may be adding schedule delay risk. Perhaps the Corps can examine how the HFFRRF component might adversely impact the Rockaway Shorefront schedule and develop contingency plans to keep the Rockaway component on track.

Additionally, thank you for the agreement that your staff will meet again with NYC Parks to discuss, in detail, the parks facilities that will be replaced as part of the Staten Island South Shore Coastal Storm Risk Management Project's scope and costs. Our teams met this week and had a productive conversation; we are now able to take next steps in clarifying these relocation and replacement scenarios as the design progresses.

Thank you again for your time and collaborative spirit as we move through these complex, yet critical, coastal protection projects.

Sincerely,

Mitchell J. Silver, FAICP
Commissioner
City of New York
Parks & Recreation

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

District Engineer

Honorable Mitchell J. Silver, FAICP
Commissioner, City of New York Parks and Recreation
The Arsenal, Central Park
New York, NY 11790-3409

JAN 0 2 2018

Dear Commissioner Silver:

Thank you for your letter dated November 8, 2017 which expands on key programmatic issues that were discussed during our recent visit to the Arsenal. The meeting was very productive, and your continued partnership is highly valued.

I understand the importance of the Rockaway Reformulation Study to the City of New York, and its completion will remain a top priority under our Sandy Recovery Program. We will continue to explore ways to potentially accelerate this project to construction, and will soon be providing detailed information concerning the proposed High Frequency Flood Risk Reduction Features for Jamaica Bay. We intend to have many of these storm risk reduction features complement the City's initiatives that are aimed at resiliency.

We will also work closely with your team while we continue the design work for the South Shore of Staten Island Project. I'm pleased that my staff has been meeting regularly with yours. If you have any additional questions, please do not hesitate to contact the Project Manager, Mr. Daniel Falt, telephone 917-790-8614, or Daniel.T.Falt@usace.army.mil.

Sincerely,

Thomas D. Asbery
Colonel, U.S. Army
District Engineer

CORRESPONDENCE FROM:

Hon. Stacey Pheffer Amato
New York State Assembly
dated 07 June 2017

RESPONSE BY:

Thomas D. Asbery
Colonel, U.S. Army
dated 05 July 2017

THE ASSEMBLY
STATE OF NEW YORK
ALBANY

COMMITTEES
Consumer Affairs & Protection
Corporations, Authorities & Commissions
Governmental Employees
Racing & Wagering
Veterans' Affairs

MEMBER
Legislative Women's Caucus

STACEY PHEFFER AMATO
Assemblywoman 23rd District
Queens County

June 7, 2017

Colonel David A. Caldwell
New York District of the U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278

Dear Colonel Caldwell:

I am writing to urge the Army Corps of Engineers New York District, in coordination with their local partners, to do an emergency sand replacement and installation of groins in Rockaway Beach, specifically between Beach 90th and Beach 95th streets and between Beach 126th and Beach 149th streets, as the lack of sand (and the absence of groins to retain that sand) leaves entire community vulnerable to a major storm which has created an emergency situation.

Hurricane Sandy devastated the Rockaway Peninsula and the communities surrounding Jamaica Bay, all of which are represented in the Rockaway Reformulation study. Immediately after the storm, the Corps allowed emergency sand replacement to protect Rockaway from future storm surges. The Corps quickly completed that work, placing 3.5 million cubic yards of sand on the Peninsula, and we applaud those efforts. However, it has been two years since that sand placement, and already the Peninsula has experienced significant erosion which has drastically affected our beaches and weakened resiliency measures protecting us throughout Hurricane Season.

For many years, both before and after Superstorm Sandy, residents of southern Queens and many experts have been advocating for more permanent measures to protect our homes and communities. The long-term comprehensive coastal storm risk reduction plan for Rockaway and Jamaica Bay requires the completion of hard protective features including a sea wall, jetties and groins. Long Island, Staten Island, the Jersey Shore, and Coney Island have all received protective measures, while the Rockaway Peninsula is left exposed.

Families in southern Queens and Rockaway deserve – and absolutely need – to have basic safety measures in place for this upcoming hurricane season, which is projected by NOAA to be the worst in several years. For these reasons, I am requesting emergency sand replacement and groin installation as soon as is logistically possible.

Thank you for your immediate attention to this matter. Should you have any questions, please do not hesitate to contact my office at 718-945-9550.

Sincerely,

Stacey Pheffer Amato

Stacey Pheffer Amato
Member of Assembly, 23rd District

ALBANY OFFICE: Room 827, Legislative Office Building, Albany, New York 12248 • 518-455-4292, FAX: 518-455-4723
DISTRICT OFFICE: 95-16 Rockaway Beach Blvd., Rockaway Beach, New York 11693 • 718-945-9550, FAX: 718-945-9549
EMAIL: amatos@nyassembly.gov

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10278-0090

District Engineer

JUL 0 5 2017

Honorable Stacy Pheffer Amato
New York State Assembly
Legislative Office Building Room 827
Albany, New York 12248

Dear Ms. Pheffer Amato:

Thank you for your letter dated June 7, 2017 which urges the United States Army Corps of Engineers to initiate beach renourishment and groin construction in Rockaway Beach, New York as quickly as possible.

As you know, Rockaway Beach received 3.5 million cubic yards of sand in 2014 to repair damages caused by Hurricane Sandy and to rebuild the beaches to the original Federal Project design template. In addition, a betterment paid for by the City of New York Department of Parks and Recreation allowed for the construction of sand dunes, providing a higher level of protection than the original Federal project constructed in 1975.

The New York District is currently working to complete a Final General Reevaluation Report. The draft version of this report, which was previously released to the public, documents proposed alternatives intended to address storm risk reduction and beach erosion in the Rockaway Beach area. New shorefront measures proposed in the report include stone groins, beachfill, and reinforced sand dunes. The proposed stone groins would be intended to reduce the amount of sand replenishment required in well documented areas of high erosion. The final report will address the extensive comments received from the public and other agencies, and will be ready for release in the spring of 2018. Engineering design and construction phases of work will begin as soon as this report is approved.

Until this report is completed and fully approved, there is no authority or funding available to the USACE to implement sand placement or groin construction. Despite this, we intend to work closely with our State and City partners to identify other opportunities for sand placement, should any interim flood risk reduction projects be considered necessary. My staff is ready to meet with your office at any time to discuss this issue in greater detail. If you have any additional questions, please contact Mr. Daniel T. Falt, Project Manager, at (917) 790-8614.

Sincerely,

Thomas D. Asbery
Colonel, U.S. Army
District Engineer

CORRESPONDENCE FROM:

Hon. Charles E. Schumer
United States Senate
dated 20 June 2017

RESPONSE BY:

Thomas D. Asbery
Colonel, U.S. Army
dated 13 July 2017

CHARLES E. SCHUMER
NEW YORK

DEMOCRATIC LEADER

United States Senate

WASHINGTON, DC 20510

June 20, 2017

Colonel Thomas D. Asbery
Commander of the Army Corps' New York District
26 Federal Plaza
New York, NY 10278

Dear Colonel Asbery:

I write to urge the Army Corps of Engineers ("Corps") to take action to address the severe and constant beach erosion along the Rockaway Peninsula that threatens the coastal protection of this vulnerable area. In 2012 Superstorm Sandy devastated the Rockaway Peninsula and we simply cannot fail to ensure it is protected from the next storm.

The Hurricane Sandy Relief Act of 2013, which I fought so hard to pass in Congress, provided the Army Corps with over $5 billion in funding to protect the region's most vulnerable areas, including fully funding the study ("Rockaway Reformulation Study") and construction of the Rockaway Beach coastal protection project ("East Rockaway Inlet to Rockaway Inlet"). However, more than four years later the study is not complete and construction has not started. It is simply unacceptable that a fully-funded project languish for so long, leaving Rockaway susceptible to erosion, storm surge and flooding. The Corps must provide a firm timetable for completion of the study and a construction schedule, including spelling out a specific timetable for construction of jetties, groins and a sea wall. Given the importance of this project, the Corps must expedite this schedule.

It is my understanding that the delay has been caused, in part, by the Corps integrating the Rockaway Reformation Study to combine the Atlantic Shorefront and Jamaica Bay CSRM studies. As I previously expressed in a letter to the Corps dated April 25, 2014, a comprehensive plan for Rockaway and Jamaica Bay is certainly necessary, but there should be no reason to delay the ocean-side and standalone bay-side features that have already been studied for years. In other words, build now what can and should be built while the Corps completes the study on the bay side and maps out other technicalities and designs. In order to expedite construction the Corps should focus on these discrete pieces such as sand replenishment, groins and jetties to retain this sand, an ocean-side sea wall structure and standalone natural and hard bay-side features. In particular I have heard from every community in Rockaway that there is a specific need for groins and jetties the entire length of the peninsula. I urge the Corps to deliver on this need; these projects should not be held up any longer by bureaucratic approvals.

Finally, I also urge the Corps to examine any and all interim resiliency measures such as emergency sand placement. In the past the Corps has placed sand dredged from nearby navigable channels such as Rockaway Inlet and Jamaica Bay Channel on erosion hot spots along the Rockaway peninsula. The Corps must identify any nearby dredging projects that would allow emergency sand placement in Rockaway.

Sincerely,

Charles E. Schumer
United States Senator

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

District Engineer

JUL 13 2017

Honorable Charles E. Schumer
United States Senate
322 Senate Hart Building
Washington, District of Columbia 20510

Dear Senator Schumer:

Thank you for your letter dated June 20, 2017 which urges the United States Army Corps of Engineers to address beach erosion and issues of coastal protection along the Rockaway Peninsula as quickly as possible.

As you know, Rockaway Beach received 3.5 million cubic yards of sand in 2014 to repair damages caused by Hurricane Sandy and to rebuild the beaches to the original Federal Project design template. In addition, a betterment paid for by the City of New York Department of Parks and Recreation allowed for the construction of sand dunes, providing a higher level of protection than the original Federal project constructed in 1975.

The New York District is currently working to complete a Final General Reevaluation Report. The draft version of this report, which was previously released to the public, documents proposed alternatives intended to address storm risk reduction and beach erosion in the Rockaway Beach area. New shorefront measures proposed in the report include stone groins, beachfill, and reinforced sand dunes. The proposed stone groins would be intended to reduce the amount of sand replenishment required in well documented areas of high erosion. The final report will address the extensive comments received from the public and other agencies, and will be ready for release in the spring of 2018. Engineering design and construction phases of work will begin as soon as this report is approved.

Until this report is completed and fully approved, there is no authority or funding available to the USACE to implement sand placement or groin construction. Despite this, we intend to work closely with our State and City partners to identify other opportunities for sand placement, should any interim flood risk reduction projects be considered necessary. My staff is ready to meet with your office at any time to discuss this issue in greater detail. If you have any additional questions, please contact Mr. Daniel T. Falt, Project Manager, at (917) 790-8614.

Sincerely,

Thomas D. Asbery
Colonel, U.S. Army
District Engineer

CORRESPONDENCE FROM:

Hon. Hakeem S. Jeffries
United States House of Representatives
dated 16 November 2016

Additional Signatures:

Hon. Jerrold Nader
United States House of Representatives

Hon. Nydia M. Velazquez
United States House of Representatives

Hon. Gregory Meeks
United States House of Representatives

Hon. Yvette Clarke
United States House of Representatives

RESPONSE BY:

Thomas D. Asbery
Colonel, U.S. Army
dated 20 December 2016

HAKEEM S. JEFFRIES
8TH DISTRICT, NEW YORK
COMMITTEE ON THE JUDICIARY
COMMITTEE ON EDUCATION AND THE WORKFORCE
WHIP, CONGRESSIONAL BLACK CAUCUS

Congress of the United States
House of Representatives
Washington, DC 20515

WASHINGTON OFFICE:
1607 LONGWORTH HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-5936

DISTRICT OFFICES:
CENTRAL BROOKLYN OFFICE:
55 HANSON PLACE, SUITE 603
BROOKLYN, NY 11217
(718) 237-2211

SOUTH BROOKLYN OFFICE:
445 NEPTUNE AVENUE, FIRST FLOOR
COMMUNITY ROOM 2C
BROOKLYN, NY 11224
(718) 373-0033

JEFFRIES.HOUSE.GOV

November 16, 2016

Colonel David A. Caldwell
Commander, New York District, U.S. Army Corps of Engineers
Jacob K. Javits Federal Office Building
26 Federal Plaza, Room 2113
New York, N.Y. 10278

Colonel Caldwell:

We write with regard to the impending deadline for comment on the Draft Integrated Hurricane Sandy General Re-evaluation Report/Environmental Impact Statement for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet, and Jamaica Bay Reformulation Study (Draft Reformulation Plan). SuperStorm Sandy made abundantly clear the existing deficiencies in coastal storm risk management, which this plan is designed to address.

The decisions made by the U.S. Army Corps of Engineers through this process will have a permanent and profound impact on the communities we represent. Accordingly, there should be thorough engagement with our constituents, so that all affected can express their input prior to moving forward. In this regard, more time is needed. Despite requests made for further engagement in our communities, additional forums for discussion have failed to materialize.

Consequently, we request that the comment period on the Draft Reformulation Plan be extended by no less than 60 days. Thank you for your prompt attention to this matter and we look forward to your response.

Sincerely,

Hakeem Jeffries
Member of Congress

Jerrold Nadler
Member of Congress

Nydia Velázquez
Member of Congress

Gregory Meeks
Member of Congress

Yvette Clarke
Member of Congress

Cc: Lt. General Todd T. Semonite, Commanding General and Chief of Engineers
Colonel Paul E. Owen, Chief of Staff, U.S. Army Corps of Engineers

PRINTED ON RECYCLED PAPER

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NY 10278-0090

Commander

Honorable Jerrold Nadler
House of Representatives
2109 Rayburn HOB
Washington, DC 20515

Dear Mr. Nadler:

Thank you for your letter dated November 16, 2016 requesting an extension of the public comment period for the Draft General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY Reformulation Study. This report was released for public review on August 18, 2016. In response to requests by the public, the comment period was extended twice. The extended public review period ended on December 2, 2016, which gave the public more than 90 days for comment. It is vital for the study process to continue as quickly as possible to facilitate the approval of the project in a timely manner.

While we have already held five public meetings in the study area to solicit public input, the District remains available to participate in additional informational meetings, as schedules permit. While any comments received will not be part of the formal process, any topical issues identified can be useful as we continue to develop the final version of the report. We look forward to continued cooperation as we complete this significant effort. If you have any additional questions please contact me, or Mr. Anthony Ciorra at (917) 790-8208.

Sincerely,

David A. Caldwell
Colonel, U.S. Army
Commander

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NY 10278-0090

Commander

Honorable Gregory W. Meeks
House of Representatives
2234 Rayburn HOB
Washington, DC 20515

Dear Mr. Meeks:

Thank you for your letter dated November 16, 2016 requesting an extension of the public comment period for the Draft General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY Reformulation Study. This report was released for public review on August 18, 2016. In response to requests by the public, the comment period was extended twice. The extended public review period ended on December 2, 2016, which gave the public more than 90 days for comment. It is vital for the study process to continue as quickly as possible to facilitate the approval of the project in a timely manner.

While we have already held five public meetings in the study area to solicit public input, the District remains available to participate in additional informational meetings, as schedules permit. While any comments received will not be part of the formal process, any topical issues identified can be useful as we continue to develop the final version of the report. We look forward to continued cooperation as we complete this significant effort. If you have any additional questions please contact me, or Mr. Anthony Ciorra at (917) 790-8208.

Sincerely,

David A. Caldwell
Colonel, U.S. Army
Commander

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NY 10278-0090

Commander

Honorable Nydia M. Velazquez
House of Representatives
2109 Rayburn HOB
Washington, DC 20515

Dear Ms. Velazquez:

Thank you for your letter dated November 16, 2016 requesting an extension of the public comment period for the Draft General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY Reformulation Study. This report was released for public review on August 18, 2016. In response to requests by the public, the comment period was extended twice. The extended public review period ended on December 2, 2016, which gave the public more than 90 days for comment. It is vital for the study process to continue as quickly as possible to facilitate the approval of the project in a timely manner.

While we have already held five public meetings in the study area to solicit public input, the District remains available to participate in additional informational meetings, as schedules permit. While any comments received will not be part of the formal process, any topical issues identified can be useful as we continue to develop the final version of the report. We look forward to continued cooperation as we complete this significant effort. If you have any additional questions please contact me, or Mr. Anthony Ciorra at (917) 790-8208.

Sincerely,

David A. Caldwell
Colonel, U.S. Army
Commander

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NY 10278-0090

Commander

Honorable Hakeem S. Jeffries
House of Representatives
1607 Longworth House Office Building
Washington, DC 20515

Dear Mr. Jeffries:

Thank you for your letter dated November 16, 2016 requesting an extension of the public comment period for the Draft General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY Reformulation Study. I was pleased to meet with you on December 1st, 2016 where we agreed on a path forward.

This report was released for public review on August 18, 2016. In response to requests by the public, the comment period was extended twice. The extended public review period ended on December 2, 2016, which gave the public more than 90 days for comment. It is vital for the study process to continue as quickly as possible to facilitate the approval of the project in a timely manner.

While we have already held five public meetings in the study area to solicit public input, the District remains available to participate in additional informational meetings, as schedules permit. While any comments received will not be part of the formal process, any topical issues identified can be useful as we continue to develop the final version of the report. We look forward to continued cooperation as we complete this significant effort. If you have any additional questions please contact me, or Mr. Anthony Ciorra at (917) 790-8208.

Sincerely,

David A. Caldwell
Colonel, U.S. Army
Commander

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NY 10278-0090

Commander

Honorable Yvette D. Clarke
House of Representatives
2058 Rayburn HOB
Washington, DC 20515

Dear Ms. Clarke:

Thank you for your letter dated November 16, 2016 requesting an extension of the public comment period for the Draft General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY Reformulation Study. This report was released for public review on August 18, 2016. In response to requests by the public, the comment period was extended twice. The extended public review period ended on December 2, 2016, which gave the public more than 90 days for comment. It is vital for the study process to continue as quickly as possible to facilitate the approval of the project in a timely manner.

While we have already held five public meetings in the study area to solicit public input, the District remains available to participate in additional informational meetings, as schedules permit. While any comments received will not be part of the formal process, any topical issues identified can be useful as we continue to develop the final version of the report. We look forward to continued cooperation as we complete this significant effort. If you have any additional questions please contact me, or Mr. Anthony Ciorra at (917) 790-8208.

Sincerely,

David A. Caldwell
Colonel, U.S. Army
Commander

CORRESPONDENCE FROM:

Hon. Steven H. Cymbrowitz
The Assembly of the State of New York
dated 1 November 2016

RESPONSE BY:

Thomas D. Asbery
Colonel, U.S. Army
dated 20 December 2016

THE ASSEMBLY
STATE OF NEW YORK
ALBANY

STEVEN H. CYMBROWITZ
Assemblyman 45th District
Kings County

CHAIRMAN
Committee on Aging

COMMITTEES
Codes
Environmental Conservation
Health
Insurance

November 1, 2016

Colonel David A. Caldwell
Commander, New York District
U.S. Army Corps of Engineers
Jacob K. Javits Federal Office Building
26 Federal Plaza, Room 2113
New York, NY 10278

Dear Colonel Caldwell,

As the elected officials for the southern Brooklyn area, we were recently made aware of the Jamaica Bay/Rockaway Draft Reformulation Plan which seeks to bring storm risk management measures into our respective communities.

The scale and scope of such a project necessitates public input and we feel that the current November 17, 2016 deadline for commentary does not provide enough time for adequate review by civic groups, community stakeholders and residents.

We are requesting that the deadline be extended to no earlier than December 31, 2016 so that our constituents can voice their support or concern for a project that will permanently change our communities.

Thank you for your attention to this matter, and we look forward to your prompt response.

Sincerely,

Steven H. Cymbrowitz
Member of Assembly

Pamela Harris Member of Assembly	Alan Maisel NYC Councilman	Roxanne J. Persaud Member of Senate
Diane J. Savino Member of Senate	Helene E. Weinstein Member of Assembly	Jaime R. Williams Member of Assembly

cc: Basil Seggos, Commissioner, NYS DEC

DISTRICT OFFICE: 1800 Sheepshead Bay Road, Brooklyn, New York, 11235, (718) 743-4078, FAX (718) 368-4391
ALBANY OFFICE: Room 824, Legislative Office Building, Albany, New York 12248, (518) 455-5214, FAX (518) 455-5738
E-MAIL: cymbros@nyassembly.gov

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NY 10278-0090

DEC 2 0 2016

Commander

Honorable Steven H. Cymbrowitz
The Assembly of the State of New York
Room 824 Legislative Office Building
Albany, NY 12248

Dear Mr. Cymbrowitz:

Thank you for your letter dated November 1, 2016 requesting an extension of the public comment period for the Draft General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY Reformulation Study. This report was released for public review on August 18, 2016. In response to requests by the public, the comment period was extended twice. The extended public review period ended on December 2, 2016, which gave the public more than 90 days for comment. It is vital for the study process to continue as quickly as possible to facilitate the approval of the project in a timely manner.

While we have already held five public meetings in the study area to solicit public input, the District remains available to participate in additional informational meetings, as schedules permit. While any comments received will not be part of the formal process, any topical issues identified can be useful as we continue to develop the final version of the report. We look forward to continued cooperation as we complete this significant effort. If you have any additional questions please contact me, or Mr. Anthony Ciorra at (917) 790-8208.

Sincerely,

David A. Caldwell
Colonel, U.S. Army
Commander

ADDITIONAL CORRESPONDENCE

(Prior to the release of the Draft HSGRR in August of 2016)

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NY 10278-0090

Commander

AUG 0 1 2016

The Honorable Charles E. Schumer
United States Senate
322 Hart Senate Office Building
Washington, DC 20510

Dear Senator Schumer:

Thank you for your letter dated June 24th, 2016 regarding the public release of the Draft General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY Reformulation Study. I appreciate your direct engagement and involvement in this issue, and agree that the timeliness of this report is of extreme importance.

The U.S. Army Corps of Engineers (Corps) has been coordinating with the State of New York, the City of New York and the U.S. Department of Interior in anticipation of the release of this report. Our path forward includes revisions to certain sections of the report that address comments from those agencies. Our report will now also include the results of a City of New York water quality study that will provide valuable information to reviewers on complex environmental and water quality issues. This should afford additional confidence for decision making in the future.

We expect the official public release of the Draft GRR and EIS during the week of August 15th, 2016, followed by a formal 60 day public review period to ensure ample opportunity for public comment. During this period, several public information sessions will be held, and local leaders will be engaged to ensure feedback is received on this proposed project.

We look forward to continued cooperation as we complete this significant effort. If you have any additional questions please call me, or Mr. Anthony Ciorra at (917) 790-8000.

Sincerely,

David A. Caldwell
Colonel, U.S. Army
Commander

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NY 10278-0090

Commander

The Honorable Phillip Goldfeder
New York State Assembly
9516 Rockaway Beach Boulevard
Rockaway Beach, NY 11693

AUG 0 1 2016

Dear Mr. Goldfeder:

Thank you for your letter dated June 24th, 2016 regarding the public release of the Draft General Reevaluation Report (GRR) and Environmental Impact Statement (EIS) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, NY Reformulation Study. I appreciate your direct engagement and involvement in this issue, and agree that the timeliness of this report is of extreme importance.

The U.S. Army Corps of Engineers (Corps) has been coordinating with the State of New York, the City of New York and the U.S. Department of Interior in anticipation of the release of this report. Our path forward includes revisions to certain sections of the report that address comments from those agencies. Our report will now also include the results of a City of New York water quality study that will provide valuable information to reviewers on complex environmental and water quality issues. This should afford additional confidence for decision making in the future.

We expect the official public release of the Draft GRR and EIS during the week of August 15th, 2016, followed by a formal 60 day public review period to ensure ample opportunity for public comment. During this period, several public information sessions will be held, and local leaders will be engaged to ensure feedback is received on this proposed project.

We look forward to continued cooperation as we complete this significant effort. If you have any additional questions please call me, or Mr. Anthony Ciorra at (917) 790-8000

Sincerely,

David A. Caldwell
Colonel, U.S. Army
Commander

United States Department of the Interior

NATIONAL PARK SERVICE
Northeast Region
United States Custom House
200 Chestnut Street
Philadelphia, PA 19106

IN REPLY REFER TO:
A.1.2.(NER-RSS)

JUL 21 2016

Mr. Clifford S. Jones
Chief, Planning Division
Department of the Army
U.S. Corps of Engineers, New York District
Jacob K. Javits Federal Building
26 Federal Plaza
New York, NY 10278-0090

Dear Mr. Jones:

Thank you for your letter dated June 29, 2016, requesting that the National Park Service (NPS) be a cooperating agency in the National Environmental Policy Act (NEPA) process for the integrated Hurricane Sandy General Reevaluation Report/Environmental Impact Statement (HSGRR/EIS) to examine coastal storm management problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay area.

The NPS is pleased to accept the role of cooperating agency in the HSGRR/EIS being prepared by the United States Army Corps of Engineers, New York District (USACE).
In addition, the NPS also requests to participate as a consulting party in the USACE's consultation process under Section 106 of the National Historic Preservation Act for the HSGRR/EIS.

We believe it is to our mutual benefit for the NPS to cooperate in the preparation of this plan. The NPS mission is to manage our lands for the preservation of and access to natural, cultural and recreational resources in perpetuity. In addition, by working collaboratively we can ensure that the HSGRR/EIS is mutually acceptable to the Secretary of the Interior and the Secretary of the Army and consistent with Gateway National Recreation Area (GATE) enabling legislation (16 U.S. Code Subchapter LXXXVII). Understanding that the HSGRR/EIS is necessary for the protection of the adjacent communities, NPS is committed to working with USACE to avoid and minimize adverse impacts on NPS resources while advancing the goals of this project. By working closely with USACE throughout the NEPA and Section 106 processes, the NPS can assist in identifying park resources of concern as well as potential issues and impacts to park resources and park visitors that need to be addressed in the NEPA and 106 review. The NPS can

also assist in identifying appropriate mitigation measures to avoid and minimize impacts to NPS resources.

We look forward to continuing to work with you as a cooperating agency and consulting party as you move forward with this project. If you have any questions, please contact Jen Nersesian, Superintendent, Gateway National Recreation Area (jen_nersesian@nps.gov , 718-354-4665).

Sincerely,

Michael A. Caldwell
Regional Director
National Park Service

cc:
Colonel David A. Caldwell, Commander and District Engineer, USACE New York District
Peter Weppler, Chief, Environmental Analysis Branch, USACE New York District
Robert Smith, Environmental Analysis Branch, USACE New York District
Dan Falt, Project Manager, USACE New York District
Andrew Raddant, Regional Environmental Officer, DOI
Frank Hays, Associate Regional Director, Resource Stewardship, NERO, NPS
Acting Chief, Division of Resource Planning and Compliance, NERO, NPS
Jacki Katzmire, Regional Environmental Coordinator, Division of Resource Planning & Compliance, NERO, NPS
Joshua Laird, Commissioner, National Parks of New York Harbor
Jennifer Nersesien, Superintendent, GATE
Minka Sendich, Deputy Superintendent, GATE
Patti Rafferty, Resource Stewardship, GATE
Dave Taft, Coordinator, JBU-GATE
Marilou Erhler, Cultural Resource Stewardship Division, GATE
Doug Adamo, Natural Resource Management Division, GATE

United States Department of the Interior

NATIONAL PARK SERVICE
Gateway National Recreation Area
210 New York Ave., Staten Island, N.Y. 10305

IN REPLY REFER TO:

July 20, 2016

Colonel David A. Caldwell
Commander and District Engineer
United States Army Corps of Engineers, New York District
26 Federal Plaza
New York, NY 10278-0090

RE: Hurricane Sandy General Reevaluation Report/Environmental Impact Statement

Dear Colonel Caldwell:

I am writing in response to Peter Weppler's June 22, 2016 request that the National Park Service (NPS) provide a fatal flaw review of the pre-public draft Hurricane Sandy General Reevaluation Report/Environmental Impact Statement (HSGRR/EIS). I appreciate that your staff have provided Gateway National Recreation Area (GATE) with an opportunity to review the pre-public document. I also want to acknowledge the collaboration and dialogue that has been offered by your staff in its development, which has been excellent and will undoubtedly result in a stronger, more comprehensive plan.

NPS is committed to working with USACE to reduce storm damage risks to communities within the project area, while also minimizing adverse impacts to National Park Service (NPS) resources. We realize this is a difficult balance with competing and often conflicting interests and priorities, and that the safety of the people in harm's way is of paramount consideration. It is our goal to work with you, the other involved agencies, and the public to ensure that the proper level of protection is achieved, and to do so in an expeditious manner.

It is also our goal to ensure that within that framework of protection we are maximizing every opportunity to preserve the natural, cultural and recreational resource values for which the NPS lands and waters within the project area were preserved. We are confident that by working together we can refine the proposal to better reflect both of our federally mandated missions—protection and stewardship—as they intersect in the Jamaica Bay and the Rockaway shoreline environments. In some cases we are hopeful that potential impacts to these resources can be reduced; and where impacts are unavoidable to safeguard the well-being of the surrounding communities, we will work with you to identify mitigation measures at the appropriate scale to compensate for the loss of an irreplaceable, publicly held good. With that in mind we offer the following initial observations and comments:

The HSGRR/EIS does not acknowledge that any plan must be mutually acceptable to the Department of the Interior as well as the Army Corps of Engineers (USACE). GATE enabling legislation (16 U.S. Code Subchapter LXXXVII) states that "The authority of the Secretary of the Army to undertake or contribute to water resource developments, including shore erosion control, beach protection, and navigation improvements (including the deepening of the shipping channel from the Atlantic Ocean to the New York harbor) on land and/or waters within the recreation area shall be exercised in accordance with plans which are mutually acceptable to the Secretary of the Interior and the Secretary of the Army and which are consistent with both the purpose of this subchapter and the purpose of existing statutes dealing with water and related land resource development."

The Tentatively Selected Plan (TSP) will have significant, persistent and irreversible impacts to GATE natural, cultural and recreational resources. The TSP will result in the loss of coastal natural resources, alteration of natural coastal function, alteration of the setting, feeling and association of six Historic Districts within GATE, and alteration of visitor experiences and opportunities. The NPS's authority to conserve and manage park resource is derived from the Organic Act of 1916, which states that "the fundamental purpose of the said parks...is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Given the magnitude and permanence of the preferred alternative, following full NEPA analysis, the NPS will likely have to conclude that the project will result in impairment of park resources.

The TSP requires extensive construction on NPS property. NPS has not yet identified a legal means to authorize construction and confer long-term liability and maintenance responsibility in perpetuity to an outside entity. As we work towards resolution on this issue for the South Shore of Staten Island Coastal Storm Risk Management Study we hope to identify a pathway forward that will be applicable to this project as well.

USACE has invited and NPS has accepted cooperating agency status under the National Environmental Policy Act (NEPA) on the HSGRR/EIS. Cooperating agency status will facilitate NPS adoption of the HSGRR/EIS in order to issue a NPS Record of Decision. The impact analysis of the HSGRR/EIS is insufficient to meet NPS NEPA requirements. In addition, conclusions of the impact analysis for no impact or long-term beneficial impact are often inconsistent with how NPS would evaluate some of the impacts identified in the HSGRR/EIS. The policies and procedures by which NPS meets NEPA requirements are provided on-line (https://www.nps.gov/subjects/nepa/policy.htm).

The plan does not adequately support the need for a tie-in that spans nearly all GATE property on the Rockaway Peninsula. The HSGRR/EIS does not evaluate tie-in alternatives that minimize impacts to GATE resources. NPS has previously discussed with USACE tie-in alternatives that would minimize impacts to NPS natural, cultural and visitor resources. These alternatives included elevation of Rockaway Point Boulevard to provide Roxbury with protection from ocean derived storm surge and tie-in along existing bayside floodwall and east end of Jacob Riis Park.

The plan does not offer a mitigation plan to compensate for the impacts to nationally significant natural, cultural, and recreational resources. We understand that additional work will be

conducted to fully identify mitigation requirements for the bay components of the project; however, mitigation for impacts to sediment transport west of the Rockaway Beach Shorefront Coastal Management Units is not identified in the plan. The existing Rockaway groin field has resulted in interruption of sediment transport processes and increased vulnerability of park resources to storm damage at Jacob Riis Park and Fort Tilden. Additional groins will be constructed as part of this project. NPS has previously requested notching or shortening of the terminal groin and/or nourishment of NPS beaches concurrent with nourishment cycles for the Rockaway Beach Shorefront to mitigate for the impact to the sediment transport.

Tribal consultation should include the Stockbridge Munsee Tribe as well as the tribes currently identified in the report (Shinecock Indian Nation, Delaware Tribe of Indians, and Delaware Nation).

The report fails to identify NPS projects as cumulative impacts. These include Sandy resilience projects at Fort Tilden, Jacob Riis Park, West Pond and Floyd Bennett Field.

Again, we are committed to seeing this plan move forward in an expeditious manner to better protect the communities in and around Jamaica Bay and the Rockaway Peninsula, and are standing by to work with you on solutions that will address the concerns conveyed in this letter. If you have any questions regarding our fatal flaw review or wish to discuss next steps, please contact me (jen_nersesian@nps.gov, 718-354-4665) or Patti Rafferty (patricia_rafferty@nps.gov, 718-354-4625), our Chief of Resource Stewardship for the park. We appreciate your ongoing collaboration in this effort.

Sincerely,

Jennifer T. Nersesian
Superintendent, Gateway National Recreation Area

cc:
Peter Weppler, Chief, Environmental Analysis Branch, USACE New York District
Dan Falt, Project Manager, USACE New York District
Frank Hays, Associate Regional Director, Resource Stewardship, NERO, NPS
Joshua Laird, Commissioner, National Parks of New York Harbor
Minka Sendich, Deputy Superintendent, GATE
Patti Rafferty, Resource Stewardship, GATE
Dave Taft, Coordinator, Jamaica Bay Unit, GATE
Pam McLay, Business Services, GATE
Marilou Erhler, Cultural Resource Stewardship, GATE
Doug Adamo, Natural Resource Stewardship, GATE

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NY 10278-0090

June 29, 2016

Planning Division

Jennifer T. Nersesian, Superintendent
National Park Service
Gateway National Recreation Area
210 New York Avenue
Staten Island, NY 10305

Dear Ms. Nersesian:

With the passage of the Hurricane Sandy Disaster Relief Appropriations Act of 2013 (Public Law 113-2), the U.S. Army Corps of Engineers has been given the authority and funding to complete ongoing coastal storm damage risk reduction projects and studies in the Northeast. As part of the planning process, the New York District is preparing an integrated Draft Hurricane Sandy General Reevaluation Report/Environmental Impact Statement (HSGRR/EIS) examining coastal storm management (CSRM) problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay area which was devastated by the impacts of Hurricane Sandy in 2012. The goal of the Draft HSGRR/EIS is to identify solutions that will reduce Atlantic shoreline and Jamaica Bay vulnerability to storm damage.

As a federal agency, the U.S. Army Corps of Engineers, New York District is required to evaluate the potential environmental impacts of its Proposed Actions and alternatives to Proposed Actions, in order to make an informed decision in defining a proposed project for implementation. The New York District must consider and incorporate, to the extent practicable, measures to avoid, minimize or mitigate adverse impacts to the human environment. The environmental analysis is conducted in compliance with NEPA, the President's Council on Environmental Quality (CEQ) regulations implementing NEPA at 40 Code of Federal Regulation (CFR) Parts 1500-1508, FEMA's regulations at 44 CFR Part 10, and the State Environmental Quality Review Act ("SEQRA") and City Environmental Quality Review.

For the purposes of this NEPA environmental review, the New York District is serving as the Lead Agency. In accordance with 40 CFR 1501.6 of the Council on Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provision of the National Environmental Policy Act, the New York District is requesting that the National Park Service, Gateway National Recreation Area (GATE) to be a cooperating agency. This request is based on the following: 1) GATE's jurisdiction over the lands within the Jamaica Bay Unit of GATE and 2) in order for the Secretary of the Army to undertake or contribute to water resource developments, including shore erosion control, beach protection, and navigation improvements on land and/or waters within the recreation area shall be exercised in accordance with plans which are mutually acceptable to the Secretary of the Interior and the Secretary of the Army and which are consistent with both the purpose of existing statutes dealing with water and related land

resource development. Note that designation as a cooperating agency does not imply that your agency supports the proposed project.

As a cooperating agency, you have the right to expect that the NEPA document will enable you to discharge your jurisdictional responsibilities. Likewise, you have the obligation to tell us if, at any point in the process, your agency's requirements are not being met. We expect that, at the end of the NEPA process, the final HSGRR/EIS will satisfy your NEPA requirements including those related to project alternatives, environmental consequences and if needed, mitigation. Further, we intend to utilize the HSGRR/EIS and subsequent Record of Decision (ROD) as our decision-making documents and as the basis for any required GATE permits. We expect the permit application to proceed concurrently with the HSGRR/EIS approval process.

If your agency will participate in the review as a cooperating agency, please contact Robert Smith at the New York District, Coastal Section, at 917-790-8729, or by email at Robert.J.Smith@usace.army.mil. If a response from you within 30 days from this letter, your consent will be assumed.

Thank you for your cooperation and interest in this project.

Sincerely,

Clifford S. Jones
Chief, Planning Division

cc:
Raddant - Regional Environmental Officer-DOI

BREEZY POINT COOPERATIVE, INC.

202-30 ROCKAWAY POINT BLVD.
ROCKAWAY POINT
NEW YORK 11697
Tel. 718-945-2300
Fax: 718-634-0261

Tuesday, May 03, 2016

Daniel Falt
U.S. Army Corps of Engineers, New York District
Programs and Project Management Division, Civil Works Programs Branch
26 Federal Plaza, Room 2127
New York, NY 10279-0090

RE: Atlantic Coast of New York
East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Project

Dear Mr. Falt:

Initially allow me to thank you for including the Breezy Point Cooperative, Inc. in the meeting on April 19, 2016 to discuss the above referenced project. Your invitation was greatly appreciated as the Cooperative is very interested in gaining information as well as an understanding of how the project may impact our community in the future.

That being said, there are several components of the project that the Cooperative respectfully requests additional clarification on in order to gain a more complete understanding of the potential effects on the community. These items include:

1. The proposed alignment of the project components, particularly the location and design of the tidal barrier are important. Do you have a rendering of what the tidal barrier would look like?
2. The proposed uniform composite dune across the entire oceanfront appears to be the most reasonable alternative, and is initially supported by the Cooperative.
3. The proposed effect that the hurricane barrier might have on backwater flooding in the Cooperative is of the utmost importance. Please provide the Corp's engineering analysis of the potential backwater effect of a tidal barrier.
4. The Cooperative desires to fully integrate the ongoing FEMA HMGP project with USACE Rockaway Resiliency Project. Please provide us with any relevant information on how this is being accomplished.
5. What was the outcome of the USACE meeting with MTA on the Gil Hodges Bridge?
6. The Cooperative requests use of Jamaica Bay Federal Navigation Channel dredge materials for nature based projects to increase resiliency and habitat within the Cooperative and surrounding area. We understand this may also involve the Corp's Operation Division and as such, who might be the project manager that we should contact?

Any information, documentation or assistance you may provide in addressing the above items would be greatly appreciated. We also look forward to receiving the final draft report and participating in community engagement sessions.

Sincerely,
Breezy Point Cooperative, Inc.

Arthur Lighthall
General Manager

Cc: Board of Directors, Denise Neibel, Aram Terchunian

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS, NORTH ATLANTIC DIVISION
FOR HAMILTON MILITARY COMMUNITY
302 GENERAL LEE AVENUE
BROOKLYN, NEW YORK 11252-6700

CENAD-PD

20 August 2014

MEMORANDUM FOR Deputy Chief for Civil Works, Headquarters, U.S. Army Corps of Engineers, (CECW-NAD/Ms. Cathy Shuman), 441 G Street, NW, Washington DC 20314-1000

SUBJECT: Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York (Rockaway Project) - Completion Strategy

1. The New York District developed the enclosed completion strategy titled "Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens (Rockaway), New York - Coastal Storm Risk Management" (20 Aug 2014). The North Atlantic Division has reviewed this proposed strategy and supports this approach to evaluate coastal and storm damage risk reduction and resiliency for this area.

2. The North Atlantic Division requests approval of the enclosed completion strategy for the 100% federally-funded Rockaway project. The completion strategy outlines the proposed approach to examine various factors and project elements of the Jamaica Bay (back-bay) and the Atlantic Ocean shorefront. This comprehensive system approach will assist in expediting the overall project, as well as address community concerns about Rockaway.

3. The comprehensive system reformulation will be presented in a single report (Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS)). The reformulation will evaluate various methods to provide risk reduction including different dimensions of beach-fill and hard structures, both as protective measures and to reduce costs for an additional 50 years of re-nourishment. Consistent with the implementation guidance received under PL 113-2, the project will be formulated with the primary purpose of Coastal Storm Risk Management (CSRM) and is treating the area as a complete system that considers the influence of the Atlantic Ocean shorefront conditions on the back-bay system.

4. I have reviewed and concur with the recommendations outlined in the enclosed completion strategy.

5. My point of contact is Mr. Joseph Forcina, Chief, Hurricane Sandy Coastal Management Division, at 347-370-4584, or Joseph.Forcina2@usace.army.mil.

Encl

DAVID J. LEACH, P.E., SES
Director of Programs

ATLANTIC COAST OF NEW YORK, EAST ROCKAWAY INLET TO ROCKAWAY INLET, AND JAMAICA BAY, QUEENS, NY - Coastal Storm Risk Management
20 AUG 2014

Overview: The Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens, New York Project is a previously authorized project that was undergoing a reformulation at the time Hurricane Sandy impacted the area. The reformulation effort was considering changes to the original project in the interest of coastal storm risk reduction, to address vulnerability to erosion, waves and surge, address measures to reduce long-term renourishment costs, and to address extending federal participation in the project for up to 50 years. A Design Agreement was executed in May 2003, with an initial study cost of $3,000,000. The Project Management Plan (PMP) identified two areas of focus: Area 1 to address the Atlantic Ocean shorefront problems, and Area 2 to address the back-bay problems in Jamaica Bay. The original PMP scope and budget prioritized Area 1, the Atlantic coastline efforts, based upon funds availability, the immediate need, and local sponsor preference.

Authorization: The 1965 authorized plan calls for a beach at elevation +10 ft NAVD and a width of 100 ft for the area from Beach 19th Street to Beach 149th Street. The authorized project also included measures to provide hurricane protection, including a seawall and an inlet closure structure. The project authorization was modified to allow the beach-fill component of the plan to be constructed separately from the hurricane protection features, and these hurricane protection features were subsequently de-authorized in WRDA 1986.

Overall Approach: The Rockaway Reformulation will be conducted in a comprehensive, systematic and holistic manner and presented in a single report (Hurricane Sandy General Reevaluation Report and Environmental Impact Statement [HSGRR/EIS]). Consistent with the implementation guidance received under PL 113-2, the project will be formulated with the primary purpose of Coastal Storm Risk Management (CSRM). A HSGRR is being prepared to reevaluate methods to provide risk management along the Atlantic Ocean, including different dimensions of beach-fill, hard structures both as protective measures, and to reduce renourishment needs, and an additional 50 years of renourishment. The reformulation effort is also evaluating methods to address coastal storm risk management in Jamaica Bay, and is treating the area as a complete system, considering the influence of the Atlantic Ocean shorefront conditions on the back-bay system.

Prior to Hurricane Sandy, the reformulation focused on shorefront measures, since there was a clear need and local sponsor support for a project in this area. The shorefront features of the Atlantic Coastline have been developed as alternatives for addressing shorefront damages and local sponsor concurrence with features and alternatives is underway. Refinements to the proposed features and the storm history used in the economic and engineering analysis are being refined to reflect Sandy impacts. Alternatives include various combinations of beach-fill with and without coastal structures to reduce long-term renourishment needs, or for increased inundation protection (consideration for a Sandy-scale event).

The formulation for the back-bay communities (Area 2) had not been significantly advanced, prior to Hurricane Sandy, due to funding constraints and prioritization of reformulation efforts. Following Hurricane Sandy, the team is reinvigorating this portion of the reformulation effort, utilizing information that has been generated in several local study efforts following Hurricane Sandy. The team is proposing a schedule that would meet the Alternatives milestone in six months, followed by identification of a Tentative Selected Plan in 9 months that would be integrated into the shorefront plans, and feed into a draft GRR and EIS.

Cost-sharing: All recommendations for initial construction of CSRM features resulting from this reformulation will be considered as updates to the previously authorized plan to account for current science and engineering. Since this project is classified as "ongoing construction" (i.e. received construction funding within last three years), all initial construction features along the shorefront and back-bay identified in this HSGRR/EIS will be recommended for 100% Federal cost-sharing. Any future renourishment efforts will be subject to additional funding appropriations and cost-sharing.

Reformulation Rationale: The following information supports the rationale for the overall approach.

1. During Hurricane Sandy, Rockaway and Jamaica Bay were severely impacted. Hurricane Sandy was estimated as a 350-yr event along the Rockaway coast, and an 800-yr event in Jamaica Bay, based upon the pre-Sandy stage frequency curves. The area was subjected to extreme erosion, surge and wave damage along the Atlantic Ocean shoreline, and extreme flooding in Jamaica Bay. The Atlantic Ocean surge and wave effects exceeded the island height, resulted in flow of water across the island, and contributed to the flooding along the Jamaica Bay shoreline. Hurricane Sandy illustrated the need to address the entire peninsula and back-bay area as a system, when considering risk-management measures.

2. Following Hurricane Sandy, New York City has stated a preference to provide a very high level of risk reduction. New York City conducted an alternatives analysis and recommended a storm surge barrier across Rockaway Inlet as the solution to protect Jamaica Bay from a Sandy-type event. A storm surge barrier plan, or other plans that provide a high level of risk reduction for the bay, require consideration for an equally high level of protection along the shorefront (which would likely require integration of a hard structure as the line of defense, and continuous line of protection that would not be needed for a plan that solely addresses shorefront development).

3. The area of Rockaway and Jamaica Bay has garnered significant attention following Hurricane Sandy, and has been the focus of many initiatives, including the North Atlantic Coast Comprehensive Study (NACCS), which emphasizes a systems approach considering the full array of measures including non-structural approaches and natural and nature based features. Rockaway needs to be addressed as a system in order to be consistent with this new approach.

4. Since the originally authorized Rockaway Project is a constructed project, it has qualified for repair and restoration to design conditions under the FCCE efforts funded under PL 113-2. Construction is presently underway which, in combination with locally-funded betterments, will restore the shoreline to a condition that contains a dune at +16 ft NAVD, and a beach berm fronting it, consistent with the previously authorized design. These construction efforts will provide a short-term level of risk reduction significantly greater than has previously existed for Rockaway. While there is an urgency to move forward, the immediate need for risk reduction has been met, and based upon historic trends, there is approximately a 4 year window before erosion rates will trigger the need for renourishment of the beach.

Challenges: The following Plan Formulation Challenges have been identified for this Project:

1. <u>Integrating the advanced plan formulation effort for the shorefront with the relatively recent planning effort for the back-bay.</u> The shorefront portion of the project has been progressing for some time while the back-bay formulation is in its earlier stages. An effort is being made to advance the analysis of alternatives in the back-bay on an aggressive schedule that fast-

tracks the overall schedule. The intent is to engage the vertical team on all aspects of the project, following the Planning Modernization principles.

2. Integration of nature-based features and non-structural measures with the overall planning effort. The Reformulation will be undertaken as a single-purpose CSRM project considering the applicability of the full array of measures including non-structural measures and nature-based features. There is a strong interest by all levels of government and stakeholder groups in the evaluation of natural and nature-based features (NNBF) and the physical setting of Jamaica Bay may be conducive to these alternatives as well as non-structural approaches. As project is to be advanced under the provisions of PL 113-2, all alternatives will be justified based upon CSRM benefits. Other benefits that NNBF may provide to habitat and species of concern will be discussed qualitatively. Alternatives milestone meetings will be utilized to confirm vertical team support for this approach.

3. Schedule Concerns in identifying a recommended plan for Jamaica Bay. In order to address schedule concerns that may arise, the Corps will engage the vertical team to address issues regarding complexity of the issue, competing needs within the bay, and the potential scope, and costs associated with the alternatives under consideration. The Corps recognizes that there will be differences of opinion on plans, but expects that the discussion of alternatives and agreement on alternatives can be facilitated utilizing the vertical team and agency representatives of the policy group, Jamaica Bay Resiliency Institute.

Major Milestones:

Atlantic Shorefront Optimized Alternatives	October 2014
Back Bay Alternatives Milestone	October 2014
Tentatively Selected Plan	June 2015
DRAFT GRR & Programmatic EIS	August 2015
Final DRAFT GRR & Programmatic EIS	August 2016
Approval of final GRR and Programmatic EIS	December 2016

Completion Strategy:

A diagram illustrating the completion strategy is attached. This diagram has been assembled to capture the following points:

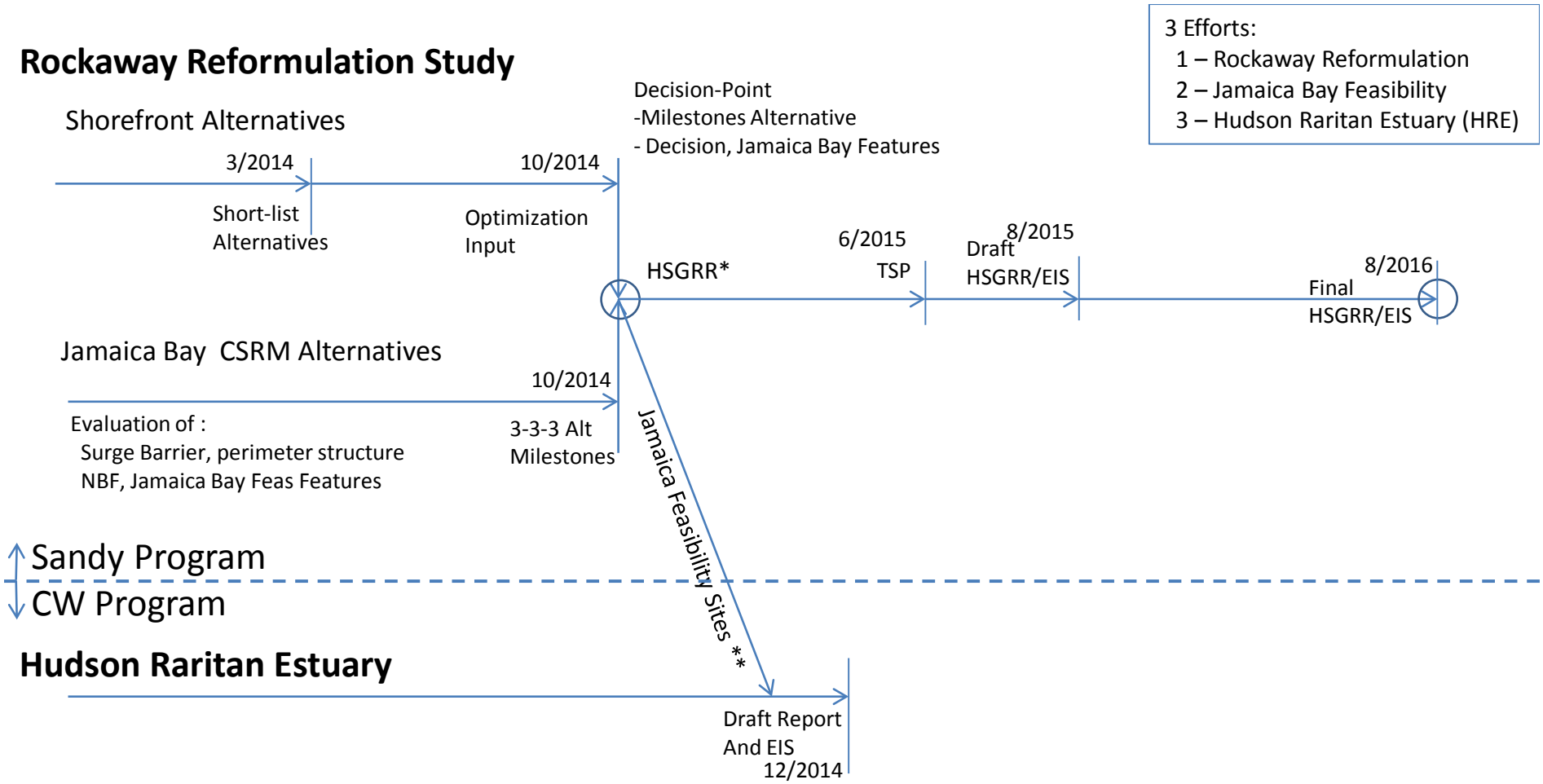
- The integration of shorefront and back-bay alternatives
- The integration of alternatives previously evaluated under the Jamaica Bay Study, and the relationship to the Hudson Raritan Estuary (HRE) effort

The figure illustrates that presently the alternative analyses are proceeding on separate parallel paths for the shorefront and back-bay. The shorefront alternatives have had a greater amount of effort in their development and have progressed further, both in the development of the alternatives and in the necessary analytical tools to evaluate the alternatives. The schedule shows that in October 2014, the District expects to have the shorefront alternatives developed to a point to have identified the optimized plan, when considering the need to address shorefront risk management. At the same time, the District is scheduled to have developed back-bay alternatives to a level of detail to satisfy the alternatives milestone, including definition of the problem, identification of the full range of alternatives, and the evaluation of alternatives sufficient to focus the planning to a short-list of alternatives. It is expected that at this point, the bayside analysis could provide input on how the shorefront alternatives would mesh with the

range of back-bay alternatives under consideration, and if refinements to the shorefront alternatives need to be considered in a systems approach.

This October 2014 milestone will satisfy the Corp's "Alternatives Milestone", and is intended to achieve Corps vertical team, and sponsor alignment of the Alternatives, and the effort involved for further alternative analysis. This will include a decision on the potential for inclusion of the features previously evaluated under the Jamaica Bay feasibility study.

The next milestone is the June 2015 Identification of a Tentatively Selected Plan (TSP). This milestone is expected to identify the recommended plan for Rockaway and Jamaica Bay that integrates both shorefront and back-bay measures. This plan will identify the fully-optimized and integrated plan of protection along the shorefront and back-bay. After vertical team agreement on the TSP, the information described in the TSP milestone would be assembled into a Draft GRR, and EIS that would be circulated for all of the necessary reviews.



* The Alternatives milestone will be used to document the decision on alternatives, and obtain concurrence on Path Forward
- Will present shorefront alternatives to a greater level of detail than backbay (identify scaled alternatives for shorefront)
- Expect to obtain agreement on integration of shorefront & backbay, approach for evaluating NNBF
- Identify to the extent the Jamaica Bay Feasibility sites will be included as a component of the CSRM measures in Rockaway

** Based upon the alternatives milestone, Jamaica Bay sites not included in Rockaway would be recommended under HRE

United States Department of the Interior

NATIONAL PARK SERVICE
Northeast Region
United States Custom House
200 Chestnut Street
Philadelphia, PA 19106

IN REPLY REFER TO:
A.1.2.(NER-RSS)

JUL 2 1 2016

Mr. Clifford S. Jones
Chief, Planning Division
Department of the Army
U.S. Corps of Engineers, New York District
Jacob K. Javits Federal Building
26 Federal Plaza
New York, NY 10278-0090

Dear Mr. Jones:

Thank you for your letter dated June 29, 2016, requesting that the National Park Service (NPS) be a cooperating agency in the National Environmental Policy Act (NEPA) process for the integrated Hurricane Sandy General Reevaluation Report/Environmental Impact Statement (HSGRR/EIS) to examine coastal storm management problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay area.

The NPS is pleased to accept the role of cooperatmg agency in the HSGRR/EIS being prepared by the United States Army Corps of Engineers, New York District (USACE).
In addition, the NPS also requests to participate as a consulting party in the USACE's consultation process under Section 106 of the National Historic Preservation Act for the HSGRR/EIS.

We believe it is to our mutual benefit for the NPS to cooperate in the preparation of this plan. The NPS mission is to manage our lands for the preservation of and access to natural, cultural and recreational resources in perpetuity. In addition, by working collaboratively we can ensure that the HSGRR/EIS is mutually acceptable to the Secretary of the Interior and the Secretary of the Army and consistent with Gateway National Recreation Area (GATE) enabling legislation (16 U.S. Code Subchapter LXXXVII). Understanding that the HSGRR/EIS is necessary for the protection of the adjacent communities, NPS is committed to working with USACE to avoid and minimize adverse impacts on NPS resources while advancing the goals of this project. By working closely with USACE throughout the NEPA and Section 106 processes, the NPS can assist in identifying park resources of concern as well as potential issues and impacts to park resources and park visitors that need to be addressed in the NEPA and 106 review. The NPS can

also assist in identifying appropriate mitigation measures to avoid and minimize impacts to NPS resources.

We look forward to continuing to work with you as a cooperating agency and consulting party as you move forward with this project. If you have any questions, please contact Jen Nersesian, Superintendent, Gateway National Recreation Area (jen_nersesian@nps.gov , 718-354-4665).

Sincerely,

Michael A. Caldwell
Regional Director
National Park Service

cc:
Colonel David A. Caldwell, Commander and District Engineer, USACE New York District
Peter Weppler, Chief, Environmental Analysis Branch, USACE New York District
Robert Smith, Environmental Analysis Branch, USACE New York District
Dan Falt, Project Manager, USACE New York District
Andrew Raddant, Regional Environmental Officer, DOI
Frank Hays, Associate Regional Director, Resource Stewardship, NERO, NPS
Acting Chief, Division of Resource Planning and Compliance, NERO, NPS
Jacki Katzmire, Regional Environmental Coordinator, Division of Resource Planning & Compliance, NERO, NPS
Joshua Laird, Commissioner, National Parks of New York Harbor
Jennifer Nersesien, Superintendent, GATE
Minka Sendich, Deputy Superintendent, GATE
Patti Rafferty, Resource Stewardship, GATE
Dave Taft, Coordinator, JBU-GATE
Marilou Erhler, Cultural Resource Stewardship Division, GATE
Doug Adamo, Natural Resource Management Division, GATE

ADDITIONAL CORRESPONDENCE

With resource agencies subsequent to release of the Revised Draft GRR/EIS.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Environmental Analysis Branch

September 27, 2018

Mr. David Stilwell
Field Supervisor
U.S. Fish and Wildlife Service
3817 Luker Road
Cortland, New York 13045

Dear Mr. Stilwell:

The U.S. Army Corps of Engineers, New York District in cooperation with the non-federal and local sponsors, the New York State Department of Environmental Conservation and the City of New York released for agency and public review the Revised Draft Hurricane Sandy General Reevaluation Report (HSGRR)/Draft Environmental Impact Statement (DEIS) on August 31, 2018. The Draft HSGRR/EIS, including the BA, was posted in the Federal Register e-NEPA system on September 7, 2018, which started the 45 day public review period. The report is posted on the New York District's http://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/East-Rockaway-Inlet-to-Rockaway-inlet-Rockaway-Beach/. The Revised Draft HSGRR incorporates comments received on the 2016 Draft HSGRR and is updated to reflect the subsequent changes to the Recommend Plan for addressing coastal storm risk for the communities surrounding Jamaica Bay and along the Atlantic Shorefront of the Rockaway peninsula.

The District has determined that the following Federally-listed species are likely to occur in the study area: 1) Piping plover (*Charadrius melodus*), Federally threatened; 2) Seabeach amaranth (*Amaranthus pumilus*), Federally threatened; and 3) rufa red knot (*Calidris canutus*), Federally threatened. After evaluating the potential effects, the District determined that the proposed action may affect, likely to adversely affect the the piping plover and seabeach amaranth and not like to adversely affect, the rufa red knot. The attached Biological Assessment (BA) (also contained within Appendix D of the Draft HSGRR/EIS) has been prepared to identify and discuss potential impacts to the listed species. The BA has been pre-coordinated with your Long Island Field Office staff. The BA provides the following information required for formal consultation:

- Description of proposed action;
- Description of the area that may be affected by the proposed action;
- Current list of threatened and endangered species and designated critical habitat that may be affected by the proposed action;
- Description of the manner in which the proposed action may affect any listed species or critical habitat, and an analysis of any cumulative effects;
- Conservation measures to be implemented as part of the proposed action; and
- Other relevant available information on the proposed action

With this letter, the District requests initiation of formal consultation with the United States Fish and Wildlife Service (FWS) under Section 7(a) (2) of the Endangered Species Act (ESA).

I look forward to working with you and your staff on this effort. If you should have any questions, please contact Ms. Daria Mazey of my staff at 917-790-8726.

Sincerely,

Peter Weppler
Chief, Environmental Analysis Branch

Enclosures
cc: USFWS-LIFO

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, New York 13045

October 15, 2018

Colonel Thomas D. Asbery
U.S. Army Corps of Engineers
Commander and District Engineer
New York District
26 Federal Plaza
New York, NY 10278

Attn: Mr. Peter Weppler

Dear Colonel Asbery:

Re: Response to request for initiation of formal consultation for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

This letter acknowledges the U.S. Fish and Wildlife Service's (Service) receipt of your correspondence dated September 27, 2018, requesting initiation of formal consultation, pursuant to section 7 of the federal Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq.*), for the above-referenced project. The U.S. Army Corps of Engineers (Corps) has requested consultation for project impacts that may affect the piping plover (*Charadrius melodus*; threatened), seabeach amaranth (*Amaranthus pumilis*; threatened) and rufa red knot (*Calidris canutus rufa*; threatened).

All substantial information required to initiate formal consultation was either included with the biological assessment and associated documents, or sent to us via electronic correspondence. As we noted in our emails dated July 16 and September 25, 2018, there may be some additional information or clarification needed regarding the project description, but we feel these should not delay initiating consultation. As is customary, we will remain in close coordination with the Corps throughout the consultation.

As a reminder, section 7(d) of the ESA requires that, after initiation of formal consultation, the federal action agency may not make any irreversible or irretrievable commitment of resources which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternatives that avoid jeopardizing the continued existence of endangered or threatened species or destroying or modifying their critical habitats until formal consultation has been concluded.

If you have any questions, please have your staff contact Steve Sinkevich of the Long Island Field Office at (631) 286-0485, extension 2121.

Sincerely,

David A. Stilwell
Field Supervisor

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Environmental Analysis Branch

November 16, 2018

Mr. David Stilwell
Field Supervisor
U.S. Fish and Wildlife Service
3817 Luker Road
Cortland, New York 13045

Dear Mr. Stilwell:

The U.S. Army Corps of Engineers (USACE), New York District (District) is in receipt of your draft FWCAR, dated October 2018 submitting recommendations on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Study.

Please find attached our responses to your Planning and Mitigation Recommendations. The District looks forward to working with your office throughout the Pre-Engineering and Design and Construction phases of this study and thank you for your continued assistance and input to this process which helps to advance the execution of this regionally-significant project.

If you require any additional information, please feel free to contact Ms. Daria Mazey Project Biologist/Planner at 917-790-8726.

Sincerely,

Peter Weppler
Chief, Environmental Analysis Branch

Enclosure
cc: LIFO

Responses to Draft FWCAR

USACE concurs with the Service's overall Planning and Mitigation Recommendations. We are committed to coordination and collaborating with FWS to advance our joint goals and obligations to ensure environmental protection and sustainability, and we offer responses to specific Recommendations, as follows:

XII. Service Planning and Mitigation Recommendations

B. Planning Recommendations

1. Habitat Loss, Degradation, and Fragmentation

FWS Recommendation: "*An adaptive management plan for mitigation measures should be developed to ensure implementation and success. Further coordination with the Service under a separate scope of work will be necessary to achieve this goal.*"

Response: Habitat mitigation is not associated with the proposed project. As part of the integrated approach for the Rockaway/Jamaica Bay study, the District considered human and ecosystem community resilience as part of the overall solution to manage risk associated with the high frequency flood areas. To minimize erosion, maximize stability and longevity, and attenuate wave energy that could cause scour within the locations of the HFFRRFs, the NED Plan has been designed to minimize and in some areas preserve the functional effectiveness of the bayside habitat.

In the Pre-Construction and engineering/design (PED) phase, further evaluation will be undertaken to minimize impacts associated with the project. If it is determined that there will be mitigation, the District will working with the resource agencies for the appropriate mitigation measure(s) per ER 1105-2-100, Planning Guidance Notebook.

3. Wildlife Management

FWS Recommendation: "*In accordance with the 2003 MOA entitled, "Aircraft-Wildlife Strikes," and the subsequent 2007 circular entitled, "Hazardous Wildlife Attractants on or Near Airports," the Corps should commence coordination with the Service and the FAA for activities in close proximity to JFK Airport so that the NNBFs can be sited and designed without creating hazardous conditions for aircraft."*

Response: In accordance with the FAA Advisory Circular 150/5200-33B and the Memorandum of Agreement with FAA to address aircraft-wildlife strikes, when considering proposed flood risk management measures and mitigation areas, USACE must take into account whether the proposed action could increase wildlife hazards. The FAA recommends minimum separation criteria for land-use practices that attract hazardous wildlife to the vicinity of airports. These criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure

airspace or air operations area (AOA).

These separation criteria include:

- Perimeter A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000 feet from the nearest AOA;
- Perimeter B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000 feet from the nearest AOA; and
- Perimeter C: Five-mile range to protect approach, departure, and circling airspace.

As stated, the closest airport to the study area that must comply with these standards is the John F. Kennedy International Airport, Queens County, New York. The natural features in the recommended alternative are within the limits of the 5-mile perimeter of the airport, and as designed are note expected to introduce hazardous wildlife attractants. Also, the habitat acreage created is not large enough provide nesting habitat for the potential species that cause hazards. The District will confirm these designs with the FAA and PANYNJ.

4. Environmental Contaminants

FWS Recommendation: "*We recommend pre-construction monitoring for sediment contaminants at the locations of the NNBFs. Construction should not proceed without prior screening for contaminants. If concentrations of contaminants in sediment exceed acceptable thresholds, biological testing and/or remediation may be necessary."*

Response**:** Hazardous, Toxic and Radioactive Waste (HTRW) can occur within the urban environment such as NYC. In the PED phase, a scope of work will be prepared to conduct specific testing for HTRW in the HFFRRF areas. If it is determined, during sampling that HTRW contamination exists, the District will assess if the project can be realigned to avoid the contaminated site. In accordance with ER 1165-2-132, if the project alignment cannot be revised, the project's non-Federal sponsor would be responsible for the removal of any contaminants to allow the construction of the alignment. The non-federal sponsor will conduct, at 100% their expense, those remedial activities necessary to remove contaminated materials in accordance with ER 1165-2-132. USACE will continue to coordinate with all parties, including the State of New York, City of New York, and NPS.

C. Mitigation Recommendations

1. Habitat Loss and Modification

b. Composite Seawall

FWS Recommendation: "*As it is designed, the landward side of the composite seawall is exposed at the crest of the dune. Based on the current project description, it appears this would result in the loss of approximately 9 ac of sandy maritime dune habitat that may serve as has habitat for beach-nesting birds. The Corps should mitigate for this loss of habitat".*

Response. During PED, the District will evaluate potential options of covering the exposed portion of the composite seawall.

e. HFFRRFs: Shoreline Armoring

FWS Recommendation: "*The Service requests that further consideration is given to the proposed construction of bulkhead along the shoreline of Thursby Basin Park on the western shore of Sommerville Basin. We recommend evaluating the feasibility of a structure further landward around the perimeter of the undeveloped lot, instead of hardening the shoreline at this location."*

Response: During PED, the alignment of hard structures will be located to minimize impacts to sensitive areas.

f. HFFRRFs: Natural and Nature Based Features

FWS Recommendation: "*Recognizing the impacts of nourishment on beach invertebrates and shorebird foraging, and that renourishment is scheduled to occur every four years for the life of the project, we recommend that Corps mitigate by creating potential shorebird foraging habitat elsewhere within the Study Area."*

Response: It is acknowledged that beach nourishment results in short-term declines in abundance, biomass, and taxa richness. However, studies within the NY/NJ Bight have shown recovery of intertidal assemblages are complete within 2-6.5 months of the conclusion of filling. Differences in the rate of recovery were most likely due to differences in when nourishment was complete. Recovery was the quickest when filling was completed before the low point in the seasonal cycle of infaunal abundance. It is important that the grain size of the fill material matched that of the beaches to be nourished.

D. Enhancement Opportunities

FWS Recommendation: "*A number of areas of saltmarsh habitat along the north shore*

of the Rockaway Peninsula were identified as potential restoration areas in the Corps' Jamaica Bay Navigational Channels and Shoreline Environmental Surveys Final Report (U.S Army Corps of Engineers 1997). Some of these areas are within or adjacent to the proposed HFFRRFs. The Corps may consider restoring saltmarsh and other coastal communities in these areas in order to provide added habitat for fish and wildlife."

Response: The purpose of this study was to provide coastal storm risk management measures to the study area. The Hudson Raritan Estuary Ecosystem Restoration Study will be focusing and recommending restoration opportunities within the Jamaica Bay Planning Region.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Office of Natural Resources, Region 2
47-40 21st Street, Long Island City, NY 11101
P: (718) 482-6464 | F: (718) 482-4502
www.dec.ny.gov

December 5, 2018

Kerri Dikun
Fish and Wildlife Biologist
USFWS - Long Island Field Office
340 Smith Road
Shirley, NY 11967

Dear Ms. Dikun:

Thank you for providing the New York State Department of Environmental Conservation (the Department) the opportunity to review the U.S. Fish and Wildlife Services' (Service) Draft Fish and Wildlife Coordination Report for the *Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study*.

The Department shares the Services' endorsement of the proposed project, provided that the Services' recommendations regarding additional surveys to further delineate and quantify potential impacts to the aquatic and shoreline environment, as well as its recommendations to minimize impacts to sensitive natural resources and to compensate to the fullest practicable extent for any unavoidable impacts to these resources are followed.

We look forward to working with the Service and the U.S. Army Corps of Engineers to achieving the project objectives while preserving and perhaps enhancing the State's valuable natural resources.

Sincerely,

Ken Scarlatelli
Regional Natural Resources Supervisor

Cc: Daria Mazey, USACE
Pete Weppler, USACE
Matt Cheblus, NYSDEC

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, New York 13045

December 11, 2018

Peter Weppler, Chief
Environmental Analysis Branch, New York District
U.S. Army Corps of Engineers
Jacob K. Javits Federal Building
New York, NY 10278-0090

Attention: Daria Mazey

Subject: Final Fish and Wildlife Coordination Act Section 2(B) Report for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study, Kings, Queens, and Nassau County, New York

Dear Mr. Weppler:

The U.S. Fish and Wildlife Service (Service) submits the enclosed document entitled, "Final Fish and Wildlife Coordination Act Section 2(B) Report for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study, Kings, Queens, and Nassau County, New York" for the U.S. Army Corps of Engineers' review.

If you have any questions or require additional information, please contact Kerri Dikun of the Long Island Field Office at (631) 286-0485.

Sincerely,

David A. Stilwell
Field Supervisor

cc: NPS, Staten Island, NY (P. Rafferty)
NOAA Fisheries, Highlands, NJ (K. Greene)
NYSDEC, Region 2, Long Island City, NY (K. Scarlatelli)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, New York 13045

April 4, 2019

Colonel Thomas D. Asbery
District Engineer, New York District
U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278

Attention: Mr. Peter M. Weppler

Dear Colonel Asbery:

Please find enclosed the U.S. Fish and Wildlife Service's (Service) Biological Opinion for the U.S. Army Corps of Engineers' (Corps) proposed project entitled, "East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study" and its effects on the federally listed Atlantic Coast piping plover (*Charadrius melodus*; threatened), seabeach amaranth (*Amaranthus pumilus*; threatened), and red knot (*Calidris canutus rufa*; threatened).

We appreciate the assistance of your staff in working with us to complete consultation on this significant project. We acknowledge that the project is only at a 15 to 30 percent design phase and, therefore, the biological opinion may not cover all the potential impacts of the finalized proposed project. As a result, please have your staff continue to coordinate with us staff to determine if reinitiation of consultation is necessary.

If you have any questions or require further assistance, please have your staff contact the staff at the Long Island Field Office at (631) 286-0485.

Sincerely,

David A. Stilwell

David A. Stilwell
Field Supervisor

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

APR 26 2019

Mr. David Stilwell
Field Supervisor
U.S. Fish and Wildlife Service
3817 Luker Road
Cortland, New York 13045

Dear Mr. Stilwell:

The U.S. Army Corps of Engineers, New York District (District) has reviewed the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study and its effects on the federally listed Atlantic Coast piping plover (*Charadrius melodus*; threatened), seabeach amaranth (*Amaranthus pumilus*; threatened), and red knot (*Calidris canutus rufa*; threatened). The District seeks to reach agreement concerning several issues identified during the review of the document, and from subsequent discussions.

During the Study's consultation, the District raised concern over the distinction between annual monitoring, protection measures, and construction monitoring during future renourishment activities. Currently, Reasonable and Prudent Measures (RPMs) 1.7, 2.1 and 2.6 include language that the vegetation and wrack monitoring plans would be approved by, and in some cases, be implemented by the Service. Please note that the District intends to implement the monitoring via District personnel or District approved ecological contractors, after coordinating the planting and monitoring plans with the Service. For all the RPMs, the District and the project's local sponsors will implement these plans to the extent practicable.

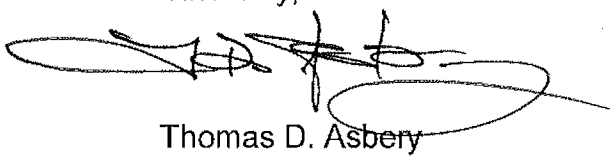
After our analysis of the BO, the District concurs with most of the recommendations. Additionally, for RPM 2.7, the behavioral monitoring program should focus on potential impacts related to the reinforced dune. Impacts which are currently evaluated under the Fire Island Inlet to Moriches Inlet Emergency Stabilization and Westhampton Interim Projects' Biological Monitoring Programs should not be unduly repeated. Monitoring efforts for research purposes cannot be undertaken using P L 113-2 funding. The District must only monitor directly related to impacts associated with the project. To ensure the appropriateness of RPM 2.7, edits are respectfully requested (see enclosure).

The District has pursued the highest degree of collaboration and agreement between the Federal, State and local agencies in this important effort. During implementation, the District cannot dictate how the state and local agencies conduct local land management practices subject to their jurisdiction. To facilitate

implementation success, the District has shared the BO with the National Parks Service (NPS) and the New York City Department of Parks and Recreation (NYCDPR) who have shared input on the ability to execute the RPMs which pertain to their lands. The District, with our partners, also request clarification on a number of items within the BO. NYCDPR and NPS will be following up shortly with their own letters regarding the feasibility of implementing the BO. The attached enclosure specifically discusses the points of clarification by RPM, Avoidance and Minimization Measures, and Conservation Measures, and where applicable, provided the recommended changes. These changes include erroneous or outdated information which the District requests correction or clarification. In particular, the District does not expect an increase in recreation to result from this project when compared to existing conditions, but only when compared to future without project conditions.

I look forward to working with you and your staff on resolving the above referenced and enclosed concerns and revising the Biological Opinion to reflect the District's comments. Thank you for continued cooperation in advancing this effort. If you have any questions, please contact me directly or Mr. Peter Weppler, Chief of the Environmental Analysis Branch at 917-790-8634.

Sincerely,



Thomas D. Asbery
Colonel, U.S. Army
Commander and District Engineer
New York District

cc.
USFWS-LIFO
NPS
NYCDPR
NYSDEC

Enclosure

Enclosure: Rockaway Biological Opinion (BO), USACE Requested Corrections
April 25, 2019

The following errors in the BO have been previously identified to the Service with a request to correct within the BO:

1. Figure 9 on page 7 is in Virginia, not NJ. Source: Figure 7-12 in Engineering Shorefront Appendix.

2. USACE has screened Mott's Basin out of the Recommended Plan. Please delete from the project description on pages 2, top of 9, and 10 (incl. Figure 12).

3. There are several instances where "increased recreation" resulting from the project are cited. As discussed, the USACE project is not projected to increase recreation beyond the current levels, but rather maintain those levels by avoiding the erosion, lost beaches, and diminished recreation that would otherwise occur without construction of the project. Please add clarifying language to reflect this such as "increased recreation compared to the future without project condition". In the District's coordination with NPS, NPS also noted that the project will not increase recreation on NPS property from existing conditions and concurred with the Corps' analysis on this issue.

   Please address this on pages 36, 47, 49 (in two places), 50 (in three places), 51 (in two places), 53, 56, 58, 62 (RPM 1.10), and 64 (RPM 2.10). If it reduces the burden on the Service, the District can respectfully make the suggested edits in track changes for your consideration if provided with a Word version of the B.O.

The District, in coordination with NYCDPR and NPS, also requests the following clarifications and/or changes (a through q):

a. RPM 1.2: "The Corps shall remove any construction material or equipment staged or stored within delineated breeding areas between Beach 19th Street and Beach 67th Street…by April 1 of any given year over the life of the project and pre-migration staging areas."

   Requested change/clarification: Please delete pre-migration staging areas, or alternatively define this term and its applicability.

b. RPM 1.3: "During construction, the Corps shall work with the NYCDPR and the NPS to ensure that plover breeding habitat from Beach 19th Street to Beach 67th Street, and 500 m from breeding areas in Jacob Riis and Fort Tilden Parks is protected during construction activities from April 1 to September 1 with symbolic fencing, signs, etc."

   Requested change/clarification: As RPM 1.3 reads, it appears to say that each nest would require fencing 500 meters around it which NPS and NYCDPR

expressed concerns to USACE about as it would impede the ability to also manage the recreational needs within their properties. Common practice for both land managers is to fence approximately 50 meters around a nest. NYCDPR current practice is to leave fencing for protected species at RBESNA from April 1 through November 30.

c. RPM 1.7: "A vegetation planting plan for the artificial dune shall be coordinated with and approved by the Service. At a minimum, it shall incorporate a mix of native dune plant species (no woody vegetation) and not be limited to a single grass species. Plantings should be made in a random manner and not rows with uniform spacing. The plantings should mimic natural dune vegetation in the region in species diversity, density, and spacing. The dune planting plan shall be completed and approved 3 months prior to initial construction."

   Requested change/clarification: Please revise the first sentence to: "A vegetation planting plan for artificial dune shall be approved by a Corps Biologist and coordinated with the New York State Department of Environmental Conservation (NYSDEC), the project's non-federal sponsor, NYCDPR and the Service. At a minimum, it shall incorporate a mix of native dune plant species and not be limited to a single grass species. … The dune planting plan shall be completed and approved 3 months prior to initial construction of the dune." Please note in general throughout the BO, District staff will approve all construction contract-related documents and will coordinate and provide to the Service. This concept also applies to RPMs 2.1 and 2.6 below.

   RPM 2.1: "The Corps shall develop and implement pre-, concurrent, and post-construction monitoring plans for piping plover and red knot and their habitats with guidance ~~and approval~~ from the Service. This shall be completed and ~~submitted to~~ **coordinated with** the Service 3 months before initial construction ~~for approval~~. The basic elements of the monitoring plan shall include transect locations, frequency of monitoring, habitat type, construction activities that are present less than and greater than 500 m, time of day, tidal phase, etc."

   RPM 2.6: "The Corps shall undertake monitoring of wrack and wrack invertebrates in the intertidal zone, and berm based on a sampling program that has been devised in consultation with~~, and agreed to, by~~ the Service prior to its implementation. The information collected during this monitoring program shall be used to adaptively manage the operation and maintenance phases of the project to further avoid and minimize take. The monitoring plan should include, but not be limited to, the response of the wrack and wrack invertebrates during and after sand placement within breeding and pre-migration staging, and foraging areas, including such information as total recovery time, recovery rates, abundance, biomass, diversity, and composition of prey items, and spatial coverage of wrack. The plan shall be finalized 3 months prior to initial construction of the project."

d. RPM 1.10: "The Corps shall work with the NYCDPR and the NPS to ensure that all suitable piping plover breeding habitat with a recent history (last five years) of plover breeding is protected by April 1 of each year to address the adverse effects associated with the expected increase in recreation" **when compared to the future without project condition.**

   Requested change/clarification: NYCDPR does not fence the entirety of the protected area. NYCDPR has a monitoring team in place starting in April and monitors regularly and will fence areas where plovers are being territorial and displaying breeding behaviors, according to the USFWS guidelines. Beach 38th to Beach 57th Streets are pre-fenced annually. NYCDPR intends to continue monitoring and protecting piping plovers per above accepted practices. Also, please clarify as noted above that the expected increase in recreation is when compared to the future without project condition.

e. RPM 2.4: "The Corps shall devise an early successional beach habitat restoration plan for the berm habitat between Beach 9th and Beach 82nd in coordination with the Service. The plan shall be finalized 3 months prior to initial construction of the project. Ten percent vegetation coverage shall be the target vegetation density with a threshold action of 17 percent coverage for planning purposes between Beach 9th Street and Beach 82nd Street, so as to keep this in an early successional habitat stage, as this is within the zone of potential chick movement."

   Requested change/clarification: In the second sentence, please clarify "prior to initial construction of the Atlantic Shorefront reach of the project." Please edit the last sentence to read: "In order to avoid dense vegetation which would impede piping plover chick movement, ten percent vegetation coverage…between Beach 9th Street and Beach 82nd Street. This is to keep the berm in an early successional habitat stage,…"

f. RPM 2.5: "The Corps shall assess the potential for, or actual, erosion associated with hard structures (e.g., groins and rock sills) between Beach 49th Street to 82nd Street, and at Jacob Riis and Fort Tilden Parks that may impact plover habitat, and throughout the ocean and bayside shoreline for red knots as the final designs are developed.

   Concurrently, develop a remedial action plan through further coordination with the Service for erosion that causes a loss of breeding, foraging, or roosting habitat. The plan shall be completed 3 months prior to initial construction."

   Requested change/clarification: The U.S. Army Corps of Engineers will not develop a remedial action plan unless erosion beyond what is reasonably expected actually occurs. For remedial action to be successful, it must address actual conditions which cannot be presupposed. Also, as discussed previously with the Service, some seasonal/annual variation as storms and currents move

sand within the system is expected and not necessarily an indication that the project is not performing as intended. Please edit the first sentence of the second paragraph to read: "In the event of unintended severe downdrift erosion resulting from the project, the Corps will develop…"

g. RPM 2.7: "The Corps shall develop a biological monitoring program for the action area, to be approved by the Service, in coordination with the NYCDPR and the NPS, and implemented by the Service or Service-approved entity to address the impacts of the dune, berm, composite seawall, and groin construction on plover and red knot biology and ecology. The monitoring program shall span the pre-initial construction, initial construction, and a determined period of the renourishment phases of the project. The monitoring program shall evaluate red knot and plover population and behavioral responses to habitat changes in the action area, such as avoiding existing foraging, roosting, or breeding areas, as a whole, or as in the case of plovers, any shifts in the species distribution relative to the hard and soft shoreline protection structures. The plan shall be finalized 3 months prior to the initiation of the biological monitoring plan."

   Requested change/clarification: Please revise first sentence to: "The Corps shall develop and implement a Biological Monitoring Program in coordination with NYCDPR, NPS, and the Service to address the impacts of the dune. The development of the Biological Monitoring Program will also be coordinated with NYSDEC..." It is the New York District's responsibility to implement all facets of our project, including Biological Monitoring Programs, and the District has the required specialized expertise. Additionally, as previously discussed, please omit sentence that begins "The Monitoring Program shall evaluate red knot and plover population and behavioral responses…" The behavioral monitoring program should focus on potential impacts related to the composite seawall as other impacts named have already been or are presently being evaluated under FIMI and Westhampton Biological Monitoring Programs associated with Corps projects. Also, any monitoring should be integrated into what is already being performed so as to avoid duplicative efforts.

h. RPMs 2.10 and 2.11: "To reduce the anticipated level of take due to increases in disturbances from recreational activities [please add: **when compared to future without project conditions]**, the Corps shall, in coordination with the NYCDPR and NPS, ensure the full implementation of the Service's "Guidelines for Managing Piping Plovers on Recreational Beach in Order to Avoid Take Under the Endangered Species Act"… in the project area, including working with the NYCDPR and the NPS to ensure implementation and enforcement of plover management activities over the life of the project."

   Requested change/clarification: "The Corps will also coordinate these with our non-federal sponsor, NYSDEC."

i. RPM 2.11: "The Corps shall work with the NYCDPR and the NPS, in coordination with Service, in developing a predator management plan for the action area where predators of piping plovers are identified, management objectives designed and implemented, and results are documented."

   Requested change/clarification: The District would like to clarify that the Corps' responsibility is limited to the development of the plan and not implementation which is outside of our authority. Please edit to read: "developing a predator management plan for the action area to identify the predators of piping plovers, how predators will be managed, and how results will be documented."

j. Additional for RPM 2.11, requested change/clarification: NPS to provide input as they noted that they do not currently practice predator control. NPS has requested, in coordination with the District, a follow-up discussion with the Service to ensure alignment on the Rockaway BO. The District will facilitate where appropriate, and coordinate on matters of joint interest. Please note, that the District does not control land management decisions on lands under NPS jurisdiction.

k. RPM 2.12: "As the project involves nighttime construction activities and no night time monitoring is proposed, all construction personnel and the Service shall be provided a daily report at the end of each day providing the location of all breeding activities, including territories, courtship areas, nest building areas, nest sites and chick rearing areas. All lights shall be directed away from these areas."

   Requested change/clarification: Please edit this RPM so the last sentence reads: "All lights shall be directed away from the areas noted as practicable to allow for safe construction."

l. RPM 3.1 (third paragraph): "All on site personnel shall be required to participate in a mandatory piping plover and seabeach amaranth training session prior to April 1 (provided and conducted by the Service or an approved Service representative). Any individuals without this training shall not be permitted on site. All costs of this training will be the responsibility of the Corps or the contractor."

   Requested change/clarification: Not practicable for entire construction crew to attend in-person off-site training. Please edit to read: "the Service will provide a Service CD or digital video to show the workers on-site which can be administered by the District."

m. Also for RPM 3.1 (first paragraph, first sentence): "A construction field meeting will be held on or before March 1 and should include the local cost sharing sponsors…"

Requested change/clarification: Please change "local cost sharing sponsors" to "non-federal sponsors" as the initial construction of this project is 100% federally funded.

n. Piping Plover Conservation Recommendation 1: "The Corps should identify areas on Long Island within their Civil Works program where natural process can form bay to overwash habitat and promote optimal plover habitat formation. The focus should be on areas outside of sites that already provide opportunities for these types of habitat development."

   Piping Plover Conservation Recommendation 2: "The Corps should identify mechanisms to contribute to plover protection measures, either by providing equipment, personnel, or funds, to local land managers within areas affected by their Civil Works projects."

   For Conservation Recommendations 1 and 2 pertaining to piping lovers, please note that this BO is specific to the East Rockaway Inlet to Rockaway Inlet Reformulation Study. While the District is not able to perform these Conservation Recommendations under the Rockaway Reformulation, this work falls within our Ecosystem Restoration mission and could be pursued where the authority exists and there is a willing and eligible non-federal sponsor identified.

o. Piping Plover Avoidance and Minimization Measure 1.4 (third paragraph): "Productivity and population surveys will be conducted each year for the life of the project."

   Please note that the Corps is not able to perform surveys over the life of the project each year as our funding is tied to construction and renourishment cycles. The surveys would be accomplished by the local sponsor and/or NPS staff who already perform this work annually. No duplicative survey work will be added.

p. Red Knot Avoidance and Minimization Measure 2.2: "The Corps will support the NYCDPR's pre- and post-construction surveys of the Project area to determine the presence of red knot."

   Requested change/clarification: Please edit to read: "NYCDPR will support the District's pre and post construction surveys related to initial construction and each renourishment cycle by conducting their regular shorebird monitoring program from April to August on an annual basis. The District will monitor for presence and absence of piping plovers and red knots prior to and during each construction/renourishment cycle."

q. The District would like to note regarding the assumption of 100 percent burial of the amaranth seed bank (page 40 of the BO), that this ignores the experience of multiple beach nourishment sites in New Jersey where seabeach amaranth populations have rebounded significantly post nourishment due to the significant

seed banks which were abundant in the sand sources. There is a potential for the Rockaway Reformulation project to improve the seabeach amaranth presence.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, New York 13045

June 25, 2019

Colonel Thomas D. Asbery
District Engineers
New York District
U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278-0900

Dear Colonel Asbery:

This is in response to your correspondence dated April 26, 2019, providing comments on the East Rockaway Inlet to Rockaway Inlet Coastal Storm Risk Management Project biological opinion (Opinion) dated April 3, 2019.

Our responses are provided below and follow as closely as possible the numbering format provided in your April correspondence. The amended Opinion is enclosed.

Corps' Comment 1: Figure 9 on page 7 is in Virginia, not NJ. Source: Figure 7-12 in Engineering Shorefront Appendix.

FWS Response: Revised as noted.

Corps' Comment 2: USACE has screened Mott's Basin out of the Recommended Plan. Please delete from the project description on pages 2, top of 9, and 10 (incl. Figure 12).

FWS Response: We have noted that it has been screened out of the Recommended Plan.

Corps' Comment 3: There are several instances where "increased recreation" resulting from the project are cited.

As discussed, the USACE project is not projected to increase recreation beyond the current levels, but rather maintain those levels by avoiding the erosion, lost beaches, and diminished recreation that would otherwise occur without construction of the project. Please add clarifying language to reflect this such as "increased recreation compared to the future without project condition". In the District's coordination with NPS, NPS also noted that the project will not increase recreation on NPS property from existing conditions and concurred with the Corps' analysis on this issue.

Please address this on pages 36, 47, 49 (in two places), 50 (in three places), 51 (in two places), 53, 56, 58, 62 (RPM 1.10), and 64 (RPM 2.10). If it reduces the burden on the Service, the District can respectfully make the suggested edits in track changes for your consideration if provided with a Word version of the B.O.

FWS Response: Recreation is an identified effect which will likely lead to incidental take, for which we have identified reasonable and prudent measures. We have amended the Opinion to reflect that it does not have to be an increase in recreation, but an effect that is reasonably certain to occur due to creation and maintenance of wide beaches over the next 50 years.

Our evaluation is based on the application of the ESA regulations, supported by science, and is consistent with past and recent biological opinions issued for Corps' beach nourishment projects on Long Island. The ESA requires that the Service evaluate the effects of the action. An effect or activity is caused by the proposed action when two tests are satisfied: First, the effect or activity would not occur but for the proposed action, and second, the effect or activity is reasonably certain to occur. In this instance, the Rockaway Opinion was based on a project that will, in part, result in impacts related to recreational activity through construction and then maintenance of the design beach profile over 50 years.

Recreational impacts are a known source of adverse effects to shorebirds, including piping plover and red knot (Burger et al. 2004; Burger and Gochfeld 1991) and often are associated with beach restoration. Anthropomorphic disturbance can lead to lower plover survival (Gibson et al. 2019; DeRose-Wilson et al. 2018) or nest abandonment or loss (Jorgensen et al. 2016). Piping plover body mass was shown to be substantially lower for individuals in areas with greater anthropogenic disturbance than for individuals associated with less disturbed habitats. Similarly, survival rates of individuals in disturbed sites were lower than those of plovers in nearby less disturbed sites and piping plovers associated with areas that have greater disturbance experience physiological and demographic consequences during the nonbreeding season and beyond (Gibson et al. 2019). DeRose-Wilson et al. (2018), based on monitoring for the Corps' Fire Island Inlet to Moriches Inlet (FIMI) project, noted, "Recreational activity on beaches can be responsible for plover chick displacement into habitats with lower food availability, resulting in lower feeding rates, slower growth, and decreased survival." And, "The effects of foot traffic to breeding plovers can range from relatively minor disturbance that temporarily interferes with normal breeding, feeding, and sheltering behavior to injury or death of chicks, destruction of an entire nest, or sustained disturbance resulting in nest abandonment. After hatching, young plovers are likely to move away from nesting areas, making them vulnerable to these effects throughout a much larger area." Recreational use of coastal habitats can limit the functional availability of shorebird foraging habitat, particularly intertidal foraging habitat, resulting in demographic consequences (DeRose-Wilson et al. 2018). Plover chicks in areas with high recreational use can experience lower survival and longer times to fledging than chicks in areas with lower recreational use, as they are forced to move to areas with lower prey densities (DeRose-Wilson et al. 2018).

Recreational effects of beach nourishment projects have been addressed in consultations for Corps' authorized, funded, or constructed projects on Long Island including: Westhampton Interim Storm Damage Protection Project (1994), West of Shinnecock Inlet Interim Storm Damage Protection Project (2001), Smith Point County Park Beach Nourishment Project (2007),

Beach Nourishment and Maintenance Dredging Smith Point and Cupsogue County Parks (2008), Sagaponack Erosion Control District and Village of Quogue beach nourishment projects (2014), Fire Island Inlet to Moriches Inlet Stabilization Project (2014), and Jones Inlet to East Rockaway Inlet, Long Beach Island, New York, Coastal Storm Risk Management Project (2014).

Taking into consideration the ESA regulations, science, and past and recent consultations, recreational activities are reasonably certain to occur and likely result in incidental take. Accordingly, the Service specified reasonable and prudent measures that are deemed necessary and appropriate to address the anticipated level of incidental take.

Corps' Comment 4. The District, in coordination with NYCDPR and NPS, also requests the following clarifications and/or changes (a through q):

4a. RPM 1.2: "The Corps shall remove any construction material or equipment staged or stored within delineated breeding areas between Beach 19th Street and Beach 67th Street…by April 1 of any given year over the life of the project and pre-migration staging areas."

Requested change/clarification: Please delete pre-migration staging areas, or alternatively define this term and its applicability.

FWS Response: A definition for plover pre-migration areas was previously provided in our March 9, 2019, response to this same question posed by the Corps during the consultation process: "Pre-migration piping plover - individual or congregating post fledges and postseason adult birds seen on the breeding grounds or adjacent beaches."

As a listed species, all stages of its life history, are considered when specifying measures that are necessary or appropriate to minimize incidental take. Gibson et al. (2019) reported on the decreased survival rates of individuals subject to anthropomorphic disturbance. Ensuring that take is minimized will increase the individual's chances of survival.

4b. RPM 1.3: "During construction, the Corps shall work with the NYCDPR and the NPS to ensure that plover breeding habitat from Beach 19th Street to Beach 67th Street, and 500 m from breeding areas in Jacob Riis and Fort Tilden Parks is protected during construction activities from April 1 to September 1 with symbolic fencing, signs, etc."

Requested change/clarification: As RPM 1.3 reads, it appears to say that each nest would require fencing 500 meters around it which NPS and NYCDPR expressed concerns to USACE about as it would impede the ability to also manage the recreational needs within their properties. Common practice for both land managers is to fence approximately 50 meters around a nest. NYCDPR current practice is to leave fencing for protected species at RBESA from April 1 through November 30.

FWS Response: We have clarified the fencing requirements in the amended Rockaway Opinion.

Amended RPM/TAC 1.3: "For the construction phase and each renourishment or other activity involving construction, maintenance, or surveying in the project and action areas (Far Rockaway Beach, Rockaway Beach, Jacob Riis and Fort Tilden Parks) piping plover breeding areas (not nests) will be fenced from April 1 to September of each year. The 500 m buffer for breeding adults and 1,000 m from chick rearing areas will be maintained between these areas and Corps' construction and renourishment activities to ensure no project related activities occur in the buffer zone. How these buffers are marked is at the discretion of the Corps for purposes of carrying out the construction, renourishment, and maintenance activities."

Note: We appreciate your comments about the use of 50-m buffers, but this is recommended for non-motorized recreational activities (pedestrians, sun bathers, jogging, picnickers, etc.) and not for a large beach nourishment and seawall construction project involving trucks, front loaders, and other related mechanized construction equipment.

For the purposes of the Rockaway Opinion, a piping plover "breeding area" is defined by the Service as an area currently occupied by courting, territorial, incubating, or brood-rearing piping plovers, nests with eggs, unfledged chicks, or fledged chicks that have not yet left their natal area, or any site so occupied during any of the five most recent nesting seasons. As noted in your comments, the Corps is interested in building off of recent and past research and monitoring efforts funded by the Corps at Westhampton (1993-2004) and Fire Island (2013-current). We completely support that approach. To that end, we have reviewed the information contained in these reports, including Hermanns et al. (2018; "Piping Plover and Red Fox Monitoring on Fire Island, NY") to provide a conservative estimate for adult plover range/buffer of 500 m. This report was provided to both the Service and the Corps as part of the required monitoring for the Corps' Fire Island Inlet to Moriches Inlet Stabilization Project.

4c. RPM 1.7: "A vegetation planting plan for the artificial dune shall be coordinated with and approved by the Service. At a minimum, it shall incorporate a mix of native dune plant species (no woody vegetation) and not be limited to a single grass species. Plantings should be made in a random manner and not rows with uniform spacing. The plantings should mimic natural dune vegetation in the region in species diversity, density, and spacing. The dune planting plan shall be completed and approved 3 months prior to initial construction."

Requested change/clarification: Please revise the first sentence to: "A vegetation planting plan for artificial dune shall be approved by a Corps Biologist and coordinated with the New York State Department of Environmental Conservation (NYSDEC), the project's non-federal sponsor, the NYCDPR, and the Service. At a minimum, it shall incorporate a mix of native dune plant species and not be limited to a single grass species… The dune planting plan shall be completed and approved 3 months prior to initial construction of the dune."

Please note in general throughout the BO, District staff will approve all construction contract related documents and will coordinate and provide to the Service. This concept also applies to RPMs 2.1 and 2.6 below.

FWS Response: The RPM/TAC was amended as given below.

Amended RPM/TAC 1.7: "No woody vegetation will be planted on the dune, only herbaceous native plants will be used. The vegetation planting density will be maintained at 24 inches on-center over the life of the project. Plantings will be made in a random manner and not rows with uniform spacing. Planting will not occur from April 1 to September 1 in order to protect breeding plovers whose breeding areas may encompass the dune area. Planting may occur after the last day of chick fledging.

Note: Under 50 CFR Part 402.14, the Service is required to specify measures that are necessary or appropriate to minimize incidental take in the biological opinion. We do not believe that these measures or this process interferes with the Corps' contracting process. As noted in section XII of the Opinion, these measures are non-discretionary, and must be undertaken by the Corps and become binding conditions of any grant or permit issued to the (applicant), as appropriate, for the exemption in section 7(o)(2) to apply. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse.

As to this specific measure, woody vegetation is not typical of dunal systems or suitable for plover habitat, as it can provide predator perches. This was a factor that was also included in the FIMP design criteria for the Coastal Process Features (see Table 4 in the FIMP Opinion). Dense vegetation also degrades plover habitat.

RPM 2.1: "The Corps shall develop and implement pre-, concurrent, and post-construction monitoring plans for piping plover and red knot and their habitats with guidance and approval from the Service. This shall be completed and submitted to **coordinated with** (Corps' suggested change in bold) the Service 3 months before initial construction for approval. The basic elements of the monitoring plan shall include transect locations, frequency of monitoring, habitat type, construction activities that are present less than and greater than 500 m, time of day, tidal phase, etc."

FWS Response: Note we have amended this RPM/TAC, as given below.

Amended RPM/TAC 2.1: "As take is expected each year of the 50-year project, pre-, concurrent, and post-construction monitoring plan will be undertaken. The following measures will be incorporated into the Piping Plover Avoidance and Minimization Measures" contained in section II(C)(1) of the Rockaway Opinion. These will be undertaken by a qualified biologist who is selected by the Corps and meets the qualifications provided below.

Estimates of piping plover annual pair counts will be made using the males within pairs. Males for pair counts and productivity estimates are used because when pairs separate, the males often keep their territory when they partner with a new female. Additionally, males are the primary territory holders and defenders (Hermanns et al. 2018).

The monitoring surveys outlined in section II(C)(1) for piping plover will be undertaken during the pre-construction phase of the project for one season prior to construction, implemented during the construction phase of the project and then for two years post construction. This cycle of monitoring will be applied to each renourishment phase as follows: one year prior to renourishment, during renourishment, and two seasons post renourishment for the life of the project.

For red knots one count will be made, at roughly ten-day intervals, on or within 3 days of the dates below:

Spring: April 5, April 15, April 25, May 5, May 15, May 25, June 5, June 15.

Fall: July 15, July 25, August 5, August 15, August 25, September 5, September 15, September 25, October 5, October 15, October 25.

Winter: November 5, November 15, November 25.

The person(s) conducting the survey must demonstrate the qualifications given below.

Qualifications:

1) A minimum Bachelor of Science degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences;
2) Skilled in identification of North Atlantic shorebird species, specifically piping plover. At least one year of full-time, or equivalent part-time, technical experience in observing piping plover and red knot.

RPM 2.6: "The Corps shall undertake monitoring of wrack and wrack invertebrates in the intertidal zone, and berm based on a sampling program that has been devised in consultation with, and agreed to, by the Service prior to its implementation. The information collected during this monitoring program shall be used to adaptively manage the operation and maintenance phases of the project to further avoid and minimize take. The monitoring plan should include, but not be limited to, the response of the wrack and wrack invertebrates during and after sand placement within breeding and pre-migration staging, and foraging areas, including such information as total recovery time, recovery rates, abundance, biomass, diversity, and composition of prey items, and spatial coverage of wrack. The plan shall be finalized 3 months prior to initial construction of the project."

FWS Response: Note, we have amended this RPM/TAC, as given below.

Amended RPM/TAC 2.6: "Monitoring of wrack and wrack invertebrates in the intertidal zone, and berm will be undertaken by a qualified biologist (biologist must have a 4-year biological sciences degree, with experience in invertebrate biology and ecology, study design). The information collected during this monitoring program will be used to

adaptively manage the operation and maintenance phases of the project to further avoid and minimize take.

The following provides the basis for a wrack monitoring plan:

The sampling methodology modified from Ruiz-Delgado (2015), Kluft and Ginsberg (2009), and Dugan et al. (2003) includes:

1) Select specific monitoring sites - Establish a monitoring area within plover breeding areas to include zones between the primary dune and low tide line between Beach 9th Street and Beach 82nd Street; and within the Jacob Riis and Fort Tilden Units of the GNRA. Reference sites along the Rockaway Peninsula will be identified by the Corps. Reference sites will serve as controls, so they should not experience anthropomorphic activities that affect wrack deposition and persistence on the beach nor be affected by the beach nourishment of hard shoreline stabilization structures (i.e., beach raking, groins, etc.).

2) Establish sample areas - Areas should be 100 m in length (alongshore).

3) Establish transects - Within each sample area, select five random points to establish transects (transects will run perpendicular to the shore).

4) Each spring (approximately Mar 21 - June 20) and summer (approximately June 21 - September 21), season three replicates will be collected. Samples will be collected at two tidal levels: the level at which wrack is stranded during the highest spring tide and located above the current high tide line and another one at which wrack is deposited during the last high tide and located at the current driftline (hereafter upper and lower level, respectively).

   The sampling points are to be randomly designated along each tidal level in covered and uncovered wrack areas during low spring tides. The along-shore distance of the sampling area will be 100 m, while the across-shore distance will be at 1 m above and below wrack bands (defined as the wrack-covered line parallel to the tide line). For each tidal level and sampling date, six random samples will be collected in each microhabitat (i.e., wrack patches and bare sand) for a total of 72 samples per habitat and tidal level. Wrack-associated fauna and burrowing fauna underneath the wrack patches will be collected in wrack-covered areas: algal wrack at the surface and 20 cm of sediment will be sampled with a 15- to 20-cm diameter core. Samples will also be taken in the nearby bare sand, with the same core to a depth of 20 cm, to measure the abundance of invertebrates in areas not covered by wrack. Samples will be sieved (at 1 mm) and preserved for species identification.

5) To quantify the overall amount of wrack within each sampling area, any wrack debris along a profile will be recorded for dimensions (length*width*depth), percent species composition, and an ordinal rating of wrack consistency (1-5), and the mean density/meter (l*w*d)/m2 of beach) will be estimated. Since the clump

will be measured at its largest length and width, and will overestimate clump cover, an elliptical surface area, estimated using the standard formula (length/2*width/2*PI), will be calculated for more accurate analysis. These surface area estimates (m2 wrack/meter of beach) for each transect will be used to generate the overall percentage cover for each area (after Dugan et al. 2003).

6) Additional environmental variables will be measured within wrack samples including: transect percent cover, relative wrack age (categorized qualitatively as fresh, decaying, or old) and percent composition of vegetation observed, temperature and humidity at the wrack/sand interface, and sand temperature at 10-cm depth beneath wrack."

4d. RPM 1.10: "The Corps shall work with the NYCDPR and the NPS to ensure that all suitable piping plover breeding habitat with a recent history (last five years) of plover breeding is protected by April 1 of each year to address the adverse effects associated with the expected increase in recreation" **when compared to the future without project condition** (Corps' suggested amendment in bold).

Requested change/clarification: The NYCDPR does not fence the entirety of the protected area. The NYCDPR has a monitoring team in place starting in April and monitors regularly and will fence areas where plovers are being territorial and displaying breeding behaviors, according to the Service guidelines. Beach 38th to Beach 57th Streets are pre-fenced annually. The NYCDPR intends to continue monitoring and protecting piping plovers per above accepted practices. Also, please clarify as noted above that the expected increase in recreation is when compared to the future without project condition.

FWS Response: This RPM/TAC complies with the regulatory language of necessary and appropriate to reduce the anticipated level of incidental take. As noted in our guidelines, "All suitable piping plover nesting habitat should be identified by a qualified biologist and delineated with posts and warning signs or symbolic fencing on or before April 1 each year." This would apply in areas where beach raking and/or project maintenance activities are taking place.

4e. RPM 2.4: "The Corps shall devise an early successional beach habitat restoration plan for the berm habitat between Beach 9th Street and Beach 82nd Street in coordination with the Service. The plan shall be finalized 3 months prior to initial construction of the project. Ten percent vegetation coverage shall be the target vegetation density with a threshold action of 17 percent coverage for planning purposes between Beach 9th Street and Beach 82nd Street, so as to keep this in an early successional habitat stage, as this is within the zone of potential chick movement."

Requested change/clarification: In the second sentence, please clarify "prior to initial construction of the Atlantic Shorefront reach of the project." Please edit the last sentence to read: "In order to avoid dense vegetation which would impede piping plover chick movement, ten percent vegetation coverage…between Beach 9th Street and Beach 82nd Street. This is to keep the berm in an early successional habitat stage…"

FWS Response: Revised as given below.

Amended RPM/TAC 2.4: "The Corps will implement the following early successional beach habitat restoration plan for the berm habitat between Beach 9th Street and Beach 82nd Street. In order to avoid dense vegetation which would impede piping plover chick movement and degrade nesting habitat, 10 percent vegetation coverage will be the target vegetation density with a threshold action of 17 percent coverage for planning purposes between Beach 9th Street and Beach 82nd Street, so as to keep this in an early successional habitat stage.

All clearing and other site preparation activities will take place outside the breeding season (April 1 to September 1)."

4f. RPM 2.5: The Corps shall assess the potential for, or actual, erosion associated with hard structures (e.g., groins and rock sills) between Beach 49th Street to 82nd Street, and at Jacob Riis and Fort Tilden Parks that may impact plover habitat, and throughout the ocean and bayside shoreline for red knots as the final designs are developed.

Concurrently, develop a remedial action plan through further coordination with the Service for erosion that causes a loss of breeding, foraging, or roosting habitat. The plan shall be completed 3 months prior to initial construction.

Requested change/clarification: The U.S. Army Corps of Engineers will not develop a remedial action plan unless erosion beyond what is reasonably expected actually occurs. For remedial action to be successful, it must address actual conditions which cannot be presupposed. Also, as discussed previously with the Service, some seasonal/annual variation as storms and currents move sand within the system is expected and not necessarily an indication that the project is not performing as intended. Please edit the first sentence of the second paragraph to read: "In the event of unintended severe downdrift erosion resulting from the project, the Corps will develop..."

FWS Response: The RPM/TAC has been revised, as given below.

Amended RPM/TAC 2.5: "The Corps will develop a remedial action plan if erosion associated with hard structures (e.g., groins and rock sills) occurs between Beach 49th Street to 82nd Street, and at Jacob Riis and Fort Tilden Parks that may impact plover habitat, and throughout the ocean and bayside shoreline for red knots. Project induced erosion will be addressed at the earliest possible time but no later than the next scheduled renourishment cycle."

Note: This RPM/TAC was modified to address the Corps' concern about the timing of the remedial action plan development. It has been revised to be required if erosion is observed in plover or red knot habitat and specifies that remediation will occur within or before the next scheduled renourishment cycle. Overall, the RPM is needed to address uncertainties identified by the Corps regarding the functioning of rehabilitated or newly constructed groins and their effects on downdrift beaches and habitat. It is necessary to identify how these uncertainties will be addressed, monitored and evaluated with respect

to their impacts on the species and their habitats. Failure to address this at this time could lead to the necessity to reinitiate consultation in the future as per the relevant triggers in 50 CFR Part 402.16: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; and (3) the action is modified in a manner causing effects to listed species or critical habitat not previously considered.

4g. RPM 2.7: "The Corps shall develop a biological monitoring program for the action area, to be approved by the Service, in coordination with the NYCDPR and the NPS, and implemented by the Service or Service-approved entity to address the impacts of the dune, berm, composite seawall, and groin construction on plover and red knot biology and ecology. The monitoring program shall span the pre-initial construction, initial construction, and a determined period of the renourishment phases of the project. The monitoring program shall evaluate red knot and plover population and behavioral responses to habitat changes in the action area, such as avoiding existing foraging, roosting, or breeding areas, as a whole, or, as in the case of plovers, any shifts in the species distribution relative to the hard and soft shoreline protection structures. The plan shall be finalized 3 months prior to the initiation of the biological monitoring plan."

Requested change/clarification: Please revise the first sentence to: "The Corps shall develop and implement a Biological Monitoring Program in coordination with the NYCDPR, the NPS, and the Service to address the impacts of the dune. The development of the Biological Monitoring Program will also be coordinated with NYSDEC..." It is the New York District's responsibility to implement all facets of our project, including Biological Monitoring Programs, and the District has the required specialized expertise. Additionally, as previously discussed, please omit the sentence that begins "The Monitoring Program shall evaluate red knot and plover population and behavioral responses..." The behavioral monitoring program should focus on potential impacts related to the composite seawall as other impacts named have already been or are presently being evaluated under FIMI and Westhampton Biological Monitoring Programs associated with Corps' projects. Also, any monitoring should be integrated into what is already being performed so as to avoid duplicative efforts.

FWS Response: Note, we have amended this RPM/TAC, as given below.

Amended RPM/TAC: "The following monitoring plan will be implemented by a qualified monitor(s) that is selected by the Corps, meeting the qualifications provided in RPM/TAC 2.10 to address the impacts of the dune, berm, composite seawall, and groin construction on plover and red knot biology and ecology. The monitoring program will evaluate red knot and plover population and behavioral responses to habitat changes in the action area, such as avoiding existing foraging, roosting, or breeding areas, as a whole, and any shifts in the species' distribution relative to these project features.

- Measure piping plover habitat use in the project area. To evaluate habitat use within the project area, the Corps will delineate the following habitats within the Project Area from Beach 17th Street to Beach 82nd Street: composite dune

crest, composite dune slope, constructed berm, and unaltered sand dune complex between Beach 17th Street and Beach 19th Street. The Corps will record and compare the number of pairs that use these identified habitats for breeding activities (including nest site selection and brood-rearing).

Nest site locations will be collected using a GPS device. To obtain information on changes in brood-rearing areas, the following will be undertaken: To monitor brood movements, broods will be searched for every 1-3 days during adult surveys or nest searching. When located, their locations will be obtained by offsetting an observer location with a distance from a rangefinder and a bearing from a compass. When the broods are located behavior data will also be collected. For five minutes, record forage rate (peck, pull, probe) continuously, and behavioral state (forage, sit, run, walk, chase, flee, preen, encounter with another individual) and habitat (moist sand, moist vegetation, dry sand, dry vegetation, and wrack) every ten seconds (Altmann 1974)."

Note: Under the ESA, the Service is required to provide measures that are necessary and appropriate to minimize incidental take. We have amended the RPM/TAC to provide specific components of monitoring to be, in some cases, incorporated into the monitoring described in section II(C)(1) of the Opinion. This amended RPM/TAC is specific to the take resulting from construction of the composite dune and shoreline hardening structures and was conceptually agreed to by the Corps during the consultation phase of the project.

4h. RPM 2.10: "To reduce the anticipated level of take due to increases in disturbances from recreational activities [please add: **when compared to future without project conditions** (Corps' suggested change in bold), the Corps shall, in coordination with the NYCDPR and the NPS, ensure the full implementation of the Service's "Guidelines for Managing Piping Plovers on Recreational Beach in Order to Avoid Take under the Endangered Species Act" in the project area, including working with the NYCDPR and the NPS to ensure implementation and enforcement of plover management activities over the life of the project."

Requested change/clarification: "The Corps will also coordinate these with our non-federal sponsor, the NYSDEC."

FWS Response: The NYSDEC, the non-federal sponsor, is incorporated in the amended RPM/TAC below. We did not amend the RPM/TAC to include the phrase "future without project conditions" for the reasons explained above.

Amended RPM/TAC 2.10: "To reduce the anticipated level of take due to increases in disturbances from recreational activities, the Corps will, in coordination with the NYCDPR and the NPS, ensure the full implementation of the Service's "Guidelines for Managing Piping Plovers on Recreational Beach in Order to Avoid Take under the Endangered Species Act" in the project area, including working with the NYCDPR and the NPS to ensure implementation and enforcement of plover management activities over

the life of the project. The Corps will also coordinate these with the non-federal sponsor, the NYSDEC."

4i. RPM 2.11: "The Corps will work with the NYCDPR and the NPS, in coordination with Service, in developing a predator management plan for the action area where predators of piping plovers are identified, management objectives designed and implemented, and results are documented."

Requested change/clarification: The District would like to clarify that the Corps' responsibility is limited to the development of the plan and not implementation which is outside of our authority. Please edit to read: "developing a predator management plan for the action area to identify the predators of piping plovers, how predators will be managed, and how results will be documented."

FWS Response: This RPM/TAC has been revised, as follows:

Amended RPM/TAC 2.11: "The Corps will work with the NYCDPR and the NPS, in coordination with Service, in developing a predator management plan for the action area where predators of piping plovers are identified, management objectives designed and ensure implementation, and ensure results are documented. The Corps will also coordinate these with the non-federal sponsor, the NYSDEC."

The predator management plan will incorporate results of monitoring described in section II(C)(1) of the Opinion and include biological triggers (specific reduction in adult, nest or chick abundance, frequency of predator visitation to plover nests or the breeding area, etc.). Additional information to assist in making informed decisions and to maintain a decision making framework about predator management will include the following:

1. Predator species abundance, to be determined through transect surveys established from Beach 9th Street to Beach 82nd Street;
2) Duration of presence at the breeding site;
3) Record of frequency of visits for that observation period (i.e., first, second, etc. occurrence);
4) Record of location; and
5) Record of predator behavior (resting, stooping, vocalizations, prey catch [species -adult, juvenile, chick,] etc.) and piping plover/red knot response (i.e., flight [noting direction], no reaction, vocalization, combination of responses, time to return to nest [when possible]).

Local landowners will be consulted and may participate with the Corps in these activities, but it is the Corps' responsibility to ensure their implementation and reporting requirements as given in the Incidental Take Statement."

Note: The project induced effects and resultant incidental take related to predation are discussed in sections VIII(D) - Effects of the Action and XIII(A)(4) - Amount and Extent of Take Anticipated, of the Opinion, respectively. Due to vandalism predator exclosures

are not widely used in the Rockaways, and, therefore, additional management options are needed. Limiting the Corps' role to identifying predators will not minimize take. Active management is necessary to minimize the anticipated level of take, and for that reason, other measures such as trapping or hazing, along with possibly increased law enforcement presence and public education needs to be incorporated into a comprehensive management plan for the project area and implemented in the project area.

We also note that over the course of the consultation, during meetings between our agencies, the Corps indicated that it could fund the USDA to undertake predator management activities in the action area. (This is consistent with the Corps' predator management approach for the Fire Island Inlet to Moriches Inlet Stabilization Project.).

4j. Additional Corps' Comments for RPM 2.11, requested change/clarification: NPS to provide input as they noted that they do not currently practice predator control. NPS has requested, in coordination with the District, a follow-up discussion with the Service to ensure alignment on the Rockaway BO. The District will facilitate where appropriate, and coordinate on matters of joint interest. Please note, that the District does not control land management decisions on lands under NPS jurisdiction.

FWS Response: The RPMs/TACs are developed to minimize anticipated incidental take due to the project. As noted in section XII of the Opinion, the Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. Accordingly, the Corps will need to coordinate with the NPS and the NYCDPR to ensure the RPMs/TACs are implemented.

We note that previously this overall issue has been dealt with by the Corps either through the Project Partnership Agreement or through close coordination with the landowners. For example, the Corps' 2016 Project Partnership Agreement with the non-federal sponsor for the Jones Inlet to East Rockaway Inlet, Long Beach Island Project, identified limitations on the use of sand fencing and beachgrass planting in certain areas as a requirement of the project in satisfaction of endangered species terms and conditions in the Long Beach BO, and have worked with the NPS on Fire Island to arrive at beach nourishment designs on federal properties to meet the FIMI project's objectives. Further, the Corps and the NPS worked together to agree on predator management within the FIMI Project Area, including the trapping of mammalian predators in the eastern portion of the Fire Island Wilderness Area as part of the FIMI predator management plan collaboration. Similarly, we believe this is achievable at Gateway National Recreation Area, where predator trapping has been undertaken in the past to promote listed species recovery.

4k. RPM 2.12: "As the project involves nighttime construction activities and no night time monitoring is proposed, all construction personnel and the Service shall be provided a daily report at the end of each day providing the location of all breeding activities,

including territories, courtship areas, nest-building areas, nest sites, and chick-rearing areas. All lights shall be directed away from these areas."

Requested change/clarification: Please edit this RPM so the last sentence reads: "All lights shall be directed away from the areas noted as practicable to allow for safe construction."

FWS Response to 4k: Revised as noted.

Amended RPM/TAC 2.12: "As the project involves nighttime construction activities and no night time monitoring is proposed, all construction personnel and the Service will be provided a daily report at the end of each day providing the location of all breeding activities, including territories, courtship areas, nest-building areas, nest sites and chick-rearing areas. All lights will be directed away from these areas as practicable to allow for safe construction."

4l. RPM 3.1 (third paragraph): "All on site personnel including the shorebird monitor(s) shall be required to participate in a mandatory piping plover and seabeach amaranth training session prior to April 1 (provided and conducted by the Service or an approved Service representative). Any individuals without this training shall not be permitted on site. All costs of this training will be the responsibility of the Corps or the contractor."

Requested change/clarification: Not practicable for entire construction crew to attend in-person off-site training. Please edit to read: "the Service will provide a Service CD or digital video to show the workers on-site which can be administered by the District."

FWS Response: Revised as noted in regard to construction personnel. However, shorebird monitors will be required to attend the training session.

Amended RPM/TAC 3.1: "All onsite personnel are required to watch a Service-provided CD or digital video regarding plover biology and protection. This will be administered by the District.

All qualified shorebird monitors will be required to participate in a mandatory piping plover and seabeach amaranth training session provided by the Service prior to April 1 (provided and conducted by the Service or an approved Service representative). Any individuals without this training will not be permitted on site. All costs of this training will be the responsibility of the Corps or the contractor."

4m. Also for RPM 3.1 (first paragraph, first sentence): "A construction field meeting will be held on or before March 1 and should include the local cost sharing sponsors..."

Requested change/clarification: Please change "local cost sharing sponsors" to "non-federal sponsors" as the initial construction of this project is 100 percent federally funded.

FWS Response: See response to 4l, above.

4n. Piping Plover Conservation Recommendation 1: "The Corps should identify areas on Long Island within their Civil Works program where natural process can form bay to overwash habitat and promote optimal plover habitat formation. The focus should be on areas outside of sites that already provide opportunities for these types of habitat development."

Piping Plover Conservation Recommendation 2: "The Corps should identify mechanisms to contribute to plover protection measures, either by providing equipment, personnel, or funds, to local land managers within areas affected by their Civil Works projects."

For Conservation Recommendations 1 and 2 pertaining to piping plovers, please note that this BO is specific to the East Rockaway Inlet to Rockaway Inlet Reformulation Study. While the District is not able to perform these Conservation Recommendations under the Rockaway Reformulation, this work falls within our Ecosystem Restoration mission and could be pursued where the authority exists and there is a willing and eligible non-federal sponsor identified.

FWS Response: As noted in section XVII of the Opinion, "Section 7(a)(1) of the Act directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, help implement recovery plans, or to develop information." These are discretionary recommendations, with the Corps making the determination which program or project activities are undertaken.

4o. Piping Plover Avoidance and Minimization Measure 1.4 (third paragraph): "Productivity and population surveys will be conducted each year for the life of the project."

Please note that the Corps is not able to perform surveys over the life of the project each year as our funding is tied to construction and renourishment cycles. The surveys would be accomplished by the local sponsor and/or NPS staff who already perform this work annually. No duplicative survey work will be added.

FWS Response: We believe this conservation measure was agreed to during the consultation. Overall, we note that monitoring over the life of the project has been included for other Corps' projects. For instance, the Corps' Draft Fire Island Inlet to Montauk Point (FIMP) Adaptive Management Plan includes endangered species monitoring over the life of that project, and includes, in part, providing the Service with annual nest site locations (see page 45 of the Corps' FIMP Monitoring and Adaptive Monitoring Plan found in Appendix J of the FIMP Draft Final General Reevaluation Report dated January 10, 2019). The Corps' FIMI project also includes monitoring for the 10-year FIMI project life, which is on-going. The Corps is responsible for ensuring the implementation of this conservation measure through coordination with all landowners.

4p. Red Knot Avoidance and Minimization Measure 2.2: "The Corps will support the NYCDPR's pre- and post-construction surveys of the Project area to determine the presence of red knot."

Requested change/clarification: Please edit to read: "The NYCDPR will support the District's pre- and post-construction surveys related to initial construction and each renourishment cycle by conducting their regular shorebird monitoring program from April to August on an annual basis. The District will monitor for presence and absence of piping plovers and red knots prior to and during each construction/renourishment cycle."

FWS Response: Revised as noted.

4q. The District would like to note regarding the assumption of 100 percent burial of the amaranth seed bank (page 40 of the BO), that this ignores the experience of multiple beach nourishment sites in New Jersey where seabeach amaranth populations have rebounded significantly post nourishment due to the significant seed banks which were abundant in the sand sources. There is a potential for the Rockaway Reformulation project to improve the seabeach amaranth presence.

FWS Response: We request further information on the sampling the Corps undertook of the seed banks that enabled them to correlate beach nourishment with amaranth abundance.

The Opinion was also amended to include the following Reporting Requirement for all Terms and Conditions:

The Corps will submit a post-construction compliance report prepared by a qualified biologist selected by the Corps (see required qualifications provided above) to the Long Island Field Office by December 1 of each year for the life of the project. This report will detail (i) dates that construction occurred; (ii) pertinent information concerning the success of the project in meeting conservation measures and reasonable and prudent measures/terms and conditions; (iii) an explanation of failure to meet such measures, if any; (iv) known project effects on listed species, if any; (v) occurrences of incidental take of listed species, if any; (vi) documentation of employee environmental education; and (vii) other pertinent information such as the development of adaptive management alternatives to address modification that may be necessary based on the monitoring efforts that are part of the project description and reasonable and prudent measures/terms and conditions.

All data collected will be provided in an Excel spreadsheet. Monitoring results will be submitted (datasheets, maps, database) on standard electronic media (e.g., CD, DVD) to the Long Island Field Office by November 1 of each year in which monitoring is completed.

Supporting credentials of all monitors (resume, references from supervisors of field work, transcripts of course work, reprints of published papers, etc.) will accompany the annual reports submitted to the Service.

Thank you for the opportunity to provide the amended Opinion to you. If you have any questions or require further assistance, please have your staff contact Steve Papa, Kerri Dikun, or Steve Sinkevich at the Long Island Field Office at (631) 286-0485.

Sincerely,

David A. Stilwell
Field Supervisor

Enclosure

Literature Cited:

Altmann, J. 1974. Observational Study of Behavior: Sampling Methods. *Behaviour* 49:227-267.

Burger, J., M. Gochfeld. 1991. Human Activity Influence and Diurnal and Nocturnal Foraging of Sanderlings (*Calidris alba*). *The Condor* 93:259–265.

Burger, J., C. Jeitner, and K. Clark. 2004. The Effect of Human Activities on Migrant Shorebirds: Successful Adaptive Management. *Environmental Conservation* 31(4): 293-288

DeRose-Wilson, A.L., K.L. Hunt, J.D. Monk, D.H. Catlin, S.M. Karpanty, and J.D. Fraser. 2018. Piping Plover Chick Survival Negatively Correlated with Beach Recreation. *Journal of Wildlife Management* 82(8):1608–1616.

Dugan, J. E., D.M. Hubbard, M.D. McCrary, and M.O. Pierson. 2003. The Response of Macrofauna Communities and Shorebirds to Macrophyte Wrack Subsidies on Exposed Sandy Beaches of Southern California. *Estuarine, Coastal, and Shelf Science* 58S, 25-40.

Gibson, D., M.K. Chaplin, K.L. Hunt, M.J. Friedrich, C.E. Weithman, L.M. Addison, V. Cavalieri, S. Coleman, F.J. Cuthbert, J.D. Fraser, W. Golder, D. Hoffman, S.M. Karpanty, A. Van Zoeren, and D.H. Catlin. 2018. Impacts of Anthropogenic Disturbance on Body Condition, Survival, and Site Fidelity of Nonbreeding Piping Plovers. *Condor* 120 (3): 566-580.

Hermanns, L.F., K.M. Black, S.G. Robinson, K.M. Walker, H.A. Bellman, J.D. Fraser, D.H. Catlin, S.J. Ritter, and S.M. Karpanty. 2018. Piping Plover and Red Fox Monitoring, Fire Island, NY. Monitoring report submitted to the U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service. Virginia Polytechnic and State University, Blacksburg, VA. 142 pp.

Jorgensen, J.G., L.R. Dinan, and M. Bomberger Brown. 2016. Flight Initiation Distances of Nesting Piping Plovers (*Charadrius melodus*) in Response to Human Disturbance. *Avian Conservation and Ecology* 11(1):5.

Kluft, J.M., and H.S. Ginsberg. April 2009. The Effect of Off-road Vehicles on Barrier Beach Invertebrates at Cape Cod and Fire Island National Seashores. Technical Report NPS/NER/NRTR—2009/138. National Park Service, Boston, MA. 54 pp.

Ruiz-Delgado, M.C., M.J. Reyes-Martínez, J.E. Sánchez-Moyano, J. López-Pérez, F.J. García-García. 2015. Distribution Patterns of Supralittoral Arthropods: Wrack Deposits as a Source of Food and Refuge on Exposed Sandy Beaches (SW Spain). *Hydrobiologia* 742:205-219.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

District Engineer

JUL 11 2019

Mr. David Stilwell
Field Supervisor
U.S. Fish and Wildlife Service
3817 Luker Road
Cortland, New York 13045

Dear Mr. Stilwell:

Thank you for your response to the U.S. Army Corps of Engineers, New York District (District) comments resulting in the Revised Biological Opinion (BO) for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study, dated 25 June 2019. As discussed, the District looks forward to continue working with the U.S. Fish and Wildlife Service (Service) during the Preconstruction, Engineering, and Design and Construction Phase. As appropriate, the District and the Service will discuss/confirm and/or refine the implementation requirements that are needed to meet the intent of the Reasonable and Prudent Measures (RPMs) necessary to address the effects on the federally listed Atlantic Coast piping plover (*Charadrius melodus*; threatened), seabeach amaranth (*Amaranthus pumilus*; threatened), and red knot (*Calidris canutus rufa*; threatened) in a manner which is feasible within the District's funding and authority constraints.

Thank you for continued cooperation in advancing this effort. If you any questions, please contact Mr. Peter Weppler, Chief of the Environmental Analysis Branch at 917-790-8634.

Sincerely,

Thomas D. Asbery
Colonel, U.S. Army
Commander

cc.
USFWS-LIFO
NPS
NYCDPR
NYSDEC

Enclosure

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

OCT 3 1 2018

Peter Weppler, Chief
Environmental Analysis Branch
Planning Division
New York District
U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278-0900

RE: Draft Final Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement, Essential Fish Habitat Assessment
Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Dear Mr. Weppler:

We have reviewed the Draft Final Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (DEIS) and essential fish habitat (EFH) assessment for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study. The project area includes the Atlantic coast of New York City between East Rockaway Inlet and Rockaway Inlet, areas within Jamaica Bay, and an offshore borrow area.

The report addresses the reevaluation of solutions to flooding attributed to storm surges in Jamaica Bay that inundate the bay shorelines of Rockaway (back bay flooding) and that overtop the Rockaway beachfront and flow across the peninsula to meet the surge into Jamaica Bay (cross shore flooding). The Recommended Plan (RP) has been formulated with two planning reaches, including 1) a reinforced dune and berm construction on the Atlantic shorefront and 2) high frequency flood risk reduction features (HFFRRF) in locations surrounding Jamaica Bay.

The Atlantic shorefront planning reach includes Rockaway Beach between Beach 9th Street and Beach 169th Street and an offshore borrow area in the Atlantic Ocean. The RP includes beach renourishment and construction of a 60 ft. wide beach berm for the length of the reach resulting in approximately 259 acres of dune and beach fill, as well as beach renourishment on a four year cycle for the 50-year life of the project. An approximately 33,000 lf composite seawall, extension of five existing groins and construction of 13 new groins are also proposed. The sand material for beach fill and berm construction will be dredged from an existing, 1830-acre offshore borrow area, two miles south of East Rockaway in waters depths of 35 – 60 ft.

The HFFRRF planning reach consists of flood control subreaches in Cedarhurst-Lawrence, Motts Basin North, Mid-Rockaway – Edgemere, Mid-Rockaway – Arverne, and Mid-Rockaway – Hammels. The RP for all of these subreaches includes construction of 11 acres of rock sills and 5,250 lf of bulkhead, modification of existing and construction of new stormwater outfalls and

culverts, and installation of pump stations. The rock sills are components of natural and nature-based features (NNBFs) proposed for the Mid-Rockaway – Edgemere and Mid-Rockaway – Arverne subreaches, Tidal marsh habitats with upland buffers will be created, restored or enhanced shoreward of the sills and will be designed to allow their shoreward migration with rising sea levels.

Magnuson Stevens Fisheries Management and Conservation Act (MSA)
The project area has been designated as EFH for a number of federally managed species including Atlantic butterfish (*Peprilus triacanthus*), Atlantic mackerel (*Scomber scombrus*), Atlantic sea herring (*Clupea harengus*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus saltatrix*), clearnose skate (*Raja eglanteria*), cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), little skate (*Leucoraja erinacea*), long-finned inshore squid (*Loligo pealei*), monkfish (*Lophius americanus*), red hake (*Urophycis chuss*), scup (*Stenotomus chrysops*), Spanish mackerel (*Scomberomorus maculates*), summer flounder (*Paralichthys dentatus*), whiting (*Merluccius bilinearis*), windowpane flounder (*Scophthalmus aquosus*), winter flounder (*Pseudopleuronectes americanus*), winter skate (*Leucoraja ocellata*) and others.

The project area is also EFH for several highly migratory species including blue shark (*Prionace glauca*), dusky shark (*Carcharhinus obscurus*), sandbar shark (*Carcharhinus plumbeus*), and sand tiger shark (*Odontaspis taurus*). Sand tiger and dusky sharks have also been designated as Species of Concern by NOAA. Species of Concern are those about which we have concerns regarding their status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act (ESA). The goal of designating a species as a Species of Concern is to promote proactive conservation efforts for these species in order to preclude the need to list them in the future.

The MSA requires federal agencies to consult with us on projects such as this that may affect EFH adversely. This process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments, lists the required contents of EFH assessments, and generally outlines each agency's obligations in this consultation procedure.

The EFH final rule published in the Federal Register on January 17, 2002 defines an adverse effect as "any impact which reduces the quality and/or quantity of EFH" and further states that:

> An adverse effect may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystems components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

We have reviewed the EFH assessment for this project. The assessment adequately evaluates many of the impacts of the project on EFH in the Atlantic shorefront and Jamaica Bay project reaches, and we agree with your conclusions on those impacts. However, some information, such as a full evaluation of impacts of dredging on the borrow area, was not provided. We understand that at this stage of the planning process, site specific information and design details are not yet

available; as a result additional coordination and consultation will take place during the Preconstruction, Engineering and Design Phase of the project so our EFH conservation recommendations provided in this letter can be refined.

The Atlantic shorefront project plan includes seawall and groin construction, dredging and beach renourishment that will result in 259 acres of dune and beach fill with subsequent renourishment efforts every four years. The NNBF rock sills constructed as part of the Jamaica Bay HFFRRF project have been designed to control erosion, help manage coastal storm risk, and provide opportunities for habitat restoration and enhancement. Construction of the sills will result in a habitat conversion of 11 acres of unconsolidated bottom to hard structure in two sub-reaches. Tidal marshes will be created, restored, or enhanced shoreward of the sills in eroded and/or degraded subtidal and intertidal habitats, and will be designed to allow their shoreward migration with rising sea levels. Construction of the NNBFs will create a mix of low and high marsh habitat and upland buffers that will have a positive effect on EFH, federally managed species and NOAA trust resources.

In the DEIS it states that as HFFRRF features are further developed, additional NEPA documentation and resource agency coordination would be provided, as necessary. We agree with this process. Also, impacts to EFH for longfin inshore squid in the borrow area were not fully evaluated because you were not aware of new research examining squid spawning in the area offshore of Long Island. We will continue to coordinate with your office to further evaluate impacts to EFH of longfin inshore squid in the borrow area, including providing additional EFH conservation recommendations as necessary.

Aquatic Resources

Longfin Inshore Squid

Longfin inshore squid spawn throughout the New York Bight; early life stages are found in coastal waters and throughout Jamaica Bay. Egg masses are demersal and are typically attached to low-relief structure (e.g. rocks, small boulders) on sandy or muddy substrate in water depths less than 50 feet (Jacobson 2005). Recent research indicates that spawning may be concentrated in coastal waters off of the Rockaway peninsula (D. Stevenson, personal communication, 2018), which could result in increased vulnerability to EFH of longfin inshore squid to dredging operations. Our office is currently investigating the locations of highest egg mass concentration, seasonal occurrence, and egg mass residence time to better define EFH, in order to evaluate dredging impacts to the species in the Atlantic shorefront borrow area.

Shellfish

Surf clam (*Spisula solidissima*), razor clam (*Ensis directus*), and tellin (*Tellina agillis*) occur in the vicinity of the offshore borrow area. Shellfish also occur in the Jamaica Bay portion of the project area, including hard clam (*Mercenaria mercenaria*), soft shell clam (*Mya arenaria*), blue mussel (*Mytilus edulis*), oyster (*Crassostrea virginica*), blue crab (*Callinectes sapidus*), and horseshoe crab (*Limulus polyphemus*).

Coen and Grizzle (2007) discuss the ecological value of shellfish habitat to a variety of managed species (e.g. American lobster, American eel, and winter flounder) and have suggested its designation as EFH for federally managed species. Clams are a prey species for a number of

federally managed fish including skates, bluefish, summer flounder and windowpane; siphons of hard clams provide a food source for winter flounder and scup (Steimle et al. 2000). Infaunal species such as clams filter significant volumes of water, effectively retaining organic nutrients from the water column (Nakamura and Kerciku 2000; Forster and Zettler 2004).

Horseshoe crabs may use multiple habitats along the shoreline of the Jamaica Bay reach, including subtidal bottoms, intertidal mudflats, and sandy beaches (Botton et al. 2006). Their eggs are a key seasonal food resource for a number of fish species including summer flounder and winter flounder (Botton and Shuster 2003); as a prey species, horseshoe crabs are considered EFH for those fishes.

Winter flounder

Winter flounder transit inlets such as East Rockaway Inlet to reach spawning areas within mid-Atlantic estuaries when water temperatures begin to decline in the fall. Tagging studies show that most return repeatedly to the same spawning grounds (Lobell 1939, Saila 1961, Grove 1982 in Collette and Klein-MacPhee 2002). Winter flounder typically spawn in the winter and early spring, although the exact timing is temperature dependent and thus varies with latitude (Able and Fahay 1998), however movement into these spawning areas may occur earlier, generally from mid- to late November through December. Winter flounder have demersal eggs that sink and remain on the bottom until they hatch. After hatching, the larvae are initially planktonic, but following metamorphosis they assume an epibenthic existence. Winter flounder larvae are negatively buoyant (Pereira et al. 1999) and are typically more abundant near the bottom (Able and Fahay 1998). These life stages are less mobile and thus more likely to be affected adversely by any impact to benthic habitat. As adults often spawn in shallow water within estuaries such as Jamaica Bay, they are especially vulnerable to benthic impacts associated with construction of the NNBFs in the Jamaica Bay HFFRRF reach.

Anadromous Fishes

Anadromous fishes such as river herring (alewife *Alosa pseudoharengus* and blueback herring *Alosa aestivalis*) use inlets such as East Rockaway Inlet as a migratory pathway to nursery and forage habitat within the estuary beyond the inlet. Alewife and blueback herring spend most of their adult life at sea, but return to freshwater areas to spawn in the spring. Both species are believed to be repeat spawners, generally returning to their natal rivers (Collette and Klein-MacPhee 2002). Because landing statistics and the number of fish observed on annual spawning runs indicate a drastic decline in alewife and blueback herring populations throughout the mid-Atlantic since the mid-1960's (ASMFC 2007), they have been designated as Species of Concern by NOAA.

Increases in turbidity due to the resuspension of sediments into the water column during renourishment can degrade water quality, lower dissolved oxygen levels, and potentially release chemical contaminants bound to the fine-grained estuarine/marine sediments, and can impede river herring migration (Auld and Schubel 1978; Breitburg 1988; Newcombe and MacDonald 1991; Burton 1993; Nelson and Wheeler 1997). Noise from beach renourishment activities may also result in adverse effects. Our concerns about noise effects come from an increased awareness that high-intensity sounds have the potential to harm both terrestrial and aquatic vertebrates (Fletcher and Busnel 1978; Kryter 1984; Popper 2003; Popper et al. 2004).

Buckel and Conover (1997) in Fahay et al. (1999) reported that diet items of juvenile bluefish include *Alosa* species such alewife and blueback herring. Juvenile *Alosa* species have also been identified as prey species for windowpane flounder and summer flounder in Steimle et al. (2000). As a result, activities that adversely affect the spawning success and the quality for the nursery habitat of these anadromous fish can adversely affect the EFH for juvenile bluefish, windowpane and summer flounder by reducing the availability of prey items.

Wetlands

Jamaica Bay is regionally significant for shellfish and marine, estuarine, and anadromous fishes, as well as for its significant migratory and wintering waterfowl concentrations. The wetlands and uplands in the bay are important as fish nursery areas and foraging areas for shorebirds and waterbirds. Wetlands in the project area perform many important ecological functions including water storage, nutrient cycling and primary production, sediment retention, water filtration or purification, and groundwater recharge. The estuary is subject to severe anthropogenic impacts, and has incurred a loss of 63% of wetlands between 1951 and 2003. During this time period, the rate of marsh loss increased from 17 acres lost per year during 1951 – 1974 to 33 acres lost per year during 1989 – 2003 (NPS 2007). Vegetated wetlands are also considered to be special aquatic sites under the Clean Water Act. Because of their ecological value, impacts on these special aquatic sites should be avoided and minimized; wetlands should be created, restored, or enhanced where feasible.

Tidal wetlands provide nursery habitat for many species of fish, including winter flounder and summer flounder. Summer flounder larvae migrate inshore into estuarine nursery areas, settling to the bottom of tidal marsh creeks to transform to their juvenile stage. These juveniles will then make extensive use of the creeks, preying on creek fauna such as Atlantic silversides and mummichogs. Juvenile summer flounder may also be found in salt marsh cord grass habitat during flood tides. Juveniles utilize the marsh edges for shelter, burying themselves in the muddy substrates. Keefe and Able (1992) in Packer et al. (1999) found that summer flounder juveniles that inhabit tidal marsh creeks exhibit the fastest growth. Larval and juvenile black sea bass also concentrate and feed extensively and shelter within these habitats. As a consequence, growth rates are high and predation rates are low, which makes these habitats effective nursery areas. Juvenile black sea bass are also known to inhabit the mouths of tidal marsh creeks as well as shallow shoals and tidal marsh edge habitat. Within these habitats, young-of-year black sea bass display high site fidelity; they may be territorial and move very little (Musick and Mercer 1977; Werme 1981; Able and Hales 1997). Black sea bass have been observed defending small areas of nursery habitat rather than fleeing to other suitable areas (Able and Fahay 1998).

An unimpeded marsh edge is important to estuarine and tidal marsh community dynamics, both to allow tidal flushing and concomitant transport of plankton, nekton, nutrients and sediment as well as to enable access to edge habitat by estuarine biota, including federally managed species, diadromous fishes, and other important prey for federally managed species. Marshes and marsh edge habitat can therefore be considered EFH for summer flounder, black sea bass, and other species.

Atlantic Shorefront

Beach Nourishment and Dredging

The dredging of sand for beach nourishment has the potential to impact both the EFH of a particular species as well as the organisms themselves in a variety of ways. Dredging can result in the impingement of eggs and larvae in the dredge plant and create undesirable suspended sediment levels in the water column. As stated above, increased suspended sediment levels can reduce dissolved oxygen, mask pheromones used by migratory fishes, and smother immobile benthic organisms and newly-settled juvenile demersal fish (Auld and Schubel 1978; Breitburg 1988; Newcombe and MacDonald 1991; Burton 1993; Nelson and Wheeler 1997). Sustained water column turbulence can reduce the feeding success of sight-feeding fish such as winter flounder and summer flounder.

Dredging can remove the substrate used by federally managed species as spawning, refuge and forage habitat. Benthic organisms that are food sources for federally managed species may also be removed during dredging. These impacts may be temporary if the substrate returns to preconstruction condition and the benthic community recovers with the same or similar organisms. The impacts may be permanent if the substrate is altered in a way that reduces its suitability as habitat, and if the benthic community is altered in a way that reduces its suitability as forage.

Overall, the dredging and placement of sand along the coastline will have some adverse effects on EFH and federally managed species due to the entrainment of early life stages in the dredge, alteration or loss of benthic habitat and forage species, and altered forage patterns and success due to increased, noise, turbidity and sedimentation. We agree that some effects will be temporary and others can be minimized using some of the management practices mentioned in the EFH assessment, such as dredging in the fall to avoid sensitive life stages of certain species, not dredging deep holes and leaving similar substrate in place to allow for recruitment.

Dredging in the borrow area can also affect EFH adversely through impacts to prey species. The EFH final rule states that the loss of prey may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat; the definition of EFH includes waters and substrate necessary to fish for feeding. Steimle et al. (2000) reported that winter flounder diets include the siphons of surf clams (*Spisula solidissima*). As a result, activities that adversely affect surf clams can adversely affect the EFH for winter flounder by reducing the availability of prey items

According to the DEIS, the offshore borrow area provides habitat for Atlantic surf clams; however surveys conducted by the USACE in 2003 and by the NYSDEC in 2012 indicate that the borrow area itself contains very low to no localized populations of surf clams. To ensure that impacts to surf clams are minimized, the borrow areas should be surveyed prior to each dredging cycle and areas of high densities should be avoided. Copies of the shellfish survey results should also be provided to us prior to any dredging in the borrow area.

The Mid-Atlantic Fisheries Management Council (MAFMC) has developed a policy statement on sand mining and beach nourishment activities that may affect federally managed species under their purview including summer flounder, scup, black sea bass, monkfish and butterfish.

These policies are intended to articulate the MAFMC's position on various development activities and facilitate the protection and restoration of fisheries habitat and ecosystem function. The MAFMC's policies on beach nourishment are:

1. Avoid sand mining in areas containing sensitive fish habitats (e.g., spawning and feeding sites, hard bottom, cobble/gravel substrate, shellfish beds).

2. Avoid mining sand from sandy ridges, lumps, shoals, and rises that are named on maps. The naming of these is often the result of the area being an important fishing ground.

3. Existing sand borrow sites should be used to the extent possible. Mining sand from new areas introduces additional impacts.

4. Conduct beach nourishment during the winter and early spring, when productivity for benthic infauna is at a minimum.

5. Seasonal restrictions and spatial buffers on sand mining should be used to limit negative impacts during fish spawning, egg development, young-of-year development, and migration periods, and to avoid secondary impacts to sensitive habitat areas such as SAV.

6. Preserve, enhance, or create beach dune and native dune vegetation in order to provide natural beach habitat and reduce the need for nourishment.

7. Each beach nourishment activity should be treated as a new activity (i.e., subject to review and comment), including those identified under a programmatic environmental assessment or environmental impact statement.

8. Bathymetric and biological monitoring should be conducted before and after beach nourishment to assess recovery in beach borrow and nourishment areas.

9. The effect of noise from mining operations on the feeding, reproduction, and migratory behavior of marine mammals and finfish should be assessed.

10. The cost effectiveness and efficacy of investments in traditional beach nourishment projects should be evaluated and consider alternative investments such as non-structural response and relocation of vulnerable infrastructure given projections of sea level rise and extreme weather events.

Sand Placement Effects on Fishes

Beach renourishment activities produce turbidity and sound impacts; fish may move away from those impacts in open water but cannot avoid them in inlets and channels. Fish that transit through inlets and channels on spawning migrations are therefore vulnerable to these impacts. As discussed earlier, winter flounder and river herring ingress through inlets to access estuarine spawning habitats. Winter flounder migrate into mid-Atlantic estuaries from mid-November through December. River herring enter these same estuaries on their spawning migrations from early March through May. Because project plans include beach renourishment along Rockaway

Beach at East Rockaway Inlet, sequencing of beach nourishment activities may be necessary in order to avoid impacts to ingressing winter flounder and river herring. This may include seasonal in-water work restrictions for winter flounder from November 15 through December 31 and from March 1 to May 31 for river herring. Any in-water work undertaken at the inlet at other times of the year should be designed with 50% of the inlet unobstructed to allow ingress and egress of fish past the work site.

Jamaica Bay HFFRRF

Impacts of NNBF Construction on EFH

The Jamaica Bay HFFRRF project plan proposing construction of NNBFs in the Edgemere and Arverne subreaches will result in permanent impacts to shallow water and tidal wetland habitat, including EFH for winter flounder. Rock sills are proposed for two subreaches of the Jamaica Bay HFFRRF, including four sections in Edgemere totaling approximately 3100 lf and three sections in Arverne totaling approximately 4800 lf, with a combined footprint of 11 acres. Tidal marshes will be created, restored, or enhanced shoreward of the proposed rock sills and will be designed to allow their shoreward migration with rising sea levels. We appreciate the Corps' use of NNBFs in this project and encourage their use in future projects when practicable.

The construction of the NNBFs, including rock sills and tidal wetlands, will result in a permanent loss of winter flounder EFH associated within the footprints of the sills and in areas shoreward of the sills due to natural sediment accretion and tidal wetlands creation. Seasonal in-water work restrictions from January 1 to May 31 will minimize impacts to winter flounder early life stages and their EFH during the construction activities and the NNBF features will provide habitat for other aquatic resources.

Impacts to Prey Species

Construction of the NNBFs may impede access by horseshoe crabs to spawning beaches. Horseshoe crab eggs are an important seasonal food source for summer flounder and winter flounder. Seasonal in-water work restrictions in areas suitable for horseshoe crab spawning from April 15 to July 15 minimize adverse effects to this prey species. Shellfish are also prey species for a number of federally managed fish including bluefish, scup, skates, summer flounder, windowpane and winter flounder. Site design and placement of the NNBFs should include an evaluation of shellfish resources in the project area; NNBFs should not be placed in areas of moderate to high densities of shellfish.

Tidal flushing and access to tidal marsh fringe habitat are important to maintain estuarine and marsh community dynamics; impediments to marsh edge habitat may therefore impact EFH for federally managed species, including winter flounder and summer flounder. Seven rock sills, approximately 350 lf to 2000 lf, are proposed in the Edgemere and Arverne subreaches. The individual sills as proposed appear to be of solid construction, with gaps between each sill but no gaps (vents/windows) within the sills. Vents/windows provide a number of benefits, including facilitating transport of plankton, nekton, sediment and nutrients into aquatic food webs that include federally managed species, diadromous fishes, and other important prey for federally managed species. These openings should generally be 10-15 feet in width, as measured from the bottom, and spaced evenly across the sill (e.g., one every 100 feet). Rock sills without

vents/windows placed at regular intervals can severely restrict biological functions and impact the marsh community. Additionally, though rare, displacement of sills either as a whole or as individual elements is a concern in highly dynamic environments.

All living shorelines must be properly maintained, which may require periodic repair of sills/reefs. A long-term maintenance plan should be developed for the proposed NNBFs, including plans to address the potential migration of hardened materials/structures. As we continue to coordinate on this project and plans are developed, information on incorporation of vents/windows and dropdowns into the sill design, overall wetland design, invasive species management, and monitoring, maintenance, and long-term stewardship of the NNBFs should be provided to us.

Essential Fish Habitat Conservation Recommendations

Pursuant to Section 305 (b) (4) (A) of the MSA, we offer the following EFH conservation recommendations to minimize adverse effects to EFH for summer flounder, bluefish, windowpane, little skate and other federally managed species:

Atlantic Shorefront

1. Coordinate with our office to determine impacts of dredging in the borrow area to longfin inshore squid EFH. If warranted, we will provide you with additional EFH conservation recommendations to address impacts to longfin inshore squid as information becomes available. We will work with you to incorporate conservation recommendations into the initial construction or subsequent maintenance dredging events.

2. Reinitiate consultation prior to each dredging event. Notification should be provided to our office prior to commencement of each dredging event and should include the location of the segment to be nourished, volume of sand to be dredged, depth of sand to be removed and the boundaries of the dredging within the borrow area.

3. Design and undertake dredging within the borrow areas in a manner that maintains geomorphic characteristics of the borrow area. Employ best management practices such as not dredging too deeply and leaving similar substrate in place to allow for benthic community recovery.

4. Incorporate MAFMC policies on sand mining and beach nourishment into the final design of this project and its long-term management plan as practicable.

5. Avoid areas of high surf clam densities within the borrow area. To ensure that impacts to surf clams are minimized, the borrow areas should be surveyed prior to each dredging cycle and areas of high densities should be avoided. Copies of the shellfish survey results should also be provided to us prior to any dredging in the borrow area.

6. Avoid turning on the intakes on the dredge plant until the dredge head is in the sediment and turn off before lifting out of the sediment to minimize larval entrainment in the dredge.

7. Provide annual reports to us on the acres of borrow area disturbed, dredging location, cubic yardage removed, depth of removal and post-dredging bathymetry of the borrow area.

8. Avoid beach renourishment activities in East Rockaway Inlet from November 15 to December 31 (winter flounder) and March 1 to May 31 (river herring) of each year to maintain access to estuarine and freshwater spawning habitats. At other times of the year, at least 50 % of the channel should remain unobstructed to allow ingress and egress of these species.

9. Use best management practices to minimize the release of suspended sediments during beach nourishment activities, including placing the material above the spring high tide line at low tide where possible and using turbidity barriers where feasible.

Jamaica Bay HFFRRF

10. Avoid construction of NNBFs below mean low water (MLW) from January 1 to May 31 of each year to minimize impacts to EFH for winter flounder. Work is permissible above MLW when the work area is exposed during low tide cycles.

11. Avoid construction of NNBFs from April 15 to July 15 of each year to protect horseshoe crab spawning habitat.

12. NNBFs should not be placed in areas of moderate to high shellfish density as practicable.

13. Incorporate vents/windows and dropdowns into rock sill design according to best management practices. Sills should be designed to optimize tidal flow and to ensure that horseshoe crabs do not get trapped behind them.

14. Provide design plans for tidal wetland creation/restoration and enhancement as well as monitoring, maintenance, adaptive management and long-term stewardship plans to us for review prior to construction.

15. Continue to coordinate with us during the Preconstruction, Engineering and Design Phase of the project.

Please note that Section 305 (b)(4)(B) of the MSA requires you to provide us with a detailed written response to these EFH conservation recommendations, including the measures adopted by you for avoiding, mitigating, or offsetting the impact of the project on EFH. In the case of a response that is inconsistent with our recommendations, Section 305 (b)(4)(B) of the MSA also indicates that you must explain your reasons for not following the recommendations. Included in such reasoning would be the scientific justification for any disagreements with us over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate or offset such effect pursuant to 50 CFR 600.920 (k). Please also note that a distinct and further EFH consultation must be reinitiated pursuant to 50 CRF 600.920 (j) if new information becomes available, or if the project is revised in such a manner that affects the basis for the above EFH conservation recommendations.

Endangered Species Act

Atlantic Large Whales

Federally endangered North Atlantic right and fin whales occur year round off the New York coast in the Atlantic Ocean. Right whales are most likely to occur in the offshore borrow areas between November and April and fin whales are most likely to occur between October and January. Right whales feed on copepods and could be foraging in the action area if suitable forage is present; right whales are also likely to occur in the action area while migrating along the Atlantic coast. Fin whale sightings off the eastern United States are centered along the 100m isobath, but fin whales are well spread out over shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1987; Hain et al. 1992). Fin whales feed on small schooling fish, squid, and crustaceans, including krill. Sperm and sei whales are limited to the offshore area beyond the continental shelf.

Sea Turtles

Four species of ESA listed threatened or endangered sea turtles under our jurisdiction are seasonally present off the New York coast in the Atlantic Ocean and could occur in the Rockaway Inlets and Jamaica Bay: the threatened Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead, the threatened North Atlantic DPS of green, and the endangered Kemp's ridley and leatherback sea turtles. Sea turtles typically occur along the Long Island coast from May to mid-November, with the highest concentration of sea turtles present from June through October.

Atlantic Sturgeon

Atlantic sturgeon are present off the New York coast in the Atlantic Ocean and could occur in the Rockaway Inlets and Jamaica Bay. The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPS of Atlantic sturgeon are endangered; the Gulf of Maine DPS is threatened. Adult and subadult Atlantic sturgeon originating from any of these DPSs could occur in the proposed project area. As young remain in their natal river/estuary until approximately age 2, and early life stages are not tolerant of saline waters, no eggs, larvae, or juvenile Atlantic sturgeon will occur within the waters off the New York coast in the Atlantic Ocean or in the Rockaway Inlets and Jamaica Bay.

Shortnose Sturgeon

Shortnose sturgeon are not expected to be present in waters south of Long Island.

As project details develop, we recommend you consider the following effects of the project on whales, sea turtles, and sturgeon:

- For any impacts to habitat or conditions that temporarily render affected water bodies unsuitable for the above-mentioned species, consider the use of timing restrictions for in water work.
- For activities that increase levels of suspended sediment, consider the use of silt management and/or soil erosion best practices (i.e., silt curtains and/or cofferdams).
- Consider the related effects to water quality after an outfall is built (i.e. , will the standards still be met, will the effluent volume change, and will there be any effects to the species).

- For pile driving or other activities that may affect underwater noise levels, consider the use of cushion blocks and other noise attenuating tools to avoid reaching noise levels that will cause injury or behavioral disturbance to sea turtles, and sturgeon - see the table below for more information regarding noise criteria for injury/behavioral disturbance in sturgeon or sea turtles.

Organism	**Injury**	**Behavioral Modification**
Sturgeon	206 dB re 1 µPaPeak and 187 dB cSEL	150 dB re 1 µPaRMS
Sea Turtles	180 dB re 1 µPaRMS	166 dB re 1 µPaRMS

Depending on the amount and duration of work that takes place in the water, listed species of whales, sea turtles, and sturgeon may occur within the vicinity of your proposed project. The Corps will be responsible for determining whether the proposed action may affect listed species. If you determine that the proposed action may affect a listed species, you should submit your determination of effects, along with justification and a request for concurrence to the attention of the Section 7 Coordinator, NMFS, Greater Atlantic Regional Fisheries Office, Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930 or nmfs.gar.esa.section7@noaa.gov. Please be aware that we have recently provided on our website guidance and tools to assist action agencies with their description of the action and analysis of effects to support their determination. See - http://www.greateratlantic.fisheries.noaa.gov/section7. After receiving a complete, accurate comprehensive request for consultation, in accordance to the guidance and instructions on our website, we would then be able to conduct a consultation under section 7 of the ESA. Should project plans change or new information become available that changes the basis for this determination, further coordination should be pursued. If you have any questions regarding these comments, please contact Edith Carson-Supino (978-282-8490; Edith.Carson-Supino@noaa.gov).

We look forward to our continued coordination with your office on this project as it moves forward. We can work with your staff to complete a programmatic consultation for the beach replenishment portion of the project to reduce the need for individual consultations. If you have any questions or need additional information, please do not hesitate to contact Ursula Howson at ursula.howson@noaa.gov or (732) 872-3116.

Sincerely,

Louis A. Chiarella,
Assistant Regional Administrator
for Habitat Conservation

cc:
ACOE – C. Alcoba, D. Mezey
PRD – D. Marrone, E. Carson-Supino
FWS – S. Sinkevich
EPA – D. Montella
NYSDEC – D. McReynolds
NEFMC – T. Nies
MAFMC – C. Moore
ASMFC – L. Havel

Literature Cited

Able, K.W. and M.P. Fahay. 1998. The First Year in the Life of Estuarine Fishes of the Middle Atlantic Bight. Rutgers University Press. New Brunswick, NJ

Able, K.W. and L.S. Hales Jr. 1997. Movements of juvenile black sea bass *Centropristis striata* (Linnaeus) in a southern New Jersey estuary. J. Exp. Mar. Biol. Ecol. 213:153-167.

Atlantic States Marine Fisheries Commission. 2007. Species Profile: shad and river herring: Atlantic states seek to improve knowledge of stock status and protect populations coast wide. www.asmfc.org. Washington, DC.

Auld, A.H. and J.R. Schubel. 1978. Effects of suspended sediments on fish eggs and larvae: a laboratory assessment. Estuar. Coast. Mar. Sci. 6:153-164.

Botton, M.L. And C. N. Shuster. 2003. Horseshoe crabs in a food web: Who eats whom? In C. N. Shuster, R. B. Barlow, and H. J. Brockmann (eds.), The American Horseshoe Crab. Harvard University Press, Cambridge, Massachusetts, pp. 133-153.

Botton, M.L., R.E. Loveland, J.T. Tanacredi, T. Itow. 2006. Horseshoe crabs (*Limulus polyphemus*) in an urban estuary (Jamaica Bay, New York) and the potential for ecological restoration. Estuaries Coasts, 29:820–830.

Breitburg, D.L. 1988. Effects of turbidity on prey consumption by striped bass larvae. Trans. Amer. Fish. Soc. 117: 72-77.

Buckel, J.A. and D.O. Conover. 1997. Movements, feeding periods, and daily ration of piscivorous young-of-the-year bluefish, *Pomatomus saltatrix*, in the Hudson River estuary. Fish. Bull. (U.S.) 95(4):665-679.

Burton, W.H. 1993. Effects of bucket dredging on water quality in the Delaware River and the potential for effects on fisheries resources. Prepared for: Delaware Basin Fish and Wildlife Management Cooperative, by Versar Inc, Columbia MD.

Coen LD, Grizzle RE. 2007. The importance of habitat created by molluscan shellfish to managed species along the Atlantic coast of the United States. Atlantic States Marine Fisheries Commission. Habitat Management Series #8.

Collette, B.B. and G. Klein-MacPhee. eds. 2002. Bigelow and Schroeder's fishes of the Gulf of Maine. Smithsonian Institution. Washington, D.C.

Fahay, M.P., P.L. Berrien, D.L. Johnson and W.W. Morse. 1999. Essential Fish Habitat Source Document: Bluefish *Pomatomus saltatrix* life history and habitat characteristics. U.S. Dep. Commer., NOAA Technical Memorandum NMFS-NE-144.

Fletcher, J. L. and R. G. Busnel. 1978. Effects of Noise on Wildlife. Academic Press, New York.

Forster S, Zettler ML. 2004. The capacity of the filter-feeding bivalve *Mya arenaria* L. to affect water transport in sandy beds. Marine Biology 144:1183–1189.

Grove, C.A. 1982. Population biology of the winter flounder, *Pseudopleuronectes americanus*, in a New England estuary. M.S. thesis, University of Rhode Island, Kingston, 95 pp.

Hain, J. H. W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The Fin Whale, *Balaenoptera physalus*, in Waters of the Northeastern United States Continental Shelf. Reports of the International Whaling Commission 42:653-669.

Jacobson, L. 2005. Essential fish habitat source document: Longfin inshore squid, Loligo pealeii, life history and habitat characteristics. NOAA Tech Memorandum NMFS- NE- 193. Woods Hole, MA. 52 p.

Keefe, M. and K.W. Able. 1992. Habitat quality in New Jersey estuaries: habitat-specific growth rates in juvenile summer flounder in vegetated habitats. Final Rep. for the New Jersey Dep. of Environmental Protection. Trenton, NJ. 26 p.

Kenney, R.D. and Winn, H.E. 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/slope areas. *Continental Shelf Research*, 7(2):107-114.

Kryter, K D. 1985. The Handbook of Hearing and the Effects of Noise (2nd ed.). Academic Press, Orlando, Florida.

Lobell, M.J. 1939. A biological survey of the salt waters of Long Island. Report on certain fishes: Winter flounder *(Pseudopleuronectes americanus)*. New York Conserv. Dept. 28th Ann. Rept. Suppl., Part I: 63-96.

Musick, J.A. and L.P. Mercer. 1977. Seasonal distribution of black sea bass, *Centropristis striata*, in the Middle Atlantic Bight with comments on the ecology and fisheries of the species. Trans. Am. Fish. Soc. 106:12-25.

Nakamura Y, Kerciku F. 2000. Effects of filter-feeding bivalves on the distribution of water quality and nutrient cycling in a eutrophic coastal lagoon. Journal of Marine Systems 26(2):209-221.

National Park Service (NPS). 2007. An update on the disappearing salt marshes of Jamaica Bay, New York. Gateway National Recreation Area, National Park Service, Dept. of the Interior. 78 p.

Nelson, D.A. and J.L. Wheeler. 1997. The influence of dredging-induced turbidity and associated contaminants upon hatching success and larval survival of winter flounder, *Pleuronectes americanus*, a laboratory study. Final report, Grant CWF #321-R, to Connecticut Department Environmental Protection, by National Marine Fisheries Service, Milford CT.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. N. Amer. J. Fish. Manag. 11:72-82.

Packer D.B., S. J. Griesbach, P.L. Berrien, C. A. Zetlin, C., D.L. Johnson D.L. and W.W. Morse. 1999. Essential fish habitat source document: summer flounder, *Paralichthys dentatus*, life history and habitat characteristics. NOAA Tech Memorandum NMFS- NE- 151. Woods Hole, MA. 88 p.

Pereira, J. J., R. Goldberg, J. J. Ziskowski, P.L. Berrien, W.W. Morse and D.L. Johnson. 1999. Essential Fish Habitat Source Document: Winter Flounder, *Pseudopleuronectes americanus*, life history and habitat characteristics. U.S. Dep. Commer., NOAA Technical Memorandum NMFS-NE-138.

Popper, A.N. 2003. Effects of anthropogenic sound on fishes. Fisheries 28:24-31.

Popper, A N., J. Fewtrell, M E. Smith, and R.D. McCauley. 2004. Anthropogenic sound: Effects on the behavior and physiology of fishes. MTS J. 37: 35-40.

Saila, S.B. 1961. The contribution of estuaries to the offshore winter flounder fishery in Rhode Island. Proc. Gulf. Carib. Fish. Inst. 14:95-109.

Steimle, F.W., R.A. Pikanowski, D.G. McMillan, C.A. Zetlin, S.J. Wilk. 2000. Demersal fish and American lobster diets in the Lower Hudson-Raritan Estuary. NOAA Technical Memorandum NMFS-NE-161. Woods Hole, MA. 106 p.

Stevenson, D. NOAA/ NMFS/ Greater Atlantic Regional Fisheries Office. Personal Communication, October 2, 2018.

Werme, C.E. 1981. Resource partitioning in a salt marsh fish community. PhD. Dissertation, Boston Univ., Boston, MA. 132 p.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Environmental Analysis Branch

November 16, 2018

Mr. Lou Chiarella,
Assistant Regional Administrator for Habitat Conservation
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
55 Great Republic Drive
Gloucester, Mass. 01930-2276

Attention: Karen Green, Field Supervisor, Sandy Hook Field Office, NJ
Ursula Howson, Biologist, Sandy Hook Field Office, NJ

Dear Mr. Chiarella:

The U.S. Army Corps of Engineers (USACE), New York District (District) is in receipt of National Marine Fisheries Service (NMFS) EFH Conservation Recommendations, dated October 31 2018 submitting recommendations on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Study.

Please find attached find our responses to your Conservation Recommendations. The District looks forward to working with your office throughout the Pre-Engineering and Design and Construction phases of this study and thank you for your continued assistance and input to this process which helps to advance the execution of this regionally-significant project.

If you require any additional information, please feel free to contact Ms. Daria Mazey Project Biologist/Planner at 917-790-8726.

Sincerely,

Peter Weppler
Chief, Environmental Analysis Branch

Enclosure
cc: NMFS, Green

Please be assured that a full evaluation of impacts within the borrow area was completed as part of this study. USACE has been working for many years to consolidate information to support consultation for this project. Two factors associated with the latest revisions to the HSGRR/EIS and attached EFH Assessment appear to have led to concerns regarding scope of the evaluation of the borrow area:

- In effort to consolidate the HSGRR/EIS, the previously provided *Borrow Area Study for the Atlantic Coast of Long Island, East Rockaway New York, Storm Damage Reduction Project* (Tetra Tech 2015) which was Appendix B2 in the 2016 Draft Report that NMFS previously reviewed was not provided as a separate appendix for the Revised Draft, but rather incorporated throughout the EIS and EFH Assessment. USACE has attached this information to NMFS as part of our response, and will include it on the public website for the project as supplementary information.
- To address a comment about addressing all portions of the study area equally, sections previously focused primarily on the borrow area, were subsumed within the discussion pertaining to Atlantic Shorefront Planning Reach. A discussion of the potential direct and indirect impacts within the borrow area are discussed as they pertain to four distinct impact categories (i.e., Sections 4.1 -4.4, and Sections 5.1-5.3). As such, a consolidated section pertaining specific to effects within the borrow area was not included, but this information is still captured in the analysis and the EIS.

As previously discussed, additional coordination is warranted during the Preconstruction, Engineering and Design Phase of the project. Based upon this additional coordination and potential data analysis specific to refined design details, USACE expects to continue to work with NMFS and include the appropriate references to existing and previous data collection as well as refine conservation recommendations as necessary.

From:	Ursula Howson - NOAA Federal
To:	Mazey, Daria S CIV USARMY CENAN (USA)
Cc:	Gallo, Jenine CIV CENAN CENAD (US); Alcoba, Catherine J CIV USARMY CENAN (US); Karen Greene - NOAA Federal
Subject:	[Non-DoD Source] EFH concurrence - East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Draft Integrated Hurricane Study.
Date:	Tuesday, December 4, 2018 1:19:41 PM

Hello Daria,

Thank you for providing the requested information on the Rockaway borrow area as per our letter dated October 31, 2018. Regarding your letter dated November 16, 2018 responding to our EFH conservation recommendations (CRs), we concur with your comments and understand that additional coordination on those CRs will occur with us during the preconstruction, engineering and design phase of the project. We look forward to our continuing coordination with your office.

Thank you,
Ursula

--

Ursula Howson, PhD
NOAA/National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office
Habitat Conservation Division
James J. Howard Marine Sciences Laboratory
74 Magruder Rd.
Highlands, NJ 07732
732 872-3116 <tel:732%20872-3116> (office)
ursula.howson@noaa.gov <mailto:ursula.howson@noaa.gov>

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Environmental Analysis Branch

October 15, 2018

Mr. Matthew Maraglio
Consistency Review Unit
Office of Communities & Waterfronts
New York Department of State
Suite 1010
One Commerce Place,
99 Washington Avenue
Albany, New York 12231-0001

Dear Mr. Maraglio:

The purpose of this letter is to request your office's concurrence with the Coastal Zone Management (CZM) Consistency Determination for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Hurricane Sandy Reformulation Study. The study area consists of the Atlantic Coast of New York City (NYC) between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York. The Atlantic Ocean shoreline, which is a peninsula approximately 10 miles in length, generally referred to as the Rockaways, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, NYC, and a section at the eastern end, known as Head-of-Bay, lies in Nassau County.

More than 850,000 residents, over 46,000 residential and non-residential structures (which includes scores of critical infrastructure features such as schools, hospitals, and nursing homes), and additional wastewater treatment, subway, and railroad infrastructure are located within the study area. The study area was one of the areas most devastated by Hurricane Sandy – there were 10 fatalities, and more than 1,000 structures were either substantially damaged to restrict re-entry or were destroyed by Hurricane Sandy. The NYC Department of Buildings post-Hurricane Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge damage. Of all buildings city-wide identified as unsafe or structurally damaged, 37 percent were located in the southern Queens portion of the study area. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes along the Rockaway Peninsula portion of the study area.

Hurricane Sandy hit the study area at nearly high tide. Waves eroded beaches, breached boardwalks and seawalls, and broke against buildings in the oceanfront communities. Storm surge inundation reached as much as 10 feet above ground in some portions of the study area. In addition, more than 1.5 million cubic yards of sand

was removed from Rockaway Beach and deposited on oceanfront communities or washed out to sea. Floodwaters funneled through Rockaway Inlet amassing a storm surge that inundated all of the neighborhoods surrounding Jamaica Bay. The low-lying neighborhoods in the central and northern portions of Jamaica Bay, where the narrow creeks and basins provide the marine aesthetic of the neighborhood, were especially devastated by flood waters. Damage to the elevated portion of the subway system in Jamaica Bay and Rockaway (the A-line) disrupted service for over six months, affecting about 35,000 riders daily. In the southern Queens portion of the study area 37 schools were closed for up to two months. Habitats important to waterfowl and coastal water birds, including shorebirds, wading birds, and seabirds, were also impacted by Hurricane Sandy. High winds and storm-driven water moved masses of coastal sediments, changed barrier landscapes, and breached dikes on impoundments managed specifically for migratory birds.

Plan formulation involved the analysis of potential structural and non-structural alternatives. The recommended plan is comprised of a shorefront component and three separate *high frequency flooding risk reduction features* (HFFRRF) projects around Jamaica Bay: 1) Mid-Rockaway, 2) Cedarhurst-Lawrence, and 3) Motts Basin North. The Mid-Rockaway HFFRRF is the largest and stretches across three neighborhoods/subreaches - Hammels, Edgemere, and Arverne. The shorefront component includes a reinforced vegetated dune with a composite seawall core and associated beach restoration with increased renourishment at the Atlantic Ocean shorefront. The structure crest elevation is +17 feet NAVD88, the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet at an elevation of +8 feet NAVD88. In order to reduce beach erosion and renourishment requirements, the project also includes an extension of 5 existing groins and new construction of 13 new groins. For the Jamaica Bay component, features to reduce the risk of frequent flooding are recommended and include natural and nature-based features (wetlands with rock sills), floodwalls, revetments, and bulkheads. Feature types are based on what is feasible and appropriate at given locations when considering existing conditions and uses.

The U.S. Army Corps of Engineers, New York District (District) has determined that the Rockaway Reformulation complies with both New York State and New York City Waterfront Revitalization Program (WRP) Coastal Zone Management (CZM) policies and project implementation will be conducted in a manner consistent with these polices. This letter provides the New York State Coastal Management Program Consistency Review Unit with information to support the District's consistency determination under the Coastal Zone Management Act, Section 307(c) (1) and (2), and 15 CFR 930.35(d). A Determination of Federal Consistency with both sets of coastal management policies is enclosed. The Policy 6.2 worksheet is also enclosed, along with a signed New York City Waterfront Revitalization Program Consistency Assessment Form

The District requests that your office review the proposed project for consistency to the maximum extent practicable with State's CZM Policies. For further information (including the Revised General Reevaluation Report and Environmental Impact Statement and associated Plan Sheets for the Recommended Plan), please refer to:

http://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/East-Rockaway-Inlet-to-Rockaway-inlet-Rockaway-Beach/.

Should you require any additional information, please contact the Project Biologist, Ms. Daria Mazey of my staff at (917) 790-8726 or by email at daria.s.mazey@usace.army.mil.

Sincerely,

Peter Weppler
Chief, Environmental Analysis Branch

Enclosures

cc: NYC-LWRP

FOR INTERNAL USE ONLY	WRP No. _____
Date Received: _____	DOS No. _____

NEW YORK CITY WATERFRONT REVITALIZATION PROGRAM
Consistency Assessment Form

Proposed actions that are subject to CEQR, ULURP or other local, state or federal discretionary review procedures, and that are within New York City's Coastal Zone, must be reviewed and assessed for their consistency with the *New York City Waterfront Revitalization Program (WRP)* which has been approved as part of the State's Coastal Management Program.

This form is intended to assist an applicant in certifying that the proposed activity is consistent with the WRP. It should be completed when the local, state, or federal application is prepared. The completed form and accompanying information will be used by the New York State Department of State, the New York City Department of City Planning, or other city or state agencies in their review of the applicant's certification of consistency.

A. APPLICANT INFORMATION

Name of Applicant: New York District, US Army Corps of Engineers

Name of Applicant Representative: Peter Weppler (POC Daria Mazey)

Address: 26 Federal Plaza, New York, NY 10278

Telephone: 917-790-8726 Email: daria.s.mazey@usace.army.mil

Project site owner (if different than above): variable/multiple owners

B. PROPOSED ACTIVITY

If more space is needed, include as an attachment.

1. Brief description of activity

The objective of the Recommended Plan is to manage the risk of coastal flooding from the Atlantic shorefront as well as the frequent flooding from smaller events in Jamaica Bay. The Recommended Plan has the following features:
• A composite seawall with a structure crest elevation of +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet;
• A beach berm elevation of +8 ft NAVD and a depth of closure of -25 ft NAVD;
• A total beach fill quantity of 1.6 million cy for the initial placement, including tolerance, overfill and advanced nourishment with a 4-year renourishment cycle of 1,021,00 cy, resulting in a minimum berm width of 60 feet;
• Extension of 5 existing groins; and
• Construction of 13 new groins.
The east beachfill taper is approximately 3,000 ft in shorefront length from Beach 19th Street east to Beach 9th Street. The taper comprises of approximately 1,000 ft of dune and beach taper including reinforced dune feature and approximately 2,000 ft of dune and beach fill without reinforced dune feature. In addition to the tapering of berm width, the dune elevation also tapers from an elevation of +18 ft NAVD at 19th Street down to approximately +12 ft NAVD at Beach 9th Street which will be tied into the existing grade. The west beachfill taper is approximately 5,000 ft in shorefront length from Beach 149th Street west to Beach 169th street fronting Riis Park. The beachfill taper will be beach fill only with a berm width tapered from the design width at 149th Street to the existing width and height at 169th Street. In addition to the beachfill taper, a tapered groin system comprised of three (3) rock groins is included for this section.
The Mid-Rockaway High Frequency Flooding Risk Reduction Feature is also located in New York City and recommends a combination of floodwalls, revetments, berms, bulkheads, and nature-based features (tidal wetlands, maritime forest and rock sills) to reduce the risk of flooding from 10% AEP in 2018 storms or less in the neighborhoods of Edgemere, Arverne, and Hammels. The plan also includes upgrades to the existing interior drainage in the form of retrofitted and/or extended outfalls with backflow prevention and the construction of pump stations to drain the neighborhoods when these features are overtopped. (For more information see Attachment A: Project Description)

2. Purpose of activity

The purpose of the project is to mitigate the risk of flooding related to coastal and tropical storms, hurricanes, future sea level rise and frequent flooding caused by high tides and smaller rainfalls along the Rockaway peninsula, both on the ocean and bay sides, where feasible. The project is needed because these communities experienced catastrophic loss of life and damage to property and infrastructure, including during Hurricane Sandy. The area is prone to erosion and shoreline destabilization, and erosion control measures such as groins on the Atlantic shorefront and nature-based features on the bayside have been proposed to manage this problem.

C. PROJECT LOCATION

Borough: Queens Tax Block/Lot(s): _____

Street Address: _____

Name of water body (if located on the waterfront): Jamaica Bay and Atlantic Ocean

D. REQUIRED ACTIONS OR APPROVALS

Check all that apply.

City Actions/Approvals/Funding

City Planning Commission ☐ Yes ☑ No

- ☐ City Map Amendment
- ☐ Zoning Map Amendment
- ☐ Zoning Text Amendment
- ☐ Site Selection – Public Facility
- ☐ Housing Plan & Project
- ☐ Special Permit
  (if appropriate, specify type: ☐ Modification ☐ Renewal ☐ other) Expiration Date: _____
- ☐ Zoning Certification
- ☐ Zoning Authorizations
- ☐ Acquisition – Real Property
- ☐ Disposition – Real Property
- ☐ Other, explain: _____
- ☐ Concession
- ☐ UDAAP
- ☐ Revocable Consent
- ☐ Franchise

Board of Standards and Appeals ☐ Yes ☑ No

- ☐ Variance (use)
- ☐ Variance (bulk)
- ☐ Special Permit
  (if appropriate, specify type: ☐ Modification ☐ Renewal ☐ other) Expiration Date: _____

Other City Approvals

- ☐ Legislation
- ☐ Rulemaking
- ☐ Construction of Public Facilities
- ☐ 384 (b) (4) Approval
- ☐ Other, explain: _____
- ☐ Funding for Construction, specify: _____
- ☐ Policy or Plan, specify: _____
- ☐ Funding of Program, specify: _____
- ☐ Permits, specify: _____

State Actions/Approvals/Funding

- ☑ State permit or license, specify Agency: NYSDEC Permit type and number: _____
- ☑ Funding for Construction, specify: Disaster Relief Appropriations Bill of 2013 (Hurricane Sandy bill)
- ☐ Funding of a Program, specify: _____
- ☐ Other, explain: _____

Federal Actions/Approvals/Funding

- ☐ Federal permit or license, specify Agency: _____ Permit type and number: _____
- ☐ Funding for Construction, specify: _____
- ☐ Funding of a Program, specify: _____
- ☐ Other, explain: _____

Is this being reviewed in conjunction with a Joint Application for Permits? ☐ Yes ☑ No

E. LOCATION QUESTIONS

1. Does the project require a waterfront site? ☑ Yes ☐ No
2. Would the action result in a physical alteration to a waterfront site, including land along the shoreline, land under water or coastal waters? ☑ Yes ☐ No
3. Is the project located on publicly owned land or receiving public assistance? ☑ Yes ☐ No
4. Is the project located within a FEMA 1% annual chance floodplain? *(6.2)* ☑ Yes ☐ No
5. Is the project located within a FEMA 0.2% annual chance floodplain? *(6.2)* ☑ Yes ☐ No
6. Is the project located adjacent to or within a special area designation? *See Maps – Part III of the NYC WRP. If so, check appropriate boxes below and evaluate policies noted in parentheses as part of WRP Policy Assessment (Section F).* ☑ Yes ☐ No

   ☐ Significant Maritime and Industrial Area (SMIA) (*2.1*)
   ☑ Special Natural Waterfront Area (SNWA) (*4.1*)
   ☑ Priority Maritime Activity Zone (PMAZ) (*3.5*)
   ☐ Recognized Ecological Complex (REC) (*4.4*)
   ☐ West Shore Ecologically Sensitive Maritime and Industrial Area (ESMIA) (*2.2, 4.2*)

F. WRP POLICY ASSESSMENT

Review the project or action for consistency with the WRP policies. For each policy, check Promote, Hinder *or* Not Applicable (N/A). *For more information about consistency review process and determination, see* ***Part I*** *of the NYC Waterfront Revitalization Program. When assessing each policy, review the full policy language, including all sub-policies, contained within* ***Part II*** *of the WRP. The relevance of each applicable policy may vary depending upon the project type and where it is located (i.e. if it is located within one of the special area designations).*

For those policies checked Promote *or* Hinder, *provide a written statement on a separate page that assesses the effects of the proposed activity on the relevant policies or standards. If the project or action promotes a policy, explain how the action would be consistent with the goals of the policy. If it hinders a policy, consideration should be given toward any practical means of altering or modifying the project to eliminate the hindrance. Policies that would be advanced by the project should be balanced against those that would be hindered by the project. If reasonable modifications to eliminate the hindrance are not possible, consideration should be given as to whether the hindrance is of such a degree as to be substantial, and if so, those adverse effects should be mitigated to the extent practicable.*

		Promote	Hinder	N/A
1	**Support and facilitate commercial and residential redevelopment in areas well-suited to such development.**	☐	☐	☑
1.1	Encourage commercial and residential redevelopment in appropriate Coastal Zone areas.	☐	☐	☑
1.2	Encourage non-industrial development with uses and design features that enliven the waterfront and attract the public.	☑	☐	☐
1.3	Encourage redevelopment in the Coastal Zone where public facilities and infrastructure are adequate or will be developed.	☐	☐	☑
1.4	In areas adjacent to SMIAs, ensure new residential development maximizes compatibility with existing adjacent maritime and industrial uses.	☐	☐	☑
1.5	Integrate consideration of climate change and sea level rise into the planning and design of waterfront residential and commercial development, pursuant to WRP Policy 6.2.	☐	☐	☑

		Promote	Hinder	N/A
2	**Support water-dependent and industrial uses in New York City coastal areas that are well-suited to their continued operation.**	☐	☐	☑
2.1	Promote water-dependent and industrial uses in Significant Maritime and Industrial Areas.	☐	☐	☑
2.2	Encourage a compatible relationship between working waterfront uses, upland development and natural resources within the Ecologically Sensitive Maritime and Industrial Area.	☑	☐	☐
2.3	Encourage working waterfront uses at appropriate sites outside the Significant Maritime and Industrial Areas or Ecologically Sensitive Maritime Industrial Area.	☐	☐	☑
2.4	Provide infrastructure improvements necessary to support working waterfront uses.	☐	☐	☑
2.5	Incorporate consideration of climate change and sea level rise into the planning and design of waterfront industrial development and infrastructure, pursuant to WRP Policy 6.2.	☑	☐	☐
3	**Promote use of New York City's waterways for commercial and recreational boating and water-dependent transportation.**	☐	☐	☑
3.1.	Support and encourage in-water recreational activities in suitable locations.	☑	☐	☐
3.2	Support and encourage recreational, educational and commercial boating in New York City's maritime centers.	☐	☐	☑
3.3	Minimize conflicts between recreational boating and commercial ship operations.	☐	☐	☑
3.4	Minimize impact of commercial and recreational boating activities on the aquatic environment and surrounding land and water uses.	☐	☐	☑
3.5	In Priority Marine Activity Zones, support the ongoing maintenance of maritime infrastructure for water-dependent uses.	☐	☐	☑
4	**Protect and restore the quality and function of ecological systems within the New York City coastal area.**	☑	☐	☐
4.1	Protect and restore the ecological quality and component habitats and resources within the Special Natural Waterfront Areas.	☑	☐	☐
4.2	Protect and restore the ecological quality and component habitats and resources within the Ecologically Sensitive Maritime and Industrial Area.	☐	☐	☑
4.3	Protect designated Significant Coastal Fish and Wildlife Habitats.	☑	☐	☐
4.4	Identify, remediate and restore ecological functions within Recognized Ecological Complexes.	☑	☐	☐
4.5	Protect and restore tidal and freshwater wetlands.	☑	☐	☐
4.6	In addition to wetlands, seek opportunities to create a mosaic of habitats with high ecological value and function that provide environmental and societal benefits. Restoration should strive to incorporate multiple habitat characteristics to achieve the greatest ecological benefit at a single location.	☑	☐	☐
4.7	Protect vulnerable plant, fish and wildlife species, and rare ecological communities. Design and develop land and water uses to maximize their integration or compatibility with the identified ecological community.	☑	☐	☐
4.8	Maintain and protect living aquatic resources.	☑	☐	☐

		Promote	Hinder	N/A
5	**Protect and improve water quality in the New York City coastal area.**	☑	☐	☐
5.1	Manage direct or indirect discharges to waterbodies.	☑	☐	☐
5.2	Protect the quality of New York City's waters by managing activities that generate nonpoint source pollution.	☑	☐	☐
5.3	Protect water quality when excavating or placing fill in navigable waters and in or near marshes, estuaries, tidal marshes, and wetlands.	☑	☐	☐
5.4	Protect the quality and quantity of groundwater, streams, and the sources of water for wetlands.	☐	☐	☑
5.5	Protect and improve water quality through cost-effective grey-infrastructure and in-water ecological strategies.	☑	☐	☐
6	**Minimize loss of life, structures, infrastructure, and natural resources caused by flooding and erosion, and increase resilience to future conditions created by climate change.**	☑	☐	☐
6.1	Minimize losses from flooding and erosion by employing non-structural and structural management measures appropriate to the site, the use of the property to be protected, and the surrounding area.	☑	☐	☐
6.2	Integrate consideration of the latest New York City projections of climate change and sea level rise (as published in *New York City Panel on Climate Change 2015 Report, Chapter 2: Sea Level Rise and Coastal Storms*) into the planning and design of projects in the city's Coastal Zone.	☑	☐	☐
6.3	Direct public funding for flood prevention or erosion control measures to those locations where the investment will yield significant public benefit.	☑	☐	☐
6.4	Protect and preserve non-renewable sources of sand for beach nourishment.	☐	☐	☑
7	**Minimize environmental degradation and negative impacts on public health from solid waste, toxic pollutants, hazardous materials, and industrial materials that may pose risks to the environment and public health and safety.**	☐	☐	☑
7.1	Manage solid waste material, hazardous wastes, toxic pollutants, substances hazardous to the environment, and the unenclosed storage of industrial materials to protect public health, control pollution and prevent degradation of coastal ecosystems.	☐	☐	☑
7.2	Prevent and remediate discharge of petroleum products.	☐	☐	☑
7.3	Transport solid waste and hazardous materials and site solid and hazardous waste facilities in a manner that minimizes potential degradation of coastal resources.	☐	☐	☑
8	**Provide public access to, from, and along New York City's coastal waters.**	☑	☐	☐
8.1	Preserve, protect, maintain, and enhance physical, visual and recreational access to the waterfront.	☑	☐	☐
8.2	Incorporate public access into new public and private development where compatible with proposed land use and coastal location.	☑	☐	☐
8.3	Provide visual access to the waterfront where physically practical.	☑	☐	☐
8.4	Preserve and develop waterfront open space and recreation on publicly owned land at suitable locations.	☑	☐	☐

		Promote	Hinder	N/A
8.5	Preserve the public interest in and use of lands and waters held in public trust by the State and City.	☑	☐	☐
8.6	Design waterfront public spaces to encourage the waterfront's identity and encourage stewardship.	☐	☐	☑
9	**Protect scenic resources that contribute to the visual quality of the New York City coastal area.**	☑	☐	☐
9.1	Protect and improve visual quality associated with New York City's urban context and the historic and working waterfront.	☑	☐	☐
9.2	Protect and enhance scenic values associated with natural resources.	☑	☐	☐
10	**Protect, preserve, and enhance resources significant to the historical, archaeological, architectural, and cultural legacy of the New York City coastal area.**	☑	☐	☐
10.1	Retain and preserve historic resources, and enhance resources significant to the coastal culture of New York City.	☑	☐	☐
10.2	Protect and preserve archaeological resources and artifacts.	☑	☐	☐

G. CERTIFICATION

The applicant or agent must certify that the proposed activity is consistent with New York City's approved Local Waterfront Revitalization Program, pursuant to New York State's Coastal Management Program. If this certification cannot be made, the proposed activity shall not be undertaken. If this certification can be made, complete this Section.

"The proposed activity complies with New York State's approved Coastal Management Program as expressed in New York City's approved Local Waterfront Revitalization Program, pursuant to New York State's Coastal Management Program, and will be conducted in a manner consistent with such program."

Applicant/Agent's Name: New York District, US Army Corps of Engineers

Address: 26 Federal Plaza, New York, NY 10278

Telephone: 917-790-8726 Email: daria.s.mazey@usace.army.mil

Applicant/Agent's Signature: _____

Date: _____

Submission Requirements

For all actions requiring City Planning Commission approval, materials should be submitted to the Department of City Planning.

For local actions not requiring City Planning Commission review, the applicant or agent shall submit materials to the Lead Agency responsible for environmental review. A copy should also be sent to the Department of City Planning.

For State actions or funding, the Lead Agency responsible for environmental review should transmit its WRP consistency assessment to the Department of City Planning.

For Federal direct actions, funding, or permits applications, including Joint Applicants for Permits, the applicant or agent shall also submit a copy of this completed form along with his/her application to the NYS Department of State Office of Planning and Development and other relevant state and federal agencies. A copy of the application should be provided to the NYC Department of City Planning.

The Department of City Planning is also available for consultation and advisement regarding WRP consistency procedural matters.

New York City Department of City Planning
Waterfront and Open Space Division
120 Broadway, 31st Floor
New York, New York 10271
212-720-3696
wrp@planning.nyc.gov
www.nyc.gov/wrp

New York State Department of State
Office of Planning and Development
Suite 1010
One Commerce Place, 99 Washington Avenue
Albany, New York 12231-0001
518-474-6000
www.dos.ny.gov/opd/programs/consistency

Applicant Checklist

- ☑ Copy of original signed NYC Consistency Assessment Form
- ☑ Attachment with consistency assessment statements for all relevant policies
- ☐ For Joint Applications for Permits, one (1) copy of the complete application package
- ☑ Environmental Review documents
- ☑ Drawings (plans, sections, elevations), surveys, photographs, maps, or other information or materials which would support the certification of consistency and are not included in other documents submitted. All drawings should be clearly labeled and at a scale that is legible.
- ☑ Policy 6.2 Flood Elevation worksheet, if applicable. For guidance on applicability, refer to the WRP Policy 6.2 Guidance document available at www.nyc.gov/wrp

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Environmental Analysis Branch

October 15, 2018

Mr. Michael Marrella
Director of Waterfront and Open Space
New York City Department of City Planning
120 Broadway, 31st Floor
New York, New York 10271

Dear Mr. Marella:

The purpose of this letter is to request your office's concurrence with the Coastal Zone Management (CZM) Consistency Determination for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Hurricane Sandy Reformulation Study. The study area consists of the Atlantic Coast of New York City (NYC) between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York. The Atlantic Ocean shoreline, which is a peninsula approximately 10 miles in length, generally referred to as the Rockaways, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, NYC, and a section at the eastern end, known as Head-of-Bay, lies in Nassau County.

More than 850,000 residents, over 46,000 residential and non-residential structures (which includes scores of critical infrastructure features such as schools, hospitals, and nursing homes), and additional wastewater treatment, subway, and railroad infrastructure are located within the study area. The study area was one of the areas most devastated by Hurricane Sandy – there were 10 fatalities, and more than 1,000 structures were either substantially damaged to restrict re-entry or were destroyed by Hurricane Sandy. The NYC Department of Buildings post-Hurricane Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge damage. Of all buildings city-wide identified as unsafe or structurally damaged, 37 percent were located in the southern Queens portion of the study area. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes along the Rockaway Peninsula portion of the study area.

Hurricane Sandy hit the study area at nearly high tide. Waves eroded beaches, breached boardwalks and seawalls, and broke against buildings in the oceanfront communities. Storm surge inundation reached as much as 10 feet above ground in some portions of the study area. In addition, more than 1.5 million cubic yards of sand was removed from Rockaway Beach and deposited on oceanfront communities or washed out to sea. Floodwaters funneled through Rockaway Inlet amassing a storm surge that inundated all of the neighborhoods surrounding Jamaica Bay. The low-lying

neighborhoods in the central and northern portions of Jamaica Bay, where the narrow creeks and basins provide the marine aesthetic of the neighborhood, were especially devastated by flood waters. Damage to the elevated portion of the subway system in Jamaica Bay and Rockaway (the A-line) disrupted service for over six months, affecting about 35,000 riders daily. In the southern Queens portion of the study area 37 schools were closed for up to two months. Habitats important to waterfowl and coastal water birds, including shorebirds, wading birds, and seabirds, were also impacted by Hurricane Sandy. High winds and storm-driven water moved masses of coastal sediments, changed barrier landscapes, and breached dikes on impoundments managed specifically for migratory birds.

Plan formulation involved the analysis of potential structural and non-structural alternatives. The recommended plan is comprised of a shorefront component and three separate *high frequency flooding risk reduction features* (HFFRRF) projects around Jamaica Bay: 1) Mid-Rockaway, 2) Cedarhurst-Lawrence, and 3) Motts Basin North. The Mid-Rockaway HFFRRF is the largest and stretches across three neighborhoods/subreaches - Hammels, Edgemere, and Arverne. The shorefront component includes a reinforced vegetated dune with a composite seawall core and associated beach restoration with increased renourishment at the Atlantic Ocean shorefront. The structure crest elevation is +17 feet NAVD88, the dune elevation is +18 feet NAVD88, and the design berm width is 60 feet at an elevation of +8 feet NAVD88. In order to reduce beach erosion and renourishment requirements, the project also includes an extension of 5 existing groins and new construction of 13 new groins. For the Jamaica Bay component, features to reduce the risk of frequent flooding are recommended and include natural and nature-based features (wetlands with rock sills), floodwalls, revetments, and bulkheads. Feature types are based on what is feasible and appropriate at given locations when considering existing conditions and uses.

The U.S. Army Corps of Engineers, New York District (District) has determined that the Rockaway Reformulation complies with both New York State and New York City Waterfront Revitalization Program (WRP) Coastal Zone Management (CZM) policies and project implementation will be conducted in a manner consistent with these polices. This letter provides the New York State Coastal Management Program Consistency Review Unit with information to support the District's consistency determination under the Coastal Zone Management Act, Section 307(c) (1) and (2), and 15 CFR 930.35(d). A Determination of Federal Consistency with both sets of coastal management policies is enclosed. The Policy 6.2 worksheet is also enclosed, along with a signed New York City Waterfront Revitalization Program Consistency Assessment Form

The District requests that your office review the proposed project for consistency to the maximum extent practicable with State's CZM Policies. For further information (including the Revised General Reevaluation Report and Environmental Impact Statement and associated Plan Sheets for the Recommended Plan), please refer to: http://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-York/East-Rockaway-Inlet-to-Rockaway-inlet-Rockaway-Beach/.

Should you require any additional information, please contact the Project Biologist, Ms. Daria Mazey of my staff at (917) 790-8726 or by email at daria.s.mazey@usace.army.mil.

Sincerely,

Peter Weppler
Chief, Environmental Analysis Branch

Enclosures

cc: NYSDOS-CZM

STATE OF NEW YORK
DEPARTMENT OF STATE
ONE COMMERCE PLAZA
99 WASHINGTON AVENUE
ALBANY, NY 12231-0001
WWW.DOS.NY.GOV

ANDREW M. CUOMO
GOVERNOR

ROSSANA ROSADO
SECRETARY OF STATE

December 6, 2018

Mr. Peter Weppler, Chief
Environmental Analysis Branch
U.S. Army Corps of Engineers/New York District
26 Federal Plaza
New York, NY 10278-0090

Re: **F-2018-1055 (DA)** - U.S. Army Corps of Engineers/New York District submission of a consistency determination for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Hurricane Sandy Reformulation Study. Jamaica Bay and Atlantic Ocean, Boroughs of Brooklyn and Queens, NYC, and Head-of-Bay, Nassau County.
Concurrence with Consistency Certification, with Recommendations

Dear Mr. Weppler:

The Department of State (Department) has completed its review of your consistency certification regarding the consistency of the above-referenced activity with the New York Coastal Management Program.

Pursuant to 15 CFR Part 930.62, and based upon the project information submitted, the Department of State concurs with your consistency certification for this activity. This concurrence is without prejudice to and does not obviate the need to obtain all other applicable licenses, permits, or other forms of authorization or approval that may be required pursuant to existing State statutes.

The Department would also like to offer the following recommendation regarding the consistency of this proposal:

- Considering that the Reformulation Study has yet to be finalized and individual project components are still under development, it is strongly recommended that coordination with the Department of State and the New York City Department of City Planning continue as the details of this project are developed and finalized to ensure continued consistency with the New York State Coastal Management Program and New York City Waterfront Revitalization Program.

Please contact Matthew Maraglio at: Matthew.Maraglio@dos.ny.gov or 518-474-6000 if you have any questions, and please reference file no. F-2018-1055 (DA).

Sincerely,

Gregory L. Capobianco
Office of Planning, Development and
Community Infrastructure

GLC/jls

ecc: COE/NY District – Daria Mazey, Steve Ryba
DEC Central Office – Sue McCormick, Matthew Chlebus
DEC Region 2 – Steve Watts
DEC Region 1 – Roger Evans, George Hammarth
NYC DCP/WRP – Michael Marrella, Christopher Wassif

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

Environmental Analysis Branch

March 12, 2019

Mr. Frank Loprano
Airport Certification Safety Inspector
Safety & Standards Branch, Airport Division
Federal Aviation Administration
159-30 Rockaway Boulevard
Jamaica, NY 11434

Dear Mr. Loprano,

Thank you to you and your colleagues for the opportunity for the U.S. Army Corps of Engineers, New York District (District) to brief the JFK-LGA Wildlife Hazard Task Force in November 2018 and again on March 13, 2019 on the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study. Enclosed please find a summary of the Recommended Plan, which includes natural and nature-based features to manage coastal erosion and flood risk along the bayside of Arverne and Edgemere on the Rockaway peninsula. Per the FAA recommendations and previous coordination that the New York District has undertaken with you, the District is proposing foraging habitat only, and not nesting or brooding habitat, in the Final Integrated General Reevaluation Report and Environmental Impact Statement (Final FR/EA) for the study due to the proximity to JFK Airport. As part of our coordination for this study, the District is providing a synopsis of project level recommendation and site level features.

As part of the project's Pre-Construction Engineering and Design (PED) Phase, detailed draft site level plans for the natural and nature-based features within the vicinity of John F. Kennedy (JFK) International Airport will be made available with your staff for your review and feedback.

In order to satisfy our agency requirements, the District respectfully requests formal concurrence from your agency upon completion of the study's coordination. The District appreciates your willingness to oversee this project for the JFK Airport. The study team looks forward to working with the FAA as detailed plans are developed in PED. If you require any additional information, please contact Daria Mazey, the lead Biologist on the study at 917-790-8031.

Sincerely,

Peter Weppler
Chief, Environmental Analysis Branch

ENCL 1: Rockaway site level NNBF features summary
CF: Francoeur, Laura, PANYNJ

U.S. Department
of Transportation
**Federal Aviation
Administration**

Eastern Region, Airports Division

1 Aviation Plaza, Room 516
Jamaica, NY 11434-4809

T: (718) 553-3330
F: (718) 995-5615

May 20, 2019

Mr. Peter Weppler
Department of the Army
U.S. Army Corps of Engineers, New York District
Jacob K. Javits Federal Building
26 Federal Plaza
New York, NY 10278-0090

Re: Jamaica Bay Reformulation Study Revised Draft

Dear Mr. Weppler:

Again, thank you for bringing the FAA onboard this project in reference to the Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay.

The staff at the Eastern Region and the FAA's Wildlife Biologist in Washington D.C. have reviewed the documents you sent and have no reservations, or objections to the information provided. The project seems to focus to minimize nesting / roosting / loafing habitats for hazardous species, which is good.

Please continue to keep us up to date on the progress of the project. You can contact me anytime via email at frank.loprano@faa.gov or call 718-553-2543.

Sincerely,

Frank J. Loprano
Airport Certification Safety Inspector
Safety and Standards Branch
Airports Division

NATIONAL PARKS SERVICE LETTER OF SUPPORT

United States Department of the Interior
NATIONAL PARK SERVICE
Gateway National Recreation Area
210 New York Avenue
Staten Island, New York 10305

November 16, 2018

Colonel Thomas D. Asbery
Commander and District Engineer
Department of the Army
U.S. Army Corps of Engineers
New York District
Jacob K. Javits Federal Building
26 Federal Plaza
New York, NY 10279-0090

Dear Colonel Asbery:

The purpose of this letter is to confirm the National Park Service's (NPS) interest in participating with the United States Army Corps of Engineers (USACE), New York State Department of Environmental Conservation, and The City of New York for the successful implementation of the Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement for the East Rockaway Inlet to Jamaica Bay (HSGRR/EIS) Coastal Risk Management Project. The NPS mission is to manage our lands for the preservation of and access to natural, cultural and recreational resources in perpetuity. Understanding that this Project is necessary for the protection of the adjacent communities, and that construction of the risk reduction features will not occur on NPS property, NPS is committed to working to avoid and minimize adverse impacts on our resources while advancing the goals of the Project.

This letter is not a commitment for construction of any portion of the Project on NPS lands. Construction of the project on Gateway National Recreation Area's (GATE) land is contingent upon: an appropriate legal authority or instrumentation to authorize construction on NPS property; commitment of a non-federal sponsor for long-term maintenance obligations and liability and risk considerations for the project on NPS lands; and, appropriate off-sets for unavoidable Project impacts to GATE natural, cultural and recreational resources. In addition, any portion of the project that may be constructed on or impact NPS resources must be mutually acceptable to the Secretary of the Interior and the Secretary of the Army and consistent with GATE enabling legislation (16 U.S. Code Subchapter LXXXVII).

NPS will continue to work with USACE and other partners to implement this project. If you have any questions, please contact me by email at jennifer_nersesian@nps.gov or by telephone (718-354-4665).

Sincerely,

Jennifer T. Nersesian
Superintendent

Cc: Cliff Jones, USACE
Dan Falt, USACE
Daria Mazey, USACE
Joshua Laird, NPS
Patti Rafferty, NPS

SECTION 106 COORDINATION CORRESPONDENCE

Landmarks Preservation Commission

1 Centre Street
9th Floor North
New York, NY 10007

Voice (212)-669-7700
Fax (212)-669-7960
http://nyc.gov/landmarks

ENVIRONMENTAL REVIEW

Project number: USACE / 106-Q
Project: ATLANTIC COAST OF NY, EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY
Date Received: 6/7/2019

Comments: The LPC is in receipt of the draft Programmatic Agreement and it appears acceptable for historic and cultural resources. The signatory page should be revised to state that Sarah Carroll, Chair of the Landmarks Preservation Commission would be the signatory for LPC.

LPC concurs with the 5/29/19 SHPO comments.

Cc: SHPO 19PR03392

Gina Santucci 6/28/19

SIGNATURE DATE
Gina Santucci, Environmental Review Coordinator

File Name: 34240_FSO_ALS_06072019.docx

Preserving America's Heritage

June 7, 2019

Ms. Carissa Scarpa
Archeologist
New York District
U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278

Ref: *Proposed Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Construction Project*
Queens and Nassau Counties, New York

Dear Ms. Scarpa:

The Advisory Council on Historic Preservation (ACHP) has received your notification and supporting documentation regarding the adverse effects of the referenced undertaking on a property or properties listed or eligible for listing in the National Register of Historic Places. Based upon the information you provided, we have concluded that Appendix A, *Criteria for Council Involvement in Reviewing Individual Section 106 Cases*, of our regulations, "Protection of Historic Properties" (36 CFR Part 800), does not apply to this undertaking. Accordingly, we do not believe that our participation in the consultation to resolve adverse effects is needed. However, if we receive a request for participation from the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officer, affected Indian tribe, a consulting party, or other party, we may reconsider this decision. Additionally, should circumstances change, and you determine that our participation is needed to conclude the consultation process, please notify us.

Pursuant to 36 CFR §800.6(b)(1)(iv), you will need to file the final Programmatic Agreement (PA), developed in consultation with the New York State Historic Preservation Office (SHPO) and any other consulting parties, and related documentation with the ACHP at the conclusion of the consultation process. The filing of the PA and supporting documentation with the ACHP is required in order to complete the requirements of Section 106 of the National Historic Preservation Act.

Thank you for providing us with your notification of adverse effect. If you have any questions or require further assistance, please contact Christopher Daniel at 202 517-0223 or via e-mail at cdaniel@achp.gov.

Sincerely,

Artisha Thompson
Historic Preservation Technician
Office of Federal Agency Programs

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

May 10, 2019

Planning Division

Harry B. Wallace
Chief
Unkechaug Nation
207 Poospansk Lane
Mastic, New York 11950

Dear Chief Wallace;

The U.S. Army Corps of Engineers, New York District (Corps) has prepared the General Reevaluation Report and Environmental Impact Statement for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens and Nassau Counties, New York. The proposed project will reduce the risk of damage from storms and cross shore flooding in addition to reducing the risk of flooding in areas along portions of the Jamaica Bay shoreline along the Rockaway peninsula.

The cultural resources investigation completed for this study consisted of the review of the previous surveys and a review of the New York State Historic Preservation Office Cultural Resources Information System. Much of the proposed project area had been included in previous surveys.

Undertaking

The measures proposed include the construction of a composite seawall buried along the beach, the construction of new and/or the extension of existing groins and sand fill along the Atlantic shoreline as well as four high-frequency flood risk reduction measures on Jamaica Bay in Cedarhurst-Lawrence, Hammels, Edgemere and Arverne, Queens and Nassau Counties, New York, as described in Enclosure 1. The APE would also include borrow areas identified as sand sources for the beach fill.

Areas of Potential Effect (APE)

The APE is the alignment of each of the measures included in the undertaking listed above and described in Enclosure 1. At this time no staging areas or access roads have been identified, however, given the nature of the surrounding area it is anticipated that staging areas will be within existing parking lots or the footprint of the alignment itself. If additional staging areas, access roads or other features are required they will be considered in this analysis once they are defined. The APE for archaeology, historic structures and historic landscapes has been defined as those areas along the proposed line of protection that would likely be directly impacted by project construction. The APE for historic structures and landscapes also includes those locations that would be anticipated to have visual impacts from the completed project.

Identification and Evaluation of Historic Properties

A number of prehistoric archaeological or Native American sites identified in and around Jamaica Bay and portions of the Rockaway Peninsula in the early twentieth century have been recorded in the New York State Museum files, although the exact locations or other information is unknown. Few sites have been identified on the main portion of the peninsula.

Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th and 26th Streets) are historic districts on the Rockaway Peninsula that are listed on the New York State and the National Registers of Historic Places. The Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club and Jacob Riis Historic Districts are all located within Gateway and are managed by the NPS. Other National Register listed or eligible properties include 2 Beach 85th Street, Hammels Pier, the New York City Transit System Building, the Rockaway Courthouse, the Temple of Israel Synagogue, the US Post Office at Far Rockaway, Trinity Chapel, the Russell Sage Memorial Church, the Trans World Airlines Flight Center at JFK International Airport, and The Marine Parkway - Gil Hodges Memorial Bridge.

The beach portion of the Jacob Riis Historic District is located within the western end of the Atlantic Shoreline APE. The Far Rockaway Beach Bungalow Historic District is located adjacent to the eastern end of the Atlantic shoreline APE. None of these historic districts are located within or near the APEs for the high-frequency flood risk reduction segments. Two Beach 85th Street, Hammels Pier and the New York City Transit System Building are located adjacent and potentially within the APE for two segments the Hammels high-frequency flood risk reduction measure (see Enclosure 1)

Assessment of Effect

Although no prehistoric or Native American archaeological sites have been identified along the Rockaway peninsula, the early discoveries at the eastern end of the peninsula do indicate a potential for utilization of the area. Sites on the peninsula, if present, may be more likely to be deeply buried as a result of the active forces of the ocean and storm surge. As part of the investigations for and construction of the reinforced dune/composite seawall, conduct geomorphological investigations to identify locations of prehistoric land surfaces that may require monitoring during excavation.

As determined for previous sand placement efforts, the placement of beach fill will not have an adverse effect on the known historic districts and properties located along the shoreline. The source of the sand will be from borrow areas for which a remote sensing survey and, in some cases, an underwater inspection of targets, has been completed. If a borrow area is selected for which an investigation has not been completed or

additional work is warranted, those investigations will be conducted prior to the use of the borrow area.

The proposed plan also intends to build new groins as well as rehabilitate and/or extend existing groins. Neither the original nomination for the Jacob Riis Park Historic District, nor the 2014 Final General Management Plan and Environmental Impact Statement mention the groins, although there are three within the current bounds of the historic district. A survey of the groins with in the shoreline APE will be conducted determine when they were built and if they are eligible for the National Register on their own or as part of the existing historic district.

Only a portion of the Arverne high-frequency flood risk reduction measure have been subject to a prior survey (Dubos Point (8) and Brant Point (9) in Panamerican 2003). Additional investigations would include expanding a Phase I survey to the other portions of this high-frequency flood risk reduction measure as well as to the other three measures. In addition, the completed survey recommends for portions of the Arverne measure recommends additional investigations prior to or as part of construction activities in these areas. These include additional research on the bulkhead, limited subsurface testing, monitoring of deeper excavation, if conducted, for prehistoric land surfaces and potential remote sensing investigations on the water side of the area.

Two eligible properties, the NYC Transit System building and 2 Beach 85th are immediately adjacent to elements associated with the Hammels high-frequency flood risk reduction measure. They will not be adversely effected by the construction of the measures, however, information related to these structures may be identified during the proposed Phase I survey or that determination could change should the alignment of each floodwall or pump station changes.

The Corps has prepared a Programmatic Agreement which stipulates the activities the Corps will undertake to address the potential for adverse effects identified above (Enclosure 2). The preliminary draft Programmatic Agreement was included in the draft general reevaluation report and environmental impact statement as part of its public review and the identification of historic properties and determination of adverse effects was included in the public meetings held during the review period.

At this time, based on further analysis, it is likely that the groins within the Jacob Riis Park Historic District will not require rehabilitation. Since this determination has not been made, the analysis of all groins, including those in the historic district, will still be conducted, and the National Park Service will be a signatory to the Programmatic Agreement.

Please review the enclosed document and provide comments in accordance with 36 CFR Part 800.6. Any comments received will be incorporated into the agreement before it is executed. If you have any questions or need additional information, please contact Nancy J. Brighton at Nancy.J.Brighton@usace.army.mil or 202-761-4618.

Thank you for your assistance with this project.

Sincerely,

WEPPLER.PETER.M.1228647353

Digitally signed by WEPPLER.PETER.M.1228647353
Date: 2019.05.10 11:13:24 -04'00'

Peter Weppler
Chief, Environmental Analysis Branch

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

May 10, 2019

Planning Division

Ms. Bonney Hartley
Tribal Historic Preservation Officer
Stockbridge-Munsee Community
New York Office
65 1st Street
Troy, New York 12180

Dear Ms. Hartley;

The U.S. Army Corps of Engineers, New York District (Corps) has prepared the General Reevaluation Report and Environmental Impact Statement for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens and Nassau Counties, New York. The proposed project will reduce the risk of damage from storms and cross shore flooding in addition to reducing the risk of flooding in areas along portions of the Jamaica Bay shoreline along the Rockaway peninsula.

The cultural resources investigation completed for this study consisted of the review of the previous surveys and a review of the New York State Historic Preservation Office Cultural Resources Information System. Much of the proposed project area had been included in previous surveys.

Undertaking

The measures proposed include the construction of a composite seawall buried along the beach, the construction of new and/or the extension of existing groins and sand fill along the Atlantic shoreline as well as four high-frequency flood risk reduction measures on Jamaica Bay in Cedarhurst-Lawrence, Hammels, Edgemere and Arverne, Queens and Nassau Counties, New York, as described in Enclosure 1. The APE would also include borrow areas identified as sand sources for the beach fill.

Areas of Potential Effect (APE)

The APE is the alignment of each of the measures included in the undertaking listed above and described in Enclosure 1. At this time no staging areas or access roads have been identified, however, given the nature of the surrounding area it is anticipated that staging areas will be within existing parking lots or the footprint of the alignment itself. If additional staging areas, access roads or other features are required they will be considered in this analysis once they are defined. The APE for archaeology, historic structures and historic landscapes has been defined as those areas along the proposed line of protection that would likely be directly impacted by project construction. The APE for historic structures and landscapes also includes those locations that would be anticipated to have visual impacts from the completed project.

Identification and Evaluation of Historic Properties

A number of prehistoric archaeological or Native American sites identified in and around Jamaica Bay and portions of the Rockaway Peninsula in the early twentieth century have been recorded in the New York State Museum files, although the exact locations or other information is unknown. Few sites have been identified on the main portion of the peninsula.

Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th and 26th Streets) are historic districts on the Rockaway Peninsula that are listed on the New York State and the National Registers of Historic Places. The Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club and Jacob Riis Historic Districts are all located within Gateway and are managed by the NPS. Other National Register listed or eligible properties include 2 Beach 85th Street, Hammels Pier, the New York City Transit System Building, the Rockaway Courthouse, the Temple of Israel Synagogue, the US Post Office at Far Rockaway, Trinity Chapel, the Russell Sage Memorial Church, the Trans World Airlines Flight Center at JFK International Airport, and The Marine Parkway - Gil Hodges Memorial Bridge.

The beach portion of the Jacob Riis Historic District is located within the western end of the Atlantic Shoreline APE. The Far Rockaway Beach Bungalow Historic District is located adjacent to the eastern end of the Atlantic shoreline APE. None of these historic districts are located within or near the APEs for the high-frequency flood risk reduction segments. Two Beach 85th Street, Hammels Pier and the New York City Transit System Building are located adjacent and potentially within the APE for two segments the Hammels high-frequency flood risk reduction measure (see Enclosure 1)

Assessment of Effect

Although no prehistoric or Native American archaeological sites have been identified along the Rockaway peninsula, the early discoveries at the eastern end of the peninsula do indicate a potential for utilization of the area. Sites on the peninsula, if present, may be more likely to be deeply buried as a result of the active forces of the ocean and storm surge. As part of the investigations for and construction of the reinforced dune/composite seawall, conduct geomorphological investigations to identify locations of prehistoric land surfaces that may require monitoring during excavation.

As determined for previous sand placement efforts, the placement of beach fill will not have an adverse effect on the known historic districts and properties located along the shoreline. The source of the sand will be from borrow areas for which a remote sensing survey and, in some cases, an underwater inspection of targets, has been completed. If a borrow area is selected for which an investigation has not been completed or additional work is warranted, those investigations will be conducted prior to the use of the borrow area.

The proposed plan also intends to build new groins as well as rehabilitate and/or extend existing groins. Neither the original nomination for the Jacob Riis Park Historic District, nor the 2014 Final General Management Plan and Environmental Impact Statement mention the groins, although there are three within the current bounds of the historic district. A survey of the groins with in the shoreline APE will be conducted determine when they were built and if they are eligible for the National Register on their own or as part of the existing historic district.

Only a portion of the Arverne high-frequency flood risk reduction measure have been subject to a prior survey (Dubos Point (8) and Brant Point (9) in Panamerican 2003). Additional investigations would include expanding a Phase I survey to the other portions of this high-frequency flood risk reduction measure as well as to the other three measures. In addition, the completed survey recommends for portions of the Arverne measure recommends additional investigations prior to or as part of construction activities in these areas. These include additional research on the bulkhead, limited subsurface testing, monitoring of deeper excavation, if conducted, for prehistoric land surfaces and potential remote sensing investigations on the water side of the area.

Two eligible properties, the NYC Transit System building and 2 Beach 85th are immediately adjacent to elements associated with the Hammels high-frequency flood risk reduction measure. They will not be adversely effected by the construction of the measures, however, information related to these structures may be identified during the proposed Phase I survey or that determination could change should the alignment of each floodwall or pump station changes.

The Corps has prepared a Programmatic Agreement which stipulates the activities the Corps will undertake to address the potential for adverse effects identified above (Enclosure 2). The preliminary draft Programmatic Agreement was included in the draft general reevaluation report and environmental impact statement as part of its public review and the identification of historic properties and determination of adverse effects was included in the public meetings held during the review period.

At this time, based on further analysis, it is likely that the groins within the Jacob Riis Park Historic District will not require rehabilitation. Since this determination has not been made, the analysis of all groins, including those in the historic district, will still be conducted, and the National Park Service will be a signatory to the Programmatic Agreement.

Please review the enclosed document and provide comments in accordance with 36 CFR Part 800.6. Any comments received will be incorporated into the agreement before it is executed. If you have any questions or need additional information, please contact Nancy J. Brighton at Nancy.J.Brighton@usace.army.mil or 202-761-4618.

Thank you for your assistance with this project.

Sincerely,

WEPPLER.PETER.M.1228647353

Digitally signed by WEPPLER.PETER.M.1228647353
Date: 2019.05.10 11:02:22 -04'00'

Peter Weppler
Chief, Environmental Analysis Branch

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

May 10, 2019

Planning Division

Mr. David Martine
Shinnecock Nation
P.O. Box 5006
Southampton, New York 11968

Dear Mr. Martine;

The U.S. Army Corps of Engineers, New York District (Corps) has prepared the General Reevaluation Report and Environmental Impact Statement for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens and Nassau Counties, New York. The proposed project will reduce the risk of damage from storms and cross shore flooding in addition to reducing the risk of flooding in areas along portions of the Jamaica Bay shoreline along the Rockaway peninsula.

The cultural resources investigation completed for this study consisted of the review of the previous surveys and a review of the New York State Historic Preservation Office Cultural Resources Information System. Much of the proposed project area had been included in previous surveys.

Undertaking

The measures proposed include the construction of a composite seawall buried along the beach, the construction of new and/or the extension of existing groins and sand fill along the Atlantic shoreline as well as four high-frequency flood risk reduction measures on Jamaica Bay in Cedarhurst-Lawrence, Hammels, Edgemere and Arverne, Queens and Nassau Counties, New York, as described in Enclosure 1. The APE would also include borrow areas identified as sand sources for the beach fill.

Areas of Potential Effect (APE)

The APE is the alignment of each of the measures included in the undertaking listed above and described in Enclosure 1. At this time no staging areas or access roads have been identified, however, given the nature of the surrounding area it is anticipated that staging areas will be within existing parking lots or the footprint of the alignment itself. If additional staging areas, access roads or other features are required they will be considered in this analysis once they are defined. The APE for archaeology, historic structures and historic landscapes has been defined as those areas along the proposed line of protection that would likely be directly impacted by project construction. The APE for historic structures and landscapes also includes those locations that would be anticipated to have visual impacts from the completed project.

Identification and Evaluation of Historic Properties

A number of prehistoric archaeological or Native American sites identified in and around Jamaica Bay and portions of the Rockaway Peninsula in the early twentieth century have been recorded in the New York State Museum files, although the exact locations or other information is unknown. Few sites have been identified on the main portion of the peninsula.

Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th and 26th Streets) are historic districts on the Rockaway Peninsula that are listed on the New York State and the National Registers of Historic Places. The Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club and Jacob Riis Historic Districts are all located within Gateway and are managed by the NPS. Other National Register listed or eligible properties include 2 Beach 85th Street, Hammels Pier, the New York City Transit System Building, the Rockaway Courthouse, the Temple of Israel Synagogue, the US Post Office at Far Rockaway, Trinity Chapel, the Russell Sage Memorial Church, the Trans World Airlines Flight Center at JFK International Airport, and The Marine Parkway - Gil Hodges Memorial Bridge.

The beach portion of the Jacob Riis Historic District is located within the western end of the Atlantic Shoreline APE. The Far Rockaway Beach Bungalow Historic District is located adjacent to the eastern end of the Atlantic shoreline APE. None of these historic districts are located within or near the APEs for the high-frequency flood risk reduction segments. Two Beach 85th Street, Hammels Pier and the New York City Transit System Building are located adjacent and potentially within the APE for two segments the Hammels high-frequency flood risk reduction measure (see Enclosure 1)

Assessment of Effect

Although no prehistoric or Native American archaeological sites have been identified along the Rockaway peninsula, the early discoveries at the eastern end of the peninsula do indicate a potential for utilization of the area. Sites on the peninsula, if present, may be more likely to be deeply buried as a result of the active forces of the ocean and storm surge. As part of the investigations for and construction of the reinforced dune/composite seawall, conduct geomorphological investigations to identify locations of prehistoric land surfaces that may require monitoring during excavation.

As determined for previous sand placement efforts, the placement of beach fill will not have an adverse effect on the known historic districts and properties located along the shoreline. The source of the sand will be from borrow areas for which a remote sensing survey and, in some cases, an underwater inspection of targets, has been completed. If a borrow area is selected for which an investigation has not been completed or additional work is warranted, those investigations will be conducted prior to the use of the borrow area.

The proposed plan also intends to build new groins as well as rehabilitate and/or extend existing groins. Neither the original nomination for the Jacob Riis Park Historic District, nor the 2014 Final General Management Plan and Environmental Impact Statement mention the groins, although there are three within the current bounds of the historic district. A survey of the groins with in the shoreline APE will be conducted determine when they were built and if they are eligible for the National Register on their own or as part of the existing historic district.

Only a portion of the Arverne high-frequency flood risk reduction measure have been subject to a prior survey (Dubos Point (8) and Brant Point (9) in Panamerican 2003). Additional investigations would include expanding a Phase I survey to the other portions of this high-frequency flood risk reduction measure as well as to the other three measures. In addition, the completed survey recommends for portions of the Arverne measure recommends additional investigations prior to or as part of construction activities in these areas. These include additional research on the bulkhead, limited subsurface testing, monitoring of deeper excavation, if conducted, for prehistoric land surfaces and potential remote sensing investigations on the water side of the area.

Two eligible properties, the NYC Transit System building and 2 Beach 85th are immediately adjacent to elements associated with the Hammels high-frequency flood risk reduction measure. They will not be adversely effected by the construction of the measures, however, information related to these structures may be identified during the proposed Phase I survey or that determination could change should the alignment of each floodwall or pump station changes.

The Corps has prepared a Programmatic Agreement which stipulates the activities the Corps will undertake to address the potential for adverse effects identified above (Enclosure 2). The preliminary draft Programmatic Agreement was included in the draft general reevaluation report and environmental impact statement as part of its public review and the identification of historic properties and determination of adverse effects was included in the public meetings held during the review period.

At this time, based on further analysis, it is likely that the groins within the Jacob Riis Park Historic District will not require rehabilitation. Since this determination has not been made, the analysis of all groins, including those in the historic district, will still be conducted, and the National Park Service will be a signatory to the Programmatic Agreement.

Please review the enclosed document and provide comments in accordance with 36 CFR Part 800.6. Any comments received will be incorporated into the agreement before it is executed. If you have any questions or need additional information, please contact Ms. Nancy J. Brighton at Nancy.J.Brighton@usace.army.mil or 202-761-4618.

Thank you for your assistance with this project.

Sincerely,

WEPPLER.PETER.M.1228647353

Digitally signed by WEPPLER.PETER.M.1228647353
Date: 2019.05.10 11:16:42 -04'00'

Peter Weppler
Chief, Environmental Analysis Branch

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

May 10, 2019

Planning Division

Mr. John Bonafide
Director
Technical Preservation Bureau and
Agency Preservation Officer
New York State Division for Historic Preservation
P.O. Box 189
Waterford, New York 12188-0189

Dear Mr. Bonafide;

The U.S. Army Corps of Engineers, New York District (Corps) has prepared the General Reevaluation Report and Environmental Impact Statement for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens and Nassau Counties, New York. The proposed project will reduce the risk of damage from storms and cross shore flooding in addition to reducing the risk of flooding in areas along portions of the Jamaica Bay shoreline along the Rockaway peninsula.

The cultural resources investigation completed for this study consisted of the review of the previous surveys and a review of the New York State Historic Preservation Office Cultural Resources Information System. Much of the proposed project area had been included in previous surveys.

Undertaking

The measures proposed include the construction of a composite seawall buried along the beach, the construction of new and/or the extension of existing groins and sand fill along the Atlantic shoreline as well as four high-frequency flood risk reduction measures on Jamaica Bay in Cedarhurst-Lawrence, Hammels, Edgemere and Arverne, Queens and Nassau Counties, New York, as described in Enclosure 1. The APE would also include borrow areas identified as sand sources for the beach fill.

Areas of Potential Effect (APE)

The APE is the alignment of each of the measures included in the undertaking listed above and described in Enclosure 1. At this time no staging areas or access roads have been identified, however, given the nature of the surrounding area it is anticipated that staging areas will be within existing parking lots or the footprint of the alignment itself. If additional staging areas, access roads or other features are required they will be considered in this analysis once they are defined. The APE for archaeology, historic structures and historic landscapes has been defined as those areas along the proposed line of protection that would likely be directly impacted by project construction. The APE for historic structures and landscapes also includes

those locations that would be anticipated to have visual impacts from the completed project.

Identification and Evaluation of Historic Properties

A number of prehistoric sites identified in and around Jamaica Bay and portions of the Rockaway Peninsula in the early twentieth century have been recorded in the New York State Museum files, although the exact locations or other information is unknown. Few sites have been identified on the main portion of the peninsula.

Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th and 26th Streets) are historic districts on the Rockaway Peninsula that are listed on the New York State and the National Registers of Historic Places. The Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club and Jacob Riis Historic Districts are all located within Gateway and are managed by the NPS. Other National Register listed or eligible properties include 2 Beach 85th Street, Hammels Pier, the New York City Transit System Building, the Rockaway Courthouse, the Temple of Israel Synagogue, the US Post Office at Far Rockaway, Trinity Chapel, the Russell Sage Memorial Church, the Trans World Airlines Flight Center at JFK International Airport, and The Marine Parkway - Gil Hodges Memorial Bridge.

The beach portion of the Jacob Riis Historic District is located within the western end of the Atlantic Shoreline APE. The Far Rockaway Beach Bungalow Historic District is located adjacent to the eastern end of the Atlantic shoreline APE. None of these historic districts are located within or near the APEs for the high-frequency flood risk reduction segments. Two Beach 85th Street, Hammels Pier and the New York City Transit System Building are located adjacent and potentially within the APE for two segments the Hammels high-frequency flood risk reduction measure (see Enclosure 1)

Assessment of Effect

Although no prehistoric or Native American archaeological sites have been identified along the Rockaway peninsula, the early discoveries at the eastern end of the peninsula do indicate a potential for utilization of the area. Sites on the peninsula, if present, may be more likely to be deeply buried as a result of the active forces of the ocean and storm surge. As part of the investigations for and construction of the reinforced dune/composite seawall, conduct geomorphological investigations to identify locations of prehistoric land surfaces that may require monitoring during excavation.

As determined for previous sand placement efforts, the placement of beach fill will not have an adverse effect on the known historic districts and properties located along the shoreline. The source of the sand will be from borrow areas for which a remote sensing survey and, in some cases, an underwater inspection of targets, has been completed. If a borrow area is selected for which an investigation has not been

completed or additional work is warranted, those investigations will be conducted prior to the use of the borrow area.

The proposed plan also intends to build new groins as well as rehabilitate and/or extend existing groins. Neither the original nomination for the Jacob Riis Park Historic District, nor the 2014 Final General Management Plan and Environmental Impact Statement mention the groins, although there are three within the current bounds of the historic district. A survey of the groins with in the shoreline APE will be conducted determine when they were built and if they are eligible for the National Register on their own or as part of the existing historic district.

Only a portion of the Arverne high-frequency flood risk reduction measure have been subject to a prior survey (Dubos Point (8) and Brant Point (9) in Panamerican 2003). Additional investigations would include expanding a Phase I survey to the other portions of this high-frequency flood risk reduction measure as well as to the other three measures. In addition, the completed survey recommends for portions of the Arverne measure recommends additional investigations prior to or as part of construction activities in these areas. These include additional research on the bulkhead, limited subsurface testing, monitoring of deeper excavation, if conducted, for prehistoric land surfaces and potential remote sensing investigations on the water side of the area.

Two eligible properties, the NYC Transit System building and 2 Beach 85th are immediately adjacent to elements associated with the Hammels high-frequency flood risk reduction measure. They will not be adversely effected by the construction of the measures, however, information related to these structures may be identified during the proposed Phase I survey or that determination could change should the alignment of each floodwall or pump station changes.

The Corps has prepared a Programmatic Agreement which stipulates the activities the Corps will undertake to address the potential for adverse effects identified above (Enclosure 2). The preliminary draft Programmatic Agreement was included in the draft general reevaluation report and environmental impact statement as part of its public review and the identification of historic properties and determination of adverse effects was included in the public meetings held during the review period. Comments were received by the National Park Service and the New York City Landmarks Preservation Commission regarding the groins and the location of historic properties and city landmarks in relation to project features.

At this time, based on further analysis, it is likely that the groins within the Jacob Riis Park Historic District will not require rehabilitation. Since this determination has not been made, the analysis of all groins, including those in the historic district, will still be conducted, and the National Park Service will be a signatory to the Programmatic Agreement. Because the City of New York is a partner in this project, the New York City Landmarks Preservation Commission will also be requested to be a signatory to the

agreement. The Delaware Nation, Delaware Tribe, Stockbridge-Munsee Community, the Shinnecock Nation and the Unkechaug Nation are also being sent this information for any final comments. The programmatic agreement include continued consultation and coordination of information with them during the implementation of the agreement.

Please review the enclosed document and provide comments in accordance with 36 CFR Part 800.6. Any comments received will be incorporated into the agreement, which will then be circulated for execution. If you have any questions or need additional information, please contact Ms. Nancy J. Brighton at Nancy.J.Brighton@usace.army.mil or 202-761-4618.

Thank you for your assistance with this project.

Sincerely,

WEPPLER.PETER.M.1228647353
Digitally signed by WEPPLER.PETER.M.1228647353
Date: 2019.05.10 10:57:32 -04'00'

Peter Weppler
Chief, Environmental Analysis Branch

Enclosure

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

May 10, 2019

Planning Division

Ms. Susan Bachor
Historic Preservation Representative
Delaware Tribe of Indians
Special Assistant Eastern Office
P.O. Box 64
Pocono Lake, Pennsylvania 18347

Dear Ms. Bachor;

The U.S. Army Corps of Engineers, New York District (Corps) has prepared the General Reevaluation Report and Environmental Impact Statement for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens and Nassau Counties, New York. The proposed project will reduce the risk of damage from storms and cross shore flooding in addition to reducing the risk of flooding in areas along portions of the Jamaica Bay shoreline along the Rockaway peninsula.

The cultural resources investigation completed for this study consisted of the review of the previous surveys and a review of the New York State Historic Preservation Office Cultural Resources Information System. Much of the proposed project area had been included in previous surveys.

Undertaking

The measures proposed include the construction of a composite seawall buried along the beach, the construction of new and/or the extension of existing groins and sand fill along the Atlantic shoreline as well as four high-frequency flood risk reduction measures on Jamaica Bay in Cedarhurst-Lawrence, Hammels, Edgemere and Arverne, Queens and Nassau Counties, New York, as described in Enclosure 1. The APE would also include borrow areas identified as sand sources for the beach fill.

Areas of Potential Effect (APE)

The APE is the alignment of each of the measures included in the undertaking listed above and described in Enclosure 1. At this time no staging areas or access roads have been identified, however, given the nature of the surrounding area it is anticipated that staging areas will be within existing parking lots or the footprint of the alignment itself. If additional staging areas, access roads or other features are required they will be considered in this analysis once they are defined. The APE for archaeology, historic structures and historic landscapes has been defined as those areas along the proposed line of protection that would likely be directly impacted by project construction. The APE for historic structures and landscapes also includes those locations that would be anticipated to have visual impacts from the completed project.

Identification and Evaluation of Historic Properties

A number of prehistoric archaeological or Native American sites identified in and around Jamaica Bay and portions of the Rockaway Peninsula in the early twentieth century have been recorded in the New York State Museum files, although the exact locations or other information is unknown. Few sites have been identified on the main portion of the peninsula.

Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th and 26th Streets) are historic districts on the Rockaway Peninsula that are listed on the New York State and the National Registers of Historic Places. The Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club and Jacob Riis Historic Districts are all located within Gateway and are managed by the NPS. Other National Register listed or eligible properties include 2 Beach 85th Street, Hammels Pier, the New York City Transit System Building, the Rockaway Courthouse, the Temple of Israel Synagogue, the US Post Office at Far Rockaway, Trinity Chapel, the Russell Sage Memorial Church, the Trans World Airlines Flight Center at JFK International Airport, and The Marine Parkway - Gil Hodges Memorial Bridge.

The beach portion of the Jacob Riis Historic District is located within the western end of the Atlantic Shoreline APE. The Far Rockaway Beach Bungalow Historic District is located adjacent to the eastern end of the Atlantic shoreline APE. None of these historic districts are located within or near the APEs for the high-frequency flood risk reduction segments. Two Beach 85th Street, Hammels Pier and the New York City Transit System Building are located adjacent and potentially within the APE for two segments the Hammels high-frequency flood risk reduction measure (see Enclosure 1)

Assessment of Effect

Although no prehistoric or Native American archaeological sites have been identified along the Rockaway peninsula, the early discoveries at the eastern end of the peninsula do indicate a potential for utilization of the area. Sites on the peninsula, if present, may be more likely to be deeply buried as a result of the active forces of the ocean and storm surge. As part of the investigations for and construction of the reinforced dune/composite seawall, conduct geomorphological investigations to identify locations of prehistoric land surfaces that may require monitoring during excavation.

As determined for previous sand placement efforts, the placement of beach fill will not have an adverse effect on the known historic districts and properties located along the shoreline. The source of the sand will be from borrow areas for which a remote sensing survey and, in some cases, an underwater inspection of targets, has been completed. If a borrow area is selected for which an investigation has not been

completed or additional work is warranted, those investigations will be conducted prior to the use of the borrow area.

The proposed plan also intends to build new groins as well as rehabilitate and/or extend existing groins. Neither the original nomination for the Jacob Riis Park Historic District, nor the 2014 Final General Management Plan and Environmental Impact Statement mention the groins, although there are three within the current bounds of the historic district. A survey of the groins with in the shoreline APE will be conducted determine when they were built and if they are eligible for the National Register on their own or as part of the existing historic district.

Only a portion of the Arverne high-frequency flood risk reduction measure have been subject to a prior survey (Dubos Point (8) and Brant Point (9) in Panamerican 2003). Additional investigations would include expanding a Phase I survey to the other portions of this high-frequency flood risk reduction measure as well as to the other three measures. In addition, the completed survey recommends for portions of the Arverne measure recommends additional investigations prior to or as part of construction activities in these areas. These include additional research on the bulkhead, limited subsurface testing, monitoring of deeper excavation, if conducted, for prehistoric land surfaces and potential remote sensing investigations on the water side of the area.

Two eligible properties, the NYC Transit System building and 2 Beach 85th are immediately adjacent to elements associated with the Hammels high-frequency flood risk reduction measure. They will not be adversely effected by the construction of the measures, however, information related to these structures may be identified during the proposed Phase I survey or that determination could change should the alignment of each floodwall or pump station changes.

The Corps has prepared a Programmatic Agreement which stipulates the activities the Corps will undertake to address the potential for adverse effects identified above (Enclosure 2). The preliminary draft Programmatic Agreement was included in the draft general reevaluation report and environmental impact statement as part of its public review and the identification of historic properties and determination of adverse effects was included in the public meetings held during the review period.

At this time, based on further analysis, it is likely that the groins within the Jacob Riis Park Historic District will not require rehabilitation. Since this determination has not been made, the analysis of all groins, including those in the historic district, will still be conducted, and the National Park Service will be a signatory to the Programmatic Agreement.

Please review the enclosed document and provide comments in accordance with 36 CFR Part 800.6. Any comments received will be incorporated into the agreement before it is executed. If you have any questions or need additional information, please contact Ms. Nancy J. Brighton at Nancy.J.Brighton@usace.army.mil or 202-761-4618.

Thank you for your assistance with this project.

Sincerely,

WEPPLER.PETER.M.1228647353

Digitally signed by WEPPLER.PETER.M.1228647353
Date: 2019.05.10 11:00:31 -04'00'

Peter Weppler
Chief, Environmental Analysis Branch

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278-0090

May 10, 2019

Planning Division

Ms. Kim Penrod
Director
Delaware Nation
Cultural Resources
P.O. Box 825
Anadarko, OK 73005

Dear Ms. Penrod;

The U.S. Army Corps of Engineers, New York District (Corps) has prepared the General Reevaluation Report and Environmental Impact Statement for the Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens and Nassau Counties, New York. The proposed project will reduce the risk of damage from storms and cross shore flooding in addition to reducing the risk of flooding in areas along portions of the Jamaica Bay shoreline along the Rockaway peninsula.

The cultural resources investigation completed for this study consisted of the review of the previous surveys and a review of the New York State Historic Preservation Office Cultural Resources Information System. Much of the proposed project area had been included in previous surveys.

Undertaking

The measures proposed include the construction of a composite seawall buried along the beach, the construction of new and/or the extension of existing groins and sand fill along the Atlantic shoreline as well as four high-frequency flood risk reduction measures on Jamaica Bay in Cedarhurst-Lawrence, Hammels, Edgemere and Arverne, Queens and Nassau Counties, New York, as described in Enclosure 1. The APE would also include borrow areas identified as sand sources for the beach fill.

Areas of Potential Effect (APE)

The APE is the alignment of each of the measures included in the undertaking listed above and described in Enclosure 1. At this time no staging areas or access roads have been identified, however, given the nature of the surrounding area it is anticipated that staging areas will be within existing parking lots or the footprint of the alignment itself. If additional staging areas, access roads or other features are required they will be considered in this analysis once they are defined. The APE for archaeology, historic structures and historic landscapes has been defined as those areas along the proposed line of protection that would likely be directly impacted by project construction. The APE for historic structures and landscapes also includes those locations that would be anticipated to have visual impacts from the completed project.

Identification and Evaluation of Historic Properties

A number of prehistoric archaeological or Native American sites identified in and around Jamaica Bay and portions of the Rockaway Peninsula in the early twentieth century have been recorded in the New York State Museum files, although the exact locations or other information is unknown. Few sites have been identified on the main portion of the peninsula.

Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th and 26th Streets) are historic districts on the Rockaway Peninsula that are listed on the New York State and the National Registers of Historic Places. The Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club and Jacob Riis Historic Districts are all located within Gateway and are managed by the NPS. Other National Register listed or eligible properties include 2 Beach 85th Street, Hammels Pier, the New York City Transit System Building, the Rockaway Courthouse, the Temple of Israel Synagogue, the US Post Office at Far Rockaway, Trinity Chapel, the Russell Sage Memorial Church, the Trans World Airlines Flight Center at JFK International Airport, and The Marine Parkway - Gil Hodges Memorial Bridge.

The beach portion of the Jacob Riis Historic District is located within the western end of the Atlantic Shoreline APE. The Far Rockaway Beach Bungalow Historic District is located adjacent to the eastern end of the Atlantic shoreline APE. None of these historic districts are located within or near the APEs for the high-frequency flood risk reduction segments. Two Beach 85th Street, Hammels Pier and the New York City Transit System Building are located adjacent and potentially within the APE for two segments the Hammels high-frequency flood risk reduction measure (see Enclosure 1)

Assessment of Effect

Although no prehistoric or Native American archaeological sites have been identified along the Rockaway peninsula, the early discoveries at the eastern end of the peninsula do indicate a potential for utilization of the area. Sites on the peninsula, if present, may be more likely to be deeply buried as a result of the active forces of the ocean and storm surge. As part of the investigations for and construction of the reinforced dune/composite seawall, conduct geomorphological investigations to identify locations of prehistoric land surfaces that may require monitoring during excavation.

As determined for previous sand placement efforts, the placement of beach fill will not have an adverse effect on the known historic districts and properties located along the shoreline. The source of the sand will be from borrow areas for which a remote sensing survey and, in some cases, an underwater inspection of targets, has been completed. If a borrow area is selected for which an investigation has not been

completed or additional work is warranted, those investigations will be conducted prior to the use of the borrow area.

The proposed plan also intends to build new groins as well as rehabilitate and/or extend existing groins. Neither the original nomination for the Jacob Riis Park Historic District, nor the 2014 Final General Management Plan and Environmental Impact Statement mention the groins, although there are three within the current bounds of the historic district. A survey of the groins with in the shoreline APE will be conducted determine when they were built and if they are eligible for the National Register on their own or as part of the existing historic district.

Only a portion of the Arverne high-frequency flood risk reduction measure have been subject to a prior survey (Dubos Point (8) and Brant Point (9) in Panamerican 2003). Additional investigations would include expanding a Phase I survey to the other portions of this high-frequency flood risk reduction measure as well as to the other three measures. In addition, the completed survey recommends for portions of the Arverne measure recommends additional investigations prior to or as part of construction activities in these areas. These include additional research on the bulkhead, limited subsurface testing, monitoring of deeper excavation, if conducted, for prehistoric land surfaces and potential remote sensing investigations on the water side of the area.

Two eligible properties, the NYC Transit System building and 2 Beach 85th are immediately adjacent to elements associated with the Hammels high-frequency flood risk reduction measure. They will not be adversely effected by the construction of the measures, however, information related to these structures may be identified during the proposed Phase I survey or that determination could change should the alignment of each floodwall or pump station changes.

The Corps has prepared a Programmatic Agreement which stipulates the activities the Corps will undertake to address the potential for adverse effects identified above (Enclosure 2). The preliminary draft Programmatic Agreement was included in the draft general reevaluation report and environmental impact statement as part of its public review and the identification of historic properties and determination of adverse effects was included in the public meetings held during the review period.

At this time, based on further analysis, it is likely that the groins within the Jacob Riis Park Historic District will not require rehabilitation. Since this determination has not been made, the analysis of all groins, including those in the historic district, will still be conducted, and the National Park Service will be a signatory to the Programmatic Agreement.

Please review the enclosed document and provide comments in accordance with 36 CFR Part 800.6. Any comments received will be incorporated into the agreement before it is executed. If you have any questions or need additional information, please contact Ms. Nancy J. Brighton at Nancy.J.Brighton@usace.army.mil or 202-761-4618.

Thank you for your assistance with this project.

Sincerely,

WEPPLER.PETER.M.1228647353
Digitally signed by WEPPLER.PETER.M.1228647353
Date: 2019.05.10 11:11:19 -04'00'

Peter Weppler
Chief, Environmental Analysis Branch

Enclosures

Historic Properties Case Report
Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens and Nassau Counties, New York

U.S. Army Corps of Engineers, New York District

Introduction

The Rockaway peninsula and southern Queens was one of the areas most devastated by Hurricane Sandy in 2012. There were 10 fatalities and more than 1,000 structures either substantially damaged or destroyed. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes along the Peninsula. Prior to Hurricane Sandy, the U.S. Army Corps of Engineers, New York District (District), was undertaking an effort to identify a long-term solution for the study area, which focused on the Atlantic Ocean shoreline. Prior to this reformulation, an existing, authorized project for the area was constructed in 1977 and renourished periodically through 2004, based upon a 1965 construction authorization. The current study was authorized by Public Law 113-2, The Disaster Relief Appropriations Act of 2013.

As a federal agency, the District has certain responsibilities to take into account the effects of their undertakings on historic properties that may be located within the Area of Potential Effect (APE) associated with the proposed undertaking. Present statutes and regulations governing these responsibilities include the National Historic Preservation Act of 1966 as amended (NHPA; 54 U.S.C 3001), the Advisory Council on Historic Preservation (ACHP) regulations implementing Section 106 of the NHPA (36 C.F.R. Part 800 *Protection of Historic Properties* August 2004) the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) and Executive Order 11593. Significant cultural resources include any material remains of human activity potentially eligible for inclusion on the National Register of Historic Places (National Register) and historic properties are those resources that are listed or been determined eligible for the National Register.

Description of the Undertaking

The East Rockaway Inlet to Rockaway Inlet and Jamaica Bay coastal storm risk management project is proposing to reduce the study area's vulnerability to coastal storms and improve community and coastal resiliency to the Rockaway Peninsula and southern Queens. The measures proposed by this study include the construction of a composite seawall buried along the beach, the construction of new and/or the extension of existing groins and sand fill along the Atlantic shoreline as well as four high-frequency flood risk reduction measures on Jamaica Bay in Cedarhurst-Lawrence, Hammels, Edgemere and Arverne, Queens and Nassau Counties, New York (Figure 1).

Figure 1: Recommended plan overview with Atlantic shoreline features and high-frequency flood risk reduction measures.

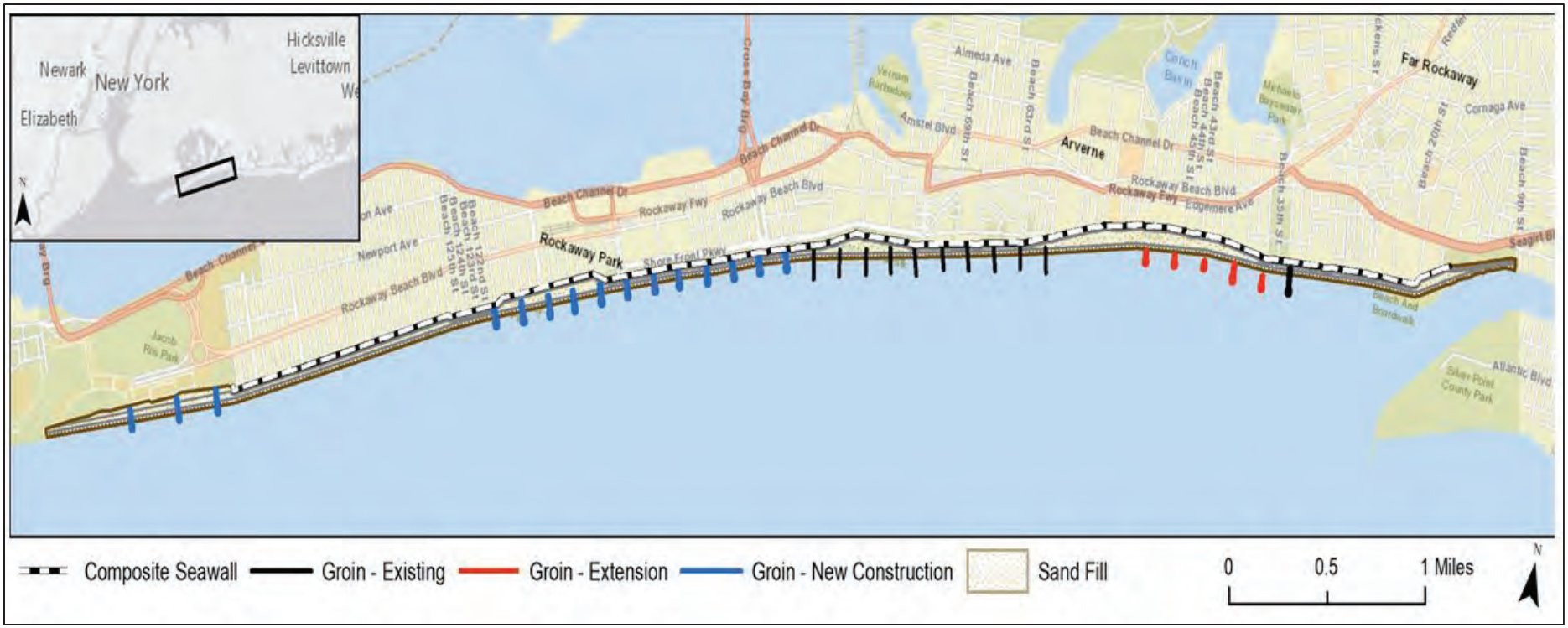


Figure 2: Atlantic Shorefront Component of the Recommended Plan

Figure 3: Groin rehabilitation and beach fill in Jacob Riis Park with the composite seawall just outside the park extending east along the Atlantic shoreline.

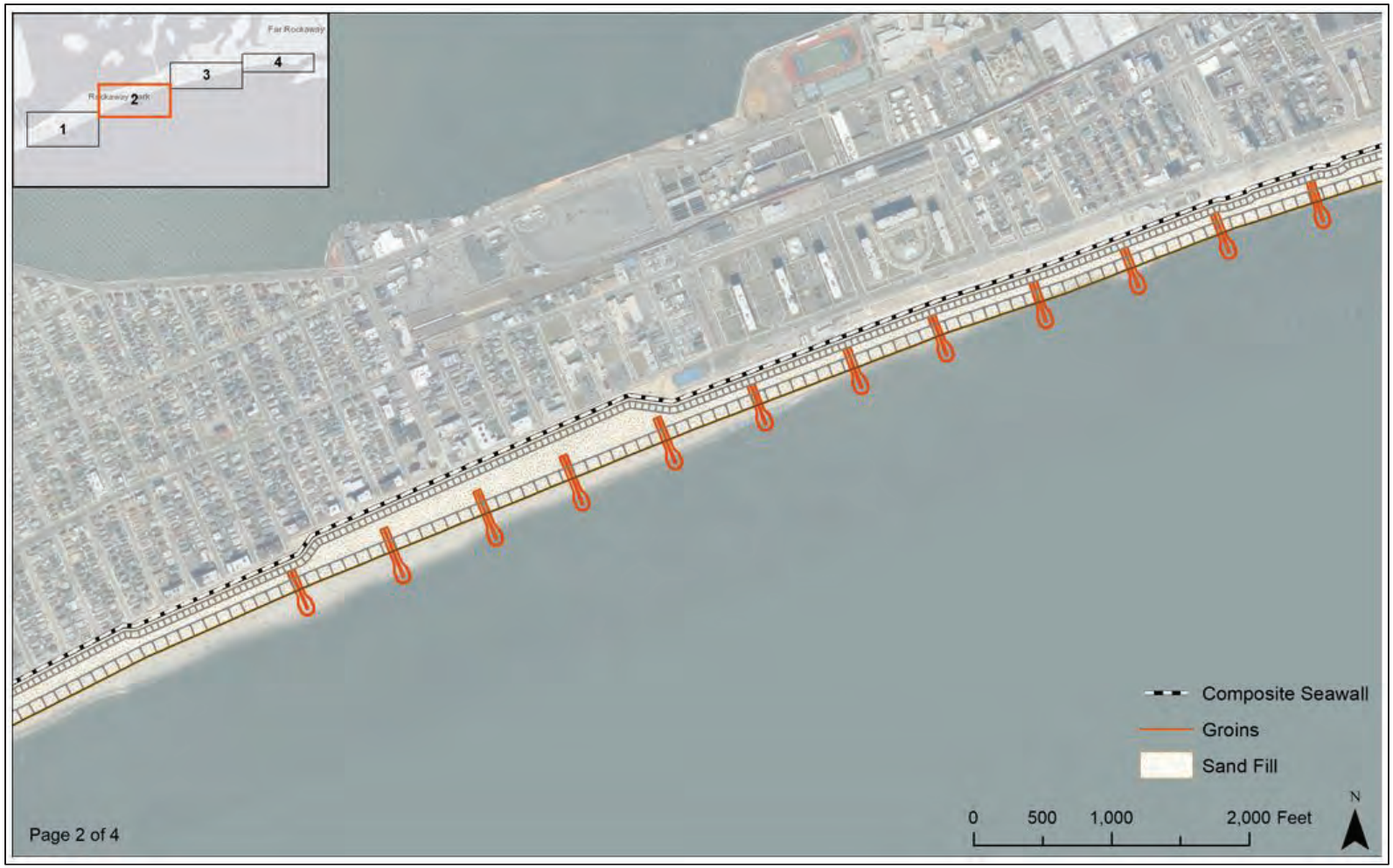


Figure 4: Groin Rehabilitation, beach fill and composite seawall along the Atlantic shoreline.

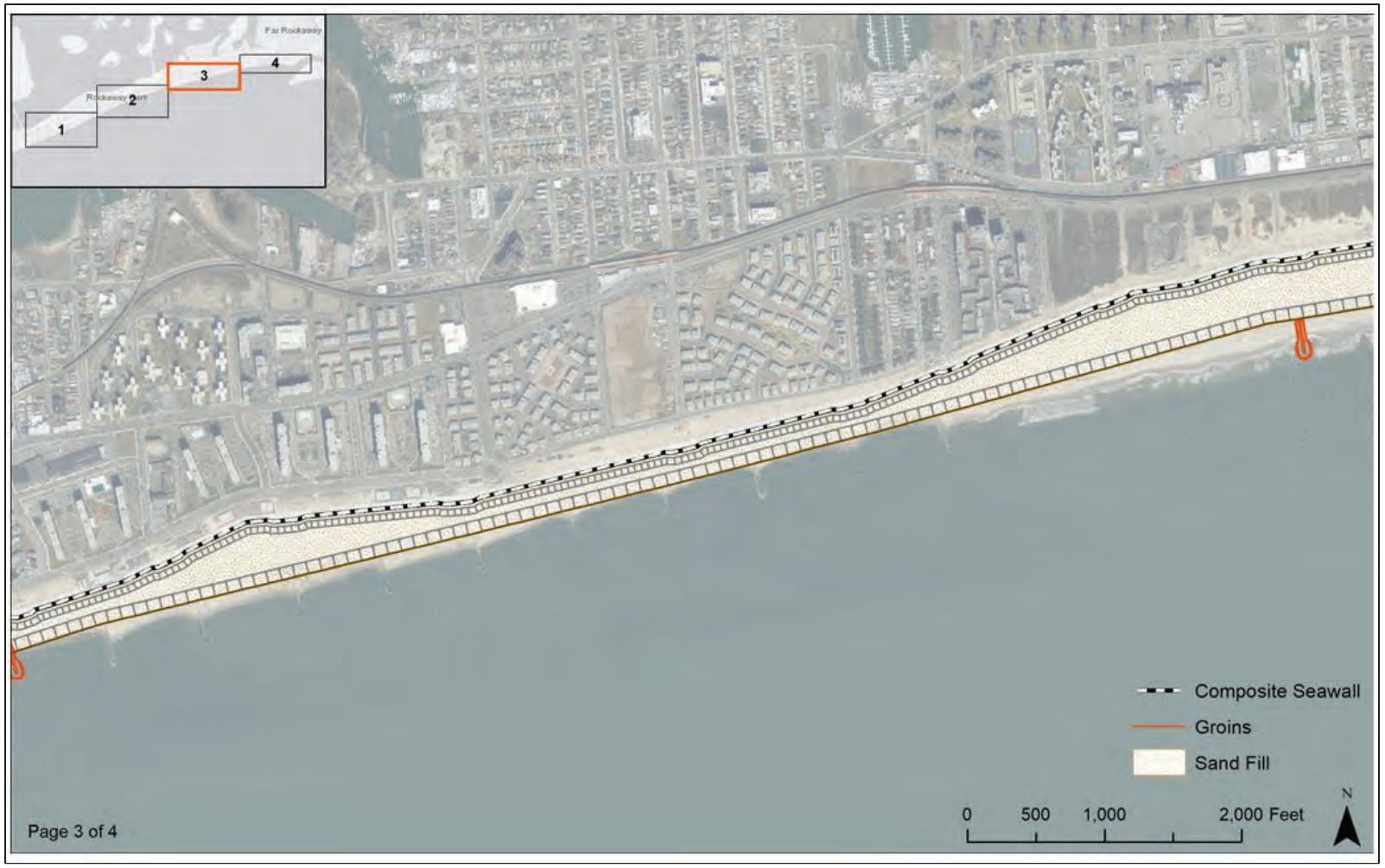


Figure 5: Composite seawall, beach fill and new groin construction (east) along the Atlantic shoreline.

Figure 6: New groin construction, beach fill and composite seawall along the Atlantic shoreline.

- Atlantic Shoreline Measures

These measures consist of a reinforced dune, also referred to as a composite seawall, approximately 60 feet wide and extending approximately 35,000 linear feet from Beach 9th to Beach 149th Street (Figures 2-6). The structure crest elevation of the seawall structure will be approximately +17 feet above NAVD 88. The dune height will be approximately +18 feet NAVD 88. The bottom of the reinforced dune will be approximately 15 feet below the dune crest. Beach fill will be placed along the reinforced dune and will be obtained from an offshore borrow area (see Figures 2-6). In addition, five existing groins will be extended and 13 new groins will be constructed (see Figures 4-6). Currently, three additional groin rehabilitations are proposed for Jacob Riis Park as well as the placement of sand fill (see Figure 3). Engineering analysis is being completed to determine if the rehabilitation of the Jacob Riis Park groins is necessary. The reinforced dune will not extend into Jacob Riis Park (see Figure 3).

- High-Frequency Flood Risk Reduction Measures

o Cedarhurst-Lawrence: Located in the channel adjacent to the Lawrence High School, this measure consists of 1,000 feet of bulkhead along the east, south and west sides where it will connect to high ground. A small extent of floodwall will be used to connect the bulkhead to the higher ground upland. The proposed elevation will be approximately 10 feet NAVD 88. The existing outfalls will be raised and a pump station will be constructed to receive stormwater when the outlets are blocked by storm surge or tide (Figure 7).

o Mid-Rockaway-Edgemere: This measure extends from Beach 35th to just beyond Beach 49th Street and will include a combination of a berm, hybrid berm, floodwall and bulkhead. Portions of the berm and hybrid berm will be fronted by scrub-shrub, salt meadow hay and smooth cordgrass natural features stabilized by a rock sill. It is anticipated that three pump stations and one road ramp will be needed. Proposed project elevations range from +8 to +9.5 feet NAVD 88 (Figure 8).

o Mid-Rockaway-Arverne: This measure extends from Almeda Avenue and Beach 58th Street all the way around Arvene's Jamaica Bay shoreline to Amstel Avenue just past Beach 74th Street. This alignment includes a berm, floodwall, revetment a bulkhead and hybrid berm. Natural features, including canopy tree, salt meadow hay, scrub-shrub, and smooth cordgrass, will be constructed in front of the floodwall, hybrid berm, and bulkhead, and protected by rock sill. Three pump stations, one flood gate and three road ramps will also be constructed (Figure 9).

o Mid-Rockaway – Hammels: This measure consists of two individual segments: an east segment of 1,400 linear feet of floodwall along Beach Channel Drive and a west segment of 1,400 linear feet from the Beach 84th Street to Beach Channel Drive. It

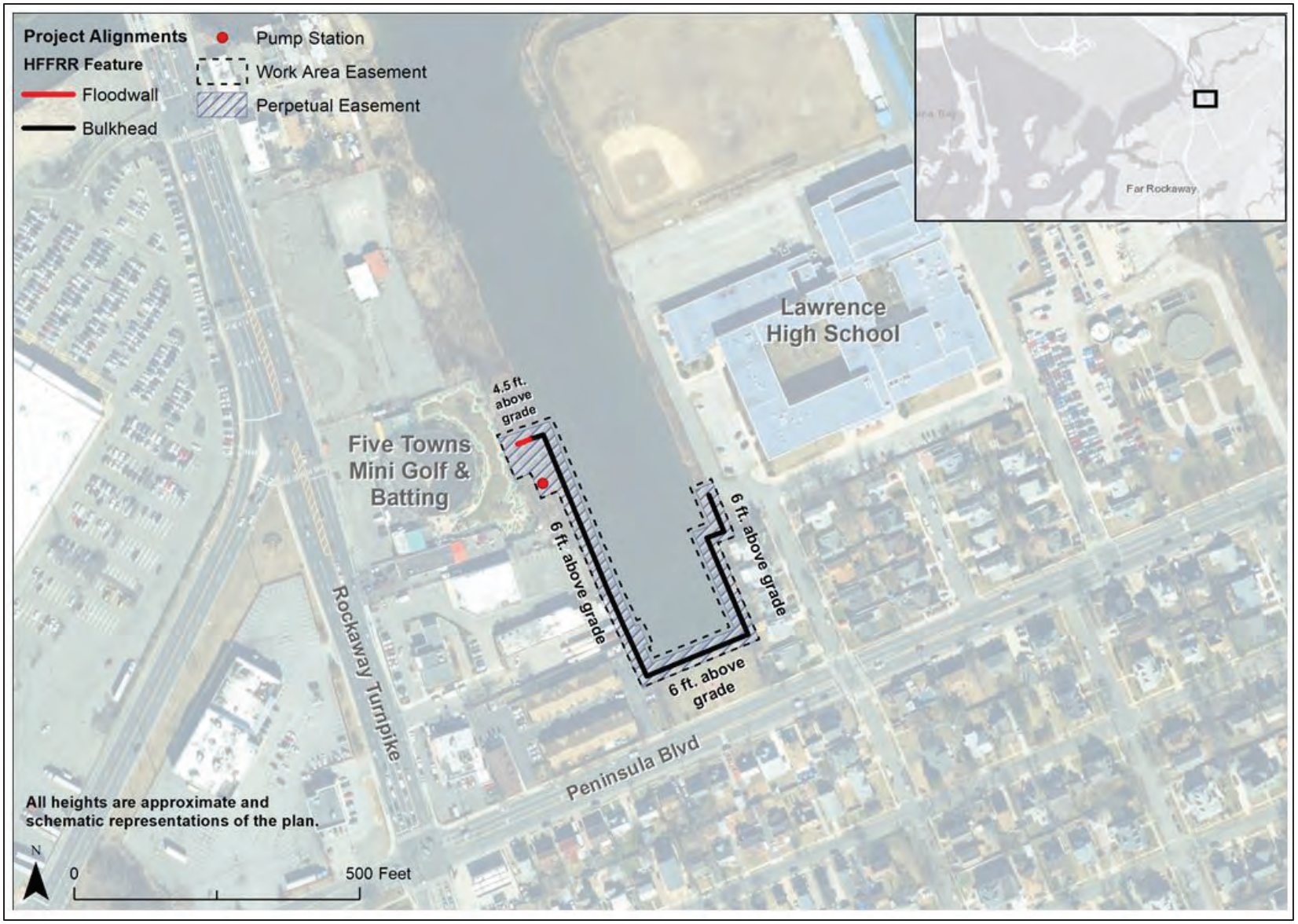


Figure 7: Cedarhurst-Lawrence High-Frequency Flood Risk Reduction Measures

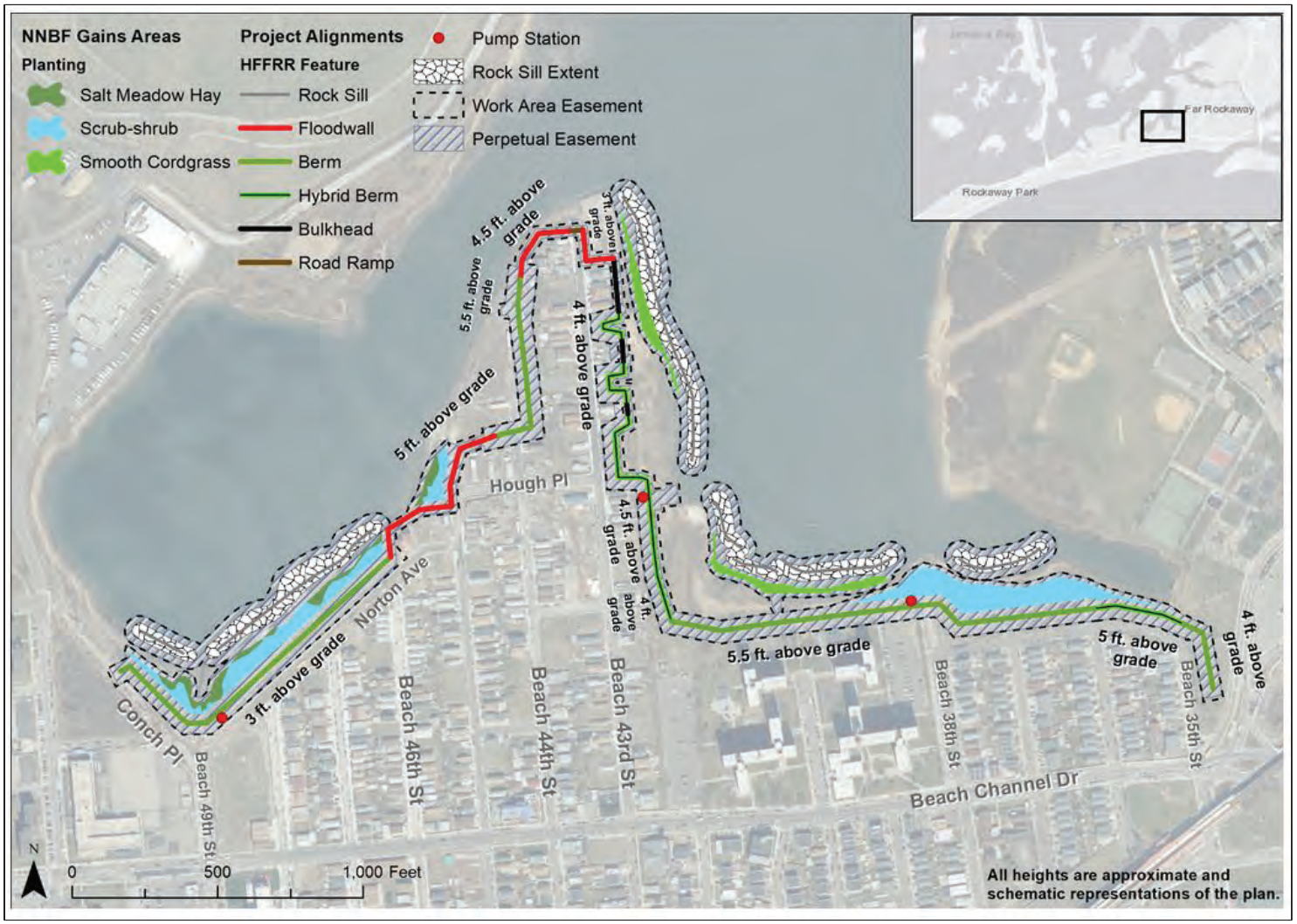


Figure 8: Edgemere High-Frequency Flood Risk Reductions Measures.

Figure 9: Arverne High-Frequency Flood Risk Reduction Measures

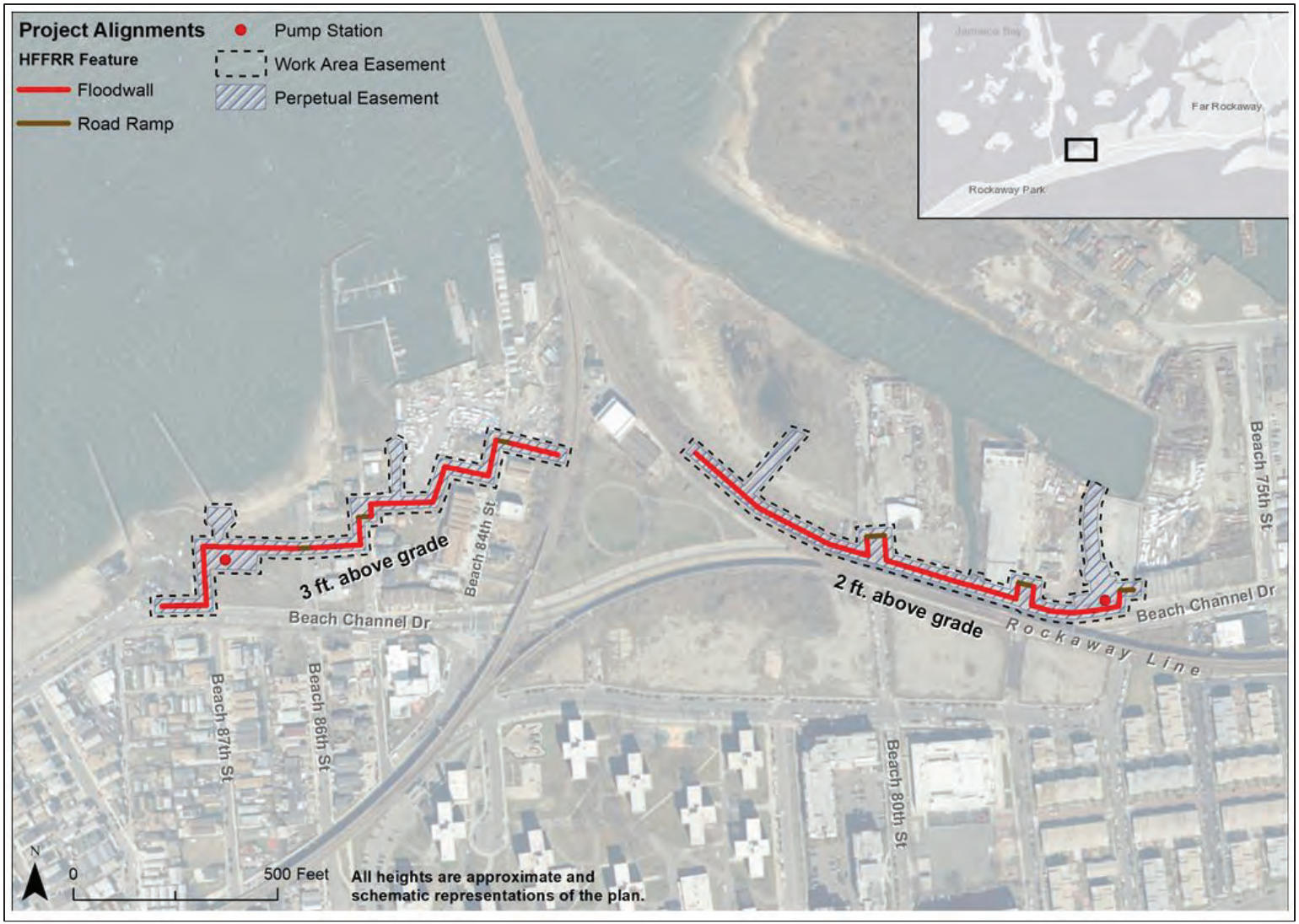


Figure 10: Hammels High-Frequency Flood Risk Reduction Measures

is anticipated that each segment will require one pump station. The segments will also require four road ramps; three on the east and one on the west (Figure 10).

Study Method and APE

The cultural resources investigation for this study has been limited to documentary research and a pedestrian survey. Documentary research consisted of gathering data from previous cultural resource studies and an examination of the New York State Historic Preservation Office (NYSHPO) Cultural Resources Information System (CRIS).

The APE is considered be located along the alignment of each of the measures described above as the undertaking to include the offshore borrow areas. At this time no staging areas or access roads have been identified, however, given the nature of the surrounding area it is anticipated that staging areas will be within existing parking lots or the footprint of the alignment itself. If additional staging areas, access roads or other features are required they will be considered in this analysis once they are defined. The APE for archaeology, historic structures and historic landscapes has been defined as those areas along the proposed line of protection that would likely be directly impacted by project construction. The APE for historic structures and landscapes also includes those locations that would be anticipated to have visual impacts from the completed project.

Previous Work

Reports utilized for this research included the cultural resources surveys conducted within and around the study's APEs. These include Gateway National Recreation Area (Gateway) Final General Management Plan Environmental Impact Statement (National Park Service [NPS] 2014) and the Jamaica Bay Cultural Resources Baseline Study and (Panamerican Consultants 2000, 2003, 2006), and remote sensing and inspection of targets (Panamerican Consultants 2003, 2005 and 2006 and Reiss 1994). This research included a review of the APEs on the NYSHPO CRIS database.

A western section of the Atlantic shoreline component is within the NPS' Gateway – Jamaica Bay Unit and both the eastern shoreline and high-frequency flood risk reduction components are located in the vicinity of the other elements of Gateway. In its cultural resources management plans for the area, the NPS has reported that there have been no Paleo-Indian or Archaic Period sites identified within its property. Woodland sites, characterized by the recovery of ceramic sherds, lithic artifacts and shell middens, have been identified within Gateway as have Contact period settlement sites, which included a mix of European and indigenous cultural items.

- Known Prehistoric Archaeological Sites

The New York State Museum files have a number of sites listed that were identified by Arthur C. Parker in the 1920s in and around Jamaica Bay and the Rockaway Peninsula and possibly within the vicinity of the study's APEs, although the exact locations and other information are unknown. These sites include:

Table 1: Arthur C. Parker sites recorded at the New York State Museum[1]

NYSM No.	Site Name	Period	Comments
4033	ACP NSAU 12A	Prehistoric or historic	Native American cemetery noted on the White Property near Cedarhurst
4034	ACP NSAU 13A	Prehistoric or historic	Possible Native American Village on Hicks Neck near Bannister Creek and Sage Pond
4050	ACP NSAU	Prehistoric	Camp site in general vicinity of Inwood, just southwest of the project area
4538	ACP QUNS	Prehistoric	Possible Native American village near Head of Bay
4547	ACP QUNS	Prehistoric	Traces of occupation near Head of Bay and Hook Creek
7772	ACP NSAU	Prehistoric or historic	Possible Native American village and shell midden site east of Woodmere Creek
7775	ACP NSAU	Prehistoric	Campsite near Sage Pond and Crooked Creek

[1]As reported in Panamerican Consultants 2003 and Merwin 2009.

In addition to Parker, other known prehistoric sites around Jamaica Bay were identified by Bolton (1920, 1922, and 1934) and Harrington (1909) (Panamerican 2003). Few sites have been identified on the Rockaway Peninsula and include NYSM-4050 above. A cemetery with associated artifacts was reported in Bayswater in 1901 as well as large shell deposits. As late as 1988, it was noted that located along the eastern shore of Jamaica Bay, in the vicinity of Bayswater, was a Woodland period site consisting of ceramics, projectile points, and a possible burial (Panamerican 2003).

These identified sites would be located outside the APEs for both the Atlantic shoreline and high-frequency flood risk reduction components but could be located nearby the Cedarhurst and Edgemere segments of the latter. It may be that on the Rockaway Peninsula, similar sites that have not been destroyed by development or storms may be more deeply buried.

- Known Historic Properties

Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th and 26th Streets) are historic districts on the Rockaway Peninsula that

are listed on the New York State and the National Registers of Historic Places. The Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club and Jacob Riis Historic Districts are all located within Gateway and are managed by the NPS. Other National Register listed or eligible properties include 2 Beach 85th Street, Hammels Pier, the New York City Transit System Building, the Rockaway Courthouse, the Temple of Israel Synagogue, the US Post Office at Far Rockaway, Trinity Chapel, the Russell Sage Memorial Church, the Trans World Airlines Flight Center at JFK International Airport, and The Marine Parkway - Gil Hodges Memorial Bridge.

One New York City designated landmark, the Richard Cornell Burial Ground, is located in Far Rockaway. Locally significant landmarks that have not been formally listed include the Waterfront Tribute Park, 9/11 Memorial and the American Airline Flight 587 Memorial.

The beach portion of the Jacob Riis Historic District is located within the western end of the Atlantic Shoreline APE (Figures 11 and 12). The Far Rockaway Beach Bungalow Historic District is located adjacent to the eastern end of the Atlantic shoreline APE (Figure 13). None of these historic districts are located within or near the APEs for the high-frequency flood risk reduction segments. Two Beach 85th Street, Hammels Pier and the New York City Transit System Building are located adjacent and potentially within the APE for two segments the Hammels high-frequency flood risk reduction measure (Figures 14 and 15).

No other historic properties or New York City landmarks are located in either component's APEs. The American Airline Flight 587 Memorial is located at the end of Beach 116th Street and is adjacent to the Atlantic shoreline APE (Figure 16).

Assessment of Effects and Recommendations

Based on the review of the existing data along the ocean and bayside of the Rockaway peninsula and along Jamaica Bay, there are National Register listed or eligible properties within or just adjacent to the APE that may be directly or indirectly effected by the project elements. Potential impacts to specific properties or category of properties is outline below and summarized in Table 2. The activities required to continue further study or to mitigate for adverse effects is included in the project Programmatic Agreement (Appendix A).

Although no prehistoric or Native American archaeological sites have been identified along the Rockaway peninsula, the early discoveries at the eastern end of the peninsula do indicate a potential for utilization of the area. Sites on the peninsula, if present, may be more likely to be deeply buried as a result of the active forces of the ocean and storm surge. As part of the investigations for and construction of the reinforced dune/composite seawall, conduct geomorphological investigations to identify locations of prehistoric land surfaces that may require monitoring during excavation.

As determined for previous sand placement efforts, the placement of beach fill will not have an adverse effect on the known historic districts and properties located along the shoreline. The source of the sand will be from borrow areas for which a remote sensing survey and, in some cases, an underwater inspection of targets, has been completed. If a borrow area is selected for which an investigation has not been completed or additional work is warranted, those investigations will be conducted prior to the use of the borrow area.

The proposed plan also intends to build new groins as well as rehabilitate and/or extend existing groins. Neither the original nomination for the Jacob Riis Park Historic District, nor the 2014 Final General Management Plan and Environmental Impact Statement mention the groins, although there are three within the current bounds of the historic district. A survey of the groins with in the shoreline APE will be conducted determine when they were built and if they are eligible for the National Register on their own or as part of the existing historic district.

Only a portion of the Arverne high-frequency flood risk reduction measures have been subject to a prior survey (Dubos Point (8) and Brant Point (9) in Panamerican 2003). Additional investigations would include expanding this survey to the other portions of this high-frequency flood risk reduction measure as well as to the other three similar measures. In addition, the completed survey recommends additional investigations prior to or as part of construction activities in these areas. These include additional research on the bulkhead, limited subsurface testing, monitoring of deeper excavation, if conducted, for prehistoric land surfaces and potential remote sensing investigations on the water side of the area.

Two eligible properties, the NYC Transit System building and 2 Beach 85th are immediately adjacent to elements associated with the Hammels high-frequency flood risk reduction measure. They will not be adversely effected by the construction of the measures, however, information related to these structures may be identified during the proposed Phase I survey or that determination could change should the alignment of each floodwall or pump station changes.

Figure 11: Location of Jacob Riis Park Historic District in relation to the project alignment APE.

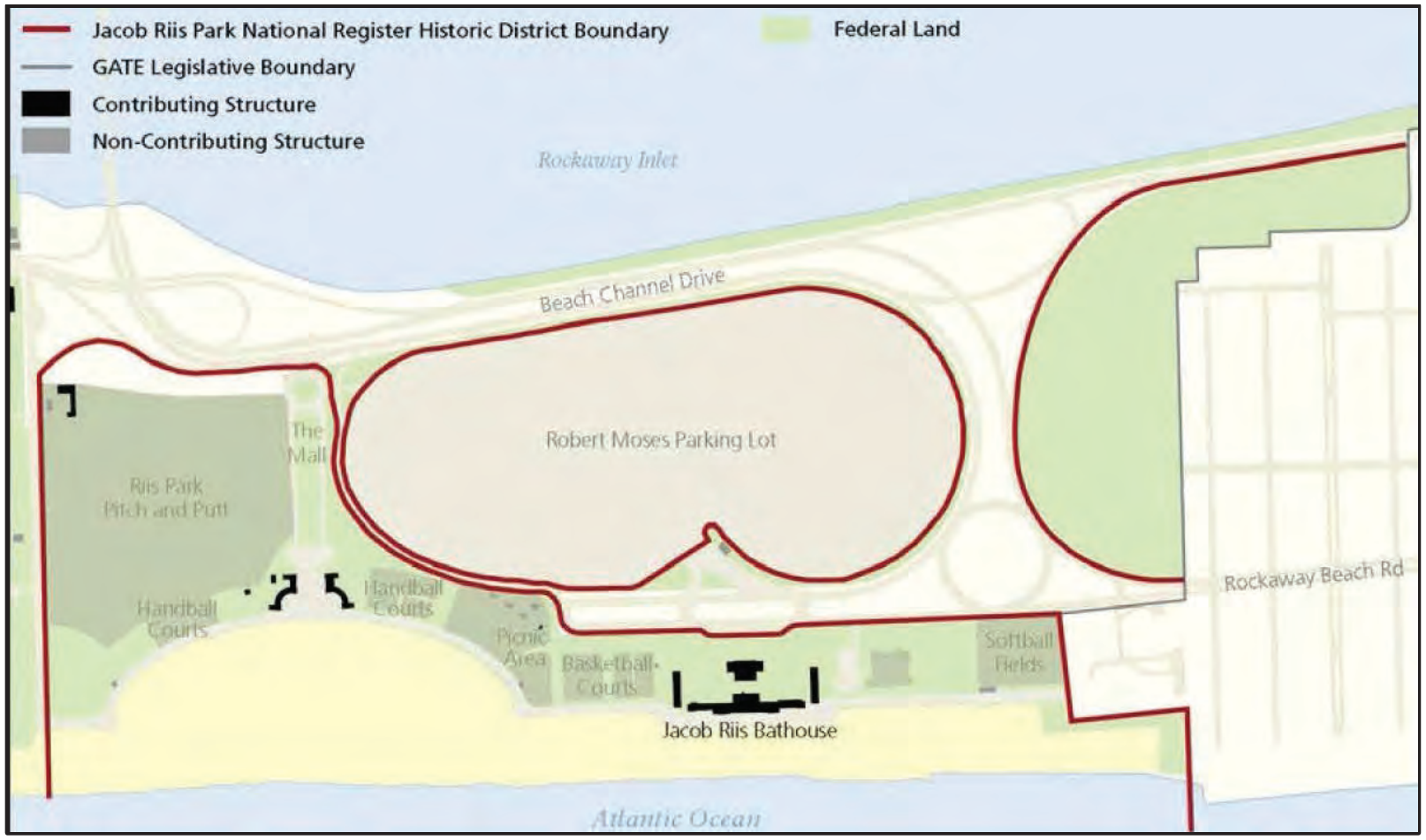


Figure 12: Jacob Riis Park Historic District elements.

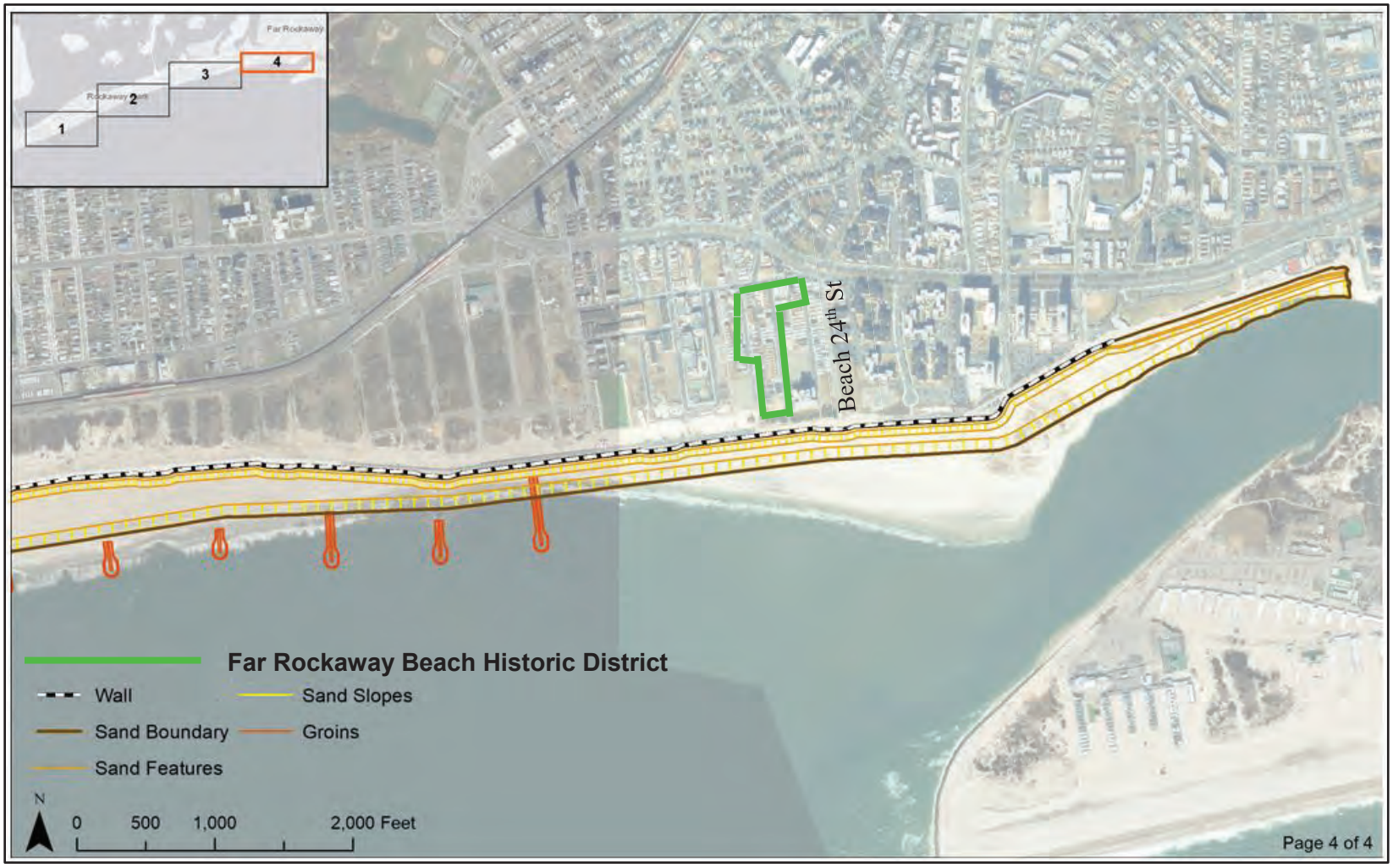


Figure 13: Location of the Far Rockaway Historic District and the project alignment APE.

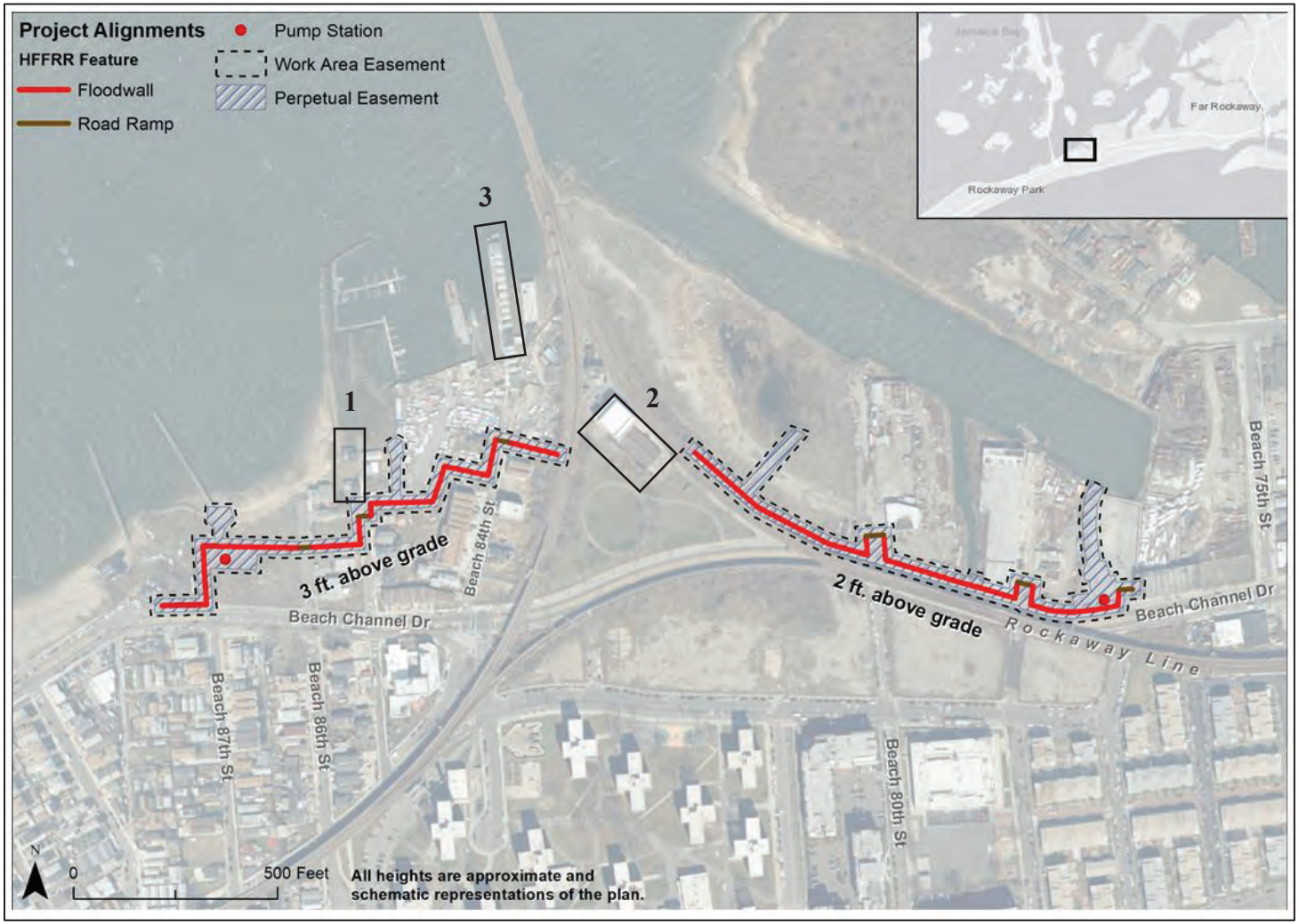


Figure 14: Location of 1) 2 Beach 85th Street; 2) New York City Transit System Building; and 3) Hammel Beach Pier and the Hammels high-frequency flood risk reduction measure alignments APE.

Figure 15: Photographs of the eligible properties near the Hammels high-frequency flood risk reduction: New York City Transit System building (top), 2 Beach 85th Street (middle) and the Hammels Pier (bottom) (NYSHPO CRIS 2019).

Figure 16: Location of Flight 587 Memorial Park.

Table 2: Assessment of Effects and Recommendations for Additional Work

Project Element	Resource	Recommendation
Reinforced dune/composite seawall	Potential prehistoric sites	Geomorphology with potential for monitoring during construction
Beach Fill	No historic properties affected	No additional work
Existing Borrow Areas	No historic properties affected	No additional work
New Borrow Areas	Potential prehistoric/historic resources	Remote sensing survey with potential underwater investigations
Groin Rehabilitation	Groins	Determine eligibility of groins as individual or historic district
Cedarhurst	Potential prehistoric/historic sites	Phase I survey; potential for subsurface investigations and remote sensing
Edgemere	Potential historic sites	Phase I survey
Arverne	Potential prehistoric/historic sites	Phase I survey; potential for subsurface investigations and remote sensing
Hammels	Potential prehistoric/historic sites	Phase I survey; potential for subsurface investigations and remote sensing; monitor alignment and proximity to eligible historic structures.

A Programmatic Agreement has been prepared to complete additional surveys on 1) the National Register eligibility of the groins along the Atlantic shoreline; 2) the potential for land surfaces and archaeological sites buried within the Rockaway peninsula; and 3) the potential for archaeological sites that might be affected by the high-frequency flood risk reduction measures. The public review of the draft General Reevaluation Report and Environmental Impact Statement included the discussion of affected historic properties as well as a preliminary draft of the programmatic agreement. The New York State Historic Preservation Office, the National Park Service, the New York City Landmarks Preservation Commission, the Delaware Nation, the Delaware Tribe, the Stockbridge-Munsee Community, the Shinnecock Nation and the Unkechaug Nation

were also provided a final draft to review and comment prior to execution of the agreement.

References

Merwin, Daria E.

2009 *A Cultural Resources Survey Report 2008-2009 Program Year, PIN 0072.14.101, New York State Route 878 (Nassau Expressway) Operational Improvement, Rockaway Turnpike to Burnside Avenue, Inwood, Town of Hempstead, Nassau County (Minor Civil Division 05930).* Institute for Long Island Archaeology, State University of New York at Stony Brook, Stony Brook, New York. Prepared for the New York State Museum, State Education Department. Sponsored by the New York State Department of Transportation and the Federal Highway Administration.

National Park Service

2014 *A New Vision for a Great Urban National Park: Gateway National Recreation Area, Final General Management Plan, Environmental Impact Statement.* U.S. Department of the Interior.

Panamerican Consultants

2000 *Cultural Resources Assessment of T-Groin Placement, Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens County, New York, Section 934.* Prepared for the U.S. Army Corps of Engineers, New York District.

2003 *Cultural Resources Baseline Study, Jamaica Bay Ecosystem Restoration Project, Kings, Queens and Nassau Counties, New York.* Prepared for the U.S. Army Corps of Engineers, New York District.

2005 *Remote Sensing Survey of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York.* Prepared for the U.S. Army Corps of Engineers, New York District.

2006 *Phase IB Investigations of Bayswater State Park and Paerdegat Basin, Jamaica Bay Ecosystem Restoration Project, Kings, Queens and Nassau Counties, New York*. Prepared for the U.S. Army Corps of Engineers, New York District.

Riess, Warren C.

1994 *East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York, Section 934 Study, Remote Sensing of Borrow Area 2.* Prepared by WCH Industries in association with Boston Affiliates. Submitted to the U.S. Army Corps of Engineers, New York District.

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
THE NEW YORK STATE HISTORIC PRESERVATION OFFICE,
THE NATIONAL PARK SERVICE,
AND
THE NEW YORK CITY LANDMARKS PRESERVATION COMMISSION
REGARDING
ATLANTIC COAST OF NEW YORK
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
GENERAL RE-EVALUTION STUDY

WHEREAS, the US Army Corps of Engineers, New York District (District) is proposing to undertake measures to reduce coastal storm damages and minimize impact on the Rockaway Peninsula from East Rockaway Inlet to Rockaway Inlet along the Atlantic Ocean and the Jamaica Bay shorelines as well as locations within Jamaica Bay (Undertaking); and

WHEREAS, the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York Hurricane Sandy General Re-Evaluation Study was authorized by the House of Representatives dated 27 September 1997 and Public Law 113-2 (29 Jan 13), the Disaster Relief Appropriations Act of 2013 authorized Corps projects for reducing flood and storm risks in the Hurricane Sandy affected area that have been or are under construction, which includes the Project; and

WHEREAS, the New York State Department of Environmental Conservation is the non-federal sponsor and New York City, through the New York City Mayor's Office Recovery and Resiliency is the local sponsor to New York State; and

WHEREAS, the Undertaking consists of levee, buried seawall, new groin construction, extension and rehabilitation of existing groins, and beach renourishment along the Atlantic Ocean shoreline of the Rockaway Peninsula, as well as residual high frequency flood risk reduction features consisting of berms, floodwalls, and bulkheads along the southeast side of Jamaica Bay (Attachments A and B); and

WHEREAS, the Area(s) of Potential Effect include the offshore borrow sites, near shore sand placement, the alignments for all of the Project features, the viewsheds associated with affected historic properties, including those from the shore to the Atlantic Ocean (Attachments A and B); and

WHEREAS, the Jacob Riis Park Historic District, and the Far Rockaway Bungalow Historic District are located within the APE along the Rockaway Peninsula (Attachments A and B); and

WHEREAS, the high frequency flood risk reduction features and other Project alignments have the potential to be sensitive for archaeological resources (Attachments A and B); and

WHEREAS, pursuant to 36 CFR Part 800, the regulations implementing

Section 106 of the National Historic Preservation Act (NHPA) (54 U.S.C 306108), the District has determined that implementation of the Project will have the potential to have an adverse effect on the Jacob Riis Park Historic District and archaeological resources potentially located within the alignment and the high frequency flood risk reduction measures; and

WHEREAS, the National Park Service (NPS) manages and administers the Jacob Riis Historic District, which is located within the Gateway National Recreation Area; and

WHEREAS, the District is consulting with and will continue to consult with the NPS, Gateway National Recreation Area, New York State Historic Preservation Office (NYSHPO), the Shinnecock Indian Nation, the Stockbridge-Munsee Community, the Delaware Tribe of Indians, the Delaware Nation (all federally-recognized Tribes), the New York state-recognized Unkecheug Indian Nation, and the New York City Landmarks Preservation Commission (NYCLPC), to define efficient and cost effective processes for taking into consideration the effects of the Project on historic properties; and

WHEREAS, the District will invite the NPS, NYSHPO, and the NYCLPC, to be signatories to this agreement; and

WHEREAS, the District has notified the Advisory Council on Historic Preservation (ACHP) of the potential for the Project to affect historic properties and that a programmatic agreement will be prepared; and

WHEREAS, the District has involved the general public through the National Environmental Policy Act (NEPA) process, which affords all persons, organizations, and government agencies the right to review and comment on proposed major federal actions that are evaluated by a NEPA document and participate in public meetings during the review of the feasibility report; and

NOW, THEREFORE, the District, NPS, NYCLPC and the NYSHPO agree that the Undertakings shall be implemented in accordance with the following stipulations in order to take into account the effects of the Undertakings on historic properties.

STIPULATIONS

I. BEACH FILL - BORROW AREA INVESTIGATIONS

A. A remote sensing (magnetometer and side scan sonar survey) of any borrow areas not previously surveyed will be conducted to identify any potential cultural resources. In addition, cores for any borrow areas not previously surveyed will be examined, if available, to determine the potential for the recovery of buried landsurfaces.

B. If a cultural resource(s), target(s), and/or anomaly(ies) are identified, the District will designate a buffer zone around each potential resource, as determined by the nature of the anomaly/return. Buffer zone(s) shall be clearly delineated on construction plans. No construction activities, including the removal of sand, anchoring, etc., that could potentially impact the wrecks will occur within the designated buffer zones.

C. If any targets and/or anomalies cannot be avoided, the District will consult with the NYSHPO to consider alternatives and determine the level of additional investigations (diving, documentation, additional reconnaissance diving, Phase II survey, etc.) are required.

D. The results of any investigations will be coordinated with the NYSHPO and other signatories and consulting parties.

E. If the anomalies/targets are determined to represent a historic property, the District in coordination with the NYSHPO will determine alternatives including avoidance, data recovery through underwater archaeological investigations, and documentation. The District will resolve adverse effects to historic properties in accordance with Stipulation IV below.

II. HIGH FREQUENCY FLOOD RISK REDUCTION FEATURES

A. The District will determine, in coordination and consultation with the NYSHPO, and the NYCLPC, what investigations are necessary to determine if the construction of any high frequency flood risk reduction features will have an adverse effect on historic properties. The District would carry out investigations, as necessary, to identify historic properties and determine the effect of the proposed features on identified features.

B. The District will document the results of any investigations and provide them for review to the NYSHPO, the federally-recognized Tribes, and the NYCLPC.

C. If a property is determined to be eligible for the National Register, the District will consult with the NYSHPO, federally-recognized Tribes and the NYCLPC to resolve the adverse effects in accordance with Stipulation IV below.

III. BURIED SEAWALL AND FLOODWALLS

A. The District will determine, in coordination and consultation with the NYSHPO, the NPS, and the NYCLPC what investigations are necessary to determine if the construction of buried seawalls, floodwalls, and other features that include subsurface disturbance will have an adverse effect on the built environment, including the beach, bulkhead, and/or groins that are contributing elements of the various historic districts, as well as on potentially sensitive areas for archaeological resources. These investigations may include, but not be limited to, construction monitoring and recordation and/or research, field investigations and analysis on the Rockaway Peninsula development to include the potential for deeply buried archaeological sites.

B. The District will document results of any investigations and provide them for review to the NYSHPO, NPS, the federally-recognized Tribes, and the NYCLPC.

C. If a property is determined to be eligible for the National Register, the District will consult with the NYSHPO, NPS, federally-recognized Tribes and the NYCLPC to resolve the adverse effects in accordance with Stipulation IV below.

IV. RESOLUTION OF ADVERSE EFFECTS

A. The District shall continue consultation with the NYSHPO, NPS, the federally-recognized Tribes, and the NYCLPC, and other consulting parties if identified, pursuant to 36 CFR Part 800.6 to avoid, minimize or mitigate adverse effects to historic properties.

B. The District shall notify the NYSHPO, NPS, the federally-recognized Tribes, and the NYCLPC, property owners and other consulting parties, if identified and provide documentation regarding the identification and evaluation of the historic properties. The District will work with the NYSHPO, other relevant signatories, etc. to determine how best to resolve any adverse effects and document the proposed resolution.

C. Once there is agreement on how the adverse effects will be resolved, the District shall prepare treatment plan that will identify the activities to be implemented that will resolve the adverse effects. The treatment plan will be provided for review and comment prior to implementation.

D. Should the District, NYSHPO, and the relevant signatories disagree on how the adverse effects will be resolved, the District shall seek to resolve such objection through consultation in accordance with procedures outlined in Stipulation X.C.

V. PUBLIC INVOLVEMENT AND OUTREACH

A. The District shall inform the public of the existence of this PA and the District's plan for meeting the stipulations of the PA. Copies of this agreement and relevant documentation prepared pursuant to the terms of this PA shall be made available for public inspection. Information regarding the specific locations of terrestrial and submerged archaeological sites, including potential wreck areas, will be withheld in accordance with the Freedom of Information Act and National Register Bulletin No. 29, if it appears that this information could jeopardize archaeological sites. Any comments received from the public related to the activities identified by this PA shall be taken into account by the District.

B. The District shall develop, in coordination with the NYSHPO, NPS, the federally-recognized Tribes, and the NYCLPC publically accessible information about the cultural resources and historic properties investigations for the Undertaking in the form of brief publication(s), exhibit(s), or website.

VI. CURATION

A. The District shall ensure that all collections resulting from the identification and evaluation of surveys, data recovery operations, or other investigations pursuant to this PA are maintained in accordance with 36 CFR Part 79 until the collection is turned over to the NPS, New York City, or other landowner/entity. Minimally, the District will ensure that analysis is complete and the final report(s) are produced and accepted by the NYSHPO prior to the turnover of collections to the appropriate entity.

B. The District shall be responsible for consulting with the NPS, New York City and other landowners regarding the curation of collections resulting from archaeological surveys,

data recovery operations, or other studies and activities pursuant to this agreement. The District shall coordinate the return of collections to non-federal landowners. If non-federal landowners wish to donate the collection, the District, in coordination with the NYSHPO, the NPS, the federally-recognized Tribes, and the NYCLPC to determine an appropriate entity to take control of the collection.

C. The District shall be responsible for the preparation of federally-owned collections and the associated records and non-federal collections donated for curation in accordance with the standards of the curation facility.

VII. UNANTICIPATED DISCOVERY

A. The following language shall be included in construction plans and specifications:

"When a previously identified cultural resource, including but not limited to archaeological sites, shipwrecks and the remains of ships and/or boats, standing structures, and properties of traditional religious and cultural significance to the federally-recognized Tribes are discovered during the execution of the Project, the individual(s) who made the discovery shall immediately secure the vicinity and make a reasonable effort to avoid or minimize harm to the resource, and notify the Project's Contracting Officer's Representative (COR) and the District. All activities shall cease within a minimum of 50 feet from the inadvertent discovery (50-foot radius 'no work' buffer) until authorized by the District and the Project COR.

B. If previously unidentified and unanticipated properties are discovered during Project activities, the District shall cease all work in the vicinity of the discovery until it can be evaluated in accordance with 36 CFR Part 800.13 "Post Review Discoveries". Upon notification of an unanticipated discovery, the District shall implement any additional reasonable measures to avoid or minimize effects to the resource. Any previously unidentified cultural resource will be treated as though it is eligible for the NRHP until such other determination may be made.

C. The District shall immediately notify the NYSHPO, the NPS, the federally-recognized Tribes, and the NYCLPC within 48 hours of the finding and request consultation to resolve potential adverse effects.

1. If the District, NYSHPO, the NPS, the federally-recognized Tribes, and the NYCLPC agree that the cultural resource is not eligible for the NRHP, then the suspension of work in the area of the discovery will end.

2. If the District, NYSHPO, the NPS, the federally-recognized Tribes, and the NYCLPC agree that the cultural resource is eligible for the NRHP, then the suspension of work will continue, and the District, in consultation with the NYSHPO, NPS, the federally-recognized Tribes and the NYCLPC, will determine the actions to avoid, minimize, or mitigate adverse effects to the historic property and will ensure that the appropriate actions are carried out.

3. If the District, the NYSHPO, the NPS, and the NYCLPC cannot agree on the appropriate course of action to address an unanticipated discovery or effects situation, then the District shall initiate the dispute resolution process set forth in Stipulation X.C below.

VIII. DISCOVERY OF HUMAN REMAINS

1. If any human remains and/or grave-associated artifacts are encountered during any of the investigations, including data recovery, the District will follow the NYSHPO Human Remains Discovery Protocol (2008; Attachment C) and, as appropriate, develop a treatment plan for human remains that is responsive to the ACHP's Policy Statement on Human Remains" (September 27, 1988), the Native American Graves Protection and Repatriation Act (PL 101-601) and , US Army Corps of Engineers, Policy Guidance Letter No. 57 (1998) Indian Sovereignty and Government-to-Government Relations with Indian Tribes.

2. The following language shall be included in the construction plans and specifications:

"When human remains, suspected human remains, or indications of a burial are discovered during the execution of a Project, the individual(s) who made the discovery shall immediately notify the local law enforcement, coroner/medical examiner, and the Project COR and the District, and make a reasonable effort to protect the remains from any harm. The human remains shall not be touched, moved or further disturbed. All activities shall cease within a minimum of 50 feet from the area of the find (50-foot radius 'no work' buffer) until authorized by the District."

IX. PROFESSIONAL QUALIFICATIONS AND STANDARDS

A. The District shall ensure that qualified professionals meeting the National Park Service professional qualifications for the appropriate discipline [National Park Service Professional Qualification Standards, Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (48 FR 44738-39)] are used to complete all identification and evaluation plans related to this undertaking, to include remote sensing surveys, underwater investigations, historic structure inventory and documentation.

B. All archaeological investigations carried out pursuant to this PA will be undertaken in accordance with the New York State Archaeological Council's Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State (1994) and Cultural Resources Standards Handbook (2000), the NYSHPO Archaeological Report Format Requirements (2005), and the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (36 CFR Part 68).

X. ADMINISTRATIVE TERMS

A. REPORTING

1. Each year following the execution of this PA until it expires or is terminated, the District shall provide the NYSHPO, NPS, the federally-recognized Tribes, all signatories, and interested parties a summary report detailing work undertaken pursuant to this PA. This report will include any scheduling changes, problems encountered, project work completed, PA activities completed, and any objections

and/or disputes received by the District in its efforts to carry out the terms of this PA.

2. Following authorization and appropriation, the District shall coordinate a meeting or equivalent with the signatories to be held annually on a mutually agreed upon date to evaluate the effectiveness of this PA and discuss activities carried out pursuant to this PA during the preceding year and activities scheduled for the upcoming year.

B. REVIEW PERIODS

1. The District shall ensure that all draft and final reports resulting from action pursuant to this PA will be provided to the NYSHPO, NPS, the federally-recognized Tribes, the NYCLPC, the Unkechaug Indian Nation, and to other interested parties, if identified.

2. The NYSHPO, ACHP, NPS, the federally-recognized Tribes, the NYCLPC, the Unkechaug Indian Nation, and any other interested party shall have 30 calendar days to review and/or object to determinations, evaluations, plans, reports and other documents submitted to them by the District.

3. Any comments and/or objections resulting from a review of any District determination, evaluations, plans, reports and other documents must be provided in writing to the District.

4. If comments, objections, etc., are not received within 30 calendar days, the District will assume concurrence with the subject determination, evaluation, plan, report or other document submitted.

C. DISPUTE RESOLUTION

1. Should any signatory object in writing to the District at any time to any actions proposed or the manner in which the terms of this PA are implemented, the District and the signatories shall attempt to resolve any disagreement arising from implementation of this PA.

2. If there is a determination that the disagreement cannot be resolved, the District shall forward all documentation relevant to the dispute to the ACHP and request the ACHP's recommendations or request the comments of the Council in accordance with 36 CFR Part 800.7(c).

3. The ACHP shall provide the District with its advice on the resolution of the objection within thirty (30) days of receiving adequate documentation. Any ACHP recommendations or comments provided in response will be considered in accordance with 36 CFR Part 800.7(c), with reference only to the subject of the dispute. The District shall respond to ACHP recommendations or comments indicating how the District has taken the ACHP recommendations or comments into account and complied with the ACHP recommendations or comments prior to proceeding with the Undertaking activities that are the subject to dispute. Responsibility to carry out all other actions under this PA that are not the subject of the dispute will remain unchanged.

4. If the ACHP does not provide its advice regarding the dispute within the thirty (30) calendar day time period, the District may make a final decision on the dispute and proceed accordingly. Prior to reaching such a final decision, the District shall prepare a written response that takes into account any timely comments regarding the dispute from the signatories to the PA, and provide them and the ACHP with a copy of such written response.

D. WITHDRAWAL AND TERMINATION

1. Any signatory may withdraw its participation in this PA by providing thirty (30) days advance written notification to all other signatories. In the event of withdrawal, any signatory to this PA may terminate it by providing 30 calendar days, written notice to the signatories. In the event of withdrawal, this PA will remain in effect for the remaining signatories.

2. This agreement may be terminated in accordance with 36 CFR Part 800, provided that the signatories consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. Any signatory requesting termination of this PA will provide thirty (30) days advance written notification to all other signatories.

3. In the event of termination, the District will comply with 36 CFR 800.4 through 800.6 with regard to individual undertakings covered by this Agreement.

E. DURATION AND SUNSET CLAUSE

1. This PA shall take effect upon execution by the District, the NYSHPO, and the signatories with the date of the final signature.

2. This PA will continue in full force and effect until the construction of the Project is complete and all terms of this PA are met, unless the Project is terminated or authorization is rescinded or a period of five years from execution of the PA has passed, at which time the agreement may be extended as written provided all signatories concur.

F.AMENDMENT

1. This PA may be amended upon agreement in writing by all signatories. Within thirty (30) days of a written request to the District, the District will facilitate consultation between the signatories regarding the proposed amendment.

2. Any amendments will be in writing and will be in effect on the date the amended PA is filed with the Council.

G. ANTI-DEFICIENCY ACT

All requirements set forth in this PA requiring expenditure of funds by the District are expressly subject to the availability of appropriations and the requirements of the Anti-Deficiency Act (31 U.S.C. 1341). No obligation undertaken by the District under the terms of this PA shall require or be interpreted to require a commitment to extend funds not appropriated for a particular purpose. If the District cannot perform any

obligation set forth in this PA because of unavailability of funds that obligation must be renegotiated among the District and the signatories as necessary.

Execution and implementation of this PA evidences that the District has satisfied its Section 106 responsibilities for all individual undertakings of the Project, and has afforded the NYSHPO and the ACHP an opportunity to comment on the undertaking and its effects on historic properties.

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
THE NEW YORK STATE HISTORIC PRESERVATION OFFICE,
THE NATIONAL PARK SERVICE,
AND
THE NEW YORK CITY LANDMARKS PRESERVATION COMMISSION
REGARDING
ATLANTIC COAST OF NEW YORK
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
GENERAL RE-EVALUTION STUDY

Execution and implementation of this PA evidences that the District has satisfied its Section 106 responsibilities for all individual undertakings of the Project, and has afforded the NYSHPO and the ACHP an opportunity to comment on the undertaking and its effects on historic properties.

By:_____ Date:_____
Thomas D. Asbery
Colonel, U.S. Army
District Engineer

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
THE NEW YORK STATE HISTORIC PRESERVATION OFFICE,
THE NATIONAL PARK SERVICE,
AND
THE NEW YORK CITY LANDMARKS PRESERVATION COMMISSION
REGARDING
ATLANTIC COAST OF NEW YORK
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
GENERAL RE-EVALUTION STUDY

Execution and implementation of this PA evidences that the District has satisfied its Section 106 responsibilities for all individual undertakings of the Project, and has afforded the NYSHPO and the ACHP an opportunity to comment on the undertaking and its effects on historic properties.

By:_____ Date:_____
National Park Service

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
THE NEW YORK STATE HISTORIC PRESERVATION OFFICE,
THE NATIONAL PARK SERVICE,
AND
THE NEW YORK CITY LANDMARKS PRESERVATION COMMISSION
REGARDING
ATLANTIC COAST OF NEW YORK
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
GENERAL RE-EVALUTION STUDY

Execution and implementation of this PA evidences that the District has satisfied its Section 106 responsibilities for all individual undertakings of the Project, and has afforded the NYSHPO and the ACHP an opportunity to comment on the undertaking and its effects on historic properties.

By:_____ Date:_____
Gina Santucci
Director of Environmental Review
New York City Landmarks Preservation Commission

PROGRAMMATIC AGREEMENT
AMONG
THE UNITED STATES ARMY CORPS OF ENGINEERS,
THE NEW YORK STATE HISTORIC PRESERVATION OFFICE,
THE NATIONAL PARK SERVICE,
AND
THE NEW YORK CITY LANDMARKS PRESERVATION COMMISSION
REGARDING
ATLANTIC COAST OF NEW YORK
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
GENERAL RE-EVALUTION STUDY

Execution and implementation of this PA evidences that the District has satisfied its Section 106 responsibilities for all individual undertakings of the Project, and has afforded the NYSHPO and the ACHP an opportunity to comment on the undertaking and its effects on historic properties.

By:_____ Date:_____
Daniel Mackay
Deputy Commissioner
Division for Historic Preservation
New York Office of Parks, Recreation and Historic Preservation

APPENDIX A: CULTURAL RESOURCES

Historic Properties Case Report
Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens and Nassau Counties, New York

U.S. Army Corps of Engineers, New York District

Introduction

The Rockaway peninsula and southern Queens was one of the areas most devastated by Hurricane Sandy in 2012. There were 10 fatalities and more than 1,000 structures either substantially damaged or destroyed. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes along the Peninsula. Prior to Hurricane Sandy, the U.S. Army Corps of Engineers, New York District (District), was undertaking an effort to identify a long-term solution for the study area, which focused on the Atlantic Ocean shoreline. Prior to this reformulation, an existing, authorized project for the area was constructed in 1977 and renourished periodically through 2004, based upon a 1965 construction authorization. The current study was authorized by Public Law 113-2, The Disaster Relief Appropriations Act of 2013.

As a federal agency, the District has certain responsibilities to take into account the effects of their undertakings on historic properties that may be located within the Area of Potential Effect (APE) associated with the proposed undertaking. Present statutes and regulations governing these responsibilities include the National Historic Preservation Act of 1966 as amended (NHPA; 54 U.S.C 3001), the Advisory Council on Historic Preservation (ACHP) regulations implementing Section 106 of the NHPA (36 C.F.R. Part 800 *Protection of Historic Properties* August 2004) the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) and Executive Order 11593. Significant cultural resources include any material remains of human activity potentially eligible for inclusion on the National Register of Historic Places (National Register) and historic properties are those resources that are listed or been determined eligible for the National Register.

Description of the Undertaking

The East Rockaway Inlet to Rockaway Inlet and Jamaica Bay coastal storm risk management project is proposing to reduce the study area's vulnerability to coastal storms and improve community and coastal resiliency to the Rockaway Peninsula and southern Queens. The measures proposed by this study include the construction of a composite seawall buried along the beach, the construction of new and/or the extension of existing groins and sand fill along the Atlantic shoreline as well as four high-frequency flood risk reduction measures on Jamaica Bay in Cedarhurst-Lawrence, Hammels, Edgemere and Arverne, Queens and Nassau Counties, New York (Figure 1).

Figure 1: Recommended plan overview with Atlantic shoreline features and high-frequency flood risk reduction measures.

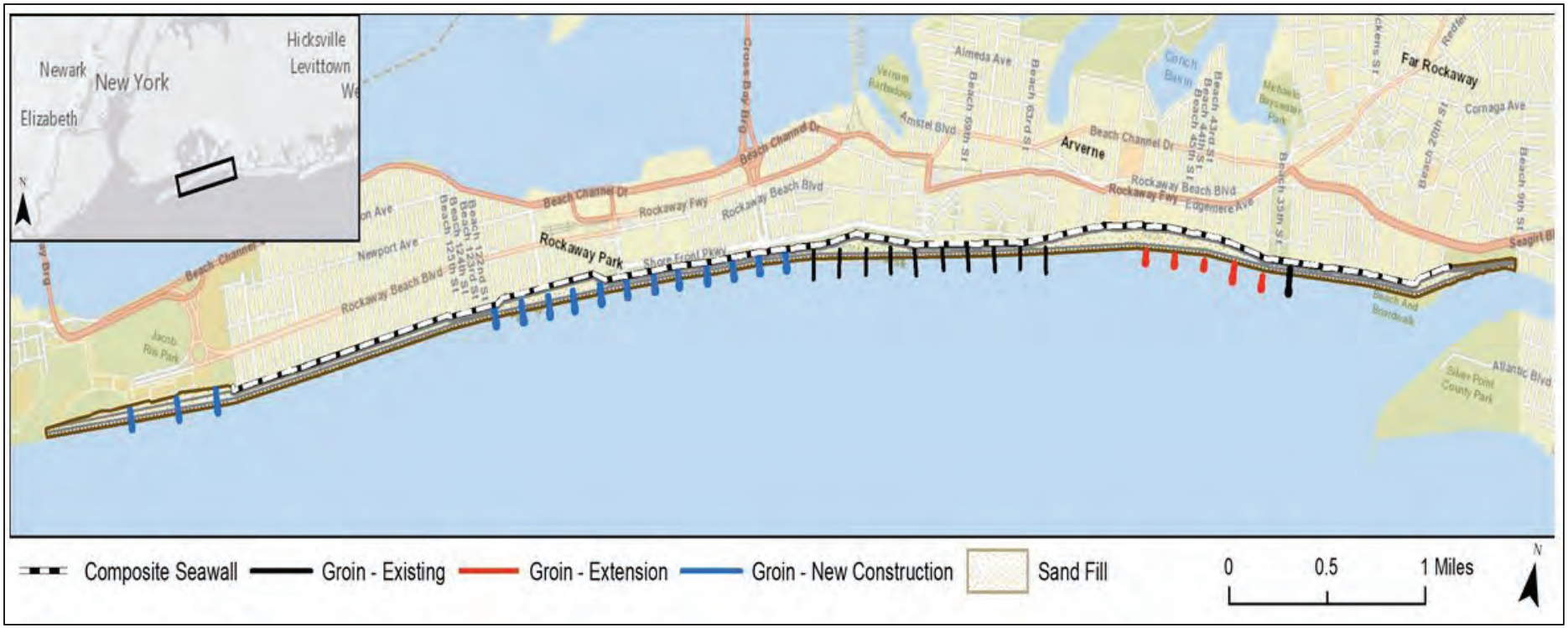


Figure 2: Atlantic Shorefront Component of the Recommended Plan

Figure 3: Groin rehabilitation and beach fill in Jacob Riis Park with the composite seawall just outside the park extending east along the Atlantic shoreline.

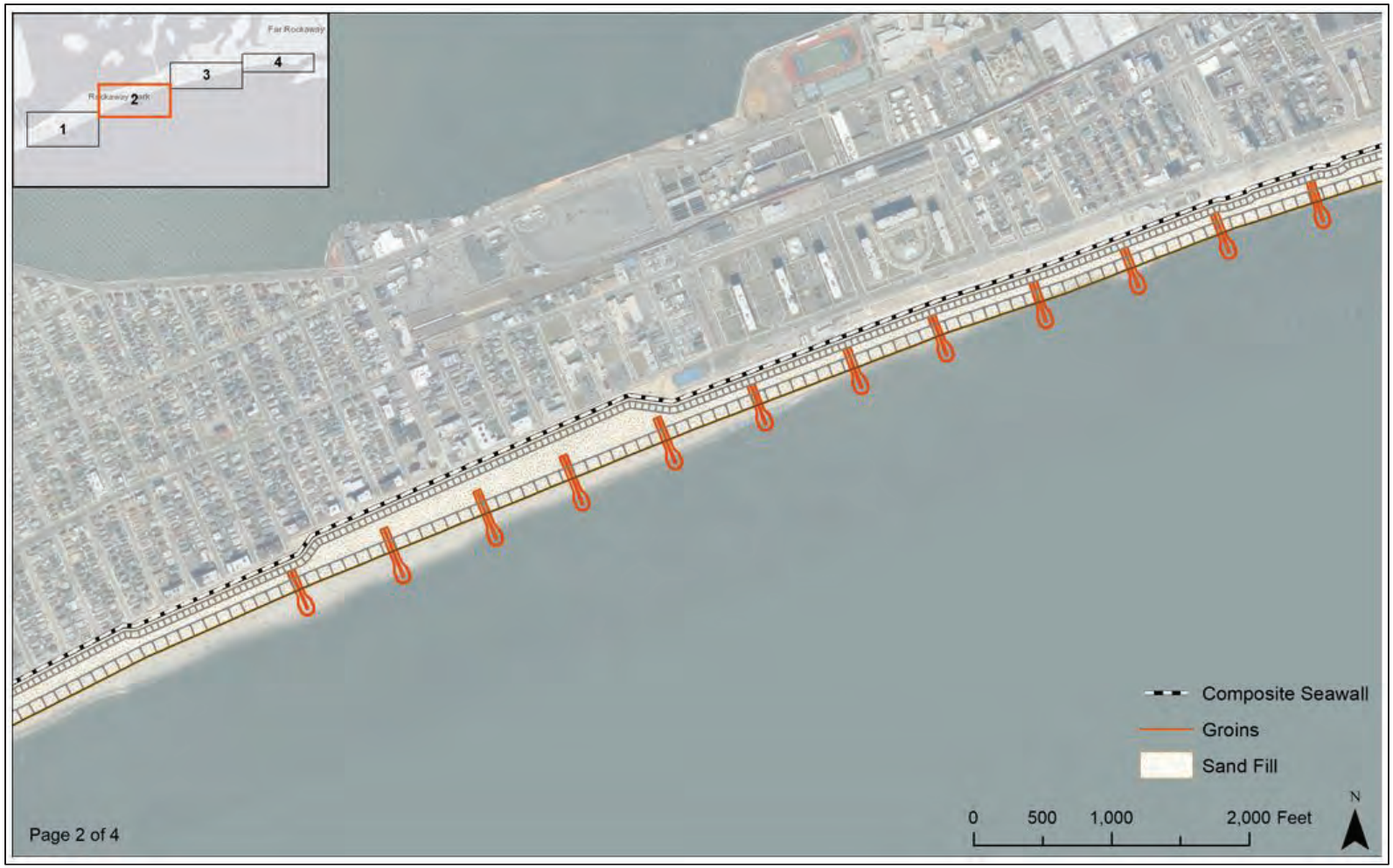


Figure 4: Groin Rehabilitation, beach fill and composite seawall along the Atlantic shoreline.

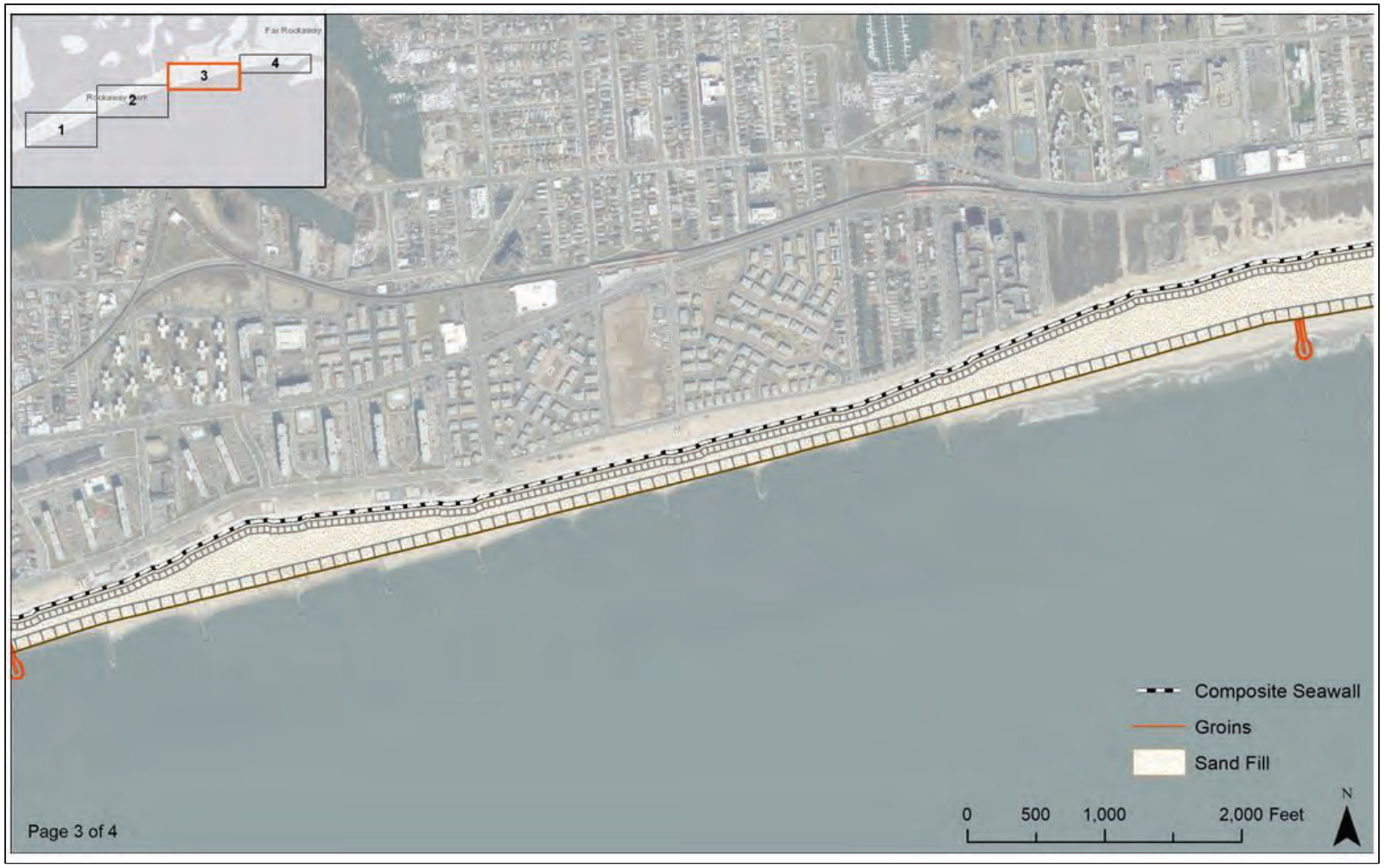


Figure 5: Composite seawall, beach fill and new groin construction (east) along the Atlantic shoreline.

Figure 6: New groin construction, beach fill and composite seawall along the Atlantic shoreline.

- Atlantic Shoreline Measures

These measures consist of a reinforced dune, also referred to as a composite seawall, approximately 60 feet wide and extending approximately 35,000 linear feet from Beach 9th to Beach 149th Street (Figures 2-6). The structure crest elevation of the seawall structure will be approximately +17 feet above NAVD 88. The dune height will be approximately +18 feet NAVD 88. The bottom of the reinforced dune will be approximately 15 feet below the dune crest. Beach fill will be placed along the reinforced dune and will be obtained from an offshore borrow area (see Figures 2-6). In addition, five existing groins will be extended and 13 new groins will be constructed (see Figures 4-6). Currently, three additional groin rehabilitations are proposed for Jacob Riis Park as well as the placement of sand fill (see Figure 3). Engineering analysis is being completed to determine if the rehabilitation of the Jacob Riis Park groins is necessary. The reinforced dune will not extend into Jacob Riis Park (see Figure 3).

- High-Frequency Flood Risk Reduction Measures

o Cedarhurst-Lawrence: Located in the channel adjacent to the Lawrence High School, this measure consists of 1,000 feet of bulkhead along the east, south and west sides where it will connect to high ground. A small extent of floodwall will be used to connect the bulkhead to the higher ground upland. The proposed elevation will be approximately 10 feet NAVD 88. The existing outfalls will be raised and a pump station will be constructed to receive stormwater when the outlets are blocked by storm surge or tide (Figure 7).

o Mid-Rockaway-Edgemere: This measure extends from Beach 35th to just beyond Beach 49th Street and will include a combination of a berm, hybrid berm, floodwall and bulkhead. Portions of the berm and hybrid berm will be fronted by scrub-shrub, salt meadow hay and smooth cordgrass natural features stabilized by a rock sill. It is anticipated that three pump stations and one road ramp will be needed. Proposed project elevations range from +8 to +9.5 feet NAVD 88 (Figure 8).

o Mid-Rockaway-Arverne: This measure extends from Almeda Avenue and Beach 58th Street all the way around Arvene's Jamaica Bay shoreline to Amstel Avenue just past Beach 74th Street. This alignment includes a berm, floodwall, revetment a bulkhead and hybrid berm. Natural features, including canopy tree, salt meadow hay, scrub-shrub, and smooth cordgrass, will be constructed in front of the floodwall, hybrid berm, and bulkhead, and protected by rock sill. Three pump stations, one flood gate and three road ramps will also be constructed (Figure 9).

o Mid-Rockaway – Hammels: This measure consists of two individual segments: an east segment of 1,400 linear feet of floodwall along Beach Channel Drive and a west segment of 1,400 linear feet from the Beach 84th Street to Beach Channel Drive. It

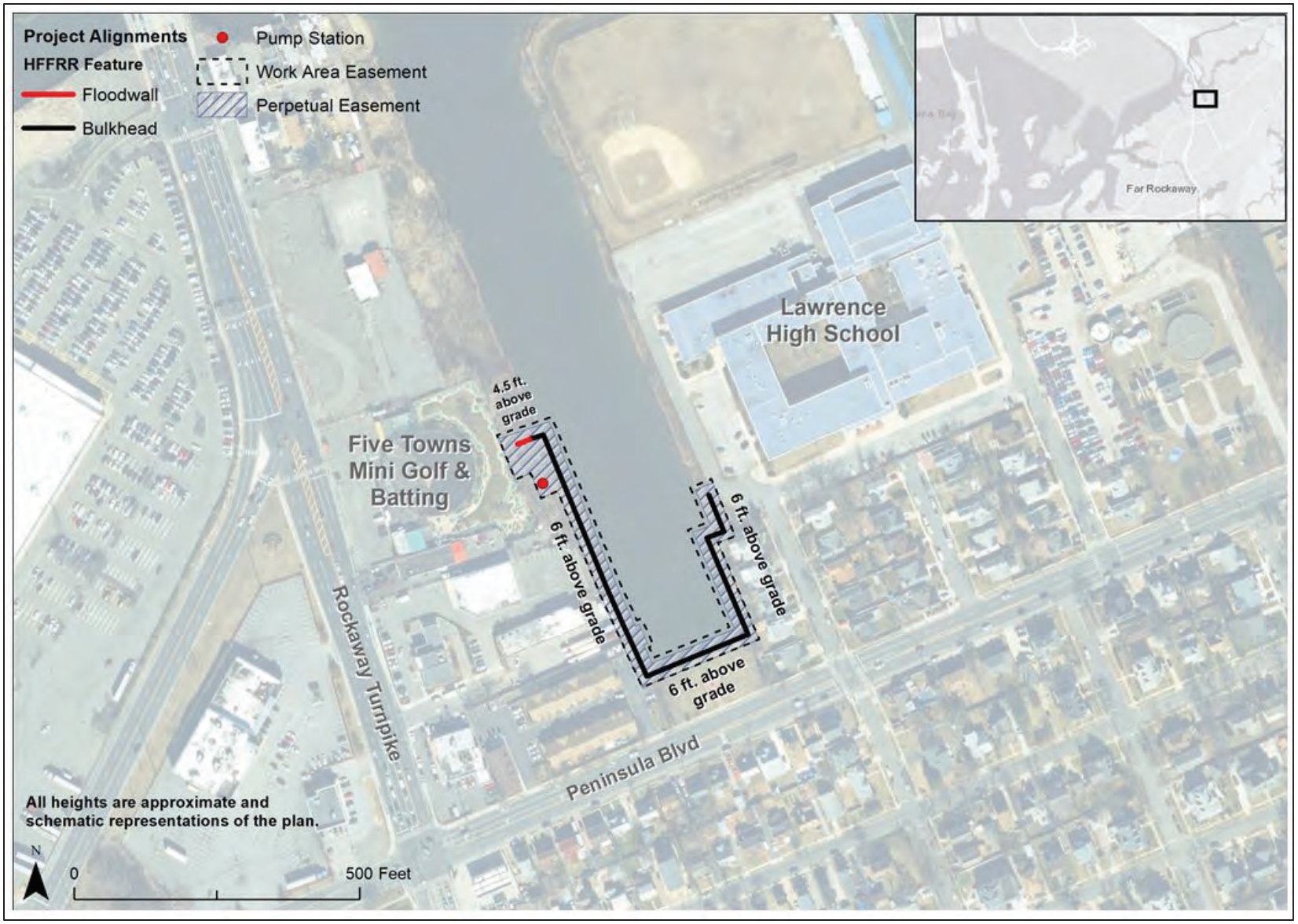


Figure 7: Cedarhurst-Lawrence High-Frequency Flood Risk Reduction Measures

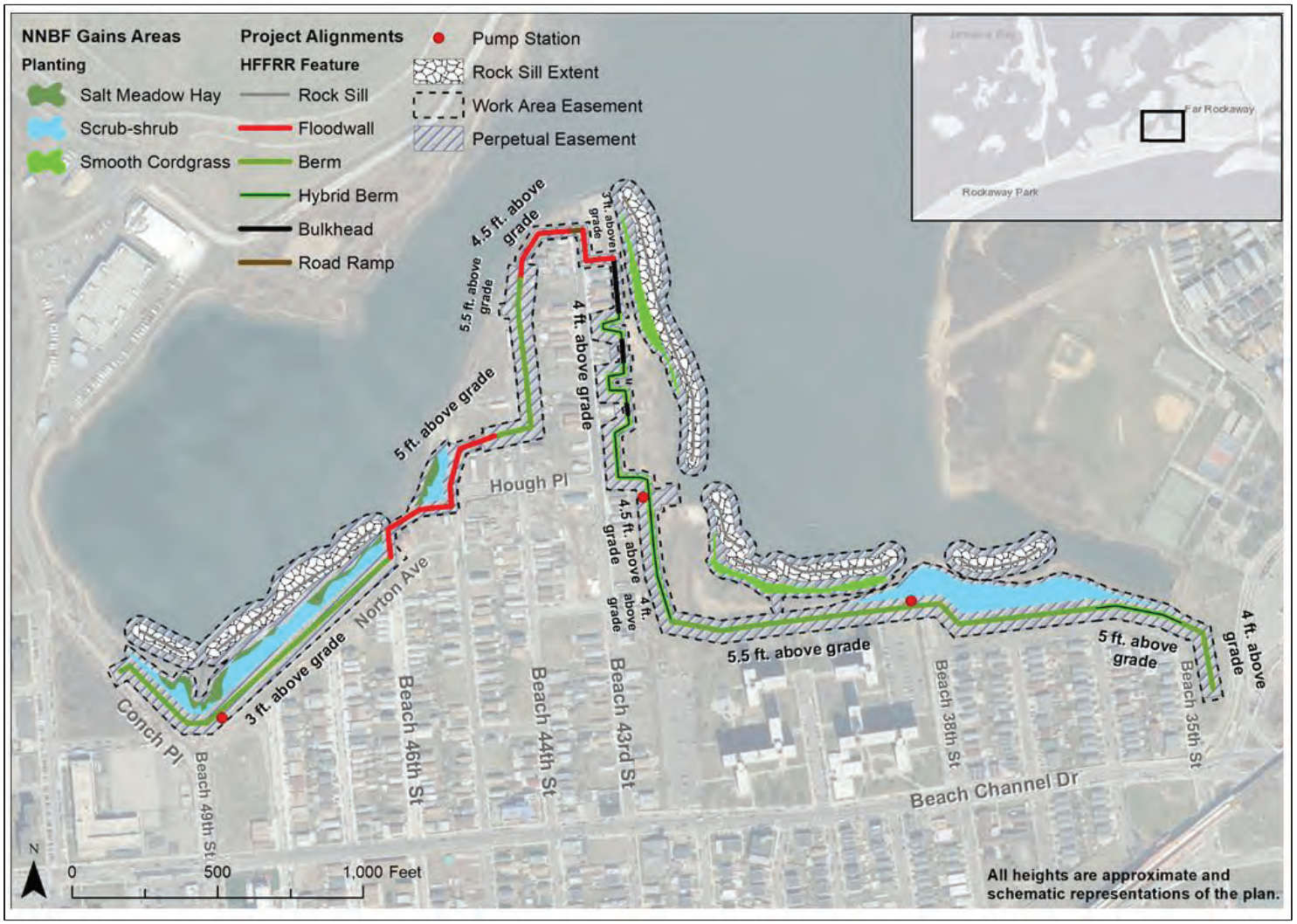


Figure 8: Edgemere High-Frequency Flood Risk Reductions Measures.

Figure 9: Arverne High-Frequency Flood Risk Reduction Measures

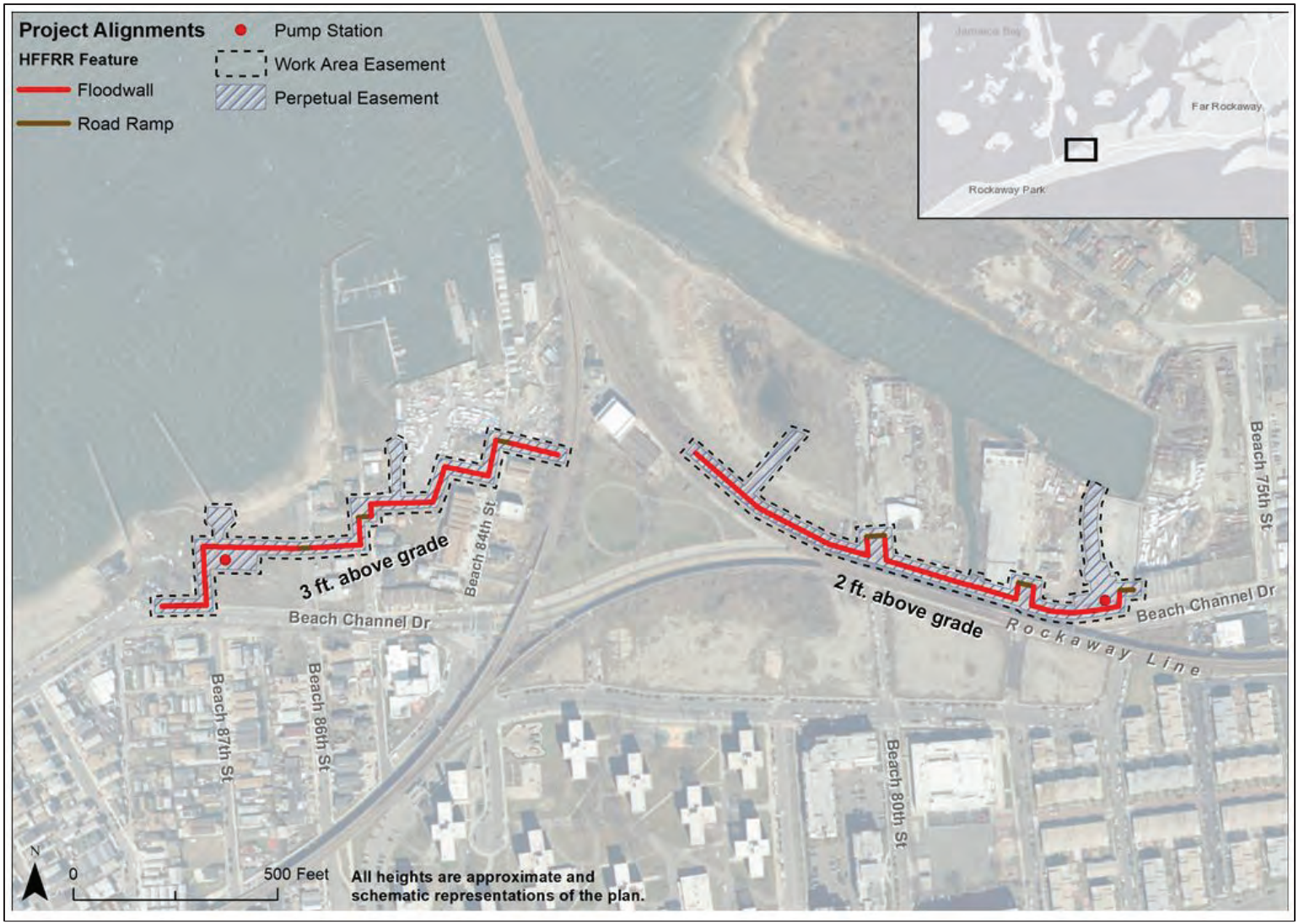


Figure 10: Hammels High-Frequency Flood Risk Reduction Measures

is anticipated that each segment will require one pump station. The segments will also require four road ramps; three on the east and one on the west (Figure 10).

Study Method and APE

The cultural resources investigation for this study has been limited to documentary research and a pedestrian survey. Documentary research consisted of gathering data from previous cultural resource studies and an examination of the New York State Historic Preservation Office (NYSHPO) Cultural Resources Information System (CRIS).

The APE is considered be located along the alignment of each of the measures described above as the undertaking to include the offshore borrow areas. At this time no staging areas or access roads have been identified, however, given the nature of the surrounding area it is anticipated that staging areas will be within existing parking lots or the footprint of the alignment itself. If additional staging areas, access roads or other features are required they will be considered in this analysis once they are defined. The APE for archaeology, historic structures and historic landscapes has been defined as those areas along the proposed line of protection that would likely be directly impacted by project construction. The APE for historic structures and landscapes also includes those locations that would be anticipated to have visual impacts from the completed project.

Previous Work

Reports utilized for this research included the cultural resources surveys conducted within and around the study's APEs. These include Gateway National Recreation Area (Gateway) Final General Management Plan Environmental Impact Statement (National Park Service [NPS] 2014) and the Jamaica Bay Cultural Resources Baseline Study and (Panamerican Consultants 2000, 2003, 2006), and remote sensing and inspection of targets (Panamerican Consultants 2003, 2005 and 2006 and Reiss 1994). This research included a review of the APEs on the NYSHPO CRIS database.

A western section of the Atlantic shoreline component is within the NPS' Gateway – Jamaica Bay Unit and both the eastern shoreline and high-frequency flood risk reduction components are located in the vicinity of the other elements of Gateway. In its cultural resources management plans for the area, the NPS has reported that there have been no Paleo-Indian or Archaic Period sites identified within its property. Woodland sites, characterized by the recovery of ceramic sherds, lithic artifacts and shell middens, have been identified within Gateway as have Contact period settlement sites, which included a mix of European and indigenous cultural items.

- Known Prehistoric Archaeological Sites

The New York State Museum files have a number of sites listed that were identified by Arthur C. Parker in the 1920s in and around Jamaica Bay and the Rockaway Peninsula and possibly within the vicinity of the study's APEs, although the exact locations and other information are unknown. These sites include:

Table 1: Arthur C. Parker sites recorded at the New York State Museum[1]

NYSM No.	Site Name	Period	Comments
4033	ACP NSAU 12A	Prehistoric or historic	Native American cemetery noted on the White Property near Cedarhurst
4034	ACP NSAU 13A	Prehistoric or historic	Possible Native American Village on Hicks Neck near Bannister Creek and Sage Pond
4050	ACP NSAU	Prehistoric	Camp site in general vicinity of Inwood, just southwest of the project area
4538	ACP QUNS	Prehistoric	Possible Native American village near Head of Bay
4547	ACP QUNS	Prehistoric	Traces of occupation near Head of Bay and Hook Creek
7772	ACP NSAU	Prehistoric or historic	Possible Native American village and shell midden site east of Woodmere Creek
7775	ACP NSAU	Prehistoric	Campsite near Sage Pond and Crooked Creek

[1]As reported in Panamerican Consultants 2003 and Merwin 2009.

In addition to Parker, other known prehistoric sites around Jamaica Bay were identified by Bolton (1920, 1922, and 1934) and Harrington (1909) (Panamerican 2003). Few sites have been identified on the Rockaway Peninsula and include NYSM-4050 above. A cemetery with associated artifacts was reported in Bayswater in 1901 as well as large shell deposits. As late as 1988, it was noted that located along the eastern shore of Jamaica Bay, in the vicinity of Bayswater, was a Woodland period site consisting of ceramics, projectile points, and a possible burial (Panamerican 2003).

These identified sites would be located outside the APEs for both the Atlantic shoreline and high-frequency flood risk reduction components but could be located nearby the Cedarhurst and Edgemere segments of the latter. It may be that on the Rockaway Peninsula, similar sites that have not been destroyed by development or storms may be more deeply buried.

- Known Historic Properties

Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club, Jacob Riis and the Far Rockaway Beach Bungalow Historic District (Beach 24th, 25th and 26th Streets) are historic districts on the Rockaway Peninsula that

are listed on the New York State and the National Registers of Historic Places. The Fort Tilden, the U.S. Coast Guard Far Rockaway, the Breezy Point Surf Club, the Silver Gull Beach Club and Jacob Riis Historic Districts are all located within Gateway and are managed by the NPS. Other National Register listed or eligible properties include 2 Beach 85th Street, Hammels Pier, the New York City Transit System Building, the Rockaway Courthouse, the Temple of Israel Synagogue, the US Post Office at Far Rockaway, Trinity Chapel, the Russell Sage Memorial Church, the Trans World Airlines Flight Center at JFK International Airport, and The Marine Parkway - Gil Hodges Memorial Bridge.

One New York City designated landmark, the Richard Cornell Burial Ground, is located in Far Rockaway. Locally significant landmarks that have not been formally listed include the Waterfront Tribute Park, 9/11 Memorial and the American Airline Flight 587 Memorial.

The beach portion of the Jacob Riis Historic District is located within the western end of the Atlantic Shoreline APE (Figures 11 and 12). The Far Rockaway Beach Bungalow Historic District is located adjacent to the eastern end of the Atlantic shoreline APE (Figure 13). None of these historic districts are located within or near the APEs for the high-frequency flood risk reduction segments. Two Beach 85th Street, Hammels Pier and the New York City Transit System Building are located adjacent and potentially within the APE for two segments the Hammels high-frequency flood risk reduction measure (Figures 14 and 15).

No other historic properties or New York City landmarks are located in either component's APEs. The American Airline Flight 587 Memorial is located at the end of Beach 116th Street and is adjacent to the Atlantic shoreline APE (Figure 16).

Assessment of Effects and Recommendations

Based on the review of the existing data along the ocean and bayside of the Rockaway peninsula and along Jamaica Bay, there are National Register listed or eligible properties within or just adjacent to the APE that may be directly or indirectly effected by the project elements. Potential impacts to specific properties or category of properties is outline below and summarized in Table 2. The activities required to continue further study or to mitigate for adverse effects is included in the project Programmatic Agreement (Appendix A).

Although no prehistoric or Native American archaeological sites have been identified along the Rockaway peninsula, the early discoveries at the eastern end of the peninsula do indicate a potential for utilization of the area. Sites on the peninsula, if present, may be more likely to be deeply buried as a result of the active forces of the ocean and storm surge. As part of the investigations for and construction of the reinforced dune/composite seawall, conduct geomorphological investigations to identify locations of prehistoric land surfaces that may require monitoring during excavation.

As determined for previous sand placement efforts, the placement of beach fill will not have an adverse effect on the known historic districts and properties located along the shoreline. The source of the sand will be from borrow areas for which a remote sensing survey and, in some cases, an underwater inspection of targets, has been completed. If a borrow area is selected for which an investigation has not been completed or additional work is warranted, those investigations will be conducted prior to the use of the borrow area.

The proposed plan also intends to build new groins as well as rehabilitate and/or extend existing groins. Neither the original nomination for the Jacob Riis Park Historic District, nor the 2014 Final General Management Plan and Environmental Impact Statement mention the groins, although there are three within the current bounds of the historic district. A survey of the groins with in the shoreline APE will be conducted determine when they were built and if they are eligible for the National Register on their own or as part of the existing historic district.

Only a portion of the Arverne high-frequency flood risk reduction measures have been subject to a prior survey (Dubos Point (8) and Brant Point (9) in Panamerican 2003). Additional investigations would include expanding this survey to the other portions of this high-frequency flood risk reduction measure as well as to the other three similar measures. In addition, the completed survey recommends additional investigations prior to or as part of construction activities in these areas. These include additional research on the bulkhead, limited subsurface testing, monitoring of deeper excavation, if conducted, for prehistoric land surfaces and potential remote sensing investigations on the water side of the area.

Two eligible properties, the NYC Transit System building and 2 Beach 85th are immediately adjacent to elements associated with the Hammels high-frequency flood risk reduction measure. They will not be adversely effected by the construction of the measures, however, information related to these structures may be identified during the proposed Phase I survey or that determination could change should the alignment of each floodwall or pump station changes.

Figure 11: Location of Jacob Riis Park Historic District in relation to the project alignment APE.

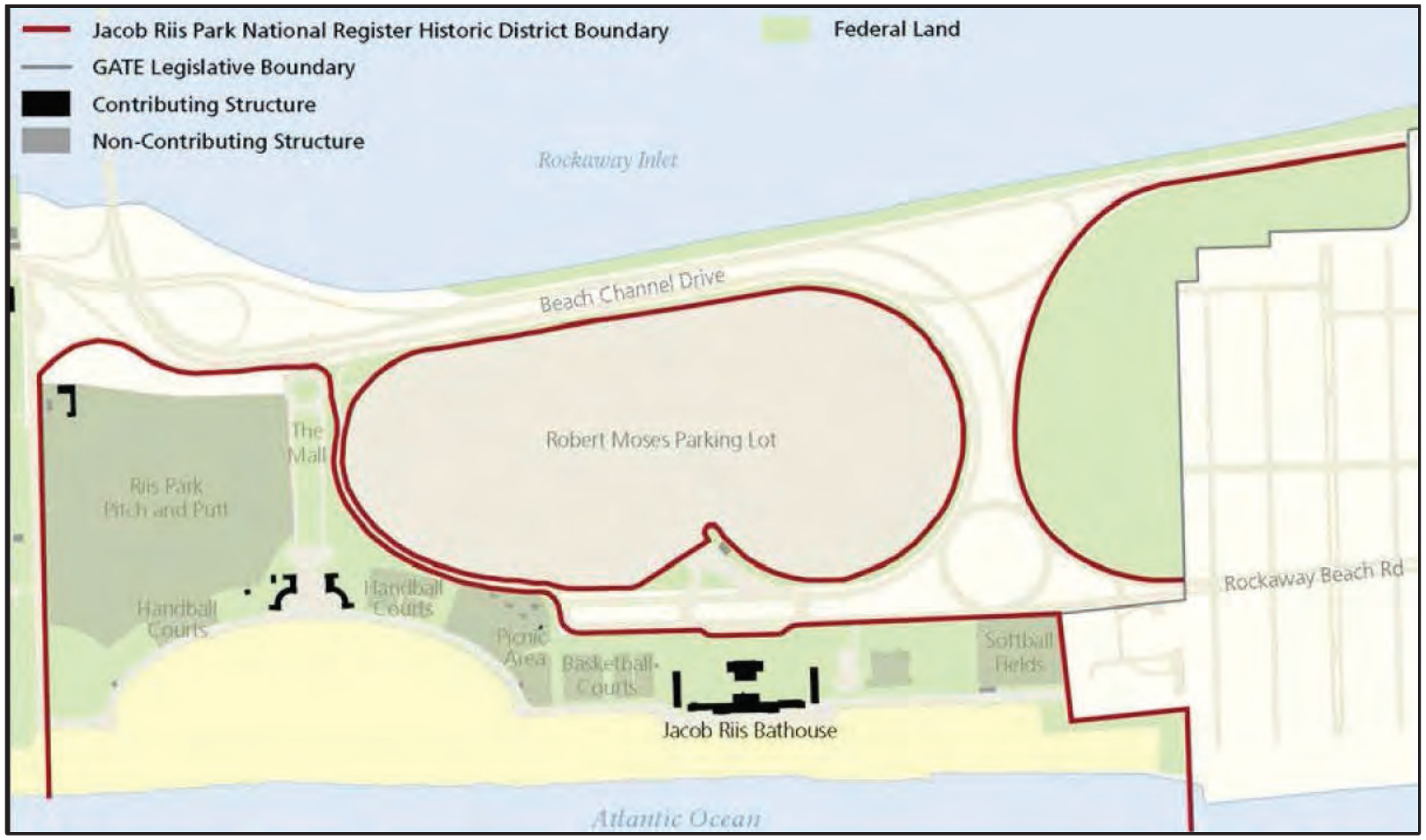


Figure 12: Jacob Riis Park Historic District elements.

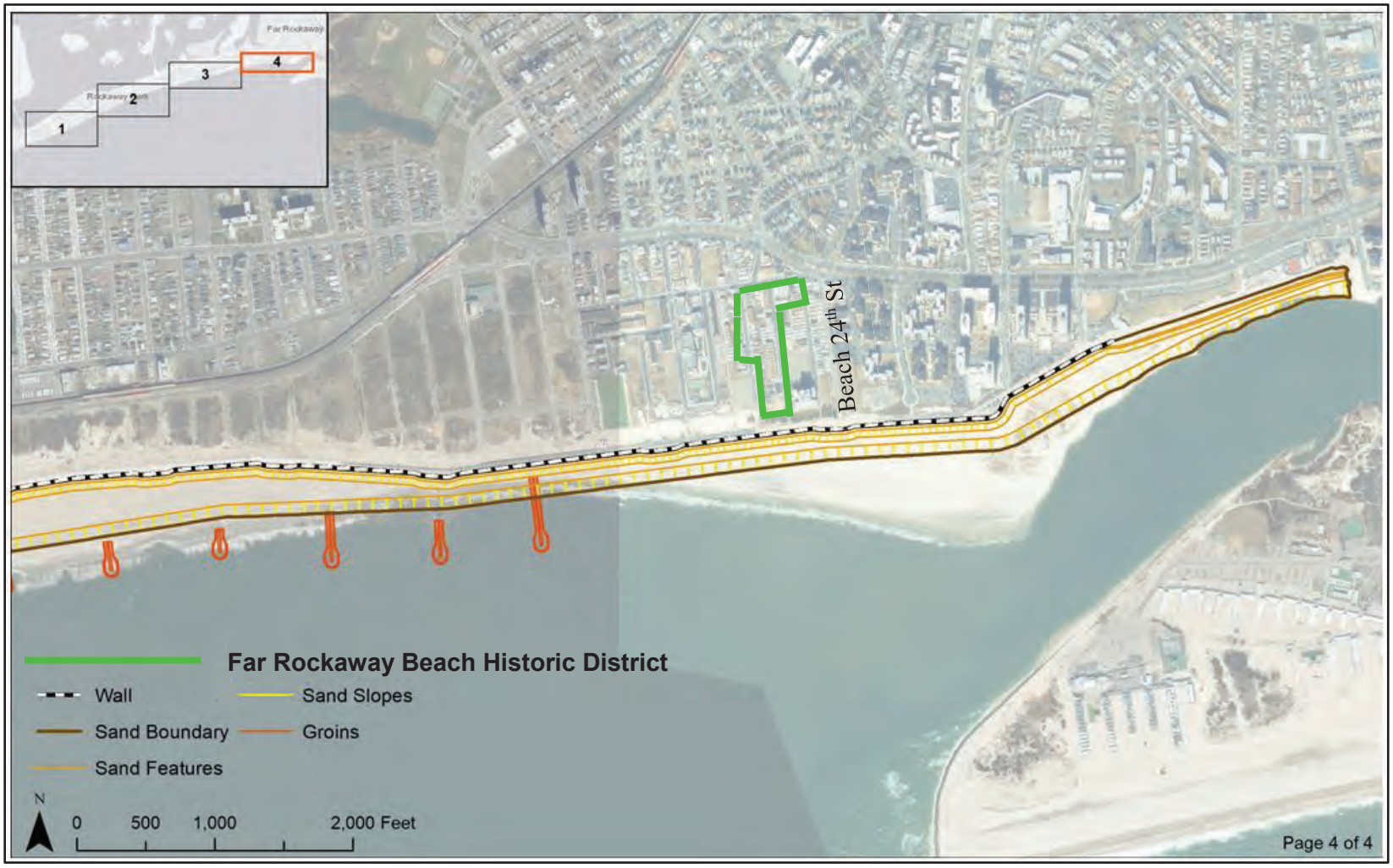


Figure 13: Location of the Far Rockaway Historic District and the project alignment APE.

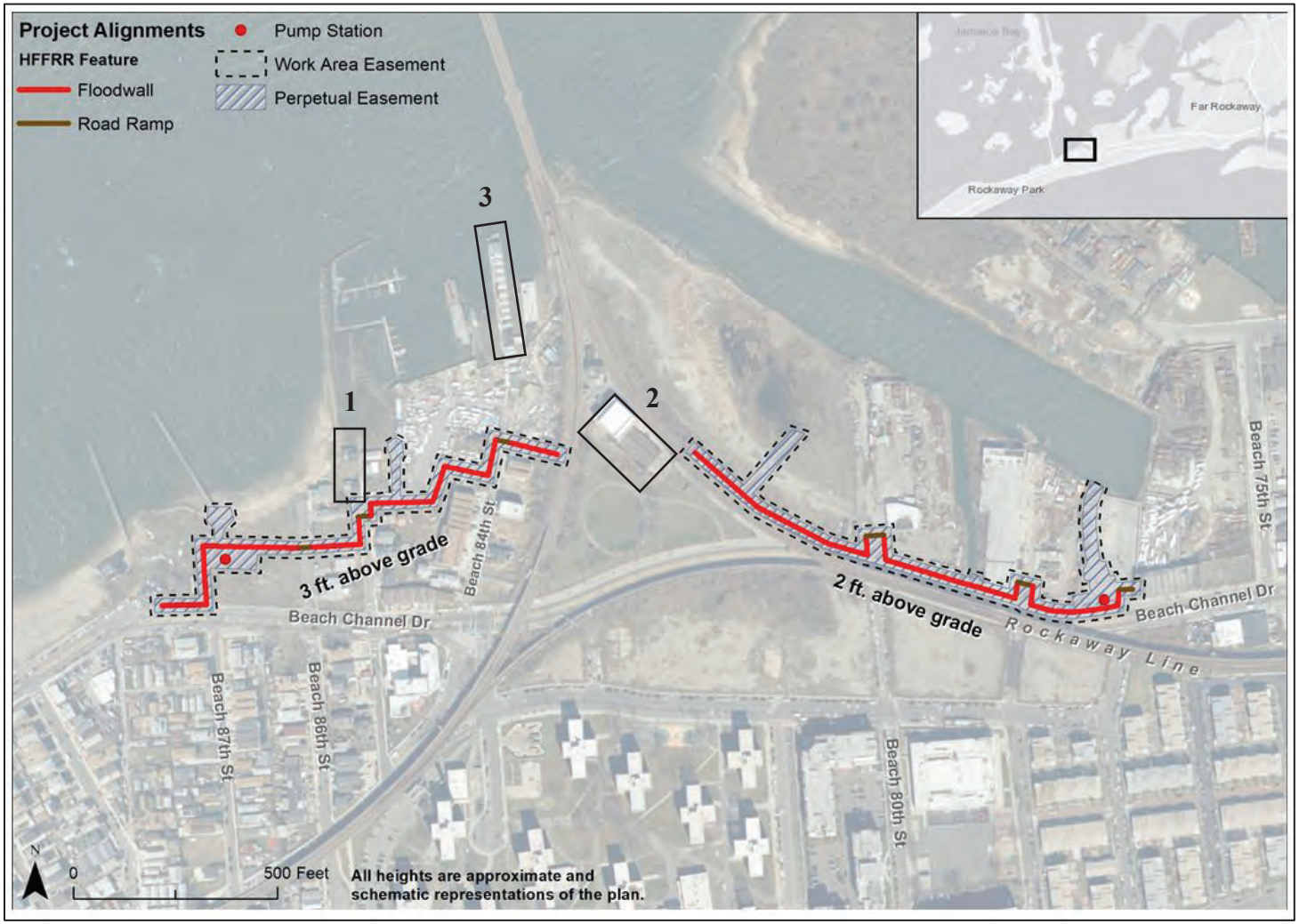


Figure 14: Location of 1) 2 Beach 85th Street; 2) New York City Transit System Building; and 3) Hammel Beach Pier and the Hammels high-frequency flood risk reduction measure alignments APE.

Figure 15: Photographs of the eligible properties near the Hammels high-frequency flood risk reduction: New York City Transit System building (top), 2 Beach 85th Street (middle) and the Hammels Pier (bottom) (NYSHPO CRIS 2019).

Figure 16: Location of Flight 587 Memorial Park.

Table 2: Assessment of Effects and Recommendations for Additional Work

Project Element	Resource	Recommendation
Reinforced dune/composite seawall	Potential prehistoric sites	Geomorphology with potential for monitoring during construction
Beach Fill	No historic properties affected	No additional work
Existing Borrow Areas	No historic properties affected	No additional work
New Borrow Areas	Potential prehistoric/historic resources	Remote sensing survey with potential underwater investigations
Groin Rehabilitation	Groins	Determine eligibility of groins as individual or historic district
Cedarhurst	Potential prehistoric/historic sites	Phase I survey; potential for subsurface investigations and remote sensing
Edgemere	Potential historic sites	Phase I survey
Arverne	Potential prehistoric/historic sites	Phase I survey; potential for subsurface investigations and remote sensing
Hammels	Potential prehistoric/historic sites	Phase I survey; potential for subsurface investigations and remote sensing; monitor alignment and proximity to eligible historic structures.

A Programmatic Agreement has been prepared to complete additional surveys on 1) the National Register eligibility of the groins along the Atlantic shoreline; 2) the potential for land surfaces and archaeological sites buried within the Rockaway peninsula; and 3) the potential for archaeological sites that might be affected by the high-frequency flood risk reduction measures. The public review of the draft General Reevaluation Report and Environmental Impact Statement included the discussion of affected historic properties as well as a preliminary draft of the programmatic agreement. The New York State Historic Preservation Office, the National Park Service, the New York City Landmarks Preservation Commission, the Delaware Nation, the Delaware Tribe, the Stockbridge-Munsee Community, the Shinnecock Nation and the Unkechaug Nation

were also provided a final draft to review and comment prior to execution of the agreement.

References

Merwin, Daria E.

2009 *A Cultural Resources Survey Report 2008-2009 Program Year, PIN 0072.14.101, New York State Route 878 (Nassau Expressway) Operational Improvement, Rockaway Turnpike to Burnside Avenue, Inwood, Town of Hempstead, Nassau County (Minor Civil Division 05930).* Institute for Long Island Archaeology, State University of New York at Stony Brook, Stony Brook, New York. Prepared for the New York State Museum, State Education Department. Sponsored by the New York State Department of Transportation and the Federal Highway Administration.

National Park Service

2014 *A New Vision for a Great Urban National Park: Gateway National Recreation Area, Final General Management Plan, Environmental Impact Statement.* U.S. Department of the Interior.

Panamerican Consultants

2000 *Cultural Resources Assessment of T-Groin Placement, Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens County, New York, Section 934.* Prepared for the U.S. Army Corps of Engineers, New York District.

2003 *Cultural Resources Baseline Study, Jamaica Bay Ecosystem Restoration Project, Kings, Queens and Nassau Counties, New York.* Prepared for the U.S. Army Corps of Engineers, New York District.

2005 *Remote Sensing Survey of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York.* Prepared for the U.S. Army Corps of Engineers, New York District.

2006 *Phase IB Investigations of Bayswater State Park and Paerdegat Basin, Jamaica Bay Ecosystem Restoration Project, Kings, Queens and Nassau Counties, New York*. Prepared for the U.S. Army Corps of Engineers, New York District.

Riess, Warren C.

1994 *East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York, Section 934 Study, Remote Sensing of Borrow Area 2.* Prepared by WCH Industries in association with Boston Affiliates. Submitted to the U.S. Army Corps of Engineers, New York District.

ATTACHMENT B: AREA OF POTENTIAL EFFECTS
FIGURES

Figure 1: Recommended plan overview with Atlantic shoreline features and high-frequency flood risk reduction measures.

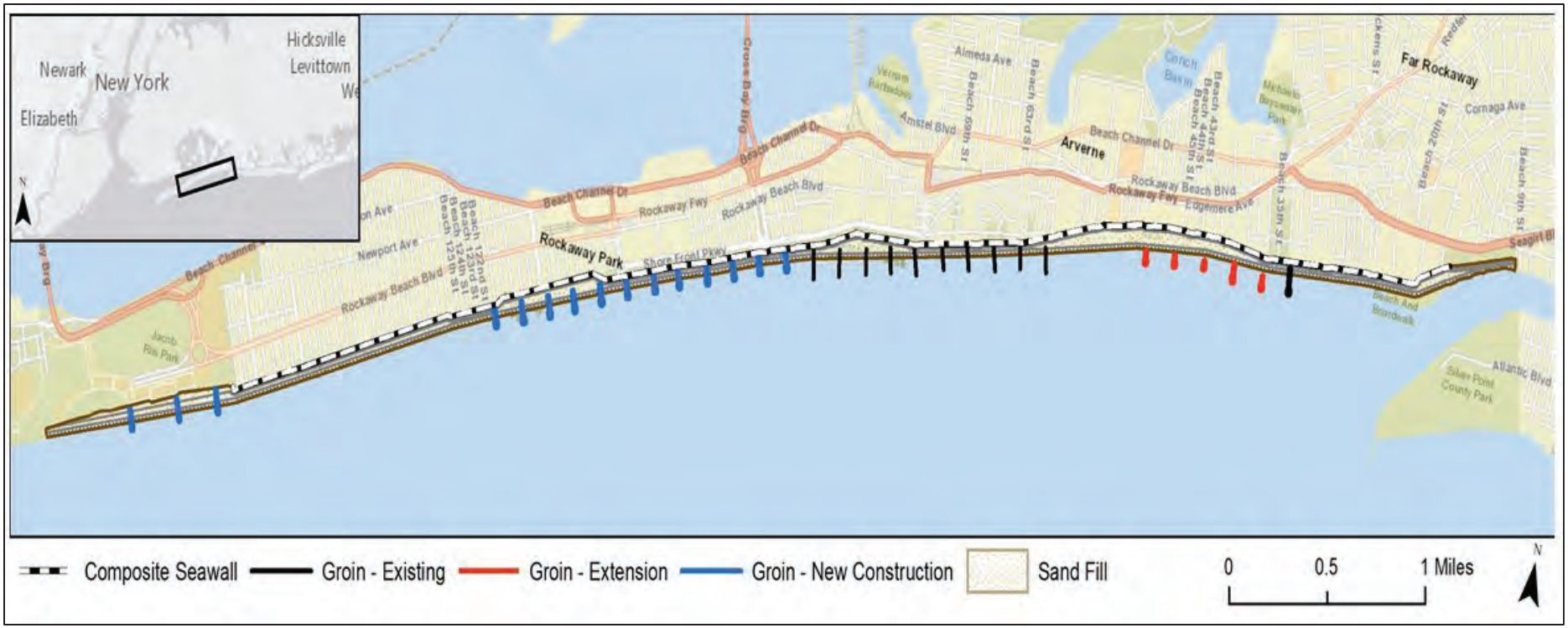


Figure 2: Atlantic Shorefront Component of the Recommended Plan

Figure 3: Groin rehabilitation and beach fill in Jacob Riis Park with the composite seawall just outside the park extending east along the Atlantic shoreline.

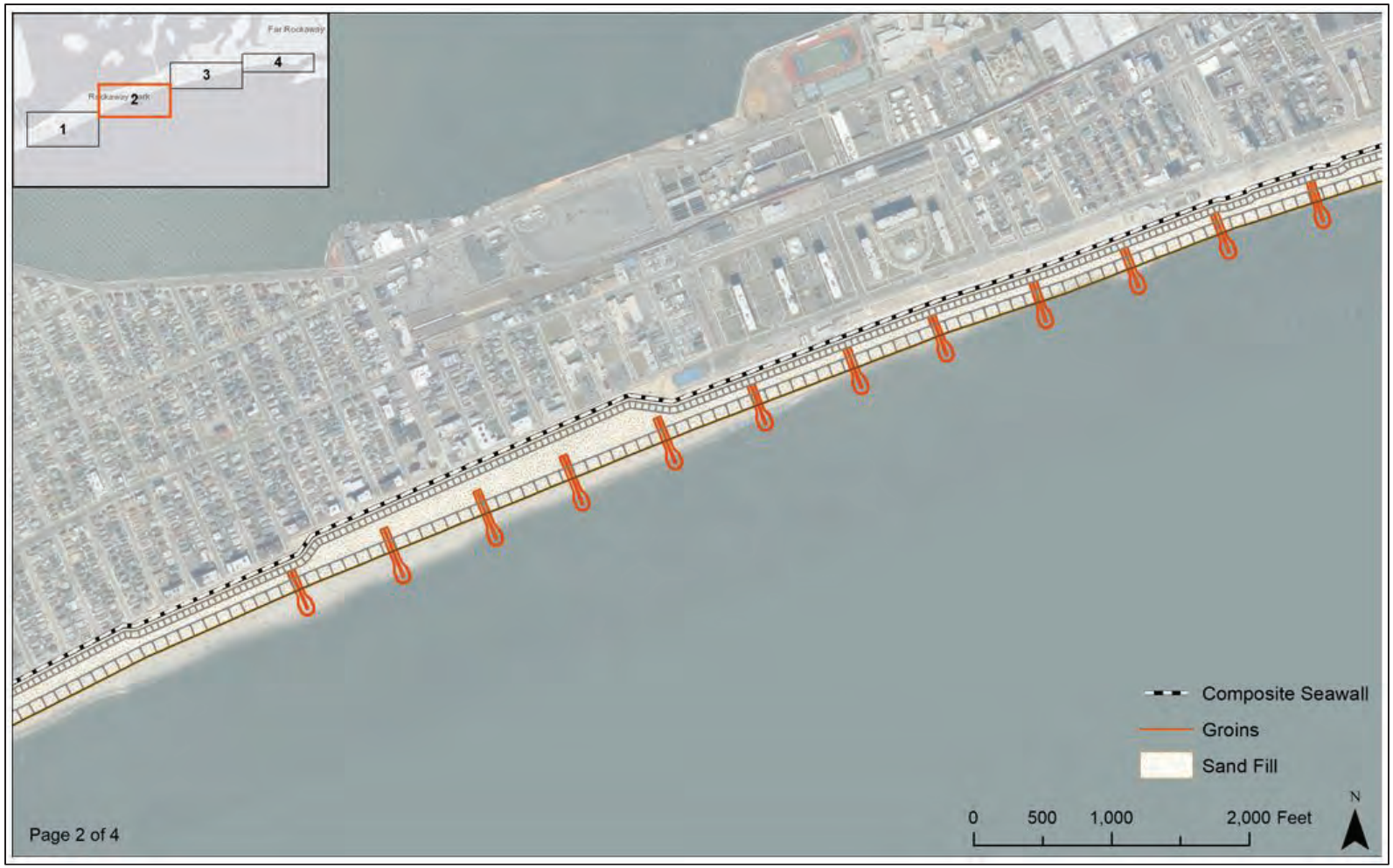


Figure 4: Groin Rehabilitation, beach fill and composite seawall along the Atlantic shoreline.

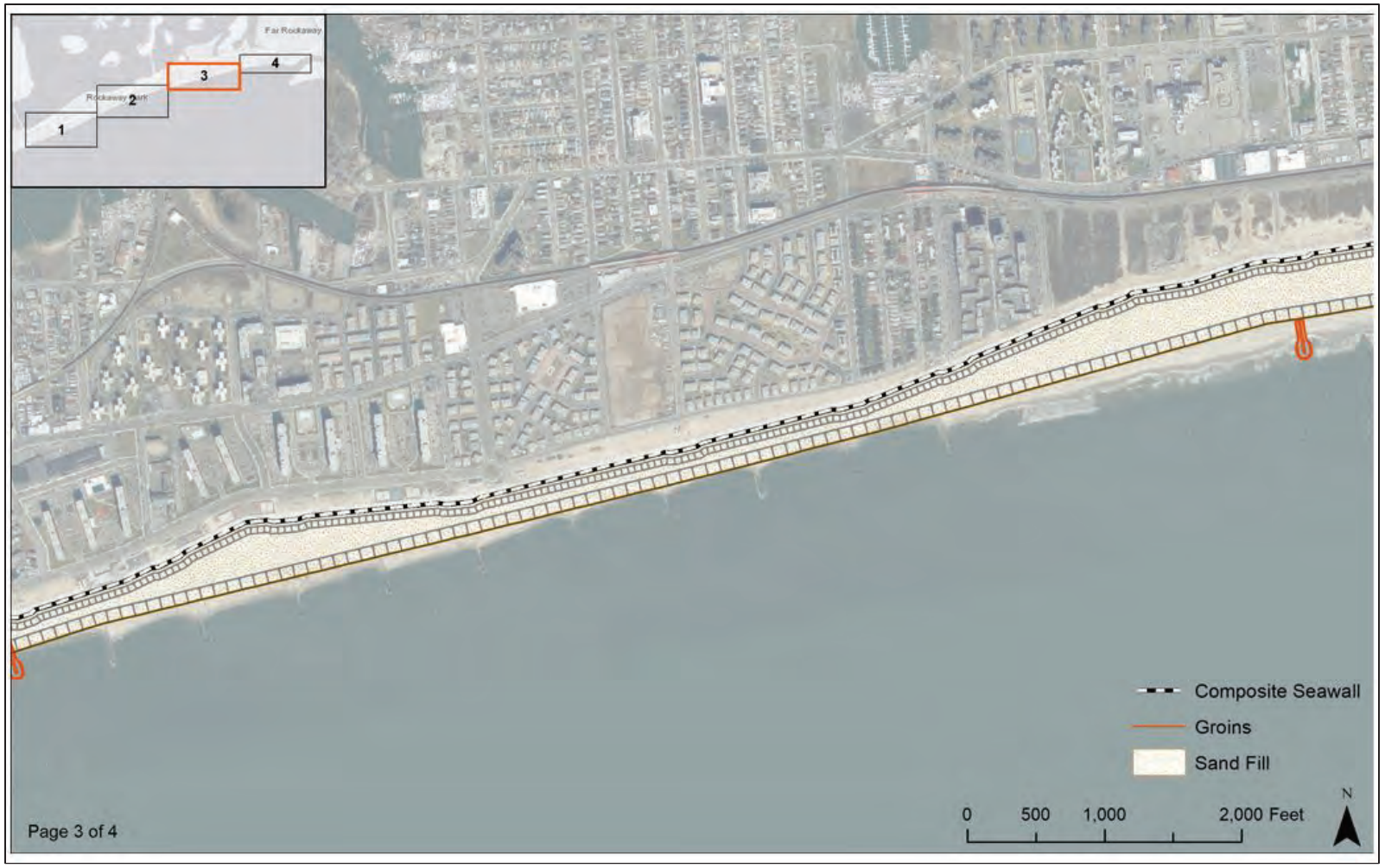


Figure 5: Composite seawall, beach fill and new groin construction (east) along the Atlantic shoreline.

Figure 6: New groin construction, beach fill and composite seawall along the Atlantic shoreline.

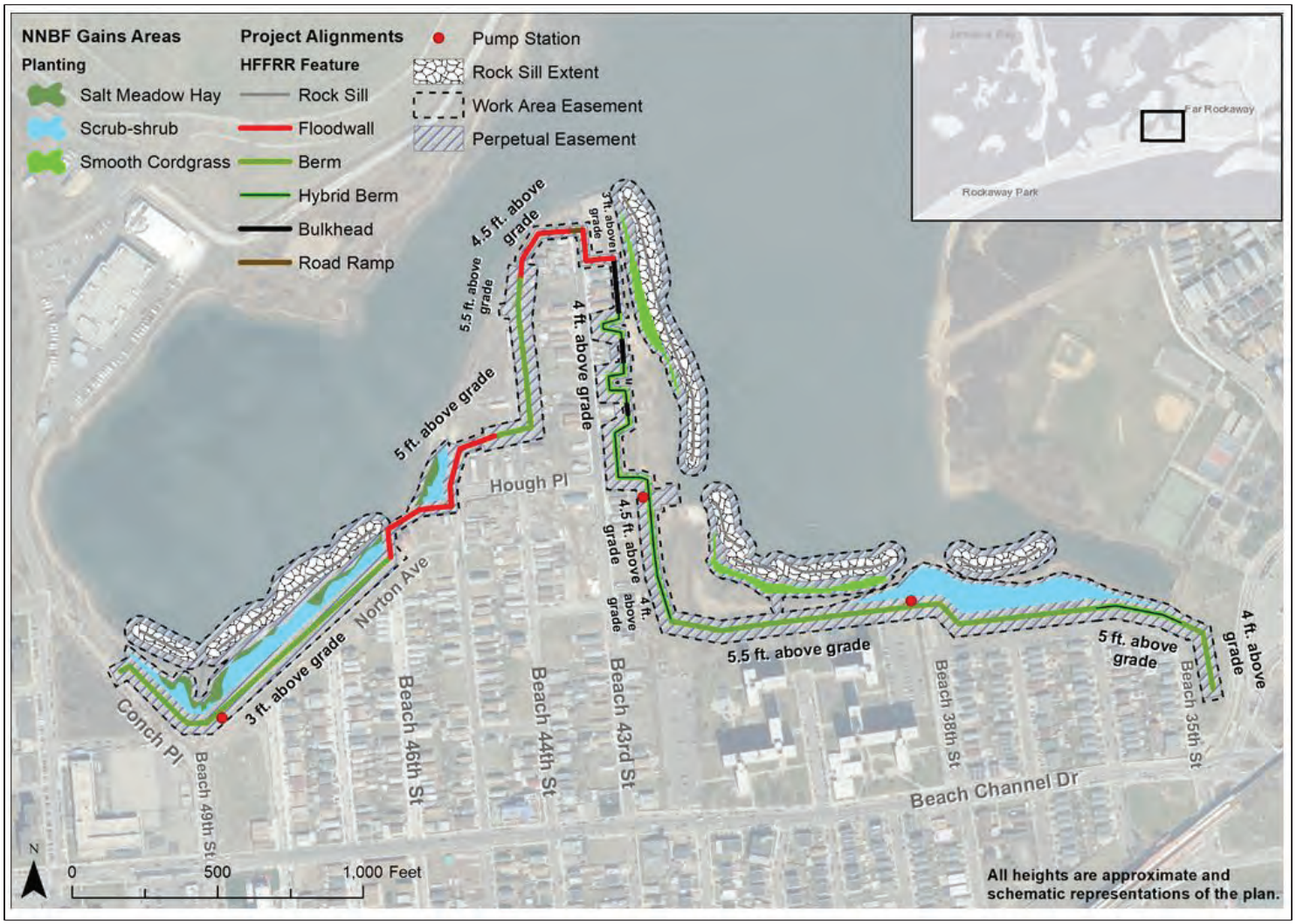


Figure 8: Edgemere High-Frequency Flood Risk Reductions Measures.

Figure 9: Arverne High-Frequency Flood Risk Reduction Measures

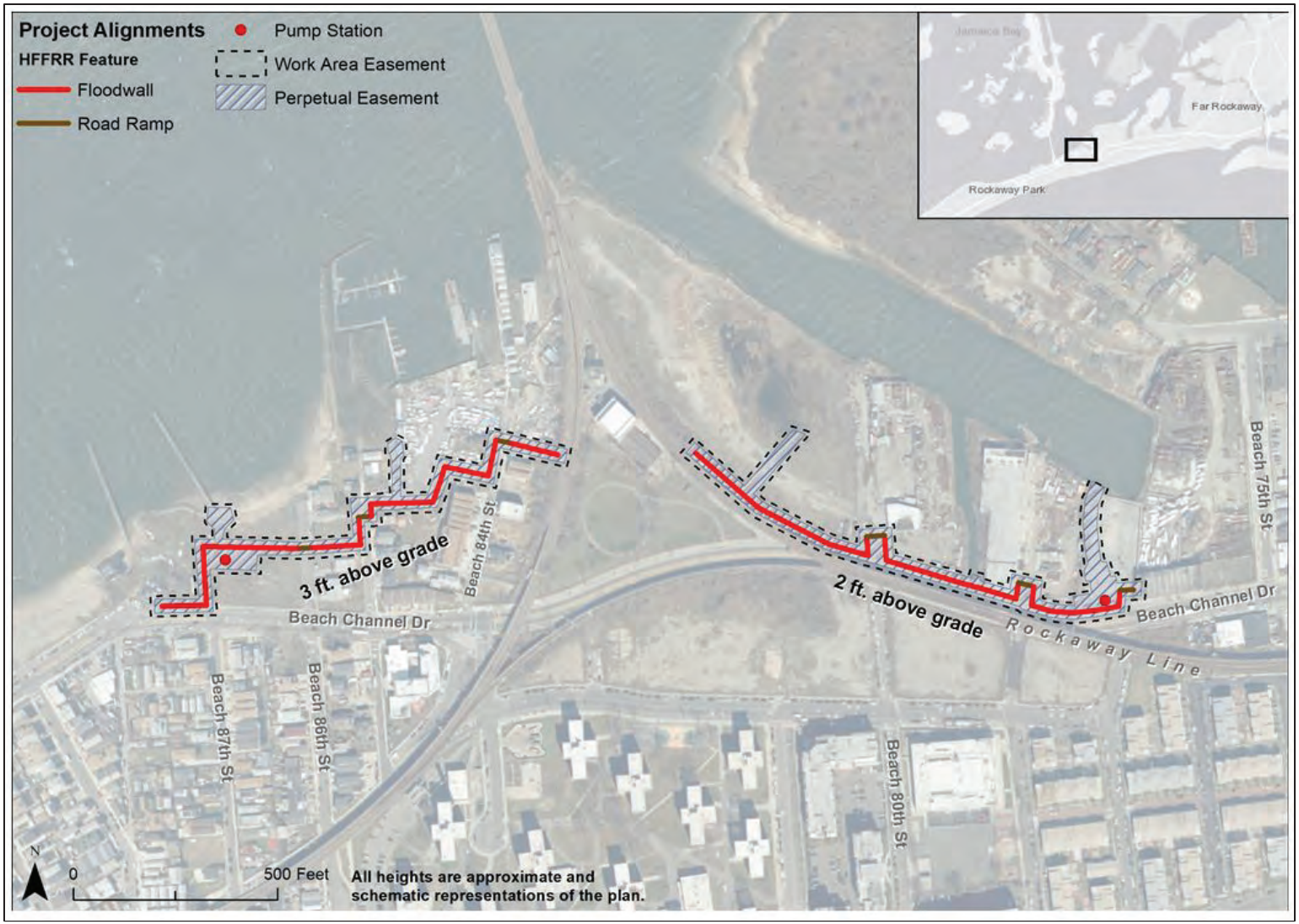


Figure 10: Hammels High-Frequency Flood Risk Reduction Measures

Figure 11: Location of Jacob Riis Park Historic District in relation to the project alignment APE.

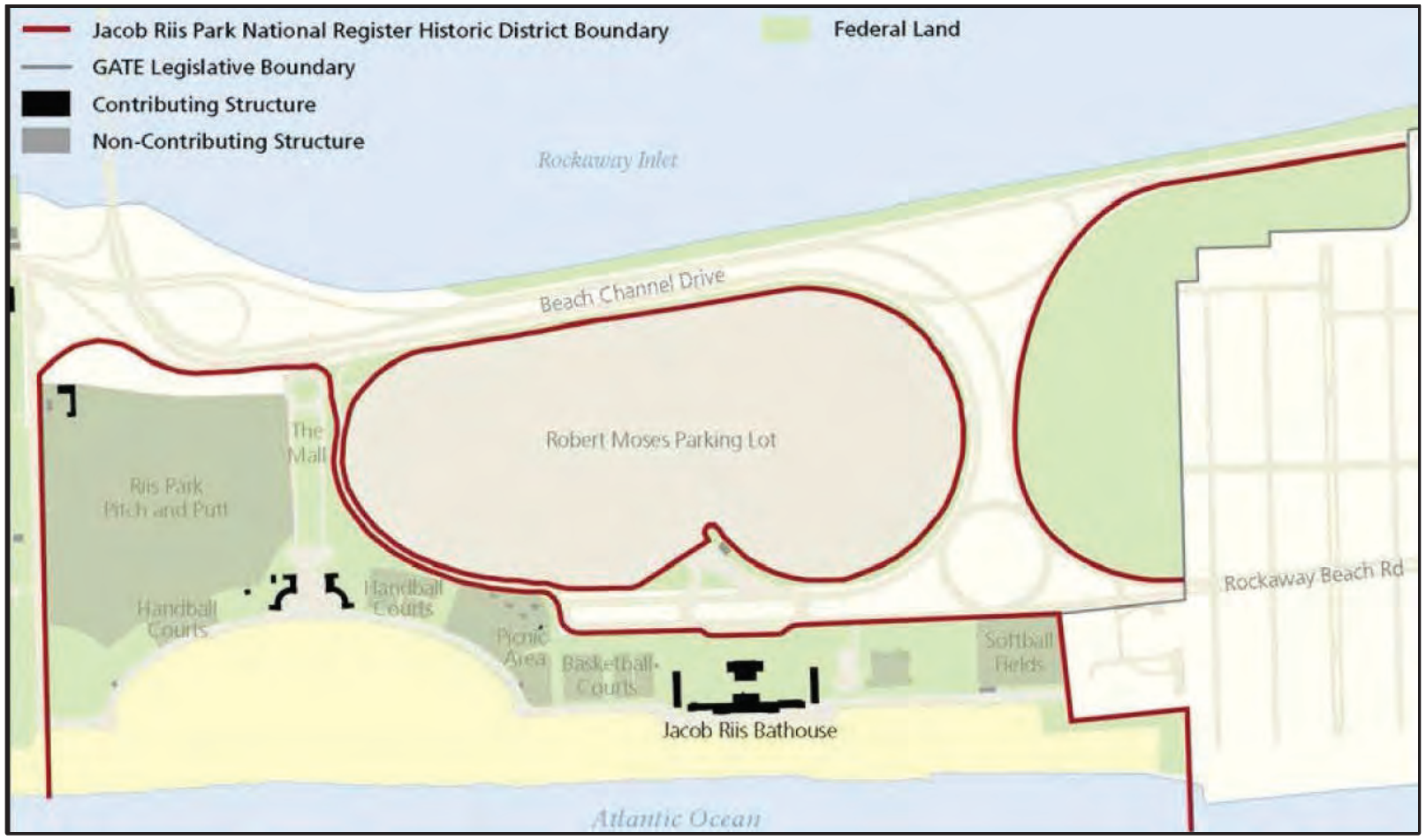


Figure 12: Jacob Riis Park Historic District elements.

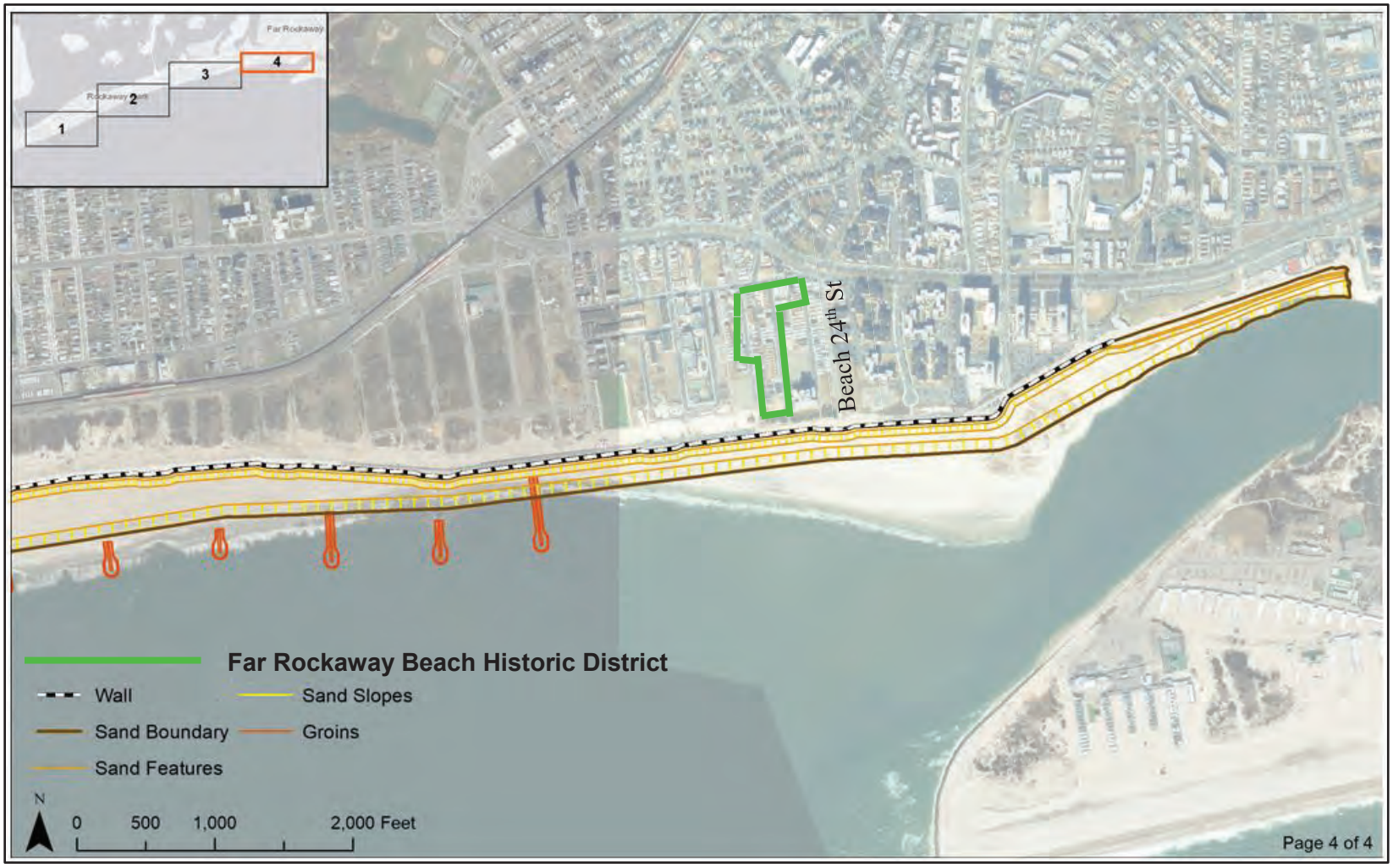


Figure 13: Location of the Far Rockaway Historic District and the project alignment APE.

APPENDIX C: HUMAN REMAINS DISCOVERY PROTOCOL

DRAFT

State Historic Preservation Office/
New York State Office of Parks, Recreation and Historic Preservation
Human Remains Discovery Protocol
(November 28, 2008)

In the event that human remains are encountered during construction or archaeological investigations, the New York State Historic Preservation Office (SHPO) recommends that the following protocol is implemented:

- At all times human remains must be treated with the utmost dignity and respect. Should human remains be encountered work in the general area of the discovery will stop immediately and the location will be immediately secured and protected from damage and disturbance.

- Human remains or associated artifacts will be left in place and not disturbed. No skeletal remains or materials associated with the remains will be collected or removed until appropriate consultation has taken place and a plan of action has been developed.

- The county coroner/medical examiner, local law enforcement, the SHPO, the appropriate Indian Nations, and the involved agency will be notified immediately. The coroner and local law enforcement will make the official ruling on the nature of the remains, being either forensic or archaeological.

- If human remains are determined to be Native American, the remains will be left in place and protected from further disturbance until a plan for their avoidance or removal can be generated. Please note that avoidance is the preferred choice of the SHPO and the Indian Nations. The involved agency will consult SHPO and appropriate Indian Nations to develop a plan of action that is consistent with the Native American Graves Protection and Repatriation Act (NAGPRA) guidance.

- If human remains are determined to be non-Native American, the remains will be left in place and protected from further disturbance until a plan for their avoidance or removal can be generated. Please note that avoidance is the preferred choice of the SHPO. Consultation with the SHPO and other appropriate parties will be required to determine a plan of action.

DRAFT

Andrew M. Cuomo
Governor

Rose Harvey
Commissioner

New York State Office of Parks,
Recreation and Historic Preservation

Division for Historic Preservation
P.O. Box 189, Waterford, New York 12188-0189
518-237-8643

May 15, 2013

Leonard Houston
U.S. Army Corps of Engineers, New York District,
Jacob K. Javits Federal Building
26 Federal Plaza
New York, New York 10278-0090

Re: CORPS
East Rockaway Beach Nourishment Project
East Rockaway Inlet
QUEENS, Queens County
13PR02248

Dear Mr. Houston:

Thank you for requesting the comments of the State Historic Preservation Office (SHPO). We have reviewed the project in accordance with Section 106 of the National Historic Preservation Act of 1966. These comments are those of the SHPO and relate only to Historic/Cultural resources. They do not include potential environmental impacts to New York State Parkland that may be involved in or near your project. Such impacts must be considered as part of the environmental review of the project pursuant to the National Environmental Policy Act and/or the State Environmental Quality Review Act (New York Environmental Conservation Law Article 8).

Based upon this review, it is the SHPO's opinion that your project will have No Effect upon cultural resources in or eligible for inclusion in the National Registers of Historic Places.

If further correspondence is required regarding this project, please be sure to refer to the OPRHP Project Review (PR) number noted above.

Sincerely,

Ruth L. Pierpont

Ruth L. Pierpont
Deputy Commissioner for Historic Preservation

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK, N.Y. 10278-0090

Reply to
Environmental Analysis Branch

May 3, 2013

Ms. Ruth L. Pierpont, Director
Historic Preservation Field Services Bureau Office
New York State Offices of Parks, Recreation and Historic Preservation
Pebbles Island – P.O. Box 189
Waterford, NY 12188-0189

RE: USACE East Rockaway Beach Nourishment Project
Dredging of East Rockaway Inlet

Dear Ms. Pierpont:

The U.S. Army Corps of Engineers, New York District (NY District) under the emergency provisions under Public Law (PL) 84-99, Flood and Coastal Storm Emergencies and PL 113-2 (Repair) and The Disaster Relief Appropriations Act – 2013 (Restore), at the request of New York State, is in the process of restoring damages to Rockaway Beach caused by Hurricane Sandy so as to restore protection to the community before the next storm season. The Atlantic Coast of Long Island New York project sustained considerable damages from Hurricane Sandy between October 28 and 30, 2012. It is critical that the rehabilitation is carried out rapidly to return protection to the affected communities and infrastructure.

For the repair and restoration activities at Rockaway Beach, the District anticipates placing approximately 3.5 Million cy/yds of sand along 6.2 miles of shoreline between Beach 19th street and Beach 149th street, all areas where we have historically placed sand in the past. The existing project constructed under the prior Section 934 effort consisted of building a 100-foot wide berm to an elevation of +10 feet National Geodetic Vertical Datum of 1929 (NGVD) (Enclosure 2-3: Proposed project scope, location and borrow area location).

The District's dredging procurement strategy is as follows:

CONTRACT 1A: The specifications will include utilization of a cutter head dredge to obtain 800,000 c/yds of East Rockaway Inlet sand. The District anticipates award of this contract can be made in Mid-May. Sand placement would be for Rockaway Beach and start early June in the vicinity of the end groin around Beach 89th, and move west to Beach 149th. This is primarily to address the most critical sand losses, and to avoid potential piping plover nesting areas in the eastern half of the project.

CONTRACT 1B: This action would be for 2.8 Million c/yds of additional sand to complete Rockaway Beach using sand from the previously used offshore borrow area via a hopper dredge,

to complete the full Restoration of Rockaway Beach to design conditions. Contract award would likely not be until the June timeframe, because of additional Federal procedural reviews required when contracts near $50 Million in scope.

Federal undertakings will comply with the Archaeological and Historical Preservation Act of 1974 (16 USC 469-469c), the Abandoned Shipwreck Act of 1987 (PL 100-298; 43 USC 2101-2106), The National Historic Preservation Act of 1966, as amended (16 USC 470) and the Advisory Council on Historic Preservation's implementing regulations 36CFR800 (protection of Historic Properties). Section 106 of the National Historic Preservation Act requires Federal agencies to provide the State Historic Preservation Officer (SHPO), as agent to the Advisory Council on Historic Preservation, reasonable opportunity to evaluate and comment on any Federal undertaking.

In a letter dated August 9, 2000, the New York State Office of Parks, Recreation and Historic Preservation Office stated that it reviewed the project in accordance with Section 106 of the National Historic Preservation Act of 1966 and determined that the Corps' project will have no effect upon cultural resources in or eligible for inclusion in the National Registers of Historic Places (Enclosure 1).

Extensive archaeological recordation, archival documentation and investigations have been performed in the past for this project area in accordance with Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations pursuant to 36 CFR 800.5. It is the NY District's opinion that the work as proposed will have no impacts to cultural resources and no further cultural resources studies will be undertaken if the plan remains as proposed.

Please review the enclosed documents that explain in further detail the scope of the emergency shoreline rehabilitation project and provide your comments in accordance with Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations pursuant to 36 CFR. If you or your staff require additional information or have any questions, please contact Heather Morgan, Project Archaeologist at (917) 790-8730.

Sincerely,

L. Houston

Leonard Houston
Chief, Environmental Analysis Branch

Enclosures:
1: USACE and NYSHPO coordination letter, August 2000
2: PL84-99 Project Information Report (PIR), Record of the Environment (REC) for Hurricane Sandy Response
3: FCCE Hurricane Sandy Rehab, Atlantic Coast of NYC, Rockaway and Coney Island Drawing

OFFICE OF PARKS · RECREATION · HISTORIC PRESERVATION
NEW YORK STATE
Bernadette Castro
Commissioner

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, PO Box 189, Waterford, New York 12188-0189 518-237-8643

February 17, 2006

Christopher Ricciardi
Project Archaeologist
Environmental Analyst Branch
New York District
US Army Corps of Engineers
Jacobe K. Javits Federal Building
New York, NY 10278-0090

Dear Mr. Ricciardi,

Re: CORPS
Rockaway Beach Nourishment Project
Dredging of East Rockaway Inlet
Queens County, NY
05PR05274 formerly 00PR2949

Thank your for requesting the comments of the New York State Historic Preservation Office (SHPO) with regard to the potential for this project to affect significant historical/cultural resources. SHPO had previously reviewed the report *Remote Sensing Survey of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York* prepared by Panamerican Consultants, Inc. in September 2005. Based on that review, SHPO had asked for additional information to addresses the potential for submerged prehistoric sites. In response you have provided SHPO with extensive coring information that had been collected for proposed borrow Area A. Based on those logs, SHPO has no further concerns regarding this issue.

Please contact me at extension 3291, or by e-mail at douglas.mackey@oprhp.state.ny.us, if you have any questions regarding these comments.

Sincerely

Douglas P. Mackey
Historic Preservation Program Analyst
Archaeology

An Equal Opportunity/Affirmative Action Agency
printed on recycled paper

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK, NY 10278-0090

REPLY TO
ATTENTION OF

February 15, 2006

Environmental Analysis Branch

Ms. Ruth L. Pierpont, Director
Historic Preservation Field Services Bureau
New York State Office of Parks, Recreation and Historic Preservation
Peebles Island - P.O. Box 189
Waterford, New York 12188-0189

RE: CORPS
Rockaway Beach Nourishment Project
Dredging of East Rockaway Inlet
Queens, Queens County
00PR2949

Dear Ms. Pierpont:

The U.S. Army Corps of Engineers, New York District (Corps), is pleased to furnish you with the copy of portions of the Engineering Report, *Preliminary Investigation – Borrow Area Identification and Investigation for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York Reformulation Study*. This report details the coring samples taken within the proposed Borrow Area A for the East Rockaway Project.

As per your request for information with regard to the undertaking studies for previously buried land surfaces, according to the study report sand cores taken to a depth of twenty feet did not reveal indications of stratified levels. The samples were fairly uniform in their composition. No discernable intrusions and/or inclusions were uncovered. The lack of stratigraphy in the samples supports the notion that the removal of sand to the recommended depth of twenty feet will not disturb potentially buried stratified surfaces. The uniformity of the samples helped to make Borrow Area A the choice for sand mining for the proposed project. Based on this information, additional studies for the potential to uncover buried land surfaces were not required in our Scope of Work.

If you have further questions, please contact the Project Archaeologist, Dr. Christopher Ricciardi at (917) 790-8630 or christopher.g.ricciardi@usace.army.mil.

Sincerely,

L. Houston

Leonard Houston
Chief, Environmental Analysis Branch

Enclosure

Printed on Recycled Paper

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK, NY 10278-0090

REPLY TO
ATTENTION OF

November 22, 2005

Environmental Analysis Branch

Ms. Ruth L. Pierpont, Director
Historic Preservation Field Services Bureau
New York State Office of Parks, Recreation and Historic Preservation
Peebles Island - P.O. Box 189
Waterford, New York 12188-0189

RE: CORPS
Rockaway Beach Nourishment Project
Dredging of East Rockaway Inlet
Queens, Queens County
00PR2949

Dear Ms. Pierpont:

The U.S. Army Corps of Engineers, New York District (Corps), is pleased to furnish you with the final copy of, *Remote Sensing Survey Of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York Project.*

As per your letter dated October 24, 2005, the Corps thanks you for your comments and agreement with the assessment of the report with regard to the East Rockaway Borrow Area Project. The Corps is currently preparing the supplemental data that your office requested with regard to Coring Sample Information and will provide that information shortly.

Once again, thank you for your participation in the Section 106 process with regard to the East Rockaway Reformulation Project.

Sincerely,

L. Houston

Leonard Houston
Chief, Environmental Analysis Branch

Enclosure

Printed on Recycled Paper

OFFICE OF PARKS · RECREATION · HISTORIC PRESERVATION
NEW YORK STATE
Bernadette Castro
Commissioner

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, PO Box 189, Waterford, New York 12188-0189 518-237-8643

October 24, 2005

Christopher Ricciardi
Project Archaeologist
Environmental Analyst Branch
New York District
US Army Corps of Engineers
Jacobe K. Javits Federal Building
New York, NY 10278-0090

Dear Mr. Ricciardi,

Re: CORPS
Rockaway Beach Nourishment Project
Dredging of East Rockaway Inlet
Queens County, NY
00PR2949

Thank your for requesting the comments of the New York State Historic Preservation Office (SHPO) with regard to the potential for this project to affect significant historical/cultural resources. SHPO has reviewed the report *Remote Sensing Survey of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York* prepared by Panamerican Consultants, Inc. in September 2005. Based on this review, SHPO offers the following comments.

1. SHPO concurs with the recommendations concerning the three identified potential shipwrecks.

2. Although the report addresses the potential for submerged prehistoric sites, and discusses potential ways to identify landforms that may contain such sites, there appears to be no actual attempt to identify such landforms, or detailed discussion of why this may not be appropriate for this project. Please provide further details on this potential and why the identified survey or analysis was not completed

Please contact me at extension 3291, or by e-mail at douglas.mackey@oprhp.state.ny.us, if you have any questions regarding these comments.

Sincerely

Douglas P. Mackey

Douglas P. Mackey
Historic Preservation Program Analyst
Archaeology

An Equal Opportunity/Affirmative Action Agency
printed on recycled paper

OFFICE OF PARKS · RECREATION · HISTORIC PRESERVATION
NEW YORK STATE
Bernadette Castro
Commissioner

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, PO Box 189, Waterford, New York 12188-0189 518-237-8643

August 11, 2003

Nancy Brighton
US Army Corps of Engineers
Jacob Javits Federal Building
New York, NY 10278-0090

Dear Ms. Brighton:

Re: CORPS
Rockaway Beach Project
T-Groing Placements
Brooklyn, Kings County, New York
03PR03715

Thank you for requesting the comments of the State Historic Preservation Office (SHPO) with regard to the potential for this project to affect significant cultural/historical resources. SHPO has reviewed the report "Draft Report - Cultural Resources Assessment of T-Groin Placement, Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet, and Jamaica Bay, Queens County, New York, Section 934" prepared by Panamerican Consultants, Inc. in June 2000. Based on this review, SHPO concurs with the recommendations of the report for limited Phase 1B underwater investigation .

Please contact me at extension 3291 if you have any questions regarding these comments.

Sincerely

Douglas P. Mackey

Douglas P. Mackey
Historic Preservation Program Analyst
Archaeology

An Equal Opportunity/Affirmative Action Agency
printed on recycled paper

OFFICE OF PARKS · RECREATION · HISTORIC PRESERVATION
NEW YORK STATE
Bernadette Castro
Commissioner

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, PO Box 189, Waterford, New York 12188-0189 518-237-8643

October 29, 2002

Leonard Houston
Corps of Engineers
New York District
Jacob Javits Federal Building
New York, New York 10278-0090

Re: CORPS
Rockaway Beach Shoreline – Beach Renourishment Projects/Rockaway Beach, East Rockaway Inlet
Brooklyn/Queens, Kings/Queens County
02PR04702

Dear Mr. Houston:

Thank you for requesting the comments of the State Historic Preservation Office (SHPO). We have reviewed the project in accordance with Section 106 of the National Historic Preservation Act of 1966.

Based upon this review, it is the SHPO's opinion that your project will have No Effect upon cultural resources in or eligible for inclusion in the National Registers of Historic Places.

If further correspondence is required regarding this project, please be sure to refer to the OPRHP Project Review (PR) number noted above.

Sincerely,

Ruth L. Pierpont

Ruth L. Pierpont
Director

RLP:cmp

An Equal Opportunity/Affirmative Action Agency
printed on recycled paper

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, N.Y. 10278-0090

REPLY TO
ATTENTION OF

September 20, 2002

Environmental Analysis Branch

Ms. Ruth L. Pierpont, Director
Historic Preservation Field Services Bureau
New York State Office of Parks, Recreation and Historic Preservation
Peebles Island - P.O. Box 189
Waterford, New York 12188-0189

RE: CORPS
Rockaway Beach Project
Brooklyn, Kings County
89PR1188

CORPS
East Rockaway Inlet Channel Dredging
Queens County
92PR1171

Public Notice No. 00-ERIMDSN

CORPS
Beach Nourishment Rockaway Beach/Channel
Dredge East Rockaway Inlet
Queens, Queens County
00PR2949

Dear Ms. Pierpont:

The U.S. Army Corps of Engineers, New York District (Corps), in its continuing effort to nourish the beaches along the Rockaway Beach shoreline as part of the above referenced Beach Erosion Control and Hurricane Protection Project for the East Rockaway Inlet, Queens County, New York (89PR1188), proposes to place material dredged from Borrow Area #2 along the shoreline between Beach 19th Street and Beach 148th Street (92PR1171; Enclosure 1). This renourishment will be the final sand placement as part of the 89PR1188 Project. These proposed actions are also described in the above referenced Public Notice issued June 16, 2000, by the Corps (Enclosure 2).

As part of previous coordination efforts for the Beach Erosion Control and Hurricane Protection project, the placement of sand on the beach from Beach 19th Street to Beach 148th Street has been determined to have no effect on historic properties (Enclosures 3 and 6). In addition, the use of material from Borrow Area 2 was also determined to have no effect on historic properties (Enclosures 3, 4 and 5). The proposed sand placement will occur from October 2003 through February 2004.

Please review the enclosed materials and provide your comments in accordance with Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36 CFR 800, by November 1, 2002. If you have any questions or require additional information, please contact Mr. Chris Ricciardi, Project Archaeologist, at 212-264-0204. Thank you for your assistance.

Sincerely,

for Leonard Houston
Chief, Environmental Analysis Branch

Enclosures

US Army Corps
of Engineers
New York District
26 Federal Plaza
New York, N.Y. 10278
ATTN: CENAN-OP-ST

Public No Enclosure 2

In replying refer to:
Public Notice No. 00 ERIMDSN
Published: 6/16/00 Expires: 7/17/00

EAST ROCKAWAY INLET, NEW YORK FEDERAL NAVIGATION PROJECT
MAINTENANCE DREDGING
and
SUPPLEMENTAL NOURISHMENT FOR THE FEDERAL BEACH EROSION CONTROL AND HURRICANE PROTECTION PROJECT FOR EAST ROCKAWAY INLET TO ROCKAWAY INLET AND JAMAICA BAY, NEW YORK

TO WHOM IT MAY CONCERN:

Pursuant to Section 404 (33 U.S.C. 1344) of the Federal Water Pollution Control Act (amended in 1977 and commonly referred to as the Clean Water Act) and Section 10 of the Rivers and Harbors Act, notice is hereby given that the U.S. Army Engineer District, New York proposes to perform maintenance dredging of the Federal Navigation Channel in East Rockaway Inlet (Attachment 1) with placement of dredged material along Rockaway beach. In addition, New York District is planning to perform a supplemental nourishment cycle for the Beach Erosion Control and Hurricane Protection Project for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York. This would require dredging of the borrow area 2 (Attachment 2) and an intermediate area (East Rockaway Inlet Borrow area) adjacent to the western boundary of the scheduled maintenance dredging limits. The dredged material will be placed along Rockaway Beach.

FEDERAL PROJECT AUTHORIZED:

The Federal maintenance dredging project for East Rockaway Inlet Navigational channel was authorized by the Rivers and Harbors Act of 1930.

The Federal Beach Erosion Control and Hurricane Protection Project for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York was authorized by the Flood Control Act of 1965 and subsequently modified in 1974 by the Water Resources Development Act (WRDA) and in 1986 in accordance with the authority provided by Section 934 of the WRDA.

FEDERAL PROJECT DESCRIPTION:

The existing Federal navigation project provides for a channel, 12 feet deep at mean low water, 250 feet wide from a 12 foot depth contour in the Atlantic ocean to a 12 foot depth contour in East Rockaway Inlet, and a 4,250 foot long jetty on the eastern side of the inlet. The channel is about 1.4 miles long.

It should be noted that due to the rapid shoaling nature of the East Rockaway inlet, advance maintenance measures are being considered, including: 1) maintaining a previously constructed deposition basin with a variable width of 150 - 270 feet which is directly parallel to the entire western boundary of the channel; and 2) maintaining a second deposition basin with a maximum width of 200 feet and length of about 0.4 miles directly parallel to the eastern boundary of the outer portion of the channel. Advance maintenance dredging of 14 feet plus 2 feet allowable overdepth has been performed for the entire channel during past maintenance operations and is planned for the proposed maintenance dredging.

In order to maximize the amount of sand available for beachfill, supplemental dredging and nourishment for the Beach Erosion Control and Hurricane Protection Project for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York will be performed. The sand for the supplemental nourishment will be dredged from an intermediate area west of the western deposition basin described above, and placed on the beaches between B27th and B40th Streets. The dimensions of this area would be 300 feet by 0.4 miles long.

Additionally, to provide beachfill in the vicinity of Beach 90th Street, the Beach Erosion Control and Hurricane Protection Project authority would be utilized to dredge a 0.22 square mile portion of a borrow area approximately 1 mile offshore (identified as borrow area number 2) to a depth of no greater than 20 feet below existing grade. This material would be placed onto the beaches between B96th and B110th Streets.

DESCRIPTION OF PROPOSED FEDERAL ACTION:

The first proposed action by the U. S. Army Engineer District, New York is the future maintenance dredging of the Federal Navigation Channel and deposition basins in East Rockaway Inlet. Approximately 210,000 cubic yards of sand will be dredged from the inlet and used in a beneficial manner as beachfill, placed along severely eroded areas of the Rockaway beach shoreline. Maintenance dredging of the channel is generally accomplished by hydraulic or similar plant. The entire channel will generally not require maintenance dredging; only areas where shoaling has reduced the depth of the channel will require dredging. The

project was last dredged in 1998, with the removal of about 218,000 cubic yards with placement along the shoreline (Rockaway Beach) west of the inlet. The currently proposed action is intended to provide a safe navigation route through the inlet and to utilize the sand dredged from the inlet in a beneficial manner as replenishment for the nearby shoreline.

The second proposed action by the New York District is the supplemental nourishment which requires dredging an intermediate area west of the western deposition basin and the borrow area 2 and placing the material as beach erosion control and hurricane protection along severely eroded areas of the Rockaway Beach shoreline. This action was last performed in 1996 when a total of about 2,700,000 cubic yards were dredged from an offshore borrow site and placed along Rockaway beach shoreline. For the currently proposed action a combined total of approximately 700,000 cubic yards of sand is expected to be dredged with about 300,000 cubic yards being removed from the intermediate area adjacent to the navigation channel and deposition basins, and the remaining quantity coming from the borrow area 2.

PLACEMENT SITE:

The dredged material from the proposed actions shall be placed along the beaches west of the inlet. Specifically, material dredged from East Rockaway Inlet, including the intermediate area, shall be placed on the beaches between B27th and B40th Streets; material dredged from the offshore borrow area shall be placed between B96th and B110th Streets. Between maintenance operations the bypassed sand placed at the feeder beach would be carried by littoral drift to feed down-drift beaches. The maintenance dredging operation would thus serve to place sand trapped in the channel back into the normal littoral movement that naturally replenishes the western beaches, while maintaining a safe channel for navigation. The beach nourishment operation would serve as replenishment to severely eroded areas of the Rockaway Beach shoreline.

ENVIRONMENTAL IMPACT ASSESSMENT:

The New York District has done a review of the Environmental Assessment (EA) for the maintenance dredging of East Rockaway Inlet project, dated October 1998, which updated an EA prepared in 1993. The EA prepared in 1993 had updated an Environmental Impact Statement that was prepared in September 1973 for maintenance dredging of East Rockaway Inlet Federal Navigation channel. It was determined that maintenance dredging of East Rockaway Inlet with placement of the sand as nourishment along the nearby shoreline of the designated beach would have no significant adverse environmental impact on water quality, marine

resources, wildlife, endangered species, recreation, aesthetics and flood protection of the area.

An update of the 1998 EA and an update of Section 404(b)(1) of the Clean Water Act 40 CFR 230 will be prepared.

In addition, New York District has also done a review of the Environmental Assessment for borrow area dredging and beach nourishment, dated 1993, which updated an EA prepared in 1973. It was determined that borrow area dredging with placement of sand as nourishment along the nearby shoreline of the designated beach would have no significant adverse environmental impact on water quality, marine resources, wildlife, endangered species, recreation, aesthetics and flood protection of the area.

An update of the 1993 EA and an update of Section 404(b)(1) of the Clean Water Act 40 CFR 230 will be prepared.

ALTERNATIVES TO THE PROPOSED ACTION:

a. No Dredging - The no dredge alternative would result in the continued shoaling of the inlet, which will eventually lead to the loss of accessibility for those activities that depend upon the inlet for water transportation.

b. USEPA designated East Rockaway Inlet Placement Site - The inlet placement site is located within a short distance from the inlet. The Corps has used this inlet placement site in the past for placement of sand dredged from the East Rockaway Inlet Federal Channel. While this alternative will potentially provide littoral drift to feed the local beaches, its action would not provide the direct benefit of placing the material on the nearby shoreline of a designated beach.

c. No Beach Nourishment - The no nourishment alternative would result in continued erosion of the Rockaway Beach shoreline, which will eventually undermine the structures of the State property and increase the potential for storm damage due to wave action and flooding.

d. Alternative to Borrow Area 2 - Utilization of the Borrow Areas 1A or 1B, which are described in the May 1993, "East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York, Final Reevaluation Report (Section 934 of WRDA 1986)," is not economically feasible for this supplemental nourishment action due to the lack of access to Borrow Area 1A (dredging would be required to provide access) and availability of an adequate quantity of material at Borrow Area 1B. In addition, the location of both sites would establish a higher unit price per cubic yard due to the greater pumping distance.

GRAIN SIZE ANALYSES:

Results of grain size analyses performed on samples collected within the project area have indicated that the material to be deposited is predominantly sand (greater than 90% sand). Therefore, the proposed dredged material would be physically compatible for beach placement, and placement on the beach would be consistent with existing laws and regulations.

MISCELLANEOUS INFORMATION:

Pursuant to Section 7 of the Endangered Species Act (16 U.S.C. (531)) and based upon a review of the latest published version of the threatened and endangered species listing, a preliminary determination is that the activity under consideration will not affect those species listed (piping plover), or proposed for listing (roseate tern) or their critical habitat, if the work is performed after 15 September and before 1 April. This will avoid the critical time frame for piping plover nesting, as determined by the U.S. Fish and Wildlife Service.

There are no known sites within the surrounding area that are eligible for or included in the National Register of Historic Places. Presently no known archaeological, scientific, prehistorical or historical data are expected to be lost by work accomplished under the required dredging.

Water Quality Certifications (WQC) have been obtained from the New York State Department of Environmental Conservation in accordance with Section 401 of the Clean Water Act, for maintenance dredging of East Rockaway Inlet and beach nourishment involving dredging of borrow area 2, with material from both operations being placed at Rockaway Beach. An amendment to the beach nourishment WQC will be obtained prior to dredging of the intermediate area (East Rockaway Inlet borrow area) with placement of dredged material at Rockaway Beach.

Pursuant to Section 307 of the Coastal Zone Management Act of 1972 as amended [16 USC 1456(C)], for activities conducted or supported by a federal agency in a state which has a federally approved coastal Zone Management (CZM) program, the Corps will submit a determination that the proposed project is consistent with the State CZM program to the maximum extent practicable. The Corps will request the State's concurrence with that determination. For activities within the coastal zone of the State of New York, project information is available from the Consistency Coordinator, New York State Department of State, Division of Coastal Resources and Waterfront Revitalization, Coastal Zone Management Program, 41 State Street, Albany, New York 12231, Telephone (518) 474-3642.

In compliance with Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (1996 amendments), an Essential Habitat Assessment will be prepared and submitted to the National Marine Fisheries Service for review and comments.

The proposed work is being coordinated with the following Federal, State and Local Agencies:

U. S. Environmental Protection Agency

U. S. Department of Commerce, National Marine Fisheries Service

U. S. Department of the Interior, Fish and Wildlife Service

U. S. Coast Guard, Third Coast Guard District

New York State Department of Environmental Conservation

New York State Department of State

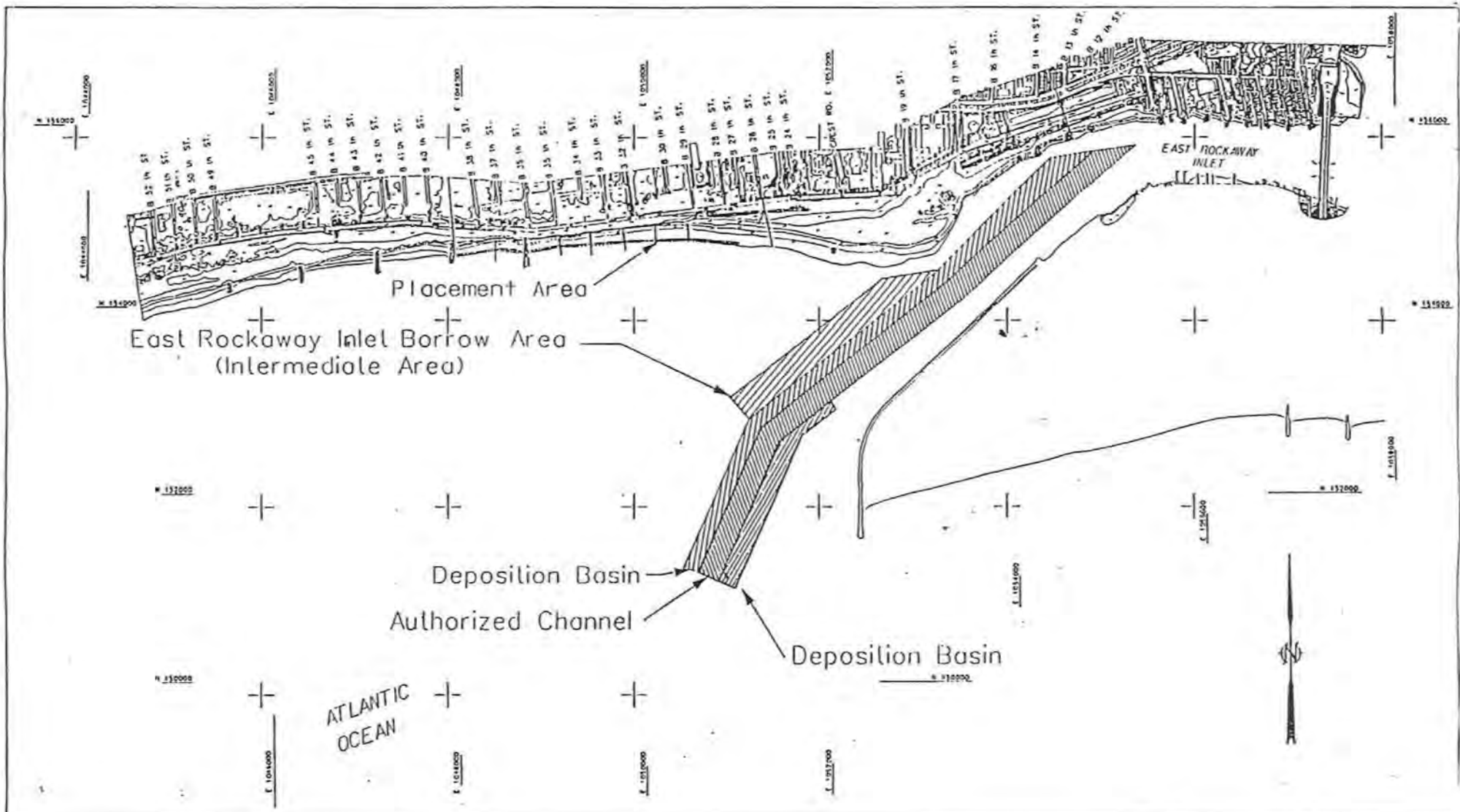
ALL COMMENTS REGARDING THIS ACTIVITY MUST BE PREPARED IN WRITING AND MAILED TO REACH THIS OFFICE AT THE ADDRESS ON THE FRONT PAGE BEFORE THE EXPIRATION DATE OF THIS NOTICE, otherwise, it will be presumed that there are no objections to the activity.

Any person who has an interest which may be affected by the placement of this dredged material may request a public hearing. The request must be submitted in writing to the District Engineer within the comment period of this notice and must clearly set forth the interest which may be affected and the manner in which the interest may be affected by the activity. It should be noted that information submitted by mail is considered just as carefully in the process and bears the same weight as that furnished at a public hearing.

It is requested that you communicate the foregoing information concerning the proposed work to any persons known by you to be interested and who have not received a copy of this notice. If you have any questions, please do not hesitate to contact Mr. William Vanterpool of this office at (212) 264-9032.

JOHN R. HARTMANN
Chief, Operations Division

Enclosure
1. East Rockaway Inlet
2. Borrow Area 2



ATTACHMENT 1

SURVEY OF: EAST ROCKAWAY INLET

EAR ROCKAWAY NEW YORK

SCALE

OFFICE OF PARKS · RECREATION · HISTORIC PRESERVATION
NEW YORK STATE
Bernadette Castro
Commissioner

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, PO Box 189, Waterford, New York 12188-0189 518-237-8643

August 9, 2000

Leonard Houston
Acting Chief, Environmental Analyst Branch
U.S. Army Corps of Engineers
New York District
Jacob K. Javits Federal Building
New York, New York 10278-0090

Dear Mr. Houston:

Re: CORPS
Beach Nourishment Rockaway Beach/Channel
Dredge East Rockaway Inlet
Queens, Queens County
00PR2949

Thank you for requesting the comments of the State Historic Preservation Office (SHPO). We have reviewed the project in accordance with Section 106 of the National Historic Preservation Act of 1966.

Based upon our review, it is the SHPO's opinion that your project will have No Effect upon cultural resources in or eligible for inclusion in the National Register of Historic Places.

If further correspondence is required regarding this project, please be sure to refer to the OPRHP Project Review (PR) number noted above.

Sincerely,

Ruth L. Pierpont

Ruth L. Pierpont
Director

RLP:bsd

An Equal Opportunity/Affirmative Action Agency
printed on recycled paper

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, N.Y. 10278-0090

REPLY TO
ATTENTION OF

July 17, 2000

Environmental Analysis Branch
Environmental Assessment Section

Ms. Ruth L. Pierpont
Director
Historic Preservation Field Services Bureau
New York State Office of Parks, Recreation and
Historic Preservation
Peebles Island
P.O. Box 189
Waterford, New York 12188-0189

RE: CORPS
Rockaway Beach Project
Brooklyn, Kings County
89PR1188

CORPS
East Rockaway Inlet Channel Dredging
Queens County
92PR1171

Public Notice No. 00-ERIMDSN

Dear Ms. Pierpont;

The U.S. Army Corps of Engineers, New York District (New York District), in its continuing effort to nourish the beaches along the Rockaway Beach shoreline as part of the above referenced Beach Erosion Control and Hurricane Protection Project for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Queens County, New York (89PR1188), proposes to place material dredged from the nearby East Rockaway Inlet Federal channel and a borrow area adjacent to the Federal channel along the shoreline between Beach 27th Street and Beach 40th Street (92PR1171; Enclosure 1). These proposed actions are also described in the above referenced Public Notice issued June 16, 2000, by the New York District (Enclosure 2).

As part of previous coordination efforts for the Beach Erosion Control and Hurricane Protection project, the placement of sand on the beach from Beach 19th Street to Beach 149th Street has been determined to have no effect on historic properties (Enclosure 3). In addition, the use of material from the Federal channel, Borrow Area 2 and portions of Borrow Area 1A and 1B were also determined to have no effect on historic properties (Enclosures 4, 5 and see Enclosure 3). As part of the current renourishment effort, an additional source of sand, the East Rockaway Inlet Borrow Area, located along the west side of the Federal channel will be utilized, in association with sand from the Federal channel and Borrow Area 2.

The East Rockaway Inlet Borrow Area is located in a very active inlet with continuous scouring and shoaling of sand on the inlet bottom. The inlet borrow area is about 300 feet wide and approximately 2120 feet long (Enclosure 6). The New York District proposes to remove approximately 300,000 cubic yards from the inlet borrow area for placement on the shoreline between Beach 27th Street and Beach 40th Street. The inlet borrow area and the adjacent channel would be dredged to about 14 feet below mean low water plus 2 feet allowable over-dredge. According to a sample of soundings taken since 1985, the East Rockaway Inlet Borrow Area has varied in depths from 12.5 –19 feet below MLW in 1985 to 8 – 15 feet MLW in 1996 to between 1 – 14 feet MLW in May 2000 (Enclosures 7 and 8; see also Enclosure 6).

According to the Cultural Resources Reconnaissance Report prepared for the Atlantic Coast of Long Island from East Rockaway Inlet to Jones Inlet (Pickman 1993), East Rockaway Inlet and the west end of Long Beach Island were situated in their current locations by the beginning of the 20th century (Enclosure 9). According to maps from the 19th century, the present location of East Rockaway Inlet was once the location of the western end of the former "Far Rockaway Beach", which had extended east toward Long Beach Island (Pickman 1993:23-24). By 1931, the inlet's position became fixed with the construction of seven timber groins and a timber bulkhead built on the east side of the inlet. Two years later, the East Rockaway Inlet jetty was built by the U.S. Army Corps of Engineers and the sand captured by the new jetty buried the earlier structures. A stone seawall that extended along the east shore of the inlet and connected to the landward end of the jetty was built in 1952 (Pickman 1993:32).

Although the area of the inlet was once a part of Rockaway Beach, the subsequent erosion of the area to a depth several feet below mean low water and continued scouring of the inlet would indicate there is no potential for the identification of significant cultural resources that are eligible for the National Register. It is also likely that the initial dredging and periodic maintenance of the Federal channel may have impacted sections of the borrow area adjacent to the channel. The New York District has determined that the dredging of the East Rockaway Inlet Borrow Area will have no effect on historic properties.

Please review the enclosed materials and provide your comments in accordance with Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36 CFR 800, by August 7, 2000. If you have any questions or require additional information, please contact Ms. Nancy Brighton, Project Archaeologist, at 212-264-2198. Thank you for your assistance.

Sincerely,

L. Houston

Leonard Houston
Acting Chief, Environmental Analysis Branch

Enclosures

Nancy

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, PO Box 189, Waterford, New York 12188-0189 518-237-8643

Bernadette Castro
Commissioner

May 10, 2000

Frank Santomauro, P.E.
Chief, Planning Division
U.S. Army Corps of Engineers
New York District
Jacob K. Javits Federal Building
New York, New York 10278-0090

Dear Mr. Santomauro:

Re: CORPS
Rockaway Inlet to Norton's Point Reconaissance
Brooklyn, Kings County
89PR1188

Thank you for requesting the comments of the State Historic Preservation Office (SHPO). We have reviewed the project in accordance with Section 106 of the National Historic Preservation Act of 1966.

Based upon our review, it is the SHPO's opinion that your project will have No Effect upon cultural resources in or eligible for inclusion in the National Register of Historic Places.

If further correspondence is required regarding this project, please be sure to refer to the OPRHP Project Review (PR) number noted above.

Sincerely,

Ruth L. Pierpont

Ruth L. Pierpont
Director

RLP:bsd

An Equal Opportunity/Affirmative Action Agency
printed on recycled paper

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, N.Y. 10278-0090

REPLY TO
ATTENTION OF

April 27, 2000

Environmental Analysis Branch
Environmental Assessment Section

J. Winthrop Aldrich
New York State Office of Parks, Recreation
and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island
P.O. Box 189
Waterford, New York 12188-0189

RE: CORPS
Rockaway Beach Project
Brooklyn, Kings County
89PR1188

Dear Mr. Aldrich;

Reference is made to the remote sensing survey conducted in 1993 by WCH Industries, Inc., in association with the Darling Marine Center, for the U.S. Army Corps of Engineers, New York District (New York District), within Borrow Area 2 as part of the above referenced project (Enclosure 1). The survey identified 34 side scan sonar targets and magnetometer anomalies throughout the borrow site. At the time of the survey, the New York District determined that the anomalies and targets would be avoided during sand removal and no further work was undertaken. Borrow Area 2 was not used as part of the initial beach fill activities for the project.

In an effort to identify enough suitable material for subsequent renourishment of the beach, the New York District has re-evaluated Borrow Area 2 and has determined that all of the borrow site must be used to provide the amount of material needed for beach placement. The New York District instructed Panamerican Consultants, Inc. (PCI), to relocate and investigate each of the targets and anomalies identified in the 1993 survey. Enclosed is the report entitled "Underwater Inspection of Targets, Borrow Area 2, Atlantic Coast of Long Island, East Rockaway Inlet to Rockaway Inlet, Queens County, New York, Storm Damage Reduction Project" that provides a description and the results of this investigation (Enclosure 2).

PCI was able to relocate 18 of the 34 targets originally recorded in 1993. All of the 18 relocated targets were identified as modern debris, specifically wire cable and concrete/rebar "bridge spans", that may have been intended for placement in the Rockaway Beach Artificial Reef located to the southwest of the borrow site. None of the targets are considered to be potentially significant submerged cultural resources. The 16 targets that are no longer present at their recorded locations were likely redeposited to other locations by either trawling activities, surf clam dredging, surge and/or current activity, or their identification was erroneous due to the

lack of contouring in the original survey. It has been determined that activities related to the dredging of Borrow Area 2 will not have an impact on any historically significant watercraft.

Please review the enclosed report and provide comments on this project to the New York District by May 31, 2000, in accordance with Section 106 of the National Historic Preservation Act, as amended, and its implementing regulation, 36 CFR 800. If you have any questions or require additional information, please contact Nancy Brighton at 212-264-2198. Thank you for your assistance.

Sincerely,

Frank Santomauro

Frank Santomauro, P.E.
Chief, Planning Division

Enclosures

GAHAGAN & BRYANT ASSOCIATES, INC.
5803 KENNETT PIKE, SUITE D
CENTREVILLE SQUARE
WILMINGTON, DELAWARE 19807-1195
TEL. (302)652-4948 FAX. (302)655-9218
GBAWILMINGTON@GBA-INC.COM

GBA
ENGINEERS ★ SURVEYORS

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, N.Y. 10278-0090

SURVEY OF:

EAST ROCKAWAY, NY
CONDITION SURVEY
ECHO SOUNDINGS

100 0 50 100 200 400

SCALE: 1 INCH = 100 FEET

PLOTTED BY: *J. DRAKE*

DATE OF SURVEY: *27 - 30 APRIL 2000*

SUBMITTED BY: *R. ROMAN*

FIELD BOOKS: *NY-08-2000*

APPROVED:

DATE: *17 MAY 2000*

SHEET 3 OF 4

N 153000

REQ. NO. 2044

Enclosure 6

N 131000

System.

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
NEW YORK, N. Y. 10007

SURVEY OF: EAST ROCKAWAY INLET, N.Y.

FINAL AFTER DREDGING
ECHO SOUNDINGS

SCALE ONE INCH = 100 FEET

BAR SCALE

PLOTTED BY: P.P., WAM II

DATE OF SURVEY: AS SHOWN

SUBMITTED BY: [signature]
CHIEF OF PARTY

FIELD BOOKS: 13829, 13830, 13843, 13844

APPROVED: [signature]
CHIEF, SURVEY BRANCH

DATE 23 October 85

SHEET 1 OF 1

FILI

Enclosure 7

E 2068500

IMPROVEMENTS

PROJECT CODE

PROJECT

MAINTENANCE DREDGING
EAST ROCKAWAY INLET

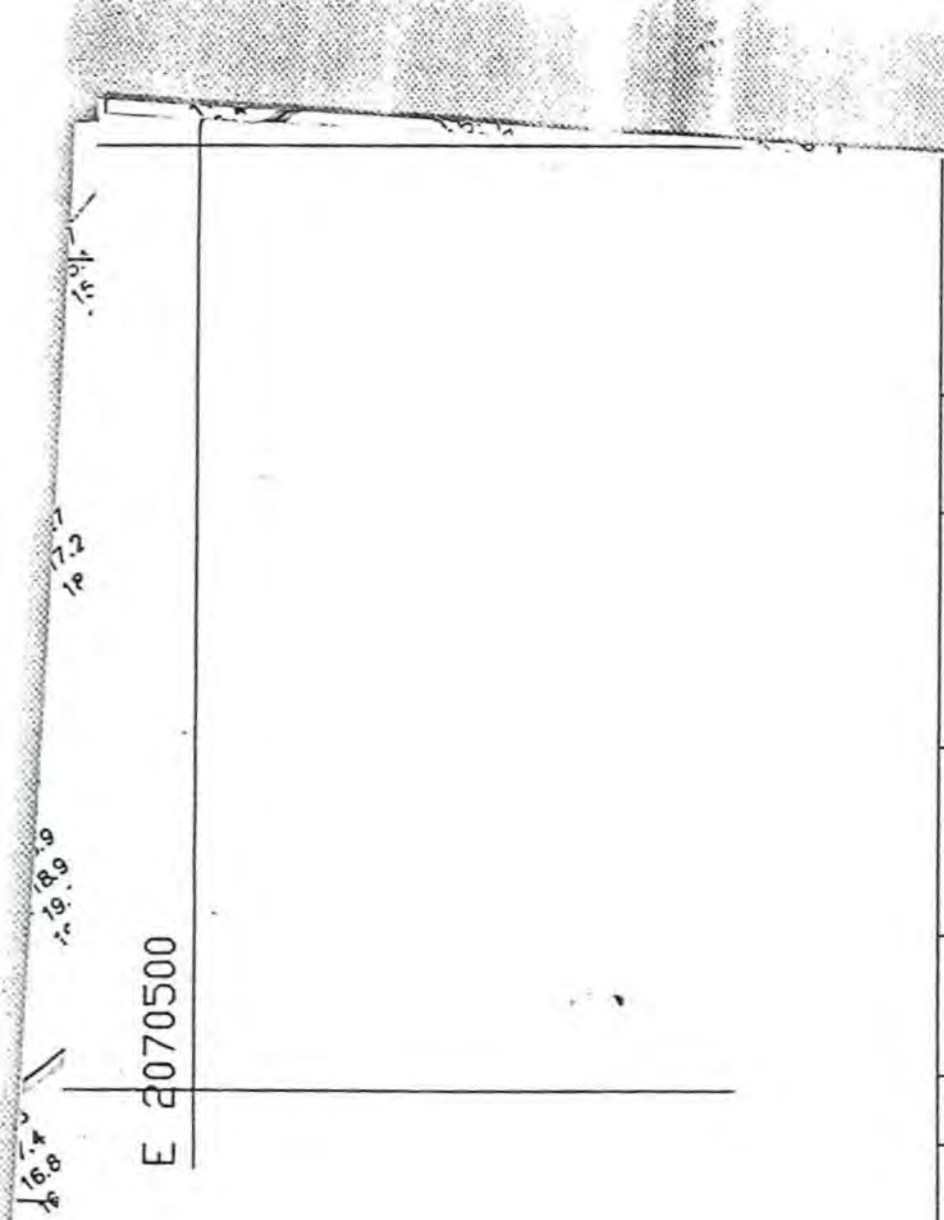
DRAWING TITLE

CONDITIONAL SURVEY

DRAWING NUMBER

GLDD / RZF1

PHASE		SHEET
SCALE 1in.= 100ft.	DRAWN J.L.H.	DESIGNED
DATE 27-OCT-1996	CHECKED	APPROVED



GREAT LAKES DREDGE & DOCK COMPANY

PROJECT CODE

PROJECT

MAINTENANCE DREDGING
EAST ROCKAWAY INLET

DRAWING TITLE

CONDITIONAL SURVEY

DRAWING NUMBER

GLDD / RZF1

PHASE date 27 Oct 96		SHEET
SCALE 1in.= 100ft.	DRAWN J.L.H	DESIGNED
DATE	CHECKED	APPROVED

CULTURAL RESOURCES RECONNAISSANCE
ATLANTIC COAST OF LONG ISLAND
JONES INLET TO EAST ROCKAWAY INLET
CITY OF LONG BEACH, VILLAGE OF ATLANTIC BEACH, LIDO BEACH AND POINT LOOKOUT AREAS, TOWN OF HEMPSTEAD
LONG BEACH ISLAND
NASSAU COUNTY, NEW YORK

92PR2416

by
Arnold Pickman

Submitted to:
U.S. Army Corps of Engineers
New York District

June 1993

Work Performed Under Contract No. DACW51-92-M-0636

Arnold Pickman

Arnold Pickman
Principal Investigator

years of the twentieth, the buildings associated with the U.S. Life Saving Stations and the Long Beach and Point Lookout Hotels and cottages continued to be the only structures on Long Beach Island. A second life saving station, not shown on the 1873 map was opened in the Point Lookout section of Long Beach Island. It is shown on maps dating to 1878 (Figure 20) and 1886 (Figure 25a) located near the shoreline in what is now the Lido Beach area.

By the 1890's both the Long Beach and Point Lookout lifesaving stations had been moved from their original locations. The Point Lookout station was apparently moved from its original location on or near the beach to a site on the northern portion of the island (see Figures 27a and 27c) approximately opposite the western portion of Alder Island.

The Long Beach life saving station was apparently moved twice from its location as shown in 1873 (Figures 18b and 18d). The 1896 Hyde map (Figure 31a and 31b) shows both an "old" and relocated position of this station. However, the "old" location shown on the map apparently refers to a ca. 1880's site. As noted above, in 1873 the station was located in the Edwards/Riverside Boulevard area. It was probably relocated when the Long Beach Hotel was constructed on the original site in 1880. This ca. 1880 site was located in the vicinity of the present Neptune Avenue, which at that time would have been near the west side of Luce's inlet. The station was subsequently moved again to the "new" location as shown on the 1896 map (Figures 27a and 27b), which was on the west end of Long Beach, near the present location of New York Avenue. It should be noted that an 1898 coastal survey chart (Figures 28a and 28b) continues to show the life saving station west of Luces' Inlet. However, this location is most likely uncorrected from an earlier edition of this chart. The location of the site as shown on subsequent maps (e.g. Figures 29 and 30) is the same as the "new" site as shown on the 1896 map.

4. Long Beach Island Morphology - Late Nineteenth/Early Twentieth Century Changes

Prior to 1886 Luce's Inlet had been partially closed by a strip of beach, but still existed as a shallow cove extending southward from Hempstead Bay (see Figure 25a). As noted above, through the third quarter of the 19th century, Rockaway Beach extended eastward to Hog Island Inlet. A body of water known as the "Bay of Far Rockaway" separated Far Rockaway beach from the mainland. This configuration is shown on maps as late as 1886 (see Figure 25b).

It would appear that after 1886 a new inlet had formed near the present location of East Rockaway inlet, creating a new island between this inlet and Hog Island Inlet (see Figure 26a). An 1898 map (see Figure 28a) indicates this new inlet as "Little Inlet and the new island as "Shelter Island", with Far Rockaway beach extending westward from "Little Inlet." After 1898 Hog Island Inlet closed, effectively extending Long Beach Island westward to East Rockaway Inlet. Thus by the first decade of the 20th century

(see Figures 29 - 31) the configuration of the western portion of Long Beach Island was close to that which now exists.

One source (Chief of Engineers 1929) states that the present East Rockaway inlet "is located at approximately the middle of the former long and narrow Bay of Far Rockaway", with the eastern end of the former Far Rockaway Beach now being incorporated into the present Long Beach Island. However, examination of the late 19th and early 20th century maps indicates that the present East Rockaway inlet is actually at the western end of the former "Far Rockaway Beach", with the present Reynolds Channel at the location of the former "Bay of Far Rockaway." Thus all of the late 19th century "Far Rockaway Beach", with the exception of its extreme western end, which was at the present location of the inlet, has apparently been incorporated into the present Long Beach Island.

On the eastern end of Long Beach Island, the 1851 Coastal Survey and 1859 Walling Maps (Figures 16 and 17a) had shown the west side of Jones Inlet aligned approximately with the east side of Alder Island. The 1873 Beers map (Figure 18a), reflects an apparent eastward shift of the eastern end of Long Beach Island and shows the western side of Jones Inlet aligned with the western portion of Meadow Island. However, a Coastal Survey map (Figure 20) indicates that by 1878 the Island's eastern end had once more retreated westward. This map also includes dashed lines which reflect shoreline changes occurring between 1878 and 1886. The northern portion of the eastern tip of Long Beach Island had evidently been eroded during this period with a narrow strip of land remaining on the southern shoreline. This strip extended eastward to once again approximately align with the western side of Meadow Island. This approximate configuration is also shown on the 1886 Beers map (Figure 25a).

Maps dating to to the 1890's and the first decade of the 20th century (Figures 26-31) show a similar configuration of the Point Lookout area to that shown on the ca. 1880's maps, with some minor changes, including an increase in the width of the Island.

At present the eastern end of Point Lookout is located some 2000-2500 feet further to the west than at the beginning of the twentieth century and is now aligned with the eastern portion of Alder Island (see Figure 71).

G. Early Twentieth Century Development

In 1898 a suit was brought by several individuals claiming ownership of Long Beach Island by virtue of a chain of purchases originating with John Hicks, who had purchased the land from a group of Hempstead freeholders in 1725. As noted above, a similar suit had been brought at the end of the 18th century. In 1902 the court again ruled that the ocean beach property was owned by the Town of Hempstead. This ruling cleared the way for the sale of Long Beach to private developers (Hazelton 1925:II:880).

steamboat dock. The dock on the north side of Point Lookout which was noted above also is not shown on any of the 20th century maps.

In 1939 a fishing pier was built at the foot of Magnolia Boulevard in Long Beach. This pier was destroyed during a hurricane in 1960 (Graf 1972:50). Graf (1972) notes that a new pier was built at this location. However, this pier has since been removed and no traces of either pier were noted during the reconnaissance.

J. Shore Protection Structures

The first shore protection structures on Long Beach were 51 wooden groins constructed in 1926 (Tolins 1956:110). These were extensively damaged by a severe storm in 1927, and extensive repairs were required (Tolins 1956:27). The ca. 1920's groins apparently were located only in the central portion of Long Beach. Graf (1972:25) indicates that the west end of Long Beach was not fully protected by groins until the 1940's.

Taney (1961:Table 4) indicates the dates of construction of shore protection structures in and near the study area as follows:

Long Beach	Groins and Bulkheads	1927
Long Beach	Groins	1937
Long Beach	Groins	1947
Lido Beach	Groins and Bulkheads	1930
Point Lookout	Groins and Bulkheads	1940
Atlantic Beach	Groins and Bulkheads	Before 1928
East Rockaway Inlet	Jetty	1934

Additional data as to shore protection structures in the project area were presented by the U.S. Army Corps of Engineers (1965) and summarized as follows:

Point Lookout - Four timber groins were constructed by the Town of Hempstead in 1949. They were subsequently destroyed and replaced by three stone groins in 1953.

Lido Beach - A total of four stone groins were build by Long Beach on the Ocean Inc. This construction took place in 1930 (as indicated above) and also in 1933.

Long Beach - In addition to the construction noted above four timber groins were constructed in 1944. These were subsequently destroyed.

Atlantic Beach - 28 timber and 5 stone filled timber groins were constructed between 1928 and 1933. It is uncertain if these include the groins listed above as constructed pre-1928. Two additional stone-filled timber groins were constructed in 1947. All of these groins have either been replaced, removed, destroyed or buried.

The existing groins within the study area were constructed beginning in 1945 (U.S. Army Corps of Engineers 1989). Nyman (1985) noted that remains of at least some of the earlier wooden groins are apparently still present in the Long Beach area and are periodically uncovered as a result of wave action. Remains of a number of these groins were noted in the City of Long Beach portion of the study area during the reconnaissance (see Figures 53a and 53b).

The remains of a timber groin were also noted in the eastern portion of the Silver Point Park section of Atlantic Beach (Figure 53c). Two other timber groins and a timber bulkhead were noted a short distance to the east (Figure 53d). The latter are apparently associated with one of the beach clubs located immediately east of the Silver Point Park section (see Figure 56).

The first shore protection structures on the west shore of Jones Inlet were constructed in 1939. During the 1940's the Town of Hempstead constructed a stone seawall and 12 stone groins in the area.

Seven timber groins and a timber bulkhead were constructed on the east side of East Rockaway Inlet in 1931. In 1933-1934 The East Rockaway Inlet jetty was constructed by the U.S. Army Corps of Engineers. The earlier structures were buried beneath the sand trapped to the east of this jetty. A stone seawall built in 1952 extends along the east shore of the Inlet, connected to the landward end of the jetty.

K. Significant Standing Structures

Two existing Long Beach structures, the Granada Towers and the U.S. Post Office, are listed on the National Register of Historic Places (U.S. Army Corps of Engineers 1992). An additional structure is listed in the historic structures inventory maintained by the New York State Division of Parks, Recreation, and Historic Preservation. This is a private residence at 116 Washington Boulevard which supposedly dates to the late 19th century and is considered to be one of the first private homes built in Long Beach (Mintz 1979, included in Bouchard and Hartgen 1985). None of these structures will be affected by the proposed project.

OFFICE OF PARKS · RECREATION · HISTORIC PRESERVATION
NEW YORK STATE
Orin Lehman
Commissioner

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, PO Box 189, Waterford, New York 12188-0189 518-237-8643

March 18, 1993

Mr. Bruce A. Bergmann
Chief, Planning Division
Department of the Army
Corps of Engineers
New York District Office
Jacob K. Javits Federal Building
New York, New York 10278-0090

Dear Mr. Bergmann:

Re: CORPS
Rockaway Beach Project
Brooklyn, Kings County
89PR1188

Thank you for requesting the comments of the State Historic Preservation Office (SHPO). We have reviewed the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, Section 934 Project in accordance with Section 106 of the National Historic Preservation Act of 1966 and the relevant implementing regulations.

Based upon this review, it is the SHPO's opinion that this project will have No Effect upon cultural resources in or eligible for inclusion in the National Register of Historic Places. This determination is based on the condition that all potential cultural resources in Borrow Area 1A and 1B are avoided according to the recommendations of the Remote Sensing Survey report. This No Effect determination does not extend to the use of Borrow Area 2, which has not been surveyed.

We look forward to receiving and commenting on the results of the Remote Sensing Survey for Borrow Area 2 when that study has been completed.

If you have any questions, please call Robert Kuhn of our Project Review Unit at (518) 237-8643 Ext. 281.

Sincerely,

Julia S. Stokes
Deputy Commissioner for
Historic Preservation

JSS/RDK/JPW:gc

An Equal Opportunity/Affirmative Action Agency
printed on recycled paper

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, N.Y. 10278-0090

REPLY TO
ATTENTION OF

March 1, 1993

Environmental Analysis Branch
Environmental Assessment Section

Ms. Julia S. Stokes
Deputy Commissioner for Historic Preservation
New York State Office of Parks, Recreation, and
Historic Preservation
Agency Building 1
Empire State Plaza
Albany, New York 12238

Dear Ms. Stokes:

The New York District, Army Corps of Engineers (Corps) is conducting a study to determine Federal interest in participating in the cost of placing material (sand) dredged from two offshore borrow areas onto nearby Rockaway Beach, Queens, New York (Attachment 1). This work is part of a plan to prevent long term beach erosion along Rockaway Beach from Beach 19th to 149th Streets. The study has been authorized under Section 934 of the Water Resources Development Act of 1986.

Current project plans call for the restoration of Rockaway Beach from Beach 19th to Beach 149th Streets and for future nourishment of two feeder beaches, (Beach 25th Street to Beach 39th Street and Beach 86th Street to Beach 110th Street), at three 3-year intervals. Sand for the construction of the project and subsequent nourishment cycles will be dredged from two offshore borrow areas (Attachment 1).

The National Register of Historic Places lists no properties within the project area that are currently on the Register or that are eligible for inclusion. A cultural resource study, prepared as part of a maintenance dredging project, entitled "Cultural Resources Reconnaissance Dredging Project, East Rockaway Inlet, New York" was written by J. Stephen Kopper (Attachment 2). This report found that there were no prehistoric or historic archaeological sites within the beachfront area bounded by Beach 19th Street and Beach 149th Street.

In addition, the Corps has coordinated with your office regarding a project authorized by Section 933 of the Water Resources Development Act of 1986 that involved dredging sand from the East Rockaway Inlet navigation channel and placing it on two sections of Rockaway Beach (Attachment 3). After a copy of the aforementioned cultural resource survey report was forwarded to your office on June 25, 1992, the Corps received your response, dated July 7, 1992, of no concern with regards to the Section 933 project (Attachment 4).

The Corps has plans to utilize two offshore borrow sites during the initial and subsequent nourishment phases of the project. The first borrow area, Borrow Area 1A and 1B, is located offshore Coney Island, New York and to the west of Rockaway Inlet (Attachment 1). In November 1992, Dr. Warren Reiss and Ocean Surveys, Inc. conducted a remote sensing survey of this area using side scan sonar and a magnetometer (Attachment 5). This investigation identified 10 "potential cultural resources" and 1 "probable significant cultural resource" based upon magnetometer and side scan sonar data. The "probable significant cultural resource" may be one or more shipwrecks, possibly a wooden hulled vessel(s) with associated large ferrous objects, such as an engine or anchor. According to current project plans, all potential resources identified by this survey will be avoided during dredging.

Borrow area 2 (Attachment 1) is located offshore of the sand placement area. Parts of this borrow site may have been used to nourish the beach during the original project in the late 1970s and early 1980s. Dredging records, however, have not indicated which areas may or may not have been impacted. As a result, the Corps has plans to conduct a remote sensing survey of the entire borrow site. The results of this investigation will be coordinated with your office upon completion of this survey.

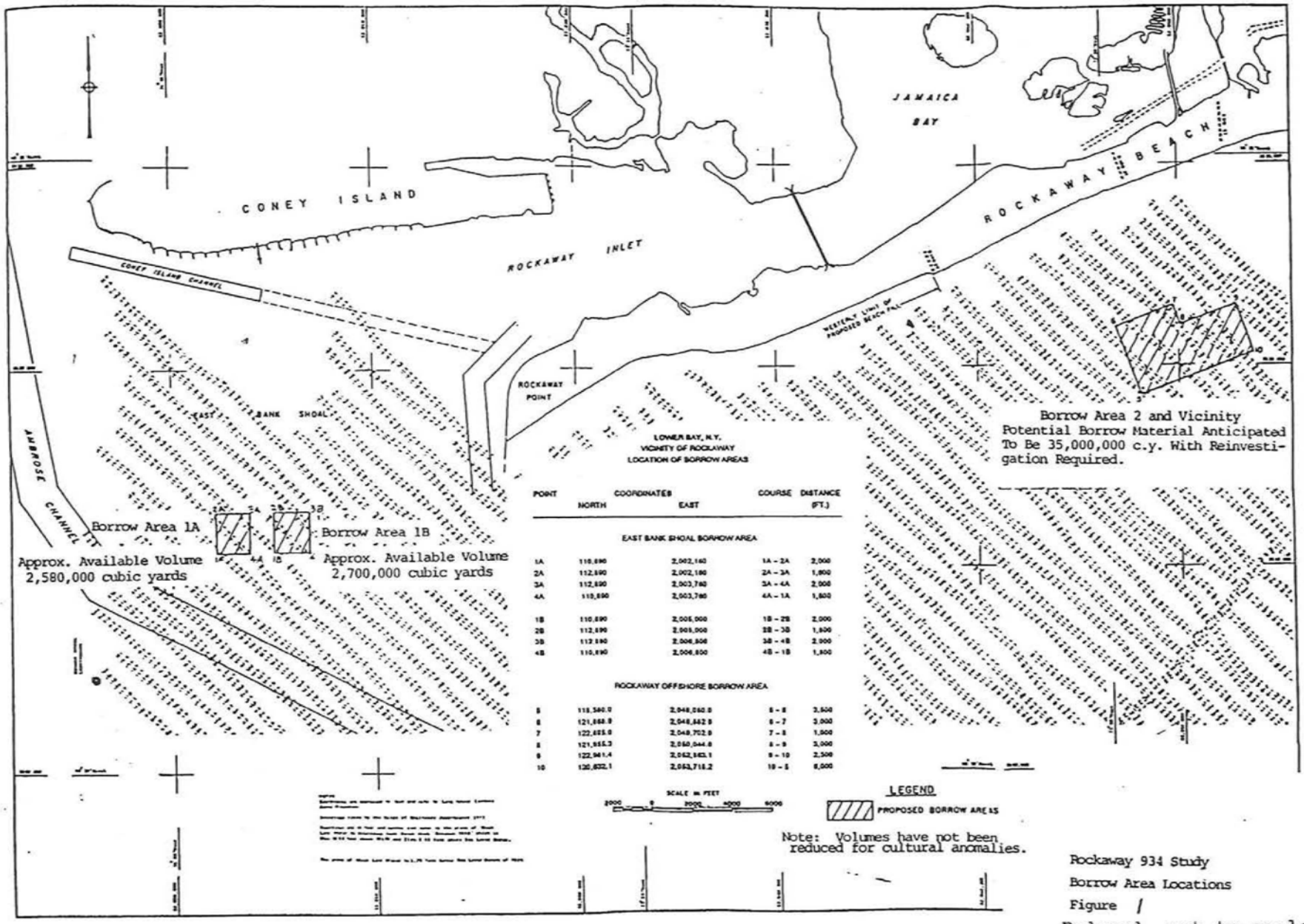
On the basis of current project plans and pending review by your office, the Corps is of the opinion that the Atlantic Coast of New York City, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York, Section 934 Project will have no effect on historic properties located on Rockaway Beach, from Beach 19th to 149th Streets, or within Borrow Areas 1A and 1B. Please provide us with Section 106 comments as pursuant to 36 CFR 800.5.

If you or your staff have any questions or require additional information, please contact Nancy Brighton, Project Archaeologist, (212)264-4663. Thank you for your assistance.

Sincerely,

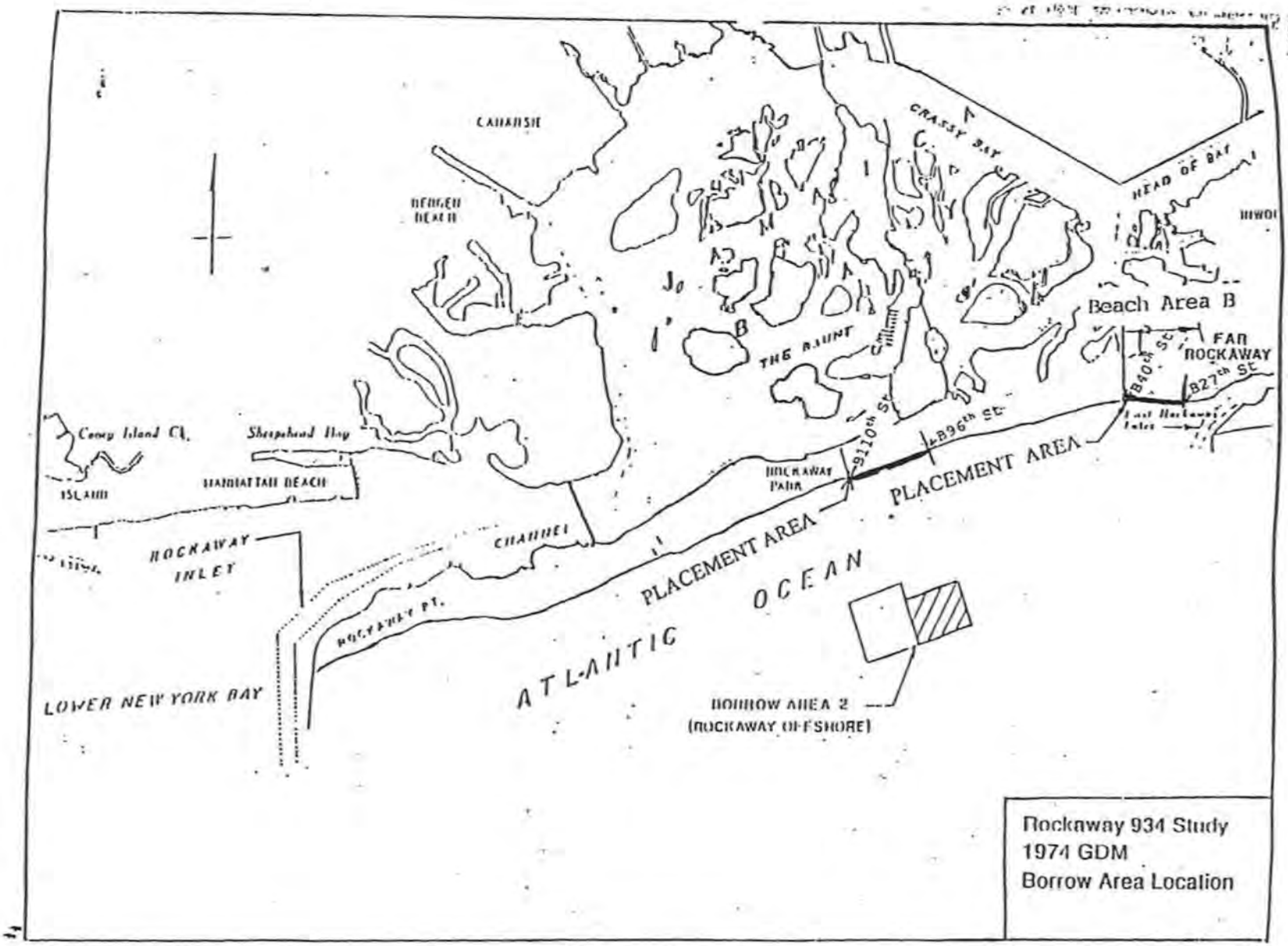
Bruce A. Bergmann
Chief, Planning Division

Attachments



Rockaway 934 Study
Borrow Area Locations
Figure 1
Reduced, not to scale

Attachment 1



ATTACHMENT 2

Attachment 2

CULTURAL RESOURCES RECONNAISSANCE

DREDGING PROJECT
EAST ROCKAWAY INLET, NEW YORK

by

J. Stephen Kopper
Department of Anthropology, C.W. Post Center
Long Island University, Greenvale, NY 11548

May 10, 1979

Funded by the Department of the Army,
New York District Corps of Engineers,
26 Federal Plaza, New York, NY 10007

Prepared Under the Supervision of J. Stephen Kopper,
Principal Investigator

J. Stephen Kopper
Principal Investigator

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, N.Y. 10278-0090

REPLY TO
ATTENTION OF

June 3, 1992

Environmental Assessment Section
Environmental Analysis Branch

Ms. Julia S. Stokes
Deputy Commissioner for Historic Preservation
New York State Office of Parks, Recreation, and Historic Preservation
Agency Building 1
Empire State Plaza
Albany, New York 12238

Dear Ms. Stokes:

The New York District, Army Corps of Engineers (Corps) is conducting a study to determine Federal interest in participating in the cost of placing material (sand) dredged from the East Rockaway Inlet navigation channel, located in Queens County, New York, onto nearby Rockaway Beach (Attachment 1). This work is part of a scheduled maintenance dredging operation of the channel as well as an attempt to prevent long term beach erosion on a portion of Long Beach Island. The study has been authorized under Section 933 of the Water Resources Development Act of 1986.

The Federal portion of the navigation channel begins to the southwest of Atlantic Beach, Long Beach Island, and proceeds in a north to northeasterly direction towards Rockaway where it terminates offshore, southwest of Beach 20th Street (Attachment 2). Maintenance dredging is necessary to prevent the build-up of shoals in the channel which create shallow depths and hazardous navigation conditions for local mariners. The area of the proposed placement of dredged material will be at one of two sections of Rockaway Beach in the Town of Far Rockaway. These sections are Beach 32nd Street to Beach 36th Street and Beach 56th to Beach 60th Street. Both are areas of intense erosion. Sand will be used to build up the existing beach to withstand wave and storm action (Attachment 3).

The National Register of Historic Places lists no properties within the project areas that are currently on the Register or that are eligible for inclusion. A cultural resource study, prepared as part of a similar maintenance

dredging project, entitled "Cultural Resources Reconnaissance Dredging Project, East Rockaway Inlet, New York" was written by J. Stephen Kopper (Attachment 4). This report found that there were no prehistoric or historic archaeological sites within the beachfront area bounded by Beach 19th Street and Beach 149th Street, which includes both proposed nourishment areas.

On the basis of current project plans and pending review by your office, the Corps is of the opinion that the Section 933, East Rockaway Inlet, New York Project will have no effect on historic properties. Please provide us with Section 106 comments as pursuant to 36 CFR 800.5.

If you or your staff have any questions or require further information on this project, please contact Nancy Brighton (212)246-4663. Thank you for your assistance.

Bruce A. Bergmann
Chief, Planning Division

Attachments

Attachment 4

New York State Office of Parks, Recreation and Historic Preservation
The Governor Nelson A. Rockefeller Empire State Plaza
Agency Building 1, Albany, New York 12238-0001

OFFICE OF PARKS, RECREATION AND HISTORIC PRESERVATION
NEW YORK STATE
Orin Lehman
Commissioner

July 7, 1992

Mr. Bruce A. Bergmann
Chief, Planning Division
Department of the Army
Environmental Analysis Branch
Jacob K. Javits Federal Building
New York, New York 10278-0090

Dear Mr. Bergmann:

Re: CORPS
East Rockaway Inlet Channel
Dredging
Queens County
92PR1171

Thank you for requesting the comments of the State Historic Preservation Office (SHPO) concerning the property referenced above. The information which you submitted has been reviewed in accordance with Section 106 of the National Historic Preservation Act of 1966 and the relevant implementing regulations.

Based upon this review, the SHPO has no concerns regarding this project's impact on archeological resources.

If you have any questions, please call Vic DiSanto of our Project Review Unit at (518) 474-0479.

Sincerely,

David S. Gillespie

David S. Gillespie
Director
Field Services Bureau

DSG/VJD:gc

ATLANTIC COAST OF NEW YORK CITY
EAST ROCKAWAY INLET TO ROCKAWAY INLET
AND JAMAICA BAY, NEW YORK
SECTION 934 STUDY
BORROW AREAS 1A AND B
REMOTE SENSING SURVEY

Prepared For:

NEW YORK DISTRICT
CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, NY 10278

Under Contract Number
DACW51-92-D-0003

Principal Investigator:

Warren C. Riess

Warren C. Riess, Ph.D.

February 11, 1993

Prepared By:
WCH Industries, Inc., 14 Felton Street, Waltham, Massachusetts 02154

In Association With
Boston Affiliates, Inc., 156 Milk Street, Boston, Massachusetts 02109

OFFICE OF PARKS · RECREATION · HISTORIC PRESERVATION
NEW YORK STATE
Orin Lehman
Commissioner

New York State Office of Parks, Recreation and Historic Preservation
The Governor Nelson A. Rockefeller Empire State Plaza
Agency Building 1, Albany, New York 12238-0001

July 7, 1992

Mr. Bruce A. Bergmann
Chief, Planning Division
Department of the Army
Environmental Analysis Branch
Jacob K. Javits Federal Building
New York, New York 10278-0090

Dear Mr. Bergmann:

Re: CORPS
East Rockaway Inlet Channel
Dredging
Queens County
92PR1171

Thank you for requesting the comments of the State Historic Preservation Office (SHPO) concerning the property referenced above. The information which you submitted has been reviewed in accordance with Section 106 of the National Historic Preservation Act of 1966 and the relevant implementing regulations.

Based upon this review, the SHPO has no concerns regarding this project's impact on archeological resources.

If you have any questions, please call Vic DiSanto of our Project Review Unit at (518) 474-0479.

Sincerely,

David S. Gillespie
Director
Field Services Bureau

DSG/VJD:gc

OFFICE OF PARKS · RECREATION · HISTORIC PRESERVATION
NEW YORK STATE
Orin Lehman
Commissioner

New York State Office of Parks, Recreation and Historic Preservation
The Governor Nelson A. Rockefeller Empire State Plaza
Agency Building 1, Albany, New York 12238-0001

June 19, 1992

Mr. Bruce A. Bergmann
Chief, Planning Division
Department of the Army
New York District, Corps of Engineers
Jacob K. Javits Federal Building
New York, New York 10278-0090

Dear Mr. Bergmann:

Re: CORPS
East Rockaway Inlet Channel Dredging
Queens County
92PR1171

Thank you for requesting the comments of the State Historic Preservation Office (SHPO) concerning the property referenced above. The information which you submitted has been reviewed in accordance with Section 106 of the National Historic Preservation Act of 1966 and the relevant implementing regulations.

Please submit the cultural resource management report cited in your letter to the SHPO for review. If you have any questions, please call Vic DiSanto at (518) 474-0479.

Sincerely yours,

David S. Gillespie
Director
Field Services Bureau

DSG/VJD:tr

received 6/25/92
EDY

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, N.Y. 10278-0090

REPLY TO
ATTENTION OF

June 3, 1992

Environmental Assessment Section
Environmental Analysis Branch

Ms. Julia S. Stokes
Deputy Commissioner for Historic Preservation
New York State Office of Parks, Recreation, and Historic Preservation
Agency Building 1
Empire State Plaza
Albany, New York 12238

Dear Ms. Stokes:

The New York District, Army Corps of Engineers (Corps) is conducting a study to determine Federal interest in participating in the cost of placing material (sand) dredged from the East Rockaway Inlet navigation channel, located in Queens County, New York, onto nearby Rockaway Beach (Attachment 1). This work is part of a scheduled maintenance dredging operation of the channel as well as an attempt to prevent long term beach erosion on a portion of Long Beach Island. The study has been authorized under Section 933 of the Water Resources Development Act of 1986.

The Federal portion of the navigation channel begins to the southwest of Atlantic Beach, Long Beach Island, and proceeds in a north to northeasterly direction towards Rockaway where it terminates offshore, southwest of Beach 20th Street (Attachment 2). Maintenance dredging is necessary to prevent the build-up of shoals in the channel which create shallow depths and hazardous navigation conditions for local mariners. The area of the proposed placement of dredged material will be at one of two sections of Rockaway Beach in the Town of Far Rockaway. These sections are Beach 32nd Street to Beach 36th Street and Beach 56th to Beach 60th Street. Both are areas of intense erosion. Sand will be used to build up the existing beach to withstand wave and storm action (Attachment 3).

The National Register of Historic Places lists no properties within the project areas that are currently on the Register or that are eligible for inclusion. A cultural resource study, prepared as part of a similar maintenance

dredging project, entitled "Cultural Resources Reconnaissance Dredging Project, East Rockaway Inlet, New York" was written by J. Stephen Kopper (Attachment 4). This report found that there were no prehistoric or historic archaeological sites within the beachfront area bounded by Beach 19th Street and Beach 149th Street, which includes both proposed nourishment areas.

On the basis of current project plans and pending review by your office, the Corps is of the opinion that the Section 933, East Rockaway Inlet, New York Project will have no effect on historic properties. Please provide us with Section 106 comments as pursuant to 36 CFR 800.5.

If you or your staff have any questions or require further information on this project, please contact Nancy Brighton (212)246-4663. Thank you for your assistance.

Bruce A. Bergmann
Chief, Planning Division

Attachments