FINAL APPENDICES TO THE

INTEGRATED GENERAL REEVALUATION REPORT AND SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

BREVARD COUNTY, FLORIDA
HURRICANE AND STORM DAMAGE REDUCTION PROJECT
MID-REACH SEGMENT

U.S. Army Corps
of Engineers
Jacksonville District

AUGUST 2010

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ENGINEERING ANALYSIS AND DESIGN

BREVARD MID-REACH, FLORIDA
GENERAL REEVALUATION REPORT

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BACKGROUND

A-1. The Brevard County, Florida, Beach Erosion Control Project, as described in House Document No. 352, 90^{th} Congress, 2^{nd} Session dated 8 July, was authorized by the River and Harbor Act of August 13, 1968. The project authorized construction of recreational and protective beaches to be constructed in the vicinity of Cape Canaveral and Indialantic-Melbourne Beach.

A-2. On September 23, 1982, the Committee on Public Works and Transportation, U.S. House of Representatives adopted a resolution directing the Board of Engineers for Rivers and Harbors to review the feasibility of providing beach erosion control works in Brevard County in the area from Patrick Air Force Base southward to the Town of Indialantic. In response to the above resolution, on 23 December 1996 the Brevard County, Florida Shore Protection Project Review Study was submitted for approval. This report recommended nourishment along 2 separable reaches. The North Reach is bounded by Canaveral Harbor to the north and Patrick Air Force Base to the south. The south reach begins near the town of Indialantic and extends southward to Spessard Holland Park. The previously constructed Patrick AFB and South Reach beach fills bound the present ‘Mid-Reach’ project site.

A-3. The North Reach project fill area includes 9.4 miles of shoreline from Florida Department of Environmental Protection (FDEP) Monument R-03 to R53. Initial construction was completed April 2001 and placed approximately 3.1 million cubic yards (Mcy) of material. The Air Force funded a nourishment of its beaches from R53 to R77, which was constructed in conjunction with the North Reach and placed 0.6 Mcy of fill. The South Reach project was initially nourished in two segments due to permit restrictions concerning turtle nesting season; the first segment (R-122.5 to R-139) was completed in April 2002 and the second segment (R-118.3 to R-123.5) was completed in April 2003. Total fill in the South Reach was approximately 1.6 Mcy.

A-4. The Mid-Reach extends 7.6 miles from monument R75.4 (the southern end of Patrick AFB) southward to R119, where the South Reach fill begins. The Mid Reach was removed from the Brevard County Shore Protection Study due to potential adverse environmental impacts to nearshore reef-rock outcrops that require further analysis. It is the purpose of this appendix to evaluate alternatives that would alleviate erosional impacts while protecting the reef ecosystem.

PROBLEM IDENTIFICATION
Beach Erosion

A-5. The beaches of Brevard County have experienced temporally and spatially variable erosion during the past several decades (USACE 1996). Similar to the previously-approved North and South Reaches of the project, the Mid-Reach has experienced MHW line and bluff erosion that threatens coastal development and infrastructure; however, the Mid-Reach is significantly different from the rest of the Brevard County Shore Protection Project due to the presence of 'reef rock' in the surf-zone. The purpose of this investigation is to (1) assess the impact of beach erosion in the project area and (2) produce alternatives to alleviate the erosion impacts while minimizing impact to the reef rock resource.

Nearshore Rock Outcrops
A-6. Extensive surveying and mapping of the nearshore rock was performed by the local sponsor (Brevard County) and is presented in a report entitled *Assessment of Nearshore Rock and Shore Protection Alternatives Along the "Mid Reach" of Brevard County, Florida* (Olsen Associates, 2003). The following is a short synopsis of the rock features in the project area.

A-7. The Mid Reach nearshore rock is characterized as tabular lithified coquina (limestone) ledges, which occur in a longshore band that extends from approximately the MLW shoreline seaward a variable distance up to approximately 300 feet. The vertical relief and longshore density of the rock vary significantly along the project area. In general the rock is most complex and extensive in the northern portion of the project and decreases in density toward the south. The rock occurs as both isolated outcrops and large tabular sections. Vertical relief ranges from 0" (flush with the surrounding beach profile) to approximately 18"; isolated portions are up to 30" above grade. Due to the location of the rock, in the energetic environment of the surf-zone, and the low relief of much of the rock, total exposed surface area of the outcrops appears to be quite variable; the most recent rock survey (derived from 2004 aerial photography) found a total of approximately 31.3 acres in the Mid Reach project area. A complete description of the reef-rock appears in the GRR Environmental Impact Statement.

NATURAL FORCES
A-8. Natural forces that influence the coastal processes characteristic of the Brevard County, Florida shoreline include winds, tides, currents, waves and storm effects. The role of each of these factors and their contribution to beach erosion in Brevard County Mid-Reach are described in the following paragraphs.

Winds
A-9. Winds and the short-period waves they produce are the primary mechanisms of sand transport at the project site. Winds offshore in the project area vary seasonally with typical prevailing winds from the northeast through southeast. Low-pressure winter cold fronts generally traverse the continental United States from west to east. These conditions occasionally produce strong storms, called nor'easters, which can cause extensive beach

erosion and shorefront damage. The summer months (June through October) are characterized by southeast trade winds and tropical weather systems traveling east to west in the lower latitudes. Tropical disturbances regularly develop into tropical storms and hurricanes, which generate devastating winds, waves and storm surge when they impact the project area.

Tides and Currents

A-10. Tides in the area are semi-diurnal; the mean tidal range at Canaveral Harbor is 3.5 feet. All elevations provided in this appendix are referenced to National Geodetic Vertical Datum of 1929 (NGVD). The National Ocean Service (NOS) has established tidal datums at the Port Canaveral Entrance based on a 1960-1978 tidal epoch; these datums are scheduled for an update to the 1983-2001 tidal epoch some time in the near future. These datums define mean high water (MHW) as 1.99 feet above NGVD, and mean Low Water (MLW) as 1.61 feet below NGVD (CO-OPS 2004). The U.S. Army Corps of Engineers, Jacksonville District (CESAJ) has established a fixed construction datum for Canaveral Harbor which is 1.90 feet below NGVD, which was referred to as MLW in some past literature. Elevation from CESAJ surveys referenced to MLW may be converted to NGVD by subtracting 1.90 feet. For the purposes of the following discussion and analysis, MLW will be defined by the NOS definition of -1.61 NGVD.

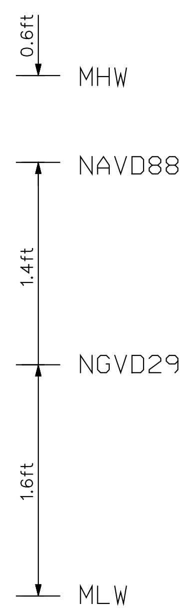

Figure A-1. Relationship between vertical geodetic and tidal datums for Brevard County SPP Mid Reach.

A-11. The primary ocean current offshore of the project area is the Florida Gulf Stream. With the exception of intermittent local reversals, it flows northward. The average annual current velocity is approximately 28 miles per day, varying from an average monthly low of about 17 miles per day in November to an average monthly high of approximately 37 miles per day in July. The axis of the Florida Gulf Stream typically lies about 30 nautical miles east of Cape Canaveral. The Gulf Stream current may have indirect effects on the sediment transport regime of the Mid Reach, but it is not one of the primary influences on the beach sediment transport regime.

A-12. Littoral currents affect the supply and distribution of sediment on the sandy beaches of Brevard County. Longshore currents, induced by oblique wave energy generally determine the long-term direction and magnitude of littoral transport. The most influential cross-shore currents are generally induced by storm waves and surge. Storm-induced cross-shore currents often result in the offshore transport of beach material, resulting in temporary or permanent erosion of the beach. More detailed discussions of longshore and cross-shore sediment transport will be presented in subsequent sections of this appendix.

Waves

A-13. The principal forcing mechanism that causes sediment transport in the nearshore environment is the dissipation of energy (and corresponding transport of sand particles) as waves enter the nearshore zone and break. Wave height, period, and direction along with storm surge are the most important factors influencing the project shoreline. In order to evaluate the effects of incident waves on the project area, a nearshore wave climate was specifically developed for the Mid-Reach by transforming available deepwater hindcast information to the nearshore using a spectrally-based wave model.

A-14. The deepwater wave information was taken from a 50-year-long (July 1, 1954 – June 30, 2004), numerically generated database developed by Oceanweather, Inc. for the Air & Environment Service of Canada (AES). In the original development of the AES information, global wind fields were locally enhanced for hurricanes and other storms, and the winds then used to drive a 3rd generation 'WAM-like' wave hindcasting model (see Swail and Cox, 2000).

A-15. The primary advantage of this dataset versus the more commonly used WIS data is the 50-year period over which the AES data is available; whereas, Atlantic coast WIS data spans a shorter 20-year time span from 1980-1999. Additionally, analysis indicates that the AES data, once transformed to the nearshore, compares more favorably with in-situ wave gage measurements near the project area than WIS data that is similarly transformed to the nearshore.

A-16. At a selected number of AES model grid points, spectral wave parameters and wind speed & direction were archived every six hours. One of the archived AES grid points lies directly off Cape Canaveral (#3278), as shown in Figure A-3. Data from this location was transformed to an intermediate depth utilizing a modified version of the Corps' Steady-State Spectral Wave Model (STWAVE).

A-17. Recent work in the Canaveral Bight by FDEP/Surfbreak Engineering Sciences (SES) has demonstrated the importance of bed-induced energy losses (e.g. bottom friction) in reducing incident wave energy, particularly during storms. A SES-modified version of STWAVE, called '$STWAVE^+$', has shown the ability to replicate these dissipation processes, and in previous work has been validated using approximately five years of wave data collected near Sebastian Inlet. In the present effort, this model was calibrated using in-situ wave gage data gathered at Spessard-Holland Park (3.5 miles south of the Mid Reach). The long-term nearshore climate was then developed by driving the calibrated STWAVE+ model using the AES information.

A-18. Nearshore wave spectra developed from the STWAVE+ simulations were archived at 105 output stations located between R-69 and R-124. The stations were located in nominally 6 meters water depth and were spaced at 150 meter intervals along shore. Output station locations were chosen primarily based on the requirements for the GENESIS model, i.e. that the station be located seaward of wave breaking. Wave spectra were computed for each station at six-hour intervals for the 50-year period from July 1954 through June 2004.

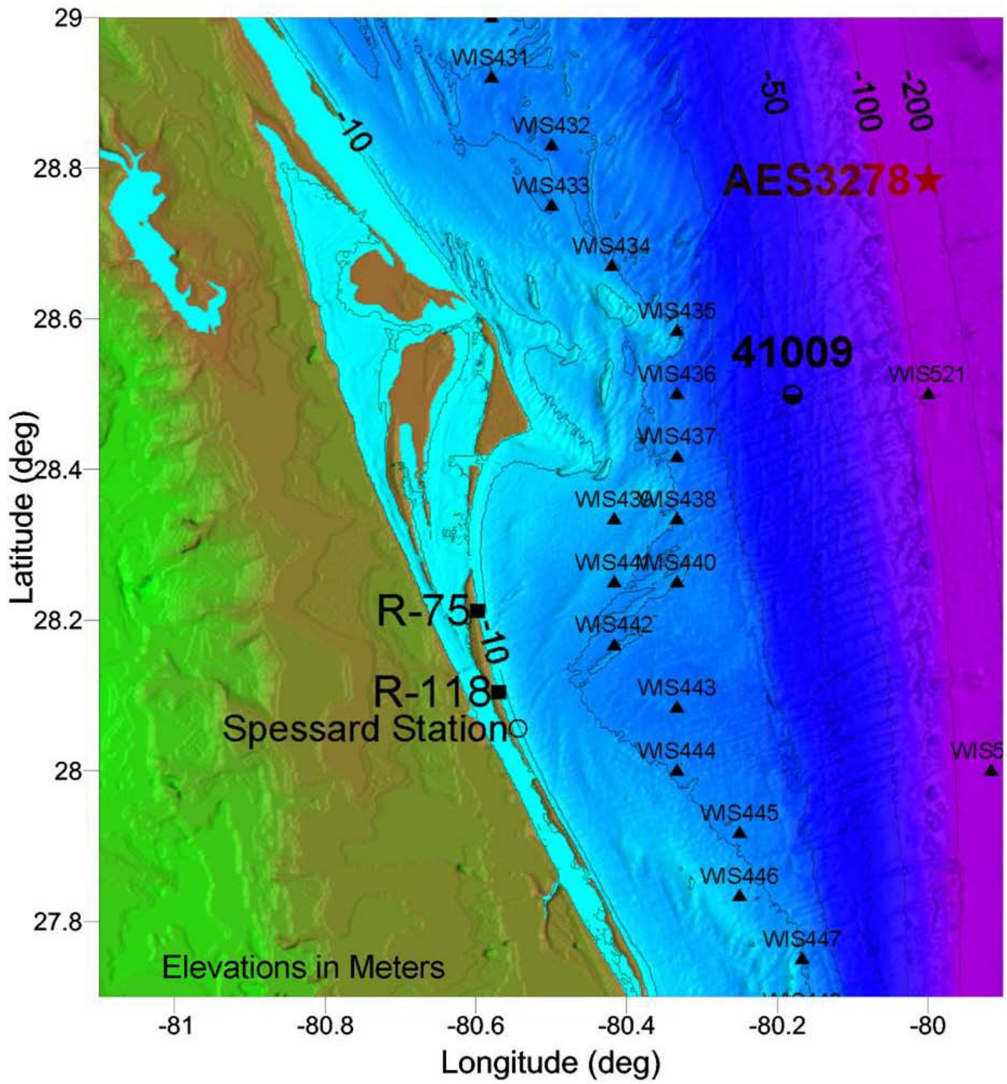

Figure A-2. Regional map of Canaveral Bight showing 1) limits of Mid-Reach study area (R-75 to R-118), 2) location of Spessard Station (R-138), and 3) AES grid point #3278. WIS stations and location of NDBC wave buoy # 41009 shown for reference.

A-19. For the purposes of discussion and comparison, STWAVE[+] output at the 6-meter depth were shoaled and refracted to breaking utilizing an iterative routine (CETN-II-19) that utilizes Snell's law and conservation of wave energy flux. This process is similar to the process GENESIS utilizes to bring intermediate depth waves to breaking before computing sediment transport rates and shoreline evolution. Because sediment transport along the beach is influenced by wave characteristics at the wave break point, breaking wave statistics provide convenient and meaningful insight into how the incident wave field directly impacts sediment transport. Wave direction is referenced to the local shoreline as shown in Figure A-3.

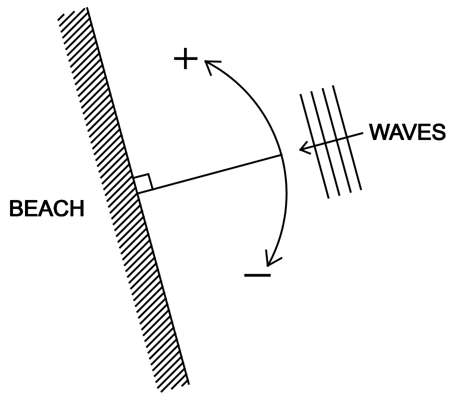

Figure A-3. Wave Direction Sign Convention

Seasonal Climate Variation

A-20. The project area is subject to seasonal variations in wave climate that are typical of the southeast Atlantic coast of the US. The region encounters relatively high-energy waves during the winter as a result of extra-tropical nor'easters, which originate in the north Atlantic, and again in the late summer and fall as a result of tropical storms and hurricanes, which originate in the Caribbean (see Figure A-4).

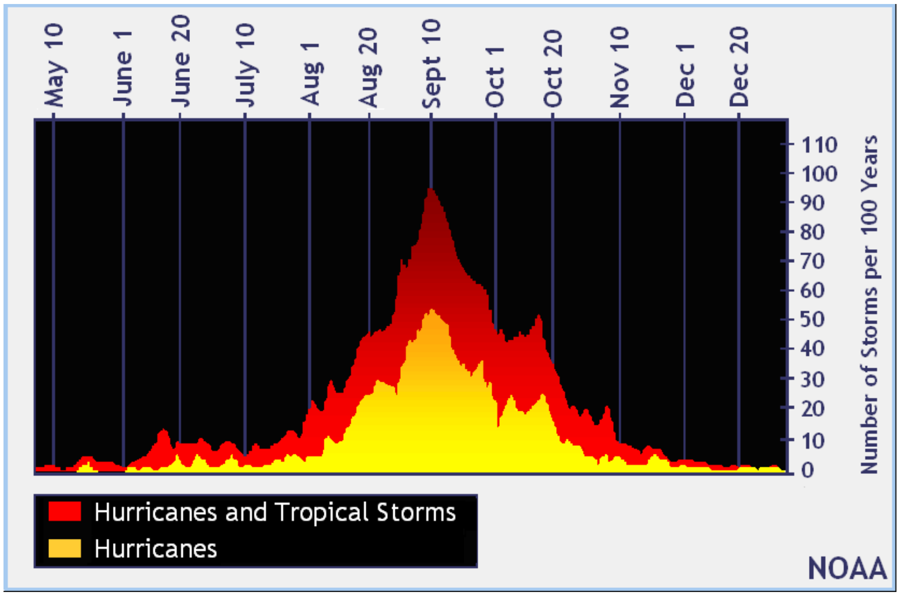

Figure A-4. Tropical storm and hurricane seasonal variation, courtesy of National Oceanographic and Atmospheric Administration (NOAA).

A-21. Corresponding to this shift in the wave energy source, there is a shift in wave direction from northerly in the winter to southerly in the summer. Monthly average wave height, period, and direction at FDEP monument R-97 (approximately the center of the Mid Reach) are presented in Figure A-5. These data were compiled by averaging the wave conditions for each month over the 49 year period from 1955 through 2003.

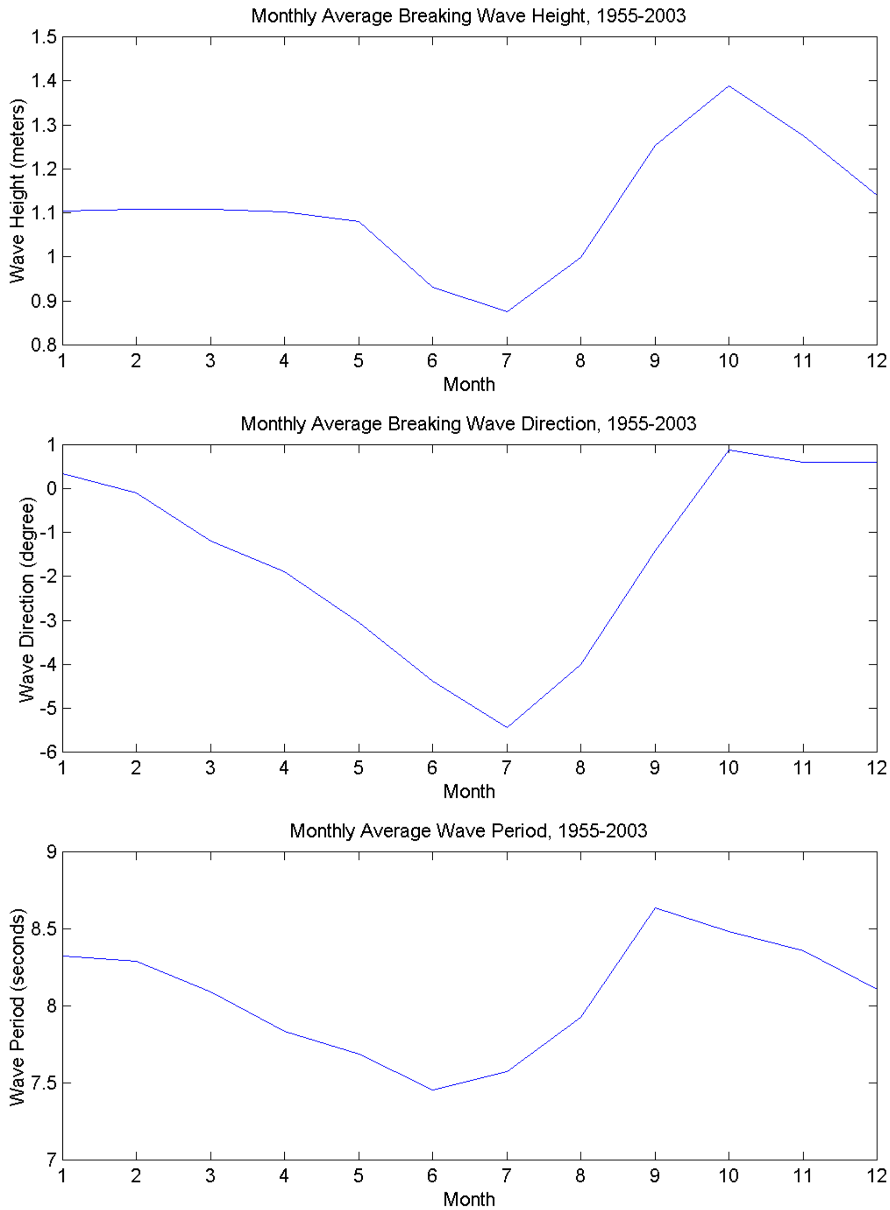

Figure A-5. Seasonal trends of breaking wave height, period and direction. X-axis refers to month, i.e. 1 = January, 2 = February, etc.

A-22. From January through May the monthly average wave height (Figure A-5, top panel) remains relatively steady while, at the same time, wave direction (middle panel) becomes more southerly and the wave period drops (bottom panel). These trends illustrate the influence of nor'easters on the wave climate and show the decline of nor'easter activity as summer approaches and sub-tropical and tropical weather systems dominate the region. May through July are typically mild owing to the gap between the end of the nor'easters and the beginning of strong tropical storm/hurricane activity—this trend is evident in the top panel, where average wave heights are at their lowest. Waves during this lull in storm activity are produced by easterly trade winds and are generally low energy and approach from south of shore-normal. August through October sees a steady increase in wave energy due to the presence of tropical storms and hurricanes, which is evident in the wave height and period plots. Wave directions remain south of shore-normal during late summer on average as tropical storms track north and east from the Caribbean. November and December see a return to the winter pattern of wave energy originating in the north Atlantic.

Storm Surge

A-23. Storm surge can be defined as an increase in water level, which results from forcing by atmospheric weather systems. Surges occur primarily as a result of atmospheric pressure gradients and surface stresses created by wind blowing over a water surface. When the water's momentum carries it beyond the position of static equilibrium, a long wave phenomenon results in which the water surface increases downwind and decreases upwind. In addition to wind speed, directional and duration, storm surge is also influenced by water depth, length of fetch and frictional characteristics of the nearshore sea bottom. Estimates of theses water level changes are required for simulation of storm conditions and for the design of beach fill crest elevations. An increase in water depth may cause coastal flooding and may potentially allow larger storm waves to attack the shore. The bulk of the storm surge impacts within the project area comes from tropical storms and hurricanes. Nor'easters produce significant wave heights and durations, but they do not generally come close enough to produce significant storm surges in Brevard County.

A-24. Dean and Chiu (1986) performed a total storm tide frequency analysis for Brevard County, Florida. The results of that study are presented in Figure A-5, which identifies the total surge and corresponding return period for 10, 20, 50, 100, and 500-year storm events. Total tide height reflects the sum effect of wind stress, atmospheric pressure, dynamic wave setup and astronomical tides.

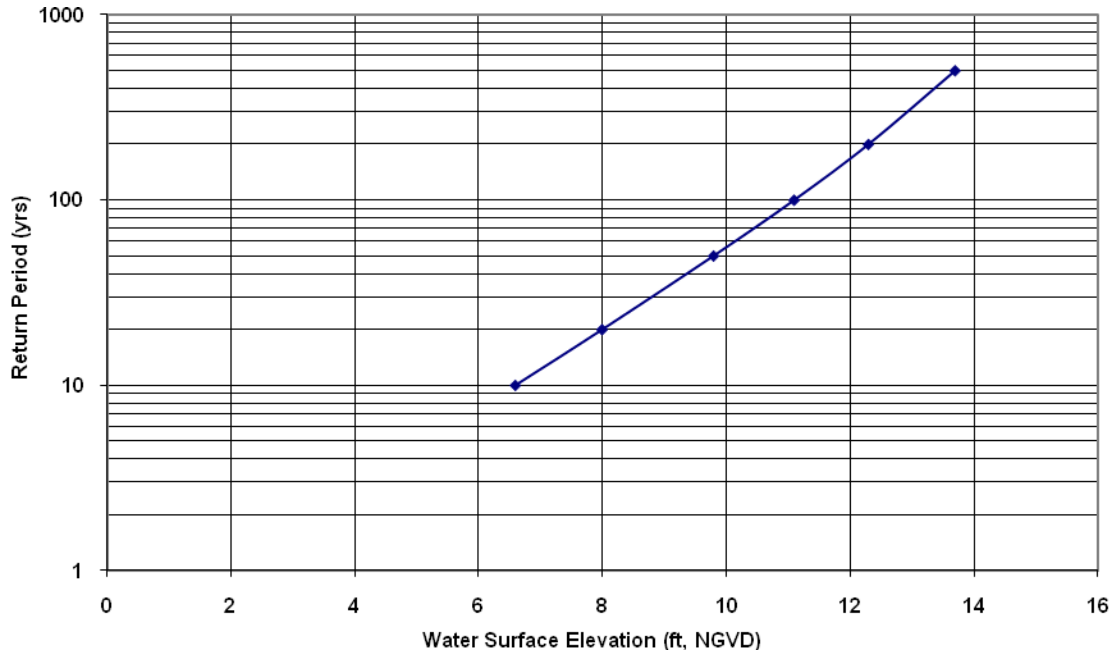

Figure A-6. Storm surge frequency relationship for Brevard County.

Sea Level Change Prediction

A-25. Throughout geologic history, global sea level variations, both rise and fall, have occurred. Changes in sea level cause the shoreline to be out of equilibrium and set into motion processes that restore equilibrium; which, in turn, cause the shoreline to erode or accrete. Two processes are predominantly responsible for relative changes in sea level: change in the absolute water level of the oceans and the subsidence or submergence of the land by geologic processes. Various methods for estimating future changes in sea level at specific location are provided in the publications discussed below.

A-26. In 1995, the U.S. Environmental Protection Agency (EPA) published a report entitled The Probability of Sea Level Rise (Titus and Narayanan, 1995). This report provides sea level information in a form that can be incorporated into engineering designs, decision analyses, and legal opinions. This report estimates that along most of the U.S. Atlantic coast, there is a 50 percent chance that sea level will rise by at least one foot by the year 2050 and two feet by the year 2100. It also estimates that there is a 1 percent chance that sea levels will rise one foot in the next thirty years and four feet in the next century. The report presents a methodology for estimating future sea level change at a particular location by simply adding the current rate of sea level change (based on historical data) to a normalized projection.

A-27. The National Ocean Service (NOS) has compiled long-term records of measured water surface elevation at various locations along the United States coastline. The closest station to the project area is gage 8721120 in Daytona Beach, FL (~75 miles to the north).

Based on available measured data, historical sea level change at this location is estimated as +2.32mm/yr (NOS 2004).

A-28. The U.S. Army Corps of Engineers (USACE) has provided guidance in the form an Engineering Circular, EC 1165-2-211 to incorporate the direct and indirect physical effects of projected future sea-level change on design, construction, operation, and maintenance of coastal projects. EC 1165-2-211 provides both a methodology and a procedure for determining a range of sea level rise estimates based on global sea level change rates, the local historic sea level change rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance: a Baseline estimate representing the minimum expected sea level change, an Intermediate estimate, and a High estimate representing the maximum expected sea level change.

A-29. Adjusting equation (2) in EC 1165-2-211 to include the historic global mean sea-level change rate of +1.7 mm/year results in updated values for the variable b being equal to 2.36E-5 for modified NRC Curve I (Intermediate), 6.20E-5 for modified NRC Curve II, and 1.005E-4 for modified NRC Curve III (High).

$$\textit{Equation 2: } E(t) = 0.0017t + bt^2$$

A-30. Equation (3) of EC 1165-2-211 Appendix B calculates eustatic sea level change over the life of the project. E(t) is eustatic sea level change and b is a constant provided in EC 1165-2-211; t_1 is the time between the project's construction date and 1986 and t_2 is the time between a future date at which one wants an estimate for sea-level change and 1986 (or $t_2 = t_1$ + number of years after construction (Knuuti, 2002)). For example, if a designer wants to know the projected eustatic sea-level change at the end of a project's period of analysis, and the project is to have a fifty year life and is to be constructed in 2012, $t_1 = 2008 – 1986 = 26$ and $t_2 = 2058 – 1986 = 76$.

$$\textit{Equation 3: } E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b(t_2^2 - t_1^2)$$

A-31. Modifying equation (3) to include site-specific sea level change data results in an equation for Relative Sea Level (RSL). This equation is used to estimate Baseline, Intermediate, and High sea level rise values over the life of the project.

$$RSL(t_2) - RSL(t_1) = (e+M)\,(t_2 - t_1) + b(t_2^2 - t_1^2)$$

$RSL(t_1)$ and $RSL(t_2)$ are the total RSL at times t_1 and t_2, and the quantity $(e + M)$ is the local change in sea level in m/year that accounts for the eustatic change as well as uplift or subsidence. The quantity *(e+M)* is found from the nearest tide gage with a tidal record of at least 40 years.

A-32. Based on historical sea level measurements taken from NOS gage 8721120 at Daytona Beach Shores, Florida, the historic sea level rise rate *(e+M)* was determined to be +2.32 +/- .63 mm/year (0.0076 ft/year) (http://tidesandcurrents.noaa.gov/sltrends/index.shtml). The project base year was specified as 2012, and the project life was projected to be 50 years. Table A-1 shows the results of equation (3) every five years, starting from the base year of 2012. From this table, the average Baseline, Intermediate, and High sea level rise rates were found to be +2.32 mm/year (0.0076 ft/year), +4.73 mm/year (0.015 ft/year), and +12.6 mm/year (0.0412 ft/year), respectively. Figure A-7 shows the three levels of projected future sea level change for the life of the project.

A-33. The local rate of vertical land movement is found by subtracting regional MSL trend from local MSL trend. The regional mean sea level trend is assumed equal to the eustatic mean sea level trend of +1.7 mm/year. Therefore in Brevard County, there is 0.62 mm/year of subsidence.

Table A-1: Relative sea level vs year- Brevard County

	Baseline (Historic)			Intermediate (Curve I)			High (Curve III)		
	Year	mm	ft	Year	mm	ft	Year	mm	ft
Base Year	2012	0.0	0.00	2012	0.00	0.00	2012	0.00	0.00
	2017	11.6	0.04	2017	18.3	0.06	2017	40.2	0.13
	2022	23.2	0.08	2022	37.8	0.12	2022	85.5	0.28
	2027	34.8	0.11	2027	58.5	0.19	2027	135.8	0.45
	2032	46.4	0.15	2032	80.4	0.26	2032	191.1	0.63
25 Year	2037	58.0	0.19	2037	103.4	0.34	2037	251.5	0.83
	2042	69.6	0.23	2042	127.7	0.42	2042	316.8	1.04
	2047	81.2	0.27	2047	153.1	0.50	2047	387.2	1.27
	2052	92.8	0.30	2052	179.6	0.59	2052	462.6	1.52
	2057	104.4	0.34	2057	207.4	0.68	2057	543.1	1.78
50 Year	2062	116.0	0.38	2062	236.4	0.78	2062	628.6	2.06

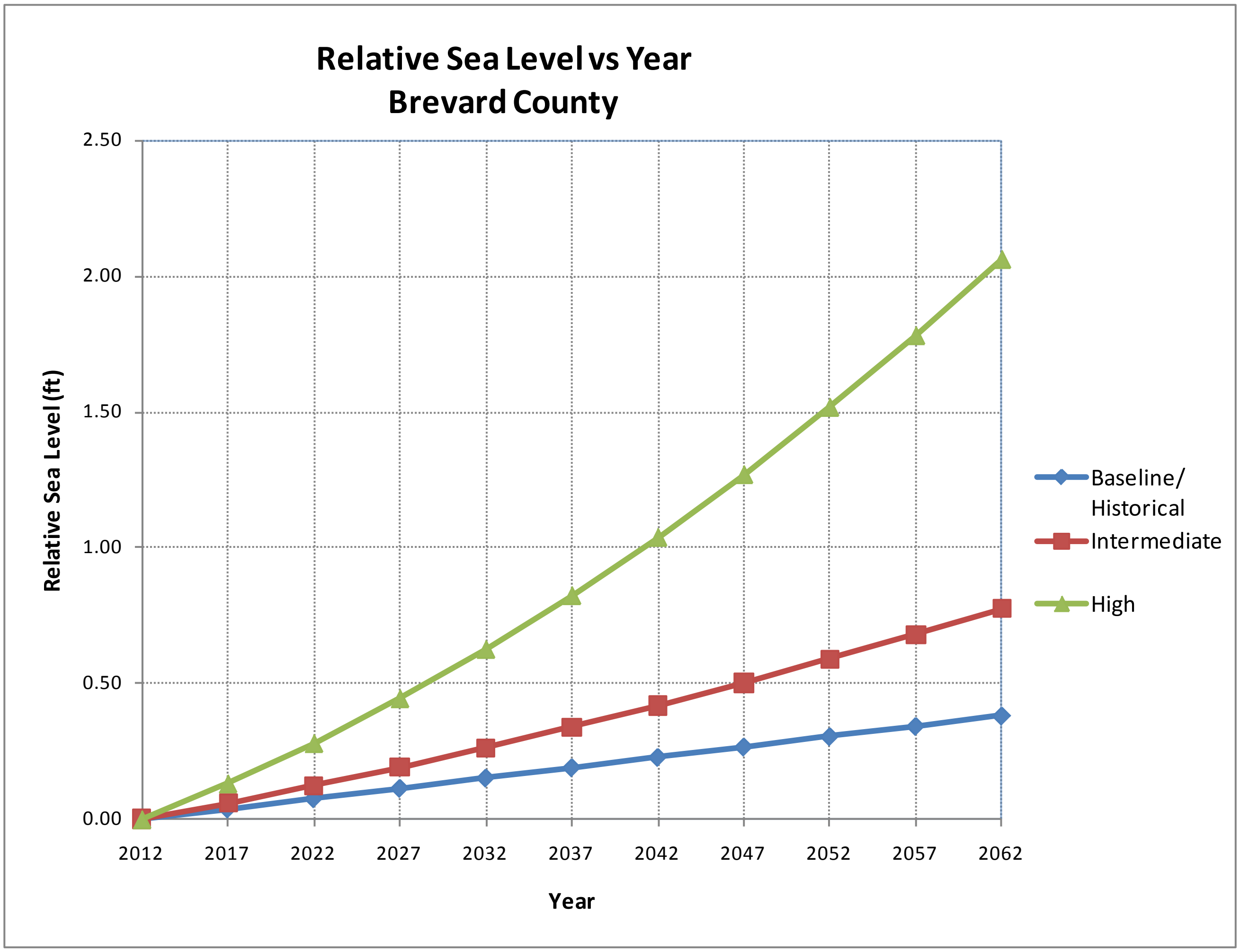

Figure A-7: Relative sea level rise, Brevard County

Beach Responses to Sea Level Change

A-34. The following section evaluates how the above sea level change scenarios outlined the preceding section could affect future beach and shoreline behavior in the project area. The principal means by which sea level change would manifest itself on an open coast, sandy beach would be through changes to shoreline position and to beach volume. The below analyses are based on the assumption that sea level change would cause a change in the horizontal and vertical position of the beach profile. This phenomenon was first outlined by Per Bruun (1962). The theory states that an increase in water level causes the beach profile to shift upward and landward in response, in order to maintain an equilibrium shape. This shift causes both a shoreline change and a volumetric change as outlined the following sections.

A-35. Shoreline Change**.** Per Bruun (1962) proposed a formula for estimating the rate of shoreline recession based on the local rate of sea level rise. This methodology also includes consideration of the local topography and bathymetry. Bruun's approach assumes that with a rise in sea level, the beach profile will attempt to reestablish the same bottom depths relative to the surface of the sea that existed prior to sea level change. That is, the natural profile will be translated upward and shoreward to maintain equilibrium. If the longshore littoral transport in and out of a given shoreline is equal, then the quantity of material required to re-establish the nearshore slope must be derived from erosion of the shore. Shoreline recession, X, resulting from sea level rise can be estimated using Bruun's Rule, as defined below:

$$X = -SW_*/(h_*+B)$$

A-36. Berm height, B, for the project area is approximately 10.6 feet; depth of closure, h_*, is estimated to be -17 feet NGVD based on the Brevard County Feasibility Report (1996); the width of the active profile, W_*, is approximately 1800 feet. This formulation results in a Baseline recession rate of -0.50 feet of shoreline per year (ft/yr), an Intermediate recession rate of 1.01 ft/yr, and a High recession rate of 2.69 ft/yr that may occur as a result of sea level rise over the project life.

A-37. The Bruun procedure is applicable to long straight sandy beaches with an uninterrupted supply of sand. Little is known about the rate at which profiles respond to changes in water level; therefore, this procedure should only be used for estimating long-term changes. The procedure is not a substitute for the analysis for historical shoreline and profile changes. If little or no historical data is available, then historical analysis may be supplemented by this method to provide an estimate of the long-term erosion rates attributable to sea level rise. The offshore contours in the project area are not entirely straight and parallel; however, Bruun's Rule does provide an estimate of the potential shoreline changes within the project area attributable to a projected rise in sea level.

A-38. Volumetric Change. Engineering Manual (EM) 1110-2-3301 gives guidance on how to calculate beach volume based on berm height, depth of closure and translation of the shoreline (in this case, shoreline recession) using equation (4-1). For this discussion, it is assumed that as an unarmored beach erodes, it maintains approximately the same profile above the seaward limit of significant transport; therefore, the volume change per unit beach width is the vertical height of the active profile, $h^* + B$, multiplied by the horizontal translation of the profile, X.

Equation 4-1: $V= (B+h^*)X$

A-39. For this discussion, it is assumed that as an unarmored beach erodes, it maintains approximately the same profile above the seaward limit of significant transport; therefore, the volume change per unit beach width is the vertical height of the active profile, $h^* + B$, multiplied by the horizontal translation of the profile, X. This formulation results in an annualized Baseline volume change of 0.51 cubic yards per foot per year(cy/ft/yr), an Intermediate volume change of 1.03 cy/ft/yr, and a High volume change of 2.75 cy/ft/yr. The annualized rates of sea level rise, shoreline recession, and volume change (volume lost) are shown in Table 2.

Table A-2: Annualized Rates of Sea Level Rise, Shoreline Recession and Volume Lost

	Sea Level Rise (S) in ft/yr	Shoreline Recession (X) in -ft/yr	Volume Lost (V) in cy/ft/yr
Baseline	0.01	0.50	0.51
Intermediate	0.02	1.01	1.03
High	0.04	2.69	2.75

A-40. The Baseline sea level change rate curve is extrapolated from the the historical shoreline change rate. Figure A-8 illustrates the difference between the Baseline change rate and the potential increase in shoreline recession that could occur if sea levels change as projected in the Intermediate curve or High curve. Similarly, Figure A-9 shows the relative increase in beach erosion that could be expected if sea level changes follow Intermediate or High estimates. These values are normalized with the estimate that results from the Baseline/Historical sea level change scenario.

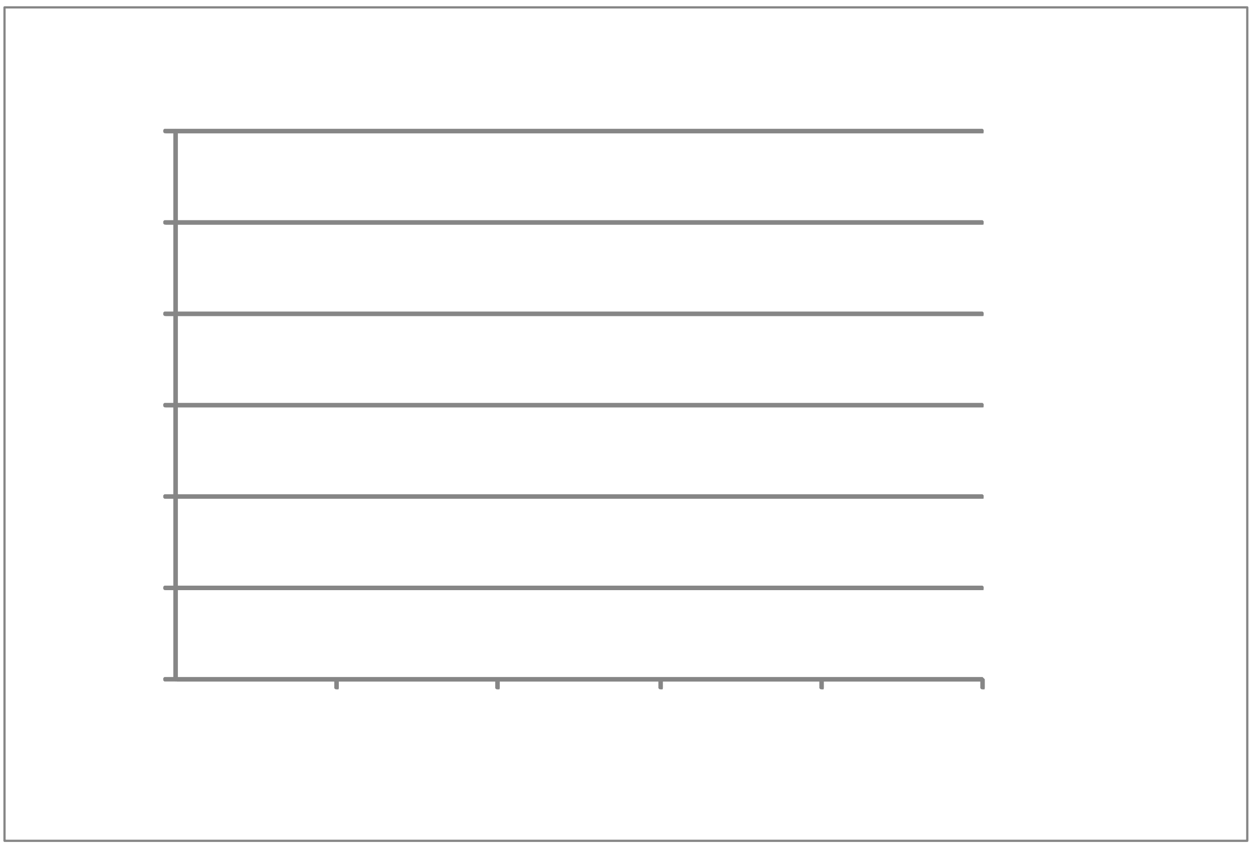

Figure A-8: Potential increased shoreline recession due to sea level rise

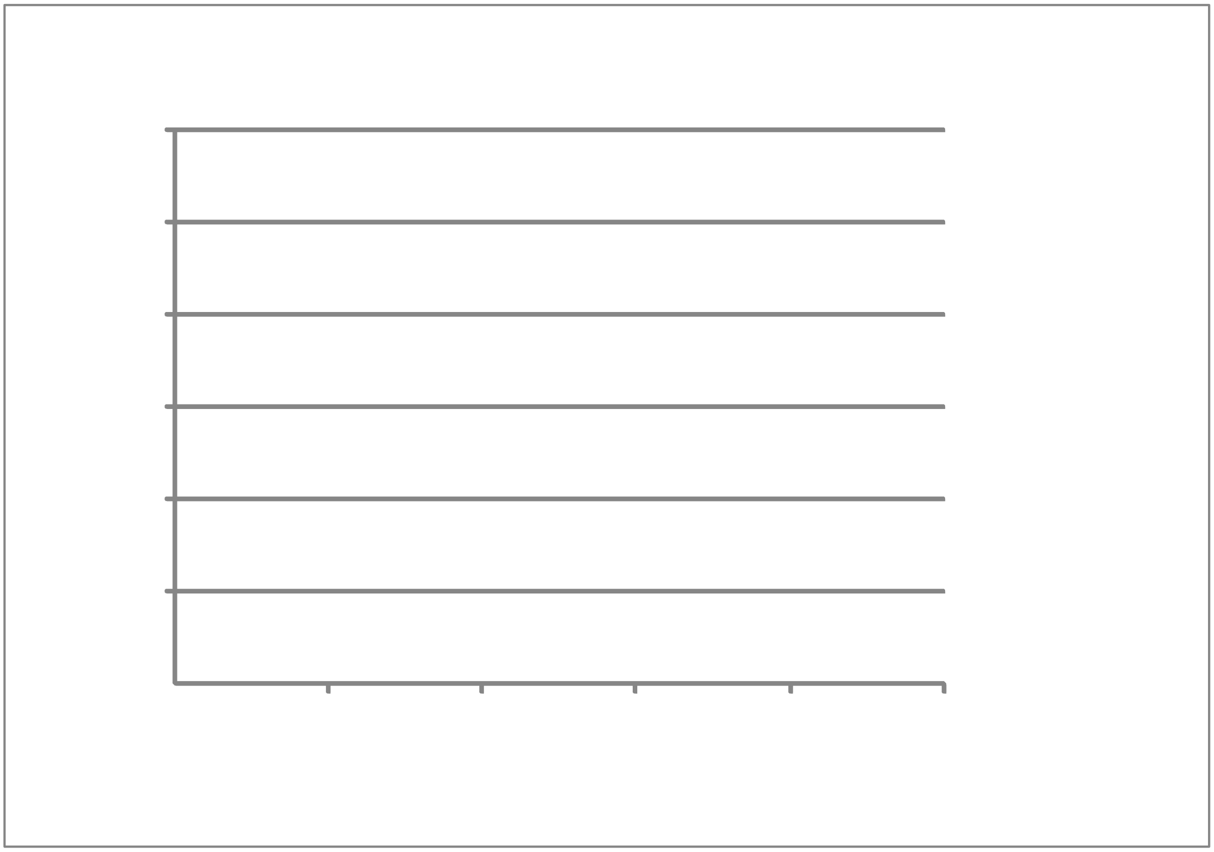

Figure A-9: Potential increased beach erosion (volume loss) due to sea level rise

HISTORICAL EVIDENCE OF COASTAL PROCESSES

A-41. The Mid Reach has experienced long term erosion due to natural processes and localized accretion due to diffusion of beach fills into the project. Both processes are analyzed in the following paragraphs.

Historic Dune and Shoreline Position Changes

A-42. An analysis of historical Brevard County shorelines was undertaken in an effort to identify regions of shoreline erosion and accretion. Mean high water (MHW) shoreline positions for the years 1972 and 1986 were obtained from Florida Department of Environmental Protection (FDEP) surveys; data from 1994 and 2002 were obtained from Corps of Engineers surveys and 2005 data are from a survey contracted by Olsen Associates for the project local sponsor, Brevard County Commission. All shoreline positions are referenced to survey monuments (benchmarks) established by FDEP. The monuments considered in this analysis commence at R-75, which is north of the northern limit of the Mid Reach and proceed south to R-119, which is the southern Mid Reach project limit.

A-43. All analyses were done utilizing beach profiles cut at each survey monument location. The dune location was estimated to be the +13.0 foot NGVD contour for this

analysis; the MHW shoreline (+2.0 feet NGVD) and dune/bluff position changes between surveys were measured directly from the beach profiles at each monument.
DISCUSSION

A-44. Long-term dune/bluff and MHW position changes are illustrated in Figure A-10. The dune and MHW line, in general, followed similar trends of recession, in every reach except Reach 1. Volumetric changes indicate that the south end of Reach 1 accreted significantly between 2002 and 2005, due to the feeder effect of the South Reach, which was initially constructed in 2002/03. This accretion is seen in the reversal of Reach 1 shoreline recession that is visible in Figure A-10. When averaged over the entire Mid-Reach, the erosional areas and accretional areas counteract each other to some degree, resulting in an average annual MHWL recession of 0.2 foot per year.

A-45. It is evident from Table A-3 that shoreline and bluff-line changes are spatially and temporally variable in the Mid Reach project area. The ‘active’ portion of the profile, which extends from berm height (approximately +10 ft, NGVD) to depth of closure, is exposed to wave energy on a daily basis. This interaction may cause both seasonal and episodic fluctuations of the beach width depending on wave height, storm surge, sediment transport patterns, and other factors. Periodic advancement and retreat of the MHWL indicates that there are both destructive and constructive forces acting on the berm and foreshore. Over the project as an average the MHW line advanced an average of 0.3 feet per year, 1972-1986; retreated 1.0 feet per year, 1986-1997; advanced 1.6 feet per year, 1997-2002; and receded 2.3 feet per year, 2002-2005. Despite the fairly large fluctuation in shoreline position in the short-term, the MHWL was relatively stable at -0.2 feet per year, 1972-2005.

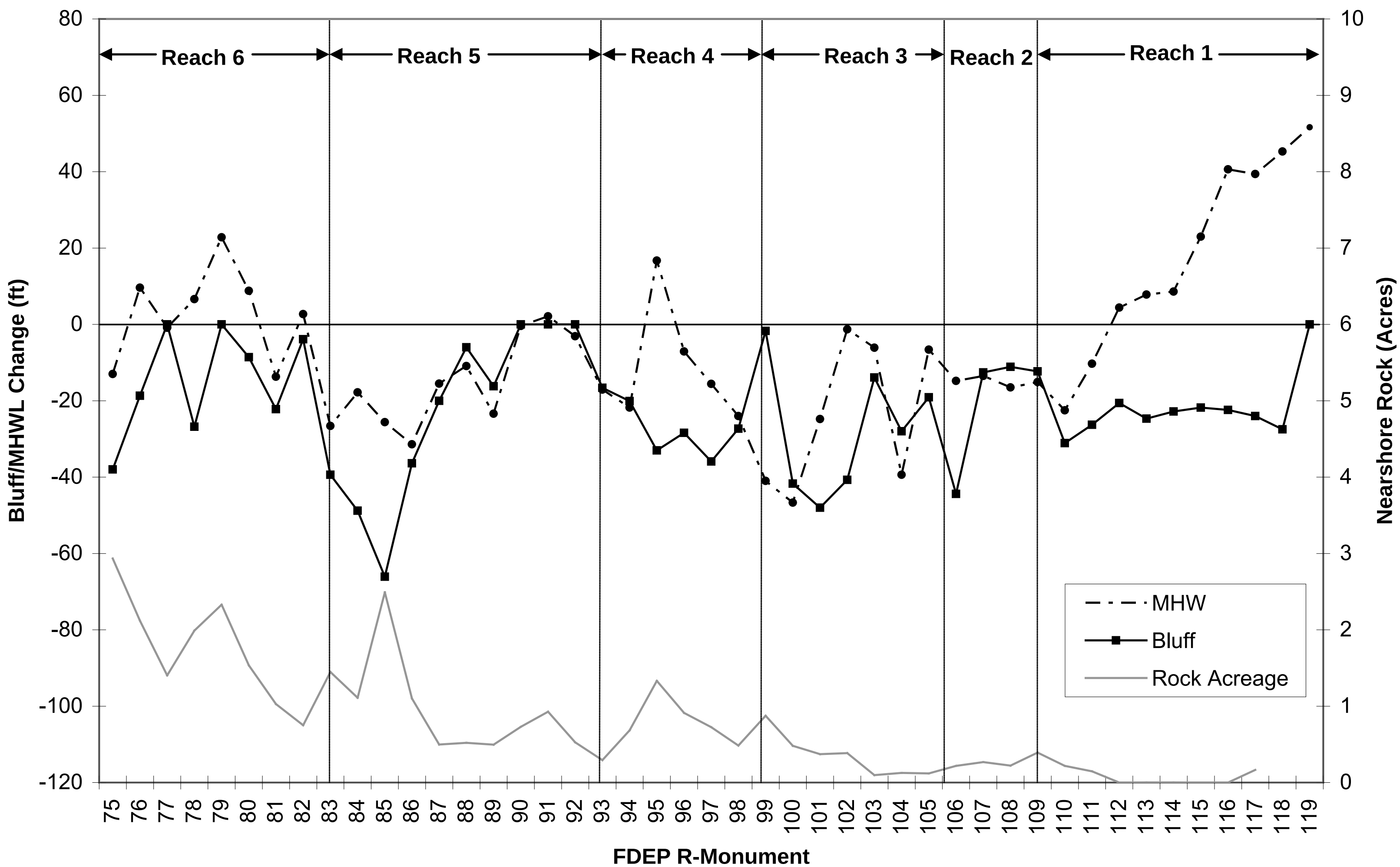

Figure A-10. MHW and dune/bluff position changes, 1972 - 2005.

A-46. In contrast to the active profile's pattern advancement and recession, the dune/bluff system remains stable or recedes in the short term and has receded in all locations in the long term (see Figure A-10); none of the data indicate that a natural rebuilding mechanism exists within the dune system in its present state. The mild but consistent recession of the shoreline appears to have 'pinched' the dune between the active beach system and upland development; i.e. there is no sand source to replenish the dune from the landward side to replace the volume lost on the seaward side as waves attack the dune during storms. The dune system is not able to migrate landward as the rest of the beach recedes due to the presence of development and infrastructure; thus, the dune steadily loses volume. This apparent lack of a dune-rebuilding mechanism results in long term erosion of the bluff that is significantly higher than the MHW shoreline erosion rate. Many locations along the project area have little or no dune/bluff left to provide protection during storms.

Localized and Short-Term Shoreline Variations

A-47. Much of the observed change (recession) that occurred between 2002 and 2005 may be attributed to the landfall of Hurricanes Frances and Jeanne during the summer of 2004. Both storms' tracks brought them ashore approximately 65 miles south of the Mid-Reach. The only beach survey data that directly brackets the occurrence of the storms covers only R111 to R118 of the Mid-Reach. These data (gathered June and November—December of 2004) indicate that the bluff was stable from 2002 until June 2004 and that the MHW line accreted 31 feet during the same period. This MHW line accretion is the previously noted diffusion of fill from the 2003 South Reach fill. By comparison, the bluff eroded an average of 10 feet and the MHW line eroded 29 feet between June and November of 2004, during which time the shoreline was subjected to the effects of Hurricanes Frances and Jeanne along with at least one Nor'easter. The beach returned to a more stable pattern from November 2004 to spring 2005 with minimal changes observed between those surveys. In response to the storms of 2004, the South Reach was renourished with 580,000 cubic yards in March and April of 2005 as a part of the Flood Control and Coastal Emergencies (FCCE) Act. This nourishment restored it back to the 2003 post-construction condition.

Table A-3. Recent MHWL and bluff line changes due to feeder effects of the 2003 South Reach nourishment and storms of summer 2004.

R-Mon	2002 to June 2004 Bluff Change	2002 to June 2004 MHWL Change	June '04 to November '04 Bluff Change	June '04 to November '04 MHWL Change	November '04 to 2005 Bluff Change	November '04 to 2005 MHWL Change
111	5	16	0	-10	-5	0
112	1	2	-6	3	4	0
113	0	26	-15	bad data	-1	na
114	-3	47	-6	-36	0	0
115	5	78	-21	-57	0	0
116	0	75	-20	-45	0	0
117	0	62	-16	-30	-1	0
118	0	-56	0	na	na	na
119	-4	61	-2	-24		
Average	**1**	**35**	**-10**	**-28**	0	0
120	0	107	0	-52		
121	2	101	-5	-52		
122	Armored	87	Armored	-56		
123	-2	52	6	-36		
124	9	-34	-1	-29		
125	0	-5	0	-8		
126	6	-21	-1	-30		
127	1	-38	-2	-10		
128	0	-42	0	23		
Average	**1**	**27**	**-2**	**-28**		

A-48. In Table A-3, note that the MHWL recession associated with the June—November 2004 period is the same for the Mid and South Reach (28 feet), but that bluff recession in the Mid Reach (-10 feet) was 5 times higher than the South Reach (-2 feet), which was protected by the newly- constructed South Reach beach berm.

A-49. Two distinct MHWL advancements took place within Reach 1. The first occurred between the 1972 and 1986 surveys when the MHWL between R-110 and R-119 advanced an average of 22 feet (see Table A-4). This isolated accretion might have been in response to the 0.5 Mcy fill that was placed between R-126 and R-136 in 1980/81. The second occurred between the 2002 and 2005 surveys when the MHWL between R-112 and R-119 advanced an average of 28 feet. This was a material diffusing northward from the initial 1.35 Mcy South Reach fill, placed in 2002/03. Interestingly, the bluff recession rate did not abate in Reach 1 during either accretional period, perhaps indicating that small (<30-foot) advancements of the MHWL position do not appreciably increase protection of the bluff during large wave events.

A-50. In conclusion, the Mid Reach has a pattern of mild MHWL retreat (-0.2 feet per year, 1972 to 2005); if the apparent effects of the 1980/81 and 2002/2003 South Reach beach fills are removed, the Mid Reach recession rate is -0.4 ft/year. Dune/bluff recession, which is the direct threat to upland infrastructure and development, was -0.8 feet per year between 1972 and 2005.

Table A-4. MHW and dune/bluff position changes, 1972 -2005

	FDEP	1972-1986		1986-1997		1997-2002		2002-2005		1972-2005	
	Monument	Bluff	MHWL	Bluff	MHWL	Bluff	MHWL	Bluff	MHWL	Bluff	MHWL
REACH 6	75	-15	-5	-1	-6	2	9	-25	-11	**-38**	**-13**
	76	2	5	5	6	-4	4	-21	-5	**-19**	**10**
	77	Armored	-8	Armored	4	Armored	0	Armored	3	**Armored**	**-1**
	78	-19	-1	-4	2	-1	7	-3	-1	**-27**	**7**
	79	Armored	8	Armored	-6	Armored	11	Armored	10	**Armored**	**23**
	80	-11	14	-1	4	0	-13	3	3	**-9**	**9**
	81	-16	2	-8	-14	-5	7	7	-9	**-22**	**-14**
	82	-5	12	-6	-25	4	14	2	2	**-4**	**3**
REACH 5	83	-23	-6	-2	-9	0	3	-15	-14	**-39**	**-27**
	84	-28	-6	1	-13	-8	9	-14	-8	**-49**	**-18**
	85	-45	-24	-5	-9	6	26	-22	-18	**-66**	**-26**
	86	-26	2	-3	-22	-2	0	-6	-12	**-36**	**-31**
	87	-6	2	-2	-8	-2	0	-10	-9	**-20**	**-16**
	88	-5	-20	3	2	-2	16	-2	-9	**-6**	**-11**
	89	-7	-1	-3	-6	-2	6	-5	-22	**-16**	**-23**
	90	Armored	15	Armored	-6	Armored	22	Armored	-30	**Armored**	**0**
	91	Armored	2	Armored	-6	Armored	23	Armored	-18	**Armored**	**2**
	92	Armored	-1	Armored	-3	Armored	17	Armored	-16	**Armored**	**-3**
REACH 4	93	-10	10	-5	-7	2	14	-4	-35	**-17**	**-17**
	94	-2	-11	1	5	-1	12	-18	-29	**-20**	**-22**
	95	-17	-14	-2	12	-5	13	-9	6	**-33**	**17**
	96	-22	-10	0	2	1	12	-7	-11	**-28**	**-7**
	97	-11	-7	-5	-3	-5	17	-15	-23	**-36**	**-16**

	98	-20	-18	-2	0	2	18	-7	-24	**-27**	**-24**
REACH 3	99	-21	-11	-2	6	3	-3	18	-33	**-2**	**-41**
	100	-23	-2	-4	-17	-2	9	-13	-38	**-42**	**-47**
	101	-34	-10	-5	12	1	-12	-10	-15	**-48**	**-25**
	102	-7	24	-5	-24	-3	5	-26	-6	**-41**	**-1**
	103	-15	22	-9	-32	-2	9	12	-5	**-14**	**-6**
	104	-8	Bad Data	-5	-50	-2	18	-12	-7	**-28**	**-39**
	105	10	15	-10	-21	12	7	-30	-8	**-19**	**-7**
REACH 2	106	-12	4	-16	-19	-6	19	-11	-19	**-44**	**-15**
	107	9	-7	-9	-13	7	27	-19	-20	**-13**	**-14**
	108	0	4	6	-12	-9	-7	-8	-1	**-11**	**-17**
REACH 1	109	-2	-8	3	-2	-16	-9	3	4	**-12**	**-15**
	110	-9	13	2	-44	-15	12	-9	-3	**-31**	**-23**
	111	-16	14	2	-39	-9	9	-3	6	**-26**	**-10**
	112	-5	7	-11	-31	-3	23	-2	5	**-21**	**4**
	113	0	18	-4	-7	-4	-24	-16	21	**-25**	**8**
	114	-2	26	-6	-34	-6	6	-9	11	**-23**	**9**
	115	-5	26	-6	-16	-8	-7	-3	21	**-22**	**23**
	116	-17	30	3	-13	-3	-7	-5	30	**-22**	**41**
	117	-15	26	7	-17	-7	-3	-9	33	**-24**	**39**
	118	0	33	-9	-18	0	30	-19	0	**-28**	**45**
	119	0	24	0	14	0	0	na	0	**0**	**52**
		1972-1986		**1986-1997**		**1997-2002**		**2002-2005**		**1972-2005**	
		Bluff	**MHWL**	**Bluff**	**MHWL**	**Bluff**	**MHWL**	**Bluff**	**MHWL**	**Bluff**	**MHWL**
Ave Change (ft)		**-11.4**	**4.2**	**-2.9**	**-10.7**	**-2.3**	**7.7**	**-8.8**	**-6.7**	**-25.2**	**-5.3**
Ave Rate (ft/yr)		**-0.8**	**0.3**	**-0.3**	**-1.0**	**-0.5**	**1.5**	**-2.9**	**-2.2**	**-0.8**	**-0.2**

Mid Reach Historical Beach Volume Changes

A-51. Beach profile surveys of part or all of the Mid Reach are available from 1972 through 2005; Table A-5 details the available data. Sources for the data include Florida Department of Environmental Protection (FDEP) beach profile surveys, monitoring surveys contracted by the project local sponsor's AE Consultant (Olsen Associates, Inc), and the Corps of Engineers-contracted surveys.

Table A-5. Beach profile surveys conducted in Brevard County 1972—2005.

Year	Month	Contracted By	Data Coverage	Onshore Data Spacing	Offshore Data Spacing
1972	9	FDEP	R1 - R218	1000	3000
1986	1	FDEP	R1 - R218	1000	3000
1993	12	Corps	R1 - R137	1000	3000
1997	9	Olsen	R75 - R118	1000	No Data
2002	5	FDEP	R1 - R188	1000	1000
2002	10	Corps	R75.5 - R118.5	500/1000	1000
2003	5	Olsen	R116 - R143	1000	1000
2004	6	Olsen	R1 - R77	1000	1000
2004	6	Olsen	R110 - R145	1000	1000
2004	11	Olsen	R118 - R139	1000	1000
2004	12	Olsen	R54 - R75	1000	1000
2005	2	Olsen	R75 - R118	500	1000
2005	5	Olsen	R110 - R145	1000	1000

A-52. Data coverage in the longshore and cross-shore varies from survey to survey. Onshore Data Spacing refers to the so-called 'wading depth' portion of the profiles, which extend from the FDEP monument atop the dune to approximately the -5 foot contour. These onshore data are typically gathered at every monument resulting in a nominal spacing of 1000 feet between beach profiles. Offshore data were gathered at every 3rd monument in 1972, 1986, and 1993 for a nominal spacing of 3000 feet for those surveys. No offshore data were gathered in 1997. All surveys from 2002 to the present include onshore and offshore data at every monument.

A-53. Volume change calculations were performed for the periods 1972-1986, 1986-1993, 1993-2002, 2002-2005, and 1972-2005. Results of the analysis are presented in Table A-4. Digital terrain models (DTM's) of each survey were created in the MicroStation® and Inroads® software package; then beach profiles were created at each FDEP survey monument. The average end area method was employed to determine the volume change between adjacent beach profiles. Volumetric calculations are presented over three spatial extents 1) the sub-aerial beach, which includes the region from the dune to the mean high water line (MHWL); 2) the sub-aqueous beach, which is the submerged portion of the profile from the MHWL to Depth of Closure (DOC); and 3) the entire active profile, which is the entire profile from Dune to DOC. DOC was established as -17 feet NGVD29 in USACE 1996. Additional analysis in Appendix K, Sub-appendix F, page 17 indicated that profile 'stability' is reaches at depths greater than -16 feet NGVD.

Figure A-11 depicts the method utilized to compute the volume change discussed in the following paragraphs.

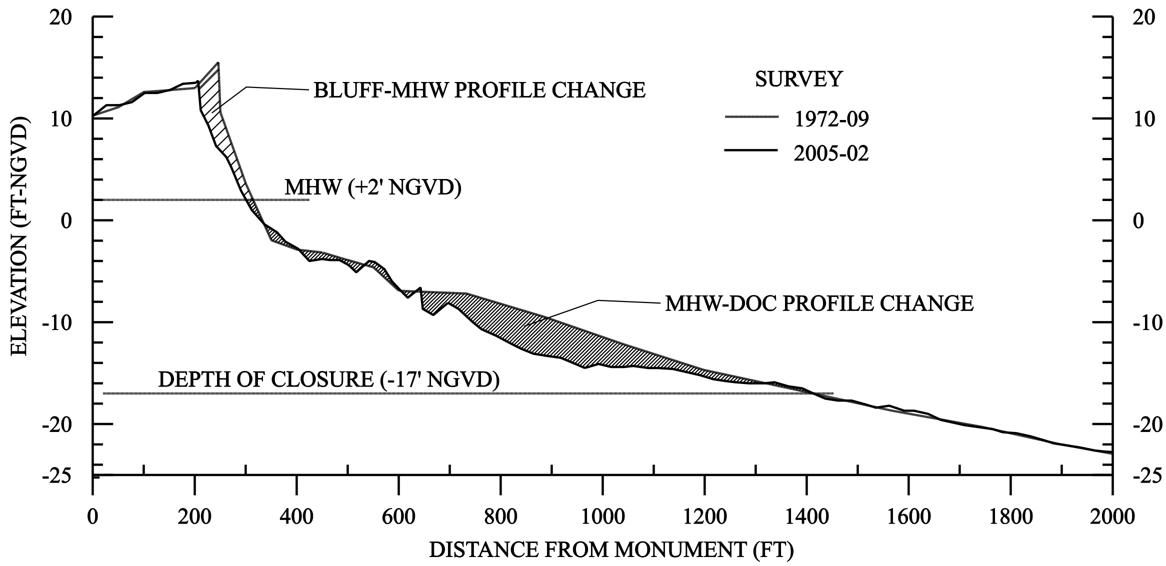

Figure A-11. Beach Profile and Volume Change Definition Sketch

A-55. The volume change data for the period from 1972-2005 are presented in Table A-6. Figure A-12 depicts the volumetric change data in terms of cubic feet per year per linear foot of shoreline. The Brevard County Mid Reach, as a whole, exhibited an erosional pattern between 1972 and 2005. Mid Reach losses were 1.2 MCY, for an average erosion rate of 36,500 cubic yards per year or 0.9 cubic yards per year, per linear foot of beach. Visible in Figure A-10 are two regions with erosion rates in excess of 1.0 cy/ft/yr centered near R-81 and R-97. The Mid Reach was erosional at all measured locations north of monument R-113. From R-113 to R-119, the beaches were slightly accretional in the long-term. This accretion is likely due to feeder effects from the beach fills that took place in the South Reach in 1980/1981 and 2002/2003.

A-56. Figure A-13 depicts the volume change above and below MHW from 1972 to 2005. Landward of MHW the profile was stable north of R-82 and south of R-117, perhaps in response to the nourishments of Patrick AFB and the South Reach, respectively. The dry beach across the rest of the Mid Reach was relatively mildly erosional, except in a stable region centered near R-90. The portion of the beach seaward of MHW was erosional from the north end of the project to R-102; relatively stable from R-102 to R-112. The accretion from R-112 to R-119 is, again, likely due to northward diffusion of the South Reach beach fills.

Table A-6. Volume Changes (1972-2005) Above and Below MHW (+2.0 ft, NGVD)

Monument			1972-2005 Volume Change (CY)		
From	To	Distance(ft)	Bluff to MHW	MHW to Closure	Entire Profile
75.4	76	600	-900	-25400	-26300
76	77	763	6000	-32300	-26300
77	78	996	6700	-42200	-35500
78	79	995	500	-49300	-48800
79	80	1027	2700	-50900	-48200
80	81	890	-500	-44100	-44600
81	82	974	-3400	-46400	-49800
82	83	962	-8900	-45800	-54700
83	84	999	-16500	-47500	-64000
84	85	734	-12300	-19300	-31600
85	86	992	-16300	-26000	-42300
86	87	871	-10800	-22900	-33700
87	88	1136	-6400	-17100	-23500
88	89	886	-1400	-13400	-14800
89	90	624	-100	-9400	-9500
90	91	893	3200	-17700	-14500
91	92	895	3600	-17800	-14200
92	93	999	-6300	-19800	-26100
93	94	997	-13400	-36600	-50000
94	95	769	-7600	-28200	-35800
95	96	948	-8900	-34800	-43700
96	97	929	-12300	-46800	-59100
97	98	1000	-14400	-50400	-64800
98	99	960	-10700	-48400	-59100
99	100	994	-15100	-50300	-65400
100	101	997	-21100	-50500	-71600
101	102	976	-17400	-49400	-66800
102	103	997	-9500	-7200	-16700
103	104	902	-6200	-6500	-12700
104	105	673	-7200	-4900	-12100
105	106	1296	-22700	3800	-18900
106	107	956	-19400	2800	-16600
107	108	917	-12200	2700	-9500
108	109	933	-10700	-1400	-12100
109	110	1159	-19500	-1800	-21300
110	111	841	-14800	-1300	-16100
111	112	999	-13600	13000	-600
112	113	875	-19100	11400	-7700
113	114	935	-18300	12200	-6100
114	115	1148	-9800	15500	5700
115	116	765	-5700	10300	4600
116	117	940	-3100	12700	9600
117	118	996	3400	22300	25700
118	119	941	3200	21100	24300
Total Length		**41083 ft**	**1972-2005 Mid Reach Volume Change**		
			Bluff to MHW	**MHW to Closure**	**Entire Profile**
			-367,200	**-838,000**	**-1,205,000**
				Annual (cy/yr)	**-37,000**
				Annual Unit (cy/ft/yr)	**-0.9**

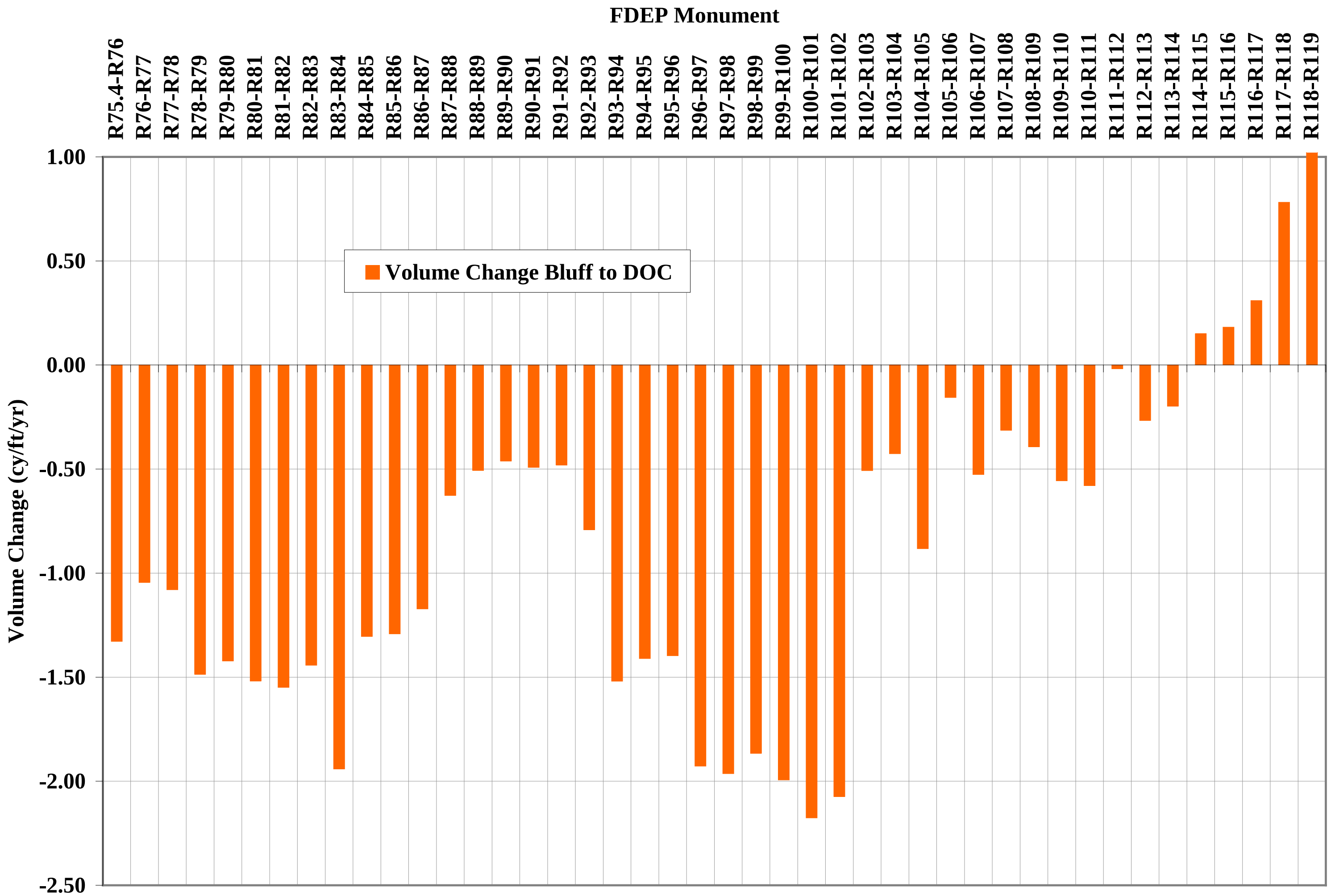

Figure A-12. Volume Change, 1972-2005, Across the Entire Active Profile (Dune to DOC), Expressed as cy/yr per linear foot of shoreline

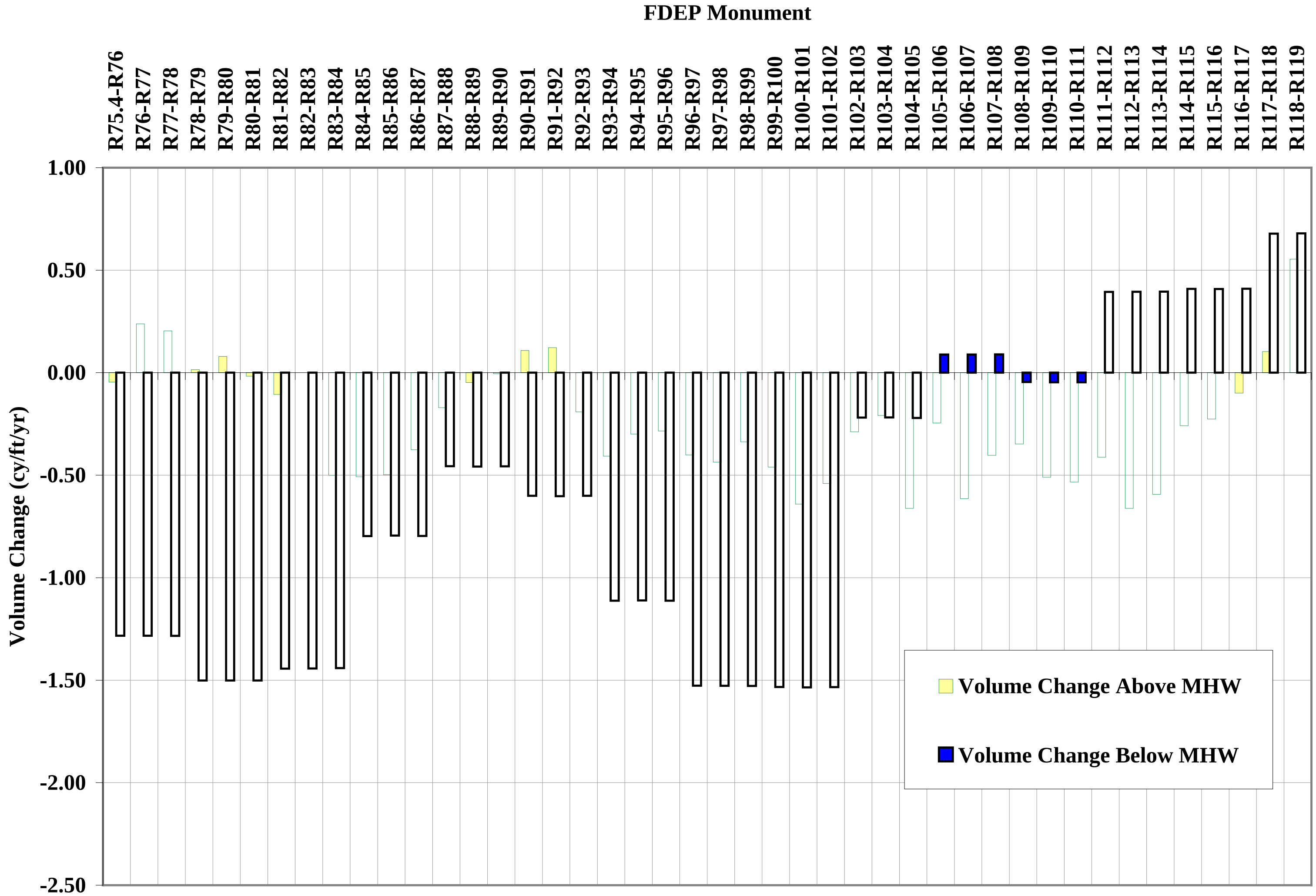

Figure A-13. Beach volume changes, from 1972-2005, above and below MHW. Volumetric changes are expressed in cubic yards per year per linear foot of beach.

A-57. For the purposes of this report, the mid reach was divided into 6 sub-reaches so that shore protection alternatives could be evaluated along shorter sections of the project. The volume changes within sub-reaches 1 through 6 are summarized in Table A-7. Volumetric data are presented in cubic yards per year per foot of shoreline, which removes any bias associated with the different lengths of the sub-reaches and the different lengths of time being compared.

Table A-7. Mid Reach volume changes per linear foot of beach, per year. Calculations extend from Dune/Bluff to DOC.

Unit Volumetric Change Bluff to DOC (cy/ft/yr)						
Reach	**Monuments**	**1972-2005**	**1972-1986**	**1986-1993**	**1993-2002**	**2002-2005**
6	R75.4 - R83	**-1.4**	0.5	-1.9	-3.4	-7.0
5	R83 - R93	**-0.9**	1.6	-3.3	-1.8	-7.3
4	R93 - R99	**-1.7**	1.1	-6.9	-1.6	-4.7
3	R99 - R109	**-1.2**	0.8	-5.9	0.8	-4.8
2	R109 - R105.5	**-0.4**	1.7	-2.7	-2.2	-2.4
1	R105.5 - R119	**0.1**	3.2	-5.9	0.1	-0.1
Entire Mid Reach	**Average**	**-0.9**	**1.6**	**-4.5**	**-0.7**	**-4.4**

A-58. The Mid Reach was accretional (1.6 cy/ft/yr) from 1972-1986, with double that rate of accretion locally, in Reach 1. This locally higher accretion rate could be due to diffusion of the 0.5 MCY South Reach fill placed in 1980. The period from 1986-1993 saw the highest average (-4.5 cy/ft/yr) and high local erosion rates everywhere except Reach 6. Between 1993 and 2002, the Mid Reach was slightly erosional on average (-0.7 cy/ft/yr) with the highest erosion occurring in Reach 1 (-3.4 cy/ft/yr) and slight accretion occurring locally in Reach 3 (0.8 cy/ft/yr). Finally, from 2002 to 2005 the area experienced a high erosion rate overall (-4.4 cy/ft/yr); the highest erosion occurring in Reach 5 (-7.3 cy/ft/yr). The hurricanes of 2004 are the primary reason for the increased erosion from 2002-2005.

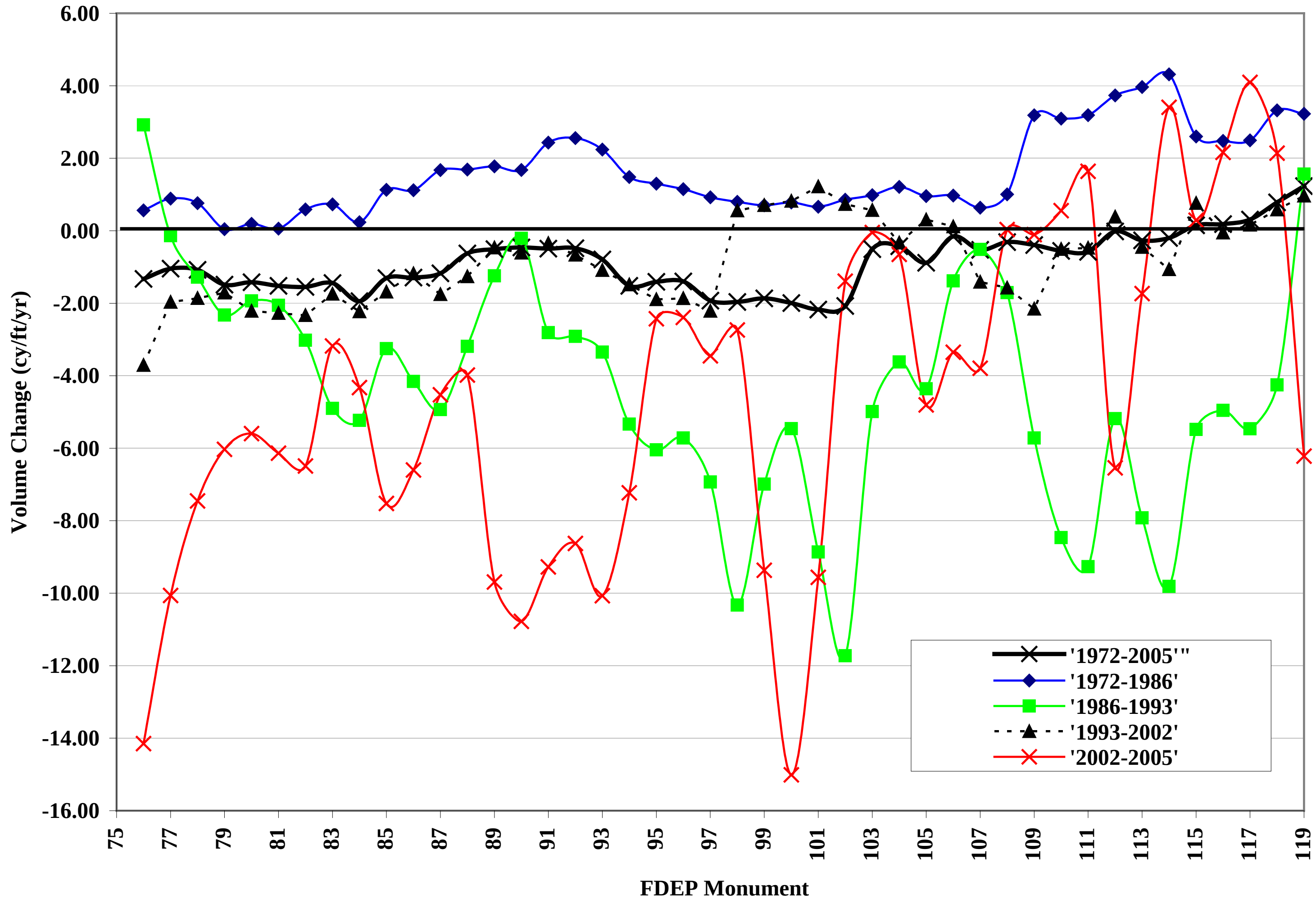

Figure A-14. Volume changes that occurred between beach surveys from dune height to depth of closure; volumetric changes are expressed as cubic yards per year per linear foot of shoreline.

A-59. The time spans between historical surveys in the Mid Reach are too long (3 to 14 years) to effectively isolate the erosion attributable to individual storms or groups of storms from erosion that may be due to longer-term processes such as gradients in longshore transport. They do, however, show that there are significant changes in the erosion or accretion patterns of the Mid Reach both temporally and spatially. Table A-7 and Figure A-14 show the relatively high (erosional) volume changes that occurred between the 1986/1993 and 2002/2005 surveys. These are in contrast to the 1972/1986 and 1993/2002 data which show relatively small changes (accretional and erosional, respectively) across the Mid Reach. The 1972/2005, volume change is relatively small, indicating that accretional forces nearly offset erosional losses over the entire 1972/2005 time span. These data suggest that the region experiences temporally and spatially variable volume losses, due to isolated storm events or abnormally severe storm seasons, but that these episodic losses are offset by recovery as the beach regains an equilibrium condition. The relatively moderate long-term volume losses in the mid reach suggest that there are background erosional forces that are independent of the large storms that impact the area.

Impact of Nearshore Rock on Beach Stability

A-60. There was some discussion in previous literature (USACE 1996 and Olsen 2003) regarding the influence of the rock on sediment transport and the potential impacts, both positive and negative, that the presence of the rock could have on the stability of the region's beaches. The water/rock/sediment interaction and the associated hydrodynamic and sediment transport mechanisms are extremely complex and occur on a wide range of spatial and temporal scales. Due to the complexity of these interactions, detailed investigation of these phenomena were beyond the scope of this report.

A-61. The nearshore rock outcrops undoubtedly influence sediment transport in the region, since they lie in the surf zone—the most energetic region along the beach profile and the region where much of the sediment transport occurs. The primary concern for this study, however, is whether the rock outcrops somehow fundamentally influence erosion and accretion patterns in such a way that they need to be accounted for in the project design. Any such relationship between the rock density and sediment transport that influenced historical erosion rates should be evident in the historical volume change and shoreline position data. That is, if the rock influenced shoreline position or volumetric change, then there would be some relationship between the rock density and the beach's behavior in the historical record.

A-62. An important aspect of the project is that there is a significant increase in rock density from south toward the north within the project area, which is clearly illustrated in Figure A-16. The variability of rock density within the mid reach is illustrated in Figures A-15 and A-16. This natural variation of rock with in the study area enables a direct comparison to determine whether the beaches long term behavior (stability) are effected by the presence or absence of the rock outcrops, since other variables such as sediment characteristics, incident wave and wind characteristics, etc are constant throughout the region.

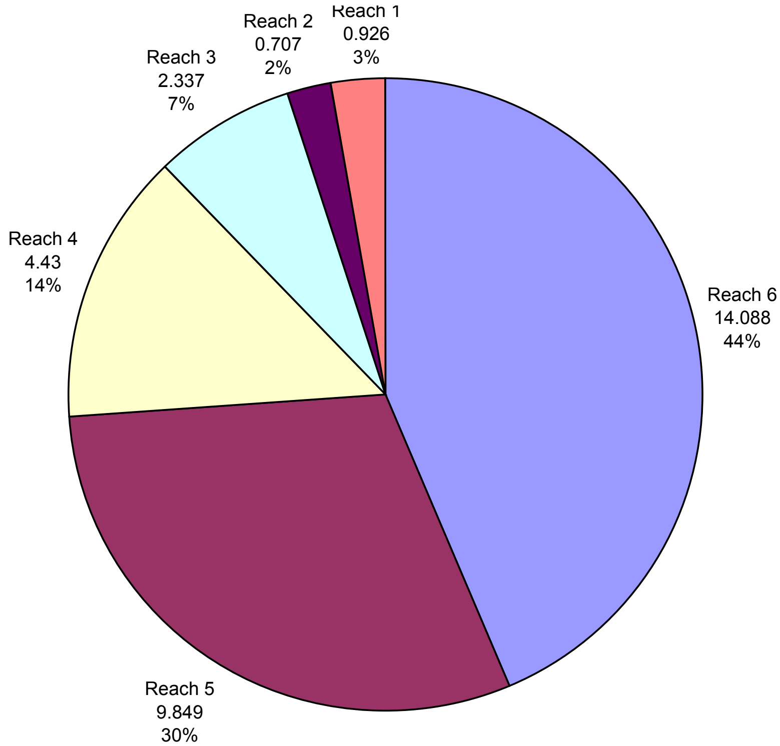

Figure A-15. Rock Distribution in the Mid Reach.

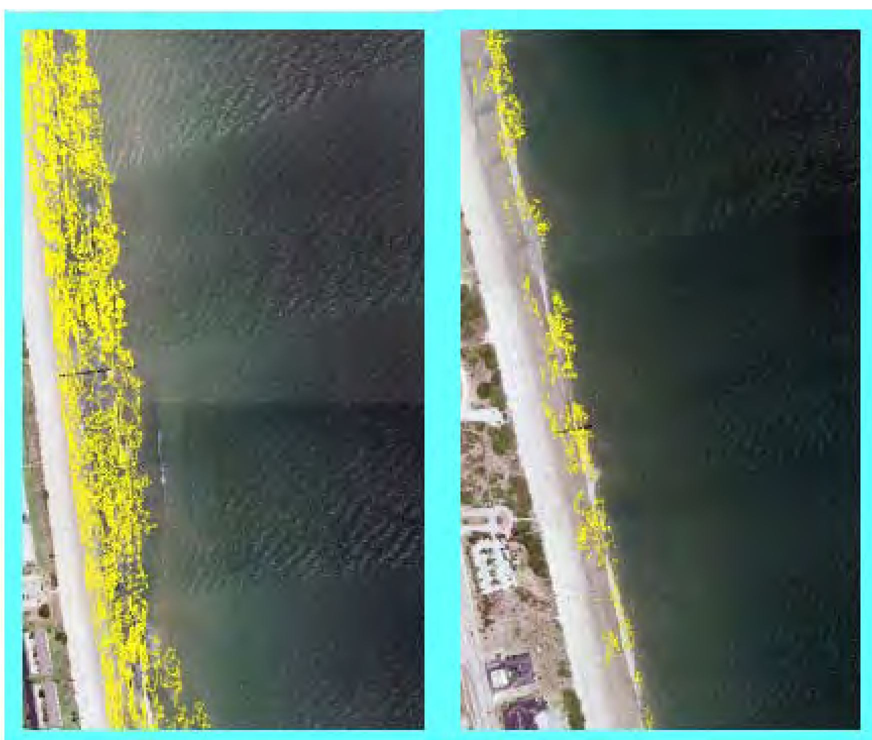

Figure A-16. Map of rock-reefs (outlined in yellow) in the Mid Reach; the left panel is typical of the northern portion of the project, the right panel is typical of the southern portion.

A-63. To ascertain whether the rock influenced historical beach erosion and accretion patterns, shoreline and dune position data along with beach volume change data were compared with rock exposed surface area for each FDEP monument. The data sets were correlated to one another using a standard statistical measure called the Pearson product-moment correlation coefficient, expressed as 'r', which indicates the strength of a linear relationship between two variables. The Pearson correlation coefficient is written:

$$r_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y},$$

where $\bar{x}$ and $\bar{y}$ are the sample means of X and Y, s_x and s_y are the sample standard deviations of X and Y and the sum is from $i = 1$ to n. An r value of 0 indicates no linear relationship between the two variables; a value of 1 would indicate a strong correlation; a value of -1 would indicate a strong inverse correlation. A correlation coefficient was computed for four beach variables versus rock density: 1) dune/bluff position change, 2) MHWL position change, 3) volume changes, dune—MHWL, and 4) volume changes, MHWL—DOC.

A-64. In Figure A-17, the x-axis is the exposed rock acreage at each monument; the y-axis is the dune and MHW position change from 1972 to 2002. The correlation between the rock acreage and MHW and dune position change is listed at the bottom right. The period from 2002-2005 was not included in this analysis so that any influence of the 2002 South Reach fill could be eliminated. In Figure A-18 the x-axis is the exposed rock acreage between adjacent monuments; the y-axis is the volume changes above and below MHW between those same monuments. The dotted lines represent linear regressions of each data set; a strong linear relationship between the independent variable (rock acreage) and the dependent variables (shoreline/dune position and beach volume) would have a clear upward or downward slope to the regression line and an r-value of 0.50 or greater.

A-65. The r = -0.01 for rock vs. MHW position indicates that the MHW position has varied in a manner that is independent of rock density. The r = -0.24 for rock acreage vs. dune position indicates that there may be a relationship between dune position and rock density, but that is weak, at best. The r = 0.10 for rock acreage vs. volume change above MHW indicates little, if any, correlation between the long term dune and beach face volume change and rock density. The r = -0.36 for rock acreage vs. volume change seaward of MHW indicates that there may be some mechanisms that increase erosion along the submerged portion of the profile in the presence of rock, but that the relationship is only weekly correlated.

A-66. Overall, variation of dune/shoreline position and beach volume change over the historical record are not well correlated with the density of rock outcrops. The MHW position and volume of the beach above MHW both varied entirely independently of the rock density; the dune position and volume changes seaward of MHW both have weak correlations with rock density, but are not strongly influenced by it. In short, historical data do not show that the rock has significant long-term impacts to the stability of the beach.

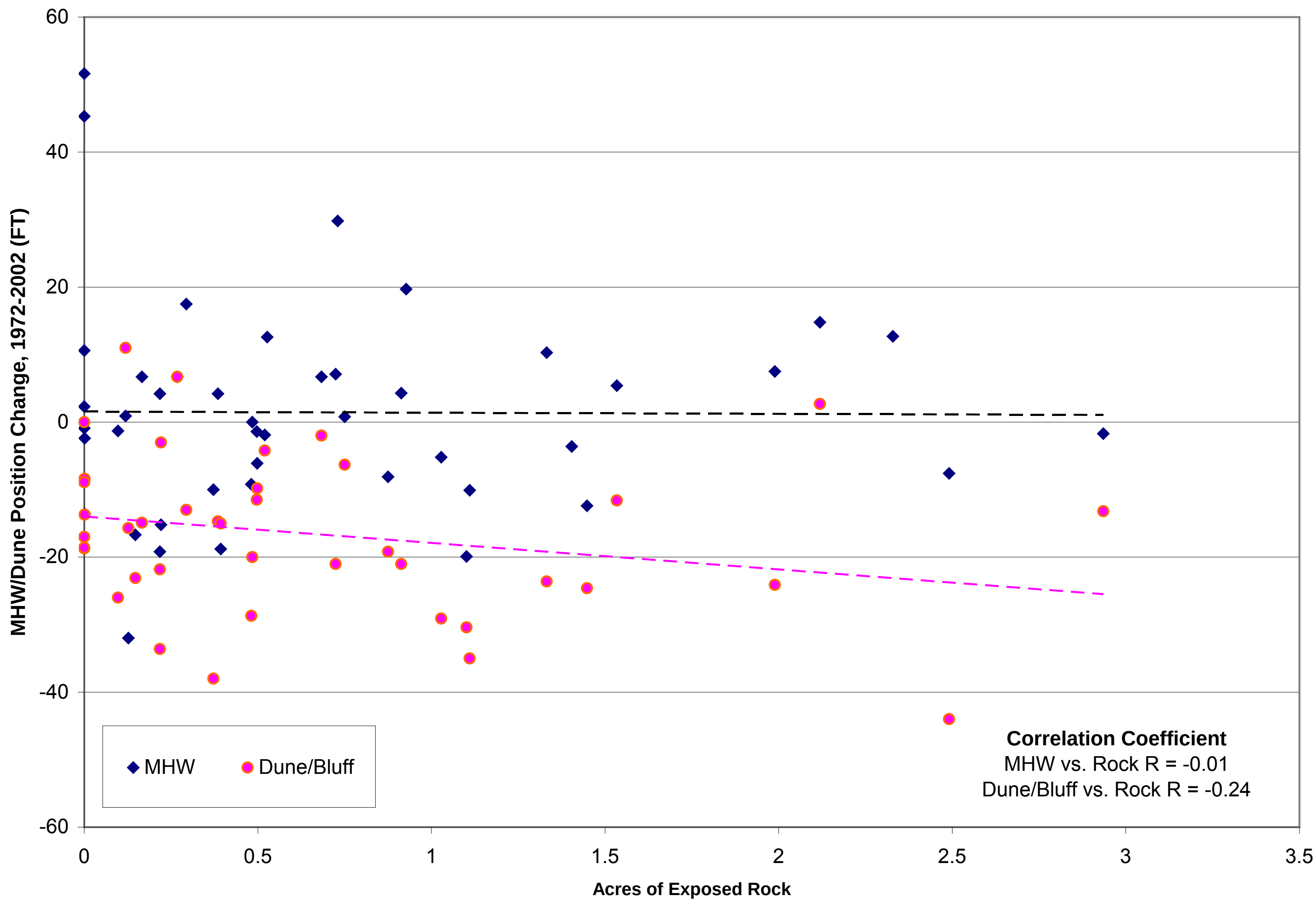

Figure A-17. Exposed rock acres vs. MHWL and Dune position change, 1972-2002.

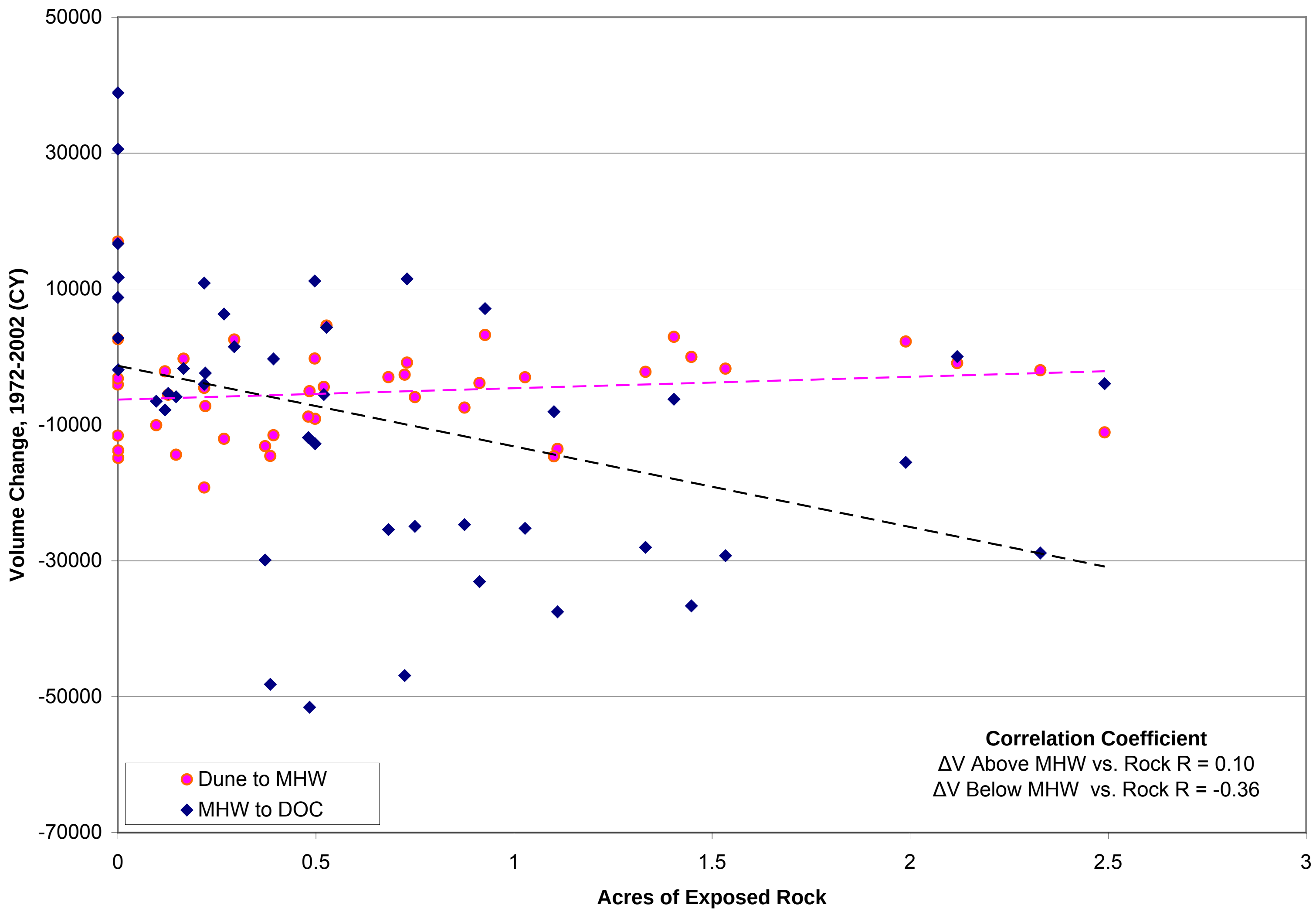

Figure A-18. Exposed Rock Acres vs. Beach Volume Change, 1972-2002.

HISTORICAL SHORE PROTECTION MEASURES

A-67. Erosional forces in Brevard County, both natural and man made, have resulted in the construction of various shore protection measures that include hard structures (bulkheads/seawalls, revetments, etc), soft structures (beach nourishment), and management measures (inlet bypassing). These previous efforts are outlined below.

Existing Shorefront Protective Structures

A-68. A variety of hard shorefront structures have been constructed in Brevard County. These structures consist of small bulkheads, seawalls, and revetments constructed by land-owners. All such structures within the Mid Reach were characterized during a field inspection and were categorized for use in the Storm Damage Model. Structures in the Mid Reach are generally less than approximately 500 feet in length, constructed in front of single lots.

Beach Nourishment and Inlet Bypassing

A-69. North Reach. Table A-8 details sand placement activities in Brevard County since 1972, during which time 14.4 Mcy have been placed. The majority of the nourishment activity in Brevard County prior to initial construction of the North and South Reach, in 2001, was placed in what is presently the North Reach. This area transitioned from accretional to erosional following the opening of Canaveral Inlet in 1951 (Kreibel et al 2002). Material dredged for construction of the Trident submarine pier in conjunction with sand sourced from an offshore borrow site provided 2.9 Mcy of sand in 1974/1975. Sand dredged during regular maintenance of the inlet was also placed on the beach or in the nearshore (-15 to -20 foot contour). The Canaveral Harbor Federal Sand Bypassing Project moved sand from the up-drift beach adjacent to the north jetty to the southern beaches in 1995, 1998, 2007, and 2010.

A-70. To date, 8.8 Mcy of sand has been placed on the beach and 0.9 Mcy has been placed in the nearshore in the North Reach. Of the total, 3.8 Mcy of the beach fill is from the initial (2001) and FCCE (2005) restoration of the North Reach project following the 2004 hurricane season, and 3.2 Mcy is from four sand bypassing events. The bypass project and the regular nourishment of the North Reach have resulted in stabilization of the North Reach beaches and the project appears to have fulfilled the project goals of restoring balance to the sediment transport regime near the inlet (Olsen 2005). Assuming continued bypassing and periodic renourishment of the North Reach, the port's down-drift erosion effects should be minimized in the future.

A-71. During the 2004 hurricane season, the area was subjected to two very severe hurricanes, Frances and Jeanne. The North Reach project performed as designed. The wave heights and storm surge during both storms were severe; however, there were no structures damaged by flooding, overtopping of the beach, or undermining.

Table A-8. Nearshore and Beach Placements in Brevard County, 1972 to 2008

Year	Fill Limits		Project Descripition	Construction Dates		Volume (CY)
1972	R-0	R-14	Fed Nav Proj O&M Beach Disposal	Mar-72	Sep-72	200,000
1974-75	R-0	R-14	Fed SPP Beach Restoration	Apr-74	Nov-74	1,250,000
1974-75	R-0	R-14	Trident Pier New Work Beach Disp	Apr-74	Nov-74	1,600,000
1980-81	R-126	R-136	Fed SPP Beach Restoration	Oct-80	Jan-81	540,000
1992	R-28	R-31	Fed Nav Proj O&M Nearshore Disposal	Jun-92	Aug-92	158,000
1993	R-28	R-31	Fed Nav Proj O&M Nearshore Disposal	Jul-93	Nov-93	200,000
1994	R-5	R-11	Local Beach Nour, City/Port Auth Co-Sponsors	Feb-94	Apr-94	100,000
1994	R-28	R-31	Fed Nav Proj O&M Nearshore Disposal	Oct-94	Oct-94	65,590
1994	R-28	R-31	Fed Nav Proj O&M Nearshore Disposal	Oct-94	Nov-94	69,390
1995	R-0	R-8	Fed Nav Proj Sand Bypass Beach Disposal	Jan-95	May-95	783,000
1995	R-28	R-31	Fed Nav Proj O&M Nearshore Disposal	Aug-95	Dec-95	322,990
1980-95	R-53	R-75	Patrick AFB	NA		380,000
1996	R-34	R-38	Local Beach Nour, City/Port Auth Co-Sponsors	Feb-96	Nar-96	40,000
1998	R-3	R-14	Fed Nav Proj Sand Bypass Beach Disposal	Apr-98	Jun-98	964,500
1996-98	R-53	R-75	Patrick AFB	NA		250,000
2000-01	R-03	R-53	Fed SPP North Reach Initial Nour	Nov-00	Apr-01	3,138,300
2000-01	R-53	R-64	Patrick AFB Nourishment main fill	Nov-00	Apr-01	515,000
2000-01	R-64.5	R-70	Patrick AFB Nourishment thin fill	Nov-00	Apr-01	83,000
2002	R-122.5	R-139	Fed SPP South Reach Initial Nour	Feb-02	Apr-02	1,179,000
2003	R-118.3	R-122.5	Fed SPP South Reach Initial Nour	Mar-03	Apr-03	281,000
2003	R-28	R-39	Fed Nav Proj O&M Nearshore Disposal	Jul 03	Aug-03	50,000
2004/05	R-118.3	R-137.5	Fed SPP South Reach FCCE* Fill	Mar-05	Apr-05	579,000
2004/05	R-7.8	R-19	Fed SPP North Reach FCCE* Fill	Apr-05	May-05	347,000
2004/05	R-33	R-54.5	Fed SPP North Reach FCCE* Fill	Mar-05	May-05	330,000
2005	R-75	R-118	Mid Reach Dune Fill		May-05	307,000
2005	R-54.5	R-75	Patrick AFB	Mar-05	May-05	274,000
2005	R-141.5	R-213	Local/FEMA/FDEP Dune Fill South County	Dec-04	Apr-05	253,000
2006	R-75	R-118	Mid Reach Dune Fill	Feb-06	Apr-06	127,000
2007	R-4	R-10	Canaveral Harbor Bypassing III	Nov-07	Dec-07	761,000
2008	R-75	R-118	Mid Reach Dune Fill	Feb-08	Apr-08	96,000
2008	R-138	R-213	South County Dune Fill	Feb-08	Apr-08	31,000
2010	R-4	R-14	Canaveral Harbor Sand Bypass IV	Feb-10	Apr-10	642,000
2010	R-118.3	R-137.5	Fed SPP South Reach Renourishment	Feb-10	Apr-10	630,000

A-72. Patrick AFB. The 3.1 miles of beach within Patrick Air Force Base (AFB) lie between the North and Mid Reaches. Patrick AFB has been less erosional than the North Reach following the construction of Canaveral Harbor, since it is further from the erosive effects of the inlet. The beaches within the base have been consistently maintained by the Air Force in recent years and have been renourished while dredge equipment was mobilized for the 2001 and 2005 North Reach beach fills.

A-73. A total of approximately 380,000 cy of sand was placed along Patrick AFB between 1980 and 1995 in several separate events. In 2000/2001 83,000 cy were placed between R-64.5 and R-70 in a narrow berm, called a ‘thin fill’. In 2005 63,000 cy was placed as a dune fill from R-64.5 to R-75.4. The material for both the thin fill and dune fill were dredged from the Canaveral Shoals II borrow site, stockpiled onshore, and then mechanically transferred southward to the fill site. The beaches within the base from R-64 to R-75.4 have the same type of nearshore rock outcrops that the Mid Reach has. The 2000 and 2005 beach fills were designed to have no impact to the nearshore rock.

A-74. <u>South Reach.</u> The beaches of the South Reach have much in common with the Mid Reach. Both have been historically mildly erosional but subject to periodic erosion of the dune and bluff as a result of storm activity (before construction of the South Reach beach fill in 2003). The primary difference is that there is no nearshore rock in the South Reach.

A-75. There have been four beach fills place in the South Reach project area: 1) a 540,000 cy beach placement between R-126 and R-136 in 1980/1981, 2) a 1.46 Mcy fill between R-119 and R-139 in 2002/2003, 3) a 579,000 cy restoration between R-119 and R-139 in 2005, and 4) a 630,000 cy renourishment of the same project limits in 2010. All projects were federally cost-shared. The 2002/2003 fill was the initial construction of the Brevard County Shore Protection Project South Reach. The 2005 nourishment was placed to repair damage to the project resulting from the 2004 Hurricanes Frances and Jeanne as part of the Flood Control and Coastal Emergencies act (FCCE). The 2010 renourishment was a standard, periodic replenishment of the project.

A-76. As with the North Reach, the South Reach project performed as designed during the severe 2004 hurricane season, with no structures lost due to flooding or undermining, although wind damage was extensive throughout the region and a significant amount of erosion occurred to the recently constructed beach berm.

A-77. <u>Mid Reach.</u> Due to the presence of the nearshore rock and the attendant concerns regarding impact or burial of the reef, the Mid Reach has never received full-scale nourishment; however, Brevard County and the State of Florida, in conjunction with FEMA, performed emergency dune and beach face restoration in 2005 (307,000 cy), 2006 (100,000 cy), and 2008 (96,000 cy) in order to maintain some minimum protection for structures in the Mid Reach. The dune projects consisted of truck-hauled, beach compatible sand from an upland source that was place using land-based equipment (trucks, loaders and bulldozers). This material was placed in front of the eroded bluff and atop the upper portion of the native berm in response to storm-induced bluff erosion. The fill section was designed to replace recently lost material and did not cover the nearshore rock outcrops. The dune-only nourishment alternatives analyzed in this report, closely resemble the Mid Reach dune projects in both form and function.

A-78. In contrast to the performance of the North and South Reaches, the Mid Reach experienced significant flooding and undermining of structures during the 2004 hurricane season due to the narrow beach widths and low berm elevations that exist within the project area.

STORM-INDUCED SHORELINE RESPONSE MODELING

A-79. Proposed shore protection measures must be subjected to a benefit-cost analysis to assess if the project is economically justified. The benefit aspect of such and economic analysis can be quantified in terms of reductions in storm damage due to the presence of shore protection measures. Benefits include reduction in physical damages to existing property and coastal armor and reduction of land loss. Additional benefits accrue due to increased recreational usage and potential littoral benefits to down-drift shorelines.

A-80. SBEACH modeling was undertaken for the Brevard County, Florida Shore Protection Project Review Study Feasibility Report (completed in 1996). This SBEACH modeling was conducted over a region which included the Mid Reach; the Mid Reach project area was subsequently removed from that feasibility report owing to the additional environmental concerns regarding the nearshore reef-rock. The results of this previous cross-shore sediment transport analysis have been utilized for this report.

SBEACH Model Set-Up and Results

A-81. Cross-shore sediment transport characteristics of Brevard County beaches were estimated using the Storm Induced BEAch CHange model (SBEACH) (Larson and Kraus, 1989). SBEACH simulates beach profile changes which result from varying storm waves and water levels. These beach profile changes include the formation and movement of major morphological features such as longshore, bars, troughs, and berms. SBEACH is a two-dimensional model that considers only cross-shore sediment transport; that is, the model assumes that simulated profile changes are produced only by cross-shore processes. Longshore wave, current and sediment transport processes are not included. SBEACH is an empirically-based numerical model which was formulated using both field data and the results of large-scale physical model tests. Input data required by SBEACH describes (1) the storm being simulated, and (2) the beach of interest. Basic requirements include time histories of wave height, wave period, water elevation, beach profile surveys, and median sediment grain size.

A-82. SBEACH calculates the cross-shore variation in wave height and wave- and wind-induced setup at discrete points along the profile from the seaward boundary to the shoreline. The limit of wave run-up is calculated to define the landward boundary of profile change. Profile changes are calculated at each model time step by solving the conservation of mass equation. An explicit finite-difference scheme is used for this solution.

A-83. In describing the extent of beach erosion, the term recession is often used. Throughout this discussion, recession is defined as the horizontal distance from the mean high water mark on the pre-storm profile to the most landward point where the vertical difference in pre- and post-storm profiles equals 0.5 feet (see Figure A-17).

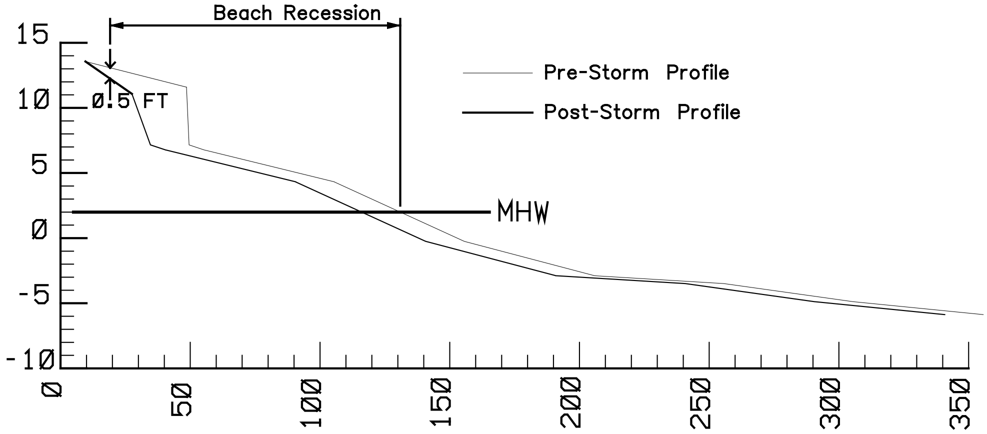

Figure A-19. Beach recession definition sketch.

A-84. Basic assumptions underlying SBEACH simulations are that (1) breaking waves and variation in water level are the major causes of sand transport and profile change, (2) cross-shore sand transport takes place primarily in the surf zone, (3) conservation of mass dictates that the amount of material eroded must equal the amount deposited, (4) median sediment grain diameter on the profile is reasonably uniform across shore, (5) influence of structures blocking longshore transport is small, and the shoreline is straight (i.e., longshore effects are negligible), and (6) linear wave theory is applicable everywhere along the profile without shallow-water wave approximations.

A-85. SBEACH has significant capabilities that make it useful for quantitative studies of beach profile response to storms. It accepts as input a pre-storm beach profile (either idealized or surveyed), time series of water level as produced by storm surge and tide, time series of wave height and period, median sediment grain size, three transport parameters and two characteristic slope parameters. The model allows for variable cross-shore grid spacing, wave refraction by specifying wave direction, randomization of input waves to better represent forcing conditions in the field, and water level setup due to input wind parameters. Output data consists of a final calculated profile at the end of the simulation, simulated profiles at intermediate time steps, intermediate and maximum wave heights, intermediate and maximum total water elevations plus setup, maximum water depth, volume change and a record of various coastal processes that may occur at any time-step during the simulation (accretion, erosion, over wash, boundary-limited run-up, and/or inundation).

A-86. Proposed shore protection measures must be subjected to a benefit-cost analysis, to assess whether Federal participation in the project is appropriate. Primary benefits are typically quantified in terms of the reduction of storm-induced damages to existing property and /or structures. In order to quantify those benefits, one must estimate (1) the damage potential which exists without the proposed protection measures (i.e. for existing conditions), and (2) the damage potential which exists with measures in place. Benefits are expressed as the reduction in storm-induced damages resulting from the presence of the shore protection measure. In order to account for risks and uncertainties inherent to the analysis procedure, methods were selected to express storm damages in a probabilistic manner. In other words, the results were required in the form of recession versus frequency of occurrence relationships. The Empirical Simulation Technique (EST) was selected as the tool of choice to establish those relationships.

SBEACH Model Analysis and Results

A-87. The initial step in a frequency of erosion study is to identify storms that have impacted the area of interest. For Atlantic coast sites, such as Brevard County, the shoreline is subjected to both tropical and extratropical (nor'easter) storms. While tropical storms often have higher winds, waves and surge, the longer duration of extratropical storms can produce beach erosion of equal or greater magnitude than hurricanes. For this application, those data sources were products of the Dredging Research Program (DRP) and Wave Information Study (WIS). The DRP data bases consist of tropical and extratropical storm surges and tidal constituents. The WIS data base contains hindcast wave information, as described in the previous discussion of forcing parameters.

A-88. In summary, the procedure for selection of storm events resulted in the identification of 20 tropical storms and 22 extratropical storms which have influenced the Brevard County beaches. The tropical storm data base encompasses those storms which occurred during the 104-year period from 1886 through 1989. The extratropical storm database includes 16 years of data, from 1977 through 1993. Estimated frequencies of occurrence for tropical and extratropical storms which influence the Brevard County beaches are 0.192 and 1.375 storms per year, respectively.

A-89. For each storm simulation, the initial step in the SBEACH modeling procedure was transformation of the deepwater wave conditions to the finite water depth corresponding to the seaward extent of the beach profile. For this application, profiles extended approximately 900 meters offshore where depths ranged from 8 to 10 meters. As mentioned previously, a comparative analysis of beach profile surveys indicated that the project shoreline could be divided into three reaches. SBEACH simulations of the 88 extratropical storms and 80 tropical storms were then performed for each reach.

A-90. The next step in the empirical simulation procedure involves preparation of the Empirical Simulation Technique (EST) input files. These files contain input vectors, response vectors, and frequency of storm occurrence parameters. The values of the input parameters reflect the storm intensity. The response vector, in this application, quantifies the beach recession resulting from a given storm; and the storm frequency parameters are used to dictate the occurrence of extratropical and tropical storms throughout the multi-year life cycle analysis.

A-91. In the Brevard County application, no distinction was made between extratropical and tropical storms in the economic model; therefore, for compatibility with the economic model, the two sets of EST results had to be merged to generate a single storm-induced recession versus frequency of occurrence relationship. The following algorithm was used to accomplish this combination of extratropical and tropical results:

For a given recession value: Tc = (I/T~ + I/T=)
Where: T, = combined return period corresponding to the chosen recession.
T, = tropical storm return period corresponding to the chosen recession.
T, = extratropical storm return period corresponding to the chosen recession.

A-92. A joint-probability analysis was undertaken utilizing the Empirical Simulation Technique (EST) to estimate return periods associated with various recession distances. This information was subsequently used as input for the storm damage calculations. The storm recession curve developed for that effort was adopted for the present General Reevaluation Report. The recession versus frequency relationships are presented in Table A-9. It is notable that previous SBEACH analysis conducted in the project area concluded that the nearshore rock outcrops did not significantly affect SBEACH erosion results (Olsen 2003).

Table A-9 Combined storm recession return periods.

Return Period	Beach Recession (ft)	Standard Deviation (ft)
1	24	3
2	111	3
5	134	3
10	148	2
25	156	2
50	164	23
75	184	24
100	196	24
150	209	17
200	214	16

SHORE PROTECTION DESIGN

A-93. A full suite of shore protection design solutions were considered during the project formulation and design phases. No action, hard structures, soft structures, etc were considered. The main report details the process by which each of these measures was evaluated for the Mid Reach project area. Due to the presence of nearshore rock outcrops in the Mid Reach, there is a need for engineering solutions that provide storm damage reduction but also avoid and minimize adverse impact to the nearshore rock resource. Since the rock outcrops begin at approximately the mean low water (MLW) line in a relatively narrow band (>300-feet), any hydraulic nourishment would permanently bury or significantly impact all rock outcrops seaward of the fill template.

A-94. The study team concluded 100% rock impact from hydraulic nourishment due to several engineering challenges associated with construction and the proximity of the rock to the shoreline. The rock occurs in a narrow width of between about 300 and 80 feet width – or about 180-ft width on overall average – immediately below (seaward of) the mean low water line; see Section 2.3.4). The smallest-scale, practically constructible hydraulic beach fill (i.e., on the order of 30 to 40 cubic yards per alongshore ft) would result in direct burial of the majority of the exposed rock and subsequent burial or sedimentation of the remainder of the rock after cross-shore equilibration within this narrow zone.

A-95. The ability to predict the degree to which the equilibrated beach fill would impact the existing exposed rock through burial and sedimentation was the primary concern, and the principal subject of discussion among the environmental agencies. The rock is of very low relief (<18" from native sand bottom), so the addition of sediment into the system would produce spatial and temporal variations in the amount of rock covered. Due to the inability to accurately predict these spatial/temporal rock impacts it was decided to be conservative and consider all impacts permanent. Additionally, through coordination meetings during project development, the regulatory agencies made it very clear that temporal impacts were considered significant. That is, temporary net loss of hardbottom habitat through sedimentation or burial, including through periodic renourishment, would require full mitigation; i.e., with no allowance (discount) for the duration of the impact.

A-96. Several logical observations/assumptions were made in the course of the analysis, 1) a beach fill will achieve a native slope from berm to depth of closure, 2) the native rock is emergent from the native profile by a maximum of approximately only 18 inches, and 3) the native rock generally slopes away from the beach. With such a low relief to the rock and the fact that it slope downward, it would take only a small upward vertical shift in the sand level to overwhelm the rock. Hydraulic beach fill templates of traditional widths (60 feet or more plus the attendant advance fill) would translate the beach profile seaward enough (hence raising the elevation of the bed across the entire profile) that they would overwhelm all of the low relief rock.

A-97. For narrower templates, considerations of hydraulic dredging requirements and limitations dictated that the study team could not guarantee the protection of the rock resources. The primary concern centered around the discharge back into the ocean of the water from the dredge pipe. The reef/rock is continuous throughout most of the project. This return water would have to flow over the rock in some locations, producing some temporary or permanent damage to the reef. The inability to predict the immediate, future, and cumulative impacts of this required us to assume that the hydraulic dredging would impact all of the rock that was seaward of the hydraulic fill templates.

A-98. Coordination with the environmental agencies made it clear that impacts to the exposed hardbottom habitat – through direct burial or subsequent indirect effect of alongshore diffusion and/or cross-shore equilibration – would be considered a project impact and would require full mitigation. The concerns about the wide fill templates overwhelming the low relief rock along with the concerns about how to quantify construction impacts from equipment, pipe, and return-water dictated that all hydraulic alternatives would cause 100% impact.

A-99. The environmental regulatory agencies have documented their position that some levels of hardbottom impact would be unacceptable, regardless of mitigation. As described in Section 7.1 (page 155-156) of the GRR/SEIS document, Brevard County applied for and acquired State and Federal permits for beach and dune renourishment along the Mid Reach shoreline during project formulation. In its original application, Brevard County proposed a project consisting partly of conventional beach fill and partly of small-scale truck-haul fill, which would result in anticipated impacts to 6.4 acres of nearshore hardbottom, and of which the latter impacts were to be mitigated. In a letter dated July 5, 2006 to Brevard County (included within Appendix K, Sub-Appendix K), the Corps of Engineers, Regulatory Division stated that the proposed project presented unacceptable impacts, and that a federal permit for the project would be denied unless the impacts to nearshore hardbottom are eliminated or significantly reduced. The scope of the County's project application was subsequently modified to reflect beach and dune fill, mitigation, and predicted hardbottom impacts (approximately 3 acres) that are very similar to those of the Selected Plan in the GRR/SEIS. That project was permitted by the State of Florida in December 2009, and is expected to receive a Department of the Army permit in early 2010. As a result of the above concerns, traditional, wide hydraulic fill templates were deemed to have too high of an impact on the rock outcrops.

A-100. Hard structures (seawalls and revetments) were considered during initial plan formulation of this study, as well; however a variety of engineering and environmental challenges ultimately eliminated all of the hard structures from consideration as detailed in the main body of this report. The final suite of alternatives consist of dune and shore face fill alternatives of various widths that are to be transported to the project area and placed with land-based equipment (trucks and tractors).

A-101. Sand placed on the beach utilizing shore-based equipment would impact only the rock that was directly buried under the construction template and that which would be covered by the processes of cross-shore and longshore equilibration. Four truck-hauled dune and beach face alternatives were analyzed: a dune-only beach fill design; and a dune + beach-face fill design with a variable MHWL advancement of 10-, 20-, or 30-feet.

Figure A-20. Mid Reach dune fill, constructed in 2005

A-102. There are two previously-permitted and constructed truck-hauled, dune/beach face nourishments in the area; (1) the Patrick AFB 'Thin Fill', and (2) the Mid Reach dune fill (depicted in Figure A-20). These projects have been monitored for rock impacts and the results indicate that it is feasible to construct a dune-only project that does not impact the rock outcrops. The dune-only alternatives considered in this section, thus, do not require mitigation for rock impacts. The proposed beach-face nourishments would place material beyond the MHW line and would directly cover a narrow band of rock along the landward limit of the rock outcrops. The quantification of rock impacts that would result from these alternatives is covered in detail in a subsequent section of this appendix.

Beach Fill Design

A-103. An analysis of native and previously-nourished beach profiles from Brevard County was conducted to aid in the design of the Mid Reach dune and beach face fill alternatives. Beach profile surveys of Brevard County from 2004, 2005, and 2008 were analyzed using the Coastal Engineering Design and Analysis System (CEDAS) Beach Morphology Analysis Package (BMAP). Comparisons of beach profiles were conducted for areas with both the Mid Reach project area and within the previously-nourished North and South Reaches. In addition, data regarding the performance of the previous North, South, and Mid Reach beach nourishments were utilized to aid in the design process.

A-104. Based on analysis of the existing beach profiles, beach face slopes from berm height to MLW are variable from approximately 1V:8H to 1V:17H throughout the Mid Reach. The average berm height is approximately +10 NGVD in areas that have a healthy supply of sand (South and North Reaches). In addition, the nourished beaches of North and South Reaches have performed best with a berm height of +10.6 feet; previous nourishment projects in the region that were constructed with a lower berm height exhibited some ponding atop the berm after construction, which indicated that the berm height was too low.

A-105. The project design volume is equivalent to the volume that is required to advance the existing beach profile seaward by the design width, d, of the project alternative (10-, 20-, or 30-feet). Shoreline recession, X, resulting from sea level rise can be estimated using Bruun's Rule, as defined below:

$$X = -SW_*/(h+B)$$

A-106. Berm height, h_*, for the project area is 10.6 feet; depth of closure, B, is estimated to be 17 feet based on beach profile data; the width of the active profile, W*, is approximately 1800 feet. The median estimated sea level rise, S, of 0.0125 ft/yr would result in a shoreline recession of 0.75 ft/yr; the 1% sea level rise of 0.0275 ft/yr would result in a recession 1.65 ft/yr.

A-107. The vertical limits of the profile translation are from berm height to depth of closure. The berm height, B, is taken to be elevation +10.6 (NGVD29); the depth of closure, h*, in the project area is taken to be -17 feet; the active height, H, of the beach profile is h*+B . The volume of the design beach fill is thus, H * d * length. The volumes for each design width in each reach were computed by this method. The volumes for the selected plan are shown in Table A-10.

Table A-10. Design fill volumes.

	Length	Project Design Width (ft)	Design Fill Density (cy/ft)	Design Volume (cy)
Reach 1	9599	10	10.2	98,000
Reach 2	3406	20	20.4	70,000
Reach 3	6239	20	20.4	128,000
Reach 4	5603	10	10.2	57,000
Reach 5	9029	10	10.2	92,000
Reach 6	7207	0	0.0	0
				445,000

With-Project Erosion Rates

A-108. Traditional beach nourishment with-project loss rates are quantified by combining the historical background erosion rates of the region with the project-induced erosion. The dominant project-induced erosion on wide nourished beaches is end-losses that occur due to diffusion of the sand from the ends of the project footprint when a significant, localized protrusion in the shoreline is created. This shoreline perturbation produces longshore sediment transport gradients that locally increase longshore transport away from the project at the ends of the fill footprint.

A-109. The longshore sediment transport model GENESIS is commonly applied to solve for the with-project erosion rate on traditional beach nourishment designs where the primary with-project erosion force is the longshore diffusion of sand out of the fill area. This diffusion is a result of a wide fill template being placed on a straight shoreline, which induces the shoreline to slowly straighten out and move sediment from wide fill area to the narrower adjacent beach. In the case of the Mid Reach selected plan, the largest beach width transition is 10 feet, and those transitions occur within the project limits, between adjacent Reaches not at the ends of the project.

A-110. The Mid Reach project area is bounded on the south by the wide (approximately an 80-foot design berm, as measured at the MWH line) South Reach beach fill, which is significantly wider than the Mid Reach proposed fill. The transition from the wide south reach fill to the narrower Mid Reach fill (10-foot design berm) will prevent any project-induced longshore diffusion out of the Mid Reach at the south end of the project area. The alternative in Reach 6, at the north end of the Mid Reach, is a 0-foot MHW extension dune-only template. This very small change in width will induce a very small diffusion of sand onto the adjacent beaches. For this reason, measurements of historical native beach erosion and the erosion of the existing dune and beach face fill projects in the Mid Reach project are utilized for computation of future with-project erosion rates.

A-111. Historical volume changes were presented previously in this appendix. These indicate that there are significant changes in the erosion or accretion patterns of the Mid Reach both temporally and spatially. Table A-7 and Figure A-14 show the relatively high (erosional) volume changes that occurred between the 1986/1993 and 2002/2005 surveys. These are in contrast to the 1972/1986 and 1993/2002 data which show relatively small changes (accretional and erosional, respectively) across the Mid Reach. The 1972/2005, volume change is relatively small at -37,000 cubic yards per year, indicating that accretional forces nearly offset erosional losses over the entire 1972/2005 time span.

A-112. Brevard County Commission (the Federal Shore Protection Project local sponsor) and FEMA placed dune/beach face fill projects in the Mid Reach in 2005, which were subsequently renourished in 2006, and 2008. These projects closely resemble the proposed Mid Reach alternatives. Analysis of beach volume changes indicate that the project has eroded at a rate of 61,000 cubic yards per year since its construction. These losses were observed to come more from the beach face and less from the dune portion of the fill (Olsen 2009).

A-113. <u>Discussion.</u> The Mid Reach proposed beach fill alternatives would be subjected to negligible longshore diffusion-related losses as discussed previously. The design dune and beach face fill would be placed above approximately the -4.0 foot NGVD contour. The construction of the fill along only the upper elevations of the active beach profile (which extends out to approximately the -17 foot NGVD contour) would put the system in a state of non-equilibrium—the beach would be expected to regain its natural profile shape, albeit seaward of its present location by 10-, 20-, or 30-feet. The fill template is therefore exposed to cross-shore erosional forces that would transport sand seaward as the beach gradually regains its equilibrium shape. Although this eroded dune and beach face sand may be transported to a seaward portion of the beach profile that still lies within the active sediment transport regime of the beach and still provide some benefits to the project, it would no longer be in the dune or beach face design template and would effectively represent losses to the project. Through this mechanism, cross-shore equilibration would be the primary erosional stress placed on a dune and beach face nourishment.

A-114. The rate of cross-shore erosion of the fill is not a predictable process given the present state of the art of cross-shore sediment transport numerical models. SBEACH is intended to model beach profile changes associated with storm waves and water level fluctuations (surge), but does not address the long-term performance of fill templates. The long-term average erosion rate of the project area has been -37,000 cubic yards per year (1972-2005). This rate has fluctuated fairly widely between individual surveys conducted between those dates (see Figure A-10). It is notable that there are no areas with significantly higher erosion rates over the long-term which precluded the need for numerical wave modeling analysis or evaluation of erosional hot spots. The measured erosion rate of the existing project (-61,000 cubic yards per year) provides the best indication of project performance and erosion rate of the available measured data. Adopting a conservative approach and rounding the measured data up, the with-project erosion rate is thus estimated to be -70,000 cubic yards per year. The total advanced nourishment amount, given the 3-year interval optimized during plan formulation, gives a total advance fill volume of 210,000 cubic yards per year.

Project Design Template

A-115. The project selected plan design is defined as an equilibrated advancement of the MHW shoreline by 10 feet (Reaches 1, 4, and 5) or 20 feet (Reaches 2, and 3). Reach 6 consists of a dune feature that is entirely advance fill meant to protect the native dune, but not provide any permanent shoreline advancement. The design template slope conforms closely to the native slope of the beach. For the purposes of formulating a simplified design template, the native beach template is divided into three cross-shore regions: upper beach face, lower beach face, and the submerged profile, as shown in Figure A-21.

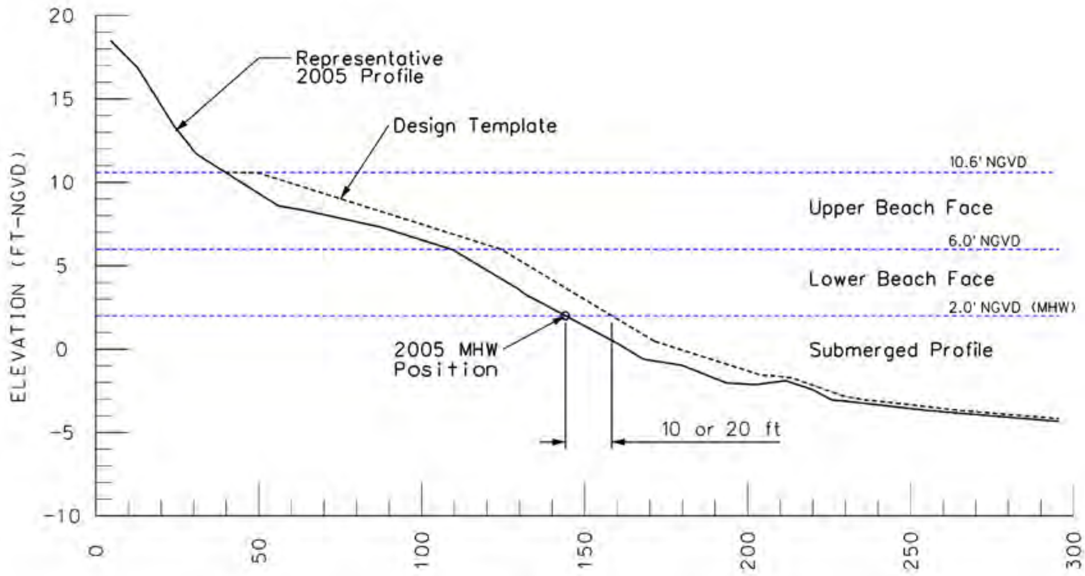

Figure A-21. Project Design Template

A-116. The upper beach face extends seaward from a berm height of +10.6 NGVD to +6.0 feet; the lower beach face extends seaward from +6.0 to the MHW elevation of +2.0 NGVD; the submerged profile extends from MHW elevation seaward. For the sake of the design template, the only the upper and lower beach face slopes are defined, whereas the submerged profile is expected to take a shape that is equivalent to the native submerged beach, albeit at a position 10 to 20 feet seaward of the native profile.

Table A-11. Project design template upper- and lower beach face slopes

Reach	Upper Beach Face Slope	Lower Beach Face Slope
1	1V:17H	1V:10H
2	1V:15H	1V:10H
3	1V:10H	1V:10H
4	1V:10H	1V:10H
5	1V:8H	1V:8H
6	NA	NA

A-117. The upper and lower beach face slopes are not always equal with the upper being less steeply sloped than the lower beach in reaches 1 and 2, as shown in Figure A-21. The native beach face slopes generally become steeper toward the north end of the project area, thus the design slopes become steeper from South to North (Reach 1 to Reach 5) as shown in Table A-11.

A-118. The project's design baseline as defined for all economic benefit and damage calculations and plan formulation steps, is the mean high water line from the year 2005.

MHW in the project area is defined as elevation +2.0 feet NGVD 29. The coordinates of the 2005 MHW line are included in Table A-12.

Table A-12. 2005 Mean High Water line position

FDEP Monument	Elevation FT-NGVD29	Easting FT-NAD27	Northing FT-NAD27	FDEP Monument	Elevation FT-NGVD29	Easting FT-NAD27	Northing FT-NAD27
R- 75	2.0	629,738.9	1,410,442.6	R- 98	2.0	633,897.2	1,389,557.9
R- 76	2.0	629,883.5	1,409,361.5	R- 99	2.0	634,080.2	1,388,632.8
R- 77	2.0	629,992.6	1,408,598.6	R- 100	2.0	634,299.3	1,387,645.2
R- 78	2.0	630,123.9	1,407,616.6	R- 101	2.0	634,550.4	1,386,677.3
R- 79	2.0	630,264.5	1,406,640.0	R- 102	2.0	634,782.9	1,385,737.8
R- 80	2.0	630,383.1	1,405,630.5	R- 103	2.0	635,018.8	1,384,758.6
R- 81	2.0	630,527.9	1,404,746.1	R- 104	2.0	635,228.5	1,383,897.8
R- 82	2.0	630,708.6	1,403,787.0	R- 105	2.0	635,382.8	1,383,259.2
R- 83	2.0	630,870.2	1,402,837.7	R- 106	2.0	635,684.8	1,381,987.9
R- 84	2.0	631,079.2	1,401,913.6	R- 107	2.0	635,921.5	1,381,002.5
R- 85	2.0	631,217.3	1,401,193.2	R- 108	2.0	636,121.7	1,380,143.7
R- 86	2.0	631,433.6	1,400,228.5	R- 109	2.0	636,351.0	1,379,238.7
R- 87	2.0	631,645.3	1,399,388.3	R- 110	2.0	636,629.9	1,378,105.6
R- 88	2.0	631,906.4	1,398,281.0	R- 111	2.0	636,845.6	1,377,305.6
R- 89	2.0	632,082.3	1,397,402.9	R- 112	2.0	637,109.4	1,376,336.7
R- 90	2.0	632,219.4	1,396,793.8	R- 113	2.0	637,332.7	1,375,489.6
R- 91	2.0	632,424.7	1,395,927.0	R- 114	2.0	637,576.8	1,374,590.6
R- 92	2.0	632,640.8	1,395,050.8	R- 115	2.0	637,889.3	1,373,488.3
R- 93	2.0	632,847.0	1,394,080.9	R- 116	2.0	638,103.6	1,372,761.1
R- 94	2.0	633,070.1	1,393,109.6	R- 117	2.0	638,356.6	1,371,888.4
R- 95	2.0	633,289.2	1,392,357.6	R- 118	2.0	638,622.4	1,370,936.9
R- 96	2.0	633,486.8	1,391,440.7	R- 119	2.0	638,961.5	1,370,022.3
R- 97	2.0	633,674.4	1,390,532.2				

Project Construction Template

A-119. Due to the preponderance of turtle nests within Brevard County, some changes have been made to the North and South Reach beach fill templates that are deemed to aid turtle nesting success. A slight seaward slope (1V:40H) of the berm aids in turtle nesting success and also reduces the chance of the berm scarping (and hindering turtle nesting) during storms. A small dune feature has also been incorporated into the North and South Reach design, which is intended to trigger nesting turtles to halt their landward migration and nest on the beach berm. Similarly, experience in permitting and monitoring the previously-constructed Mid Reach dune fill has indicated that a steep upper slope of 1V:1.5H aids in turtle nesting by keeping the turtles from walking over the dune and keeping them atop the beach berm when seeking nesting areas.

A-120. The with-project erosion rate is computed to be approximately 70,000 cubic yards per year. To account for the erosion that will occur between renourishment events on a 3-year interval, 210,000 cubic yards of material will be placed as advanced fill. Advance nourishment of the project will be accomplished by construction of a beach template that is wider than the design template and with construction of a dune feature. The construction template includes a wider overall berm fill with a steeper seaward slope than the design template along with a dune fill element above the berm height, as illustrated in Figure A-22. Due to the presence of the dune feature, the construction template is referenced from the berm elevation of +10.6 feet NGVD.

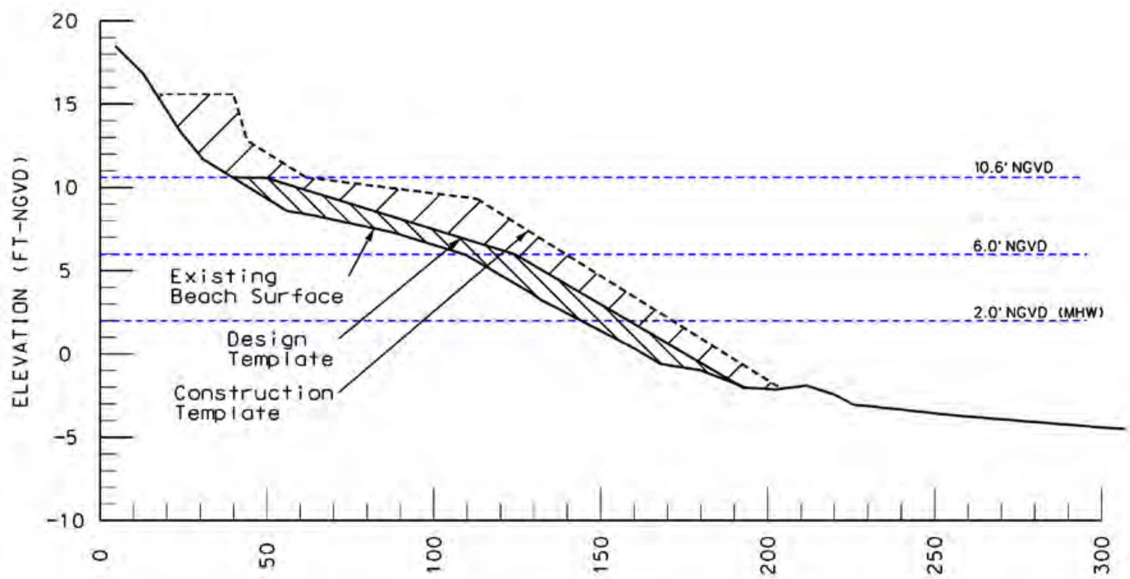

Figure A-22. Typical project design template and construction template

A-121. The width of the construction template elements (dune and berm widths) are designed to accommodate the full volume of sand that would be required to advance the 2005 shoreline by 10 feet (Reaches 1,4, and 5) or 20 feet (Reaches 2 and 3) from berm height (+10.6 feet) to depth of closure (-17 feet NGVD). This volume is calculated as 445,000 cubic yards. In addition, the construction template includes 210,000 cubic yards of advance fill for a total of 655,000 cubic yards of fill to be placed in the project area at initial construction. The project baseline for the construction template is the +10.6 foot elevation of the 2005 beach profile at each FDEP monument in Reaches 1-5, which corresponds with the natural berm height elevation of the project area. In Reach 6 the baseline for construction is the +12.8 foot contour from 2005, which corresponds to the position of the existing dune face at that time. Table A-13 includes the location of the project baseline at each monument.

Table A-13. 2005 elevation +10.6/+12.8 NGVD29 position at FDEP monuments

FDEP Monument	Elevation FT-NGVD29	Easting FT-NAD27	Northing FT-NAD27	FDEP Monument	Elevation FT-NGVD29	Easting FT-NAD27	Northing FT-NAD27
R- 75	12.8	629,646.5	1,410,442.6	R- 98	10.6	633,814.2	1,389,543.3
R- 76	12.8	629,787.3	1,409,361.4	R- 99	10.6	634,023.7	1,388,622.8
R- 77	12.8	629,933.4	1,408,589.6	R- 100	10.6	634,223.9	1,387,632.0
R- 78	12.8	630,034.3	1,407,616.6	R- 101	10.6	634,450.0	1,386,659.7
R- 79	12.8	630,159.5	1,406,640.0	R- 102	10.6	634,674.6	1,385,718.8
R- 80	12.8	630,297.2	1,405,630.5	R- 103	10.6	634,936.4	1,384,744.2
R- 81	12.8	630,446.0	1,404,746.1	R- 104	10.6	635,125.9	1,383,879.8
R- 82	12.8	630,605.5	1,403,787.0	R- 105	10.6	635,272.7	1,383,239.9
R- 83	10.6	630,793.3	1,402,837.7	R- 106	10.6	635,576.3	1,381,968.8
R- 84	10.6	630,985.2	1,401,897.1	R- 107	10.6	635,808.4	1,380,982.6
R- 85	10.6	631,144.3	1,401,180.3	R- 108	10.6	636,020.2	1,380,125.8
R- 86	10.6	631,361.5	1,400,210.7	R- 109	10.6	636,258.1	1,379,222.4
R- 87	10.6	631,575.3	1,399,369.6	R- 110	10.6	636,527.2	1,378,087.6
R- 88	10.6	631,835.7	1,398,268.9	R- 111	10.6	636,746.6	1,377,288.2
R- 89	10.6	632,023.0	1,397,392.5	R- 112	10.6	636,990.1	1,376,315.8
R- 90	10.6	632,150.0	1,396,781.6	R- 113	10.6	637,216.9	1,375,469.3
R- 91	10.6	632,350.8	1,395,914.0	R- 114	10.6	637,458.4	1,374,569.8
R- 92	10.6	632,563.4	1,395,037.2	R- 115	10.6	637,771.7	1,373,467.6
R- 93	10.6	632,756.1	1,394,064.9	R- 116	10.6	637,962.9	1,372,736.4
R- 94	10.6	632,972.0	1,393,092.4	R- 117	10.6	638,218.7	1,371,864.2
R- 95	10.6	633,177.1	1,392,337.9	R- 118	10.6	638,534.6	1,370,921.5
R- 96	10.6	633,380.0	1,391,421.9	R- 119	10.6	638,784.5	1,370,014.0
R- 97	10.6	633,584.2	1,390,516.4				

A-122. Due to local variations in native beach width and dune width, the construction template widths vary from one reach to the next as outlined in Table A-14 below. All widths referenced to the 2005 baseline elevation +10.6/+12.8 contour positions (Table A-13).

Table A-14. Construction template dune and berm width

	Dune Fill Width (ft)	Berm Fill Width (ft)
Reach 1	27	75
Reach 2	43	80
Reach 3	38	80
Reach 4	20	55
Reach 5	23	30
Reach 6	10	NA

A-123. The construction template slopes are consistent throughout Reaches 1-5 and are illustrated in Figure A-23. The dune portion of this fill template begins at the height of the native dune crest seaward on a 1V:1.5H slope to the elevation +12.8, then seaward at a 1V:8H slope to elevation +10.6. The berm then slopes 1V:40H until the design berm width (Table A-11), then slopes seaward on a 1V:8H slope until intersection with the existing bottom.

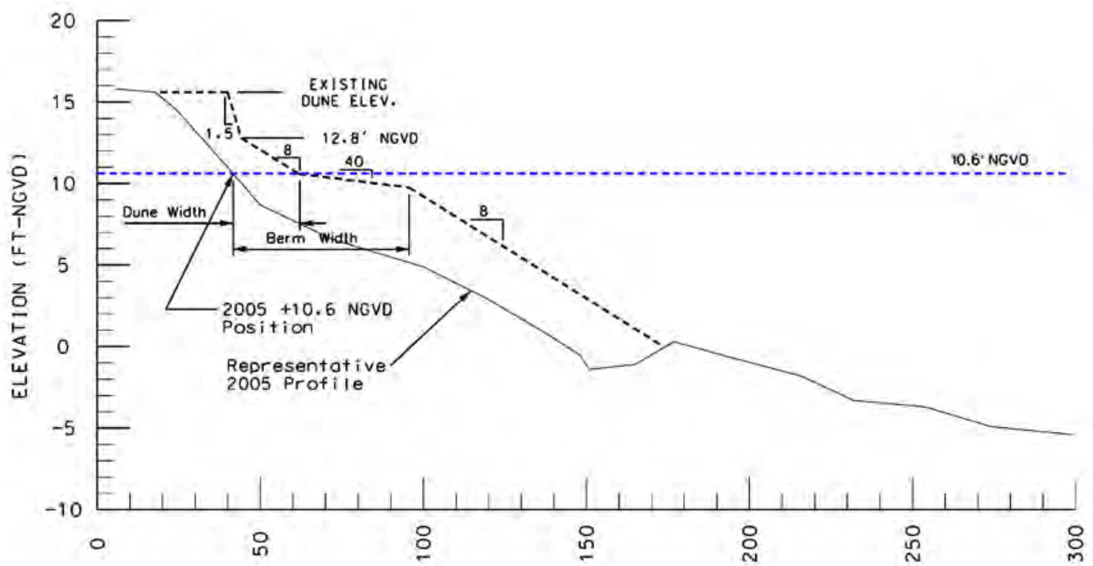

Figure A-23. Construction template for dune and beach face fills in Reaches 1-5.

A-124. The construction template for Reach 6 is shown in Figure A-20. The position of this template at each monument location is referenced to the +12.8 foot NGVD29 elevation. The template extends from the native dune height seaward on a 1V:1.5H slope until elevation +12.8, then seaward at a 1V:6H slope until intersection with the existing bottom. The width of the template as measured at the +12.8 foot elevation is 10 feet.

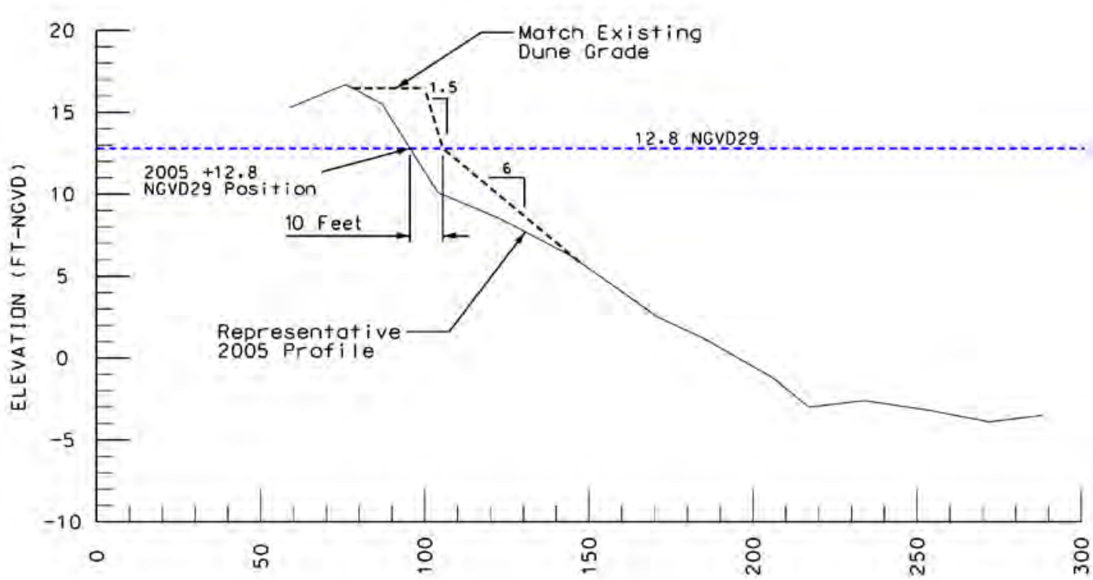

Figure A-24. Reach 6 dune fill template.

ROCK OUTCROP IMPACTS

A-125. Numerous shore protection alternatives were investigated for this study, including beach replenishment alternatives that could partially or completely cover portions of the nearshore rock. It was therefore necessary to quantify the amount of rock that would be impacted by the many different beach nourishment alternatives being evaluated. A portion of rock would be directly buried during construction and an additional amount of rock would be indirectly impacted due to longshore and cross-shore migration of the fill. Impacts through the direct or indirect burial of the rock were quantified for each alternative by superimposing each beach nourishment planform 'footprint' over the rock map and extracting the overlapping region where the fill would cover the rock outcrops. The product of this analysis is the acreage of rock impacted by direct or indirect burial.

A-126. A detailed map of exposed rock outcrops was created by Olsen Associates in 2004 utilizing ARC GIS-based analysis of high resolution aerial photographs. This map was used to derive the exposed rock acreage between each monument (Figure A-25).

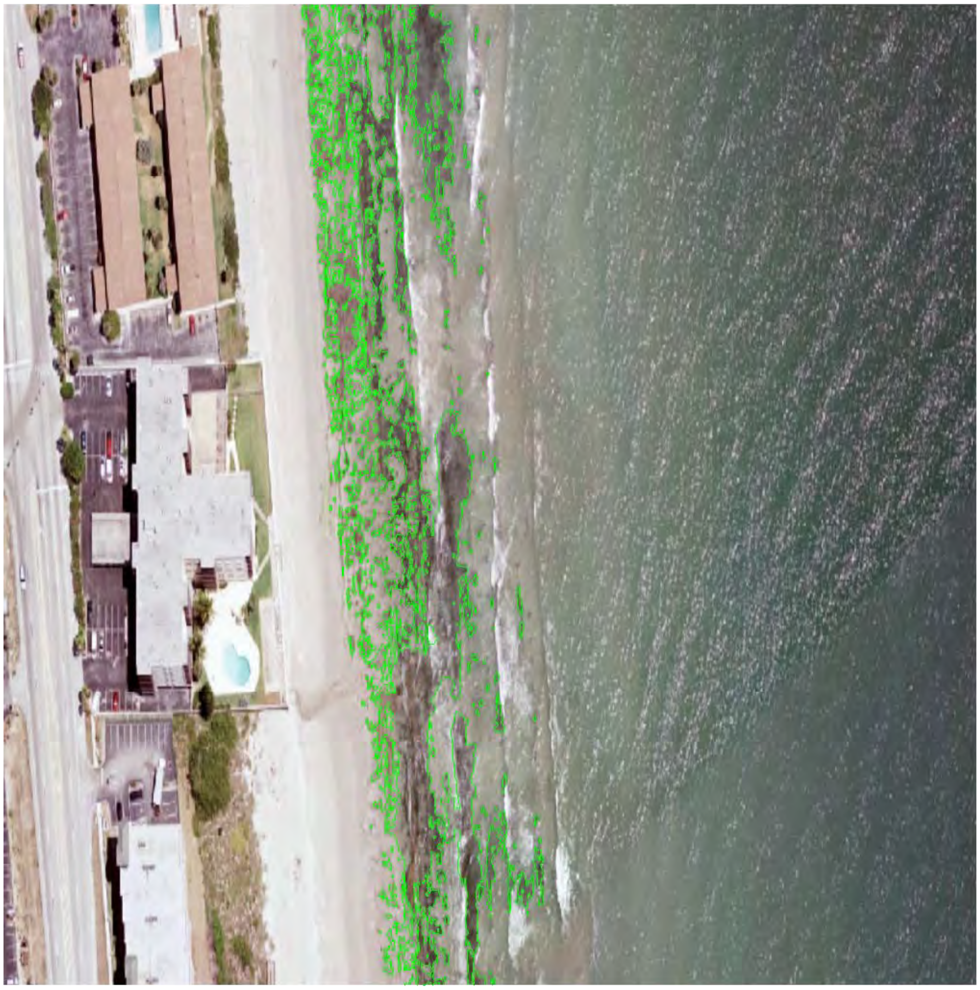

Figure A-25. Aerial photograph of rock outcrops; green outlines indicate a detail of the rock map that was derived from the photographs.

A-127. The native beach profile consists of sand from the dune seaward to approximately the MLW line where the sandy beach intersects the rock outcrops. The rock outcrops extend seaward a variable distance up to a maximum width of approximately 300’ at which point the bottom becomes sandy again out to deep water. The vertical relief of the rock varies from 0 (flush with the surrounding bottom) to approximately 18-inches above grade (see Figure A-26).

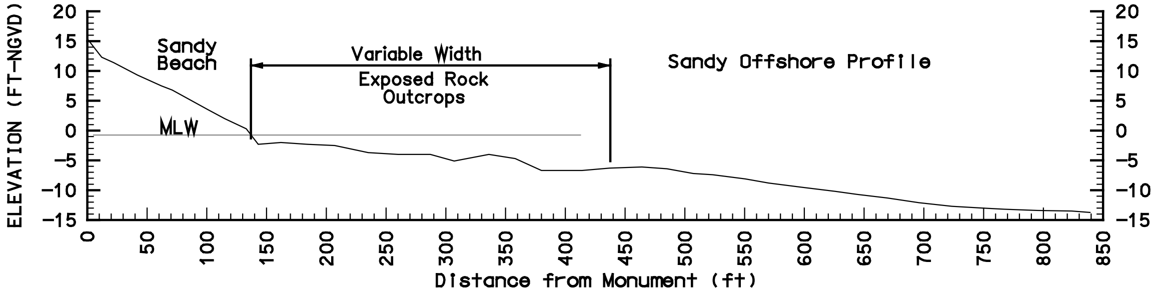

Figure A-26. Example beach profile, including nearshore rock outcrops that extend seaward from the MLW shoreline.

A-128. Truck-Haul Rock Impacts. Dune and beach face fill alternatives would not impact *all* rock that lay seaward of the fill templates, but only a strip that lay between the toe of native sandy beach and the with-project toe of fill. The critical design criteria for quantifying the impacts to rock by the truck-haul fill is, therefore, the equilibrated toe of fill, i.e. the maximum seaward extent that the beach fill will attain during the project life.

A-129. All coverage of the native reef/rock was computed based on translation of the native beach profile seaward to predict the with-project beach face/rock interface. The fill material is highly compatible with the native beach, thus the fill should obtain the same average profile shape as the existing beach and. The toe of fill and rock impact analyses assume that the entire profile will translate seaward relative to the fixed, emergent rock. Numerical models such as SBEACH have been suggested for use in calculation of equilibrium toe of fill. SBEACH is a storm response model intended for computation of short-term post storm beach profile response; it is not appropriate for predicting the toe of beach fill or other long-term beach fill behaviors. There are no other numerical models or analytical techniques that would be able to more accurately predict the rock impacts due to sand burial. Similarly, it is not possible to assign a probability or likelihood of future unintended rock burial in the area.

A-130. The berm/upper beach has a native mean grain size of 0.45 mm (1.16φ) and the overall native mean grain size from dune to depth of closure is 0.31 mm (1.75φ). The Canaveral Shoals II (CSII) borrow area has a mean grain size of 0.39 (1.36φ). The fill sand is a close match to the native berm/upper beach sand in both grain size and sorting, and is significantly courser than the mean grain size across the entire beach. The relatively narrow truck haul fill widths considered for this study (10—40 feet) would place this courser CSII fill material in a configuration that would closely mimic the native beach above approximately MLW. This compatible fill material should therefore behave in a similar fashion to the native beach and attain an equilibrated slope and berm height very similar to the native profile. The equilibrated toe of fill can thus be predicted using the profile translation method, i.e. the fill template would simply translate the existing profile above the rock layer seaward without appreciably changing its shape (see Figure A-27, below).

A-131. Based on the assumption of translating the native profile seaward, the relatively flat, tabular nature of the rock outcroppings means that a 20-foot equilibrated beach width change would cover approximately a 20’ strip of nearshore rock. This is depicted in Figure A-27. This assumption is significantly conservative given that the courser 0.39mm fill material is predicted to equilibrate to a slope that is steeper than the native beach.

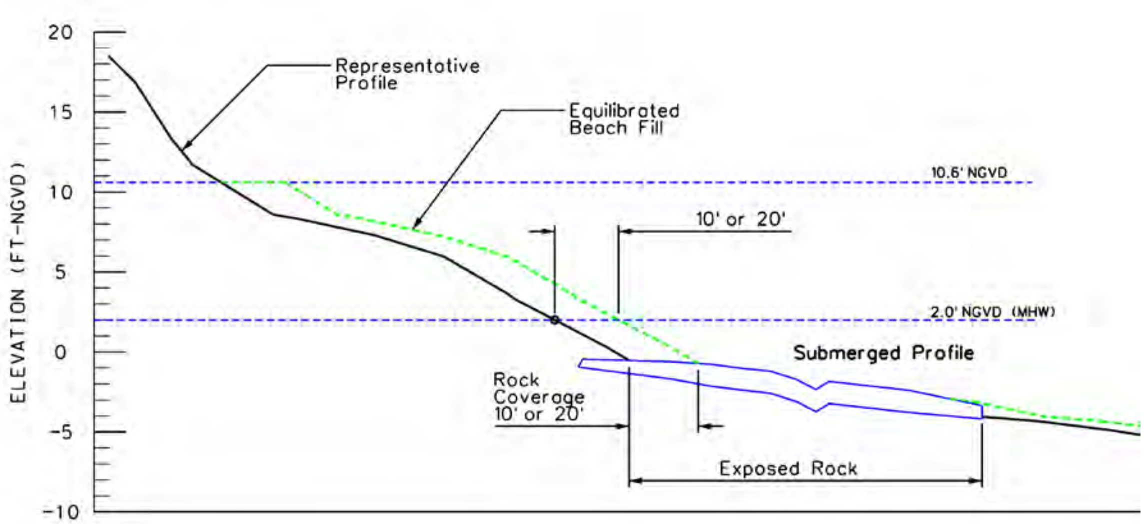

Figure A-27. Example beach profile with truck-hauled beach fill rock impact.

Figure A-28. Rock outcrop impacts due to beach fill.

A-132. In order to quantify the total rock covered by each alternative, first, the natural intersection line between the sand and rock was delineated on the rock map. This line was then translated seaward by a distance equivalent to the equilibrated beach fill width. All rock that fell between the present and post-fill beach-rock intersection was considered to be impacted by the project and would require mitigation.

A-133. Figure A-28 illustrates the technique utilized for quantifying the rock impacts as described above. The blue solid line on the left represents the natural intersection between sand and rock, the red dotted line on the right indicates the post-fill sand-rock intersection, or toe of fill. The hatched region in between represents the impacted rock outcrops.

A-134. Each of the dune + beach-face fill alternatives includes a design fill and an advanced fill as outlined in the Project Design section of this appendix. Table A-15 summarized the rock impacts, for both the design and advanced fill that would result from construction of the NED and Locally Preferred plans. The project is designed such that the design fill will remain intact at all times, while the advance fill would be eroded partially or completely between periodic renourishments. This gradual advance fill erosion would re-expose some of the impacted rock beginning immediately after construction. It has been noted elsewhere in this report that it is difficult to very accurately predict the with- and without-project water/sediment/rock interactions in the nearshore due to the complexity and natural variability of the system. In order to determine a conservative estimate of total rock impacts, there has been no attempt to differentiate the temporary impacts of the advance fill from the permanent impacts associated with the design fill. These estimates of rock impact due to construction of these alternatives should be viewed as a conservative (high) estimate of the with-project rock impacts.

A-135. The GRR includes reef/rock monitoring as a requirement and such monitoring will additionally be required for State of Florida Water Quality Permits. Spot checks of rock burial/exposure are called for in the monitoring plan. However comprehensive mapping of rock exposure across the entire project area is extremely difficult due to wave and water quality issues that limit the collection of the required high-resolution aerials that are used to develop rock 'maps'. The proper conditions occur infrequently, so monthly or even quarterly comprehensive mapping is not practicable.

A-136. The existing, locally constructed project has been monitoring rock coverage since initial construction. A similar monitoring program will be implemented following construction of the Mid Reach project [as described in Appendix K, Sub-Appendix J]. Future monitoring will allow for adaptive management of the project should there be additional rock impacts. Given the background erosional forces present in the study area, any unintended rock impacts would be temporary and could be mitigated by allowing the impacted segment to erode until re-exposed.

A-137. The project’s mitigation ratio that would require construction of 1.6 acres of compensatory reef per each 1.0 acre of impacted hardbottom includes a risk and uncertainty allowance of up to 50% (see Appendix K, Sub-Appendix G, page 35 and Sub-Appendix H, page 4).

Table A-15. Rock impacts by reach for the NED and locally preferred plans.

	Reach Limits			NED Plan			
	FDEP Monuments		Length (ft)	Design Fill Template	Design Template Rock Impact (acres)	Advance Template Rock Impact (acres)	Rock Impact* (acres)
Reach 1	R119 -	R109	9,599	10'	0.2	0.2	0.3
Reach 2	R109 -	R105.5	3,406	20'	0.4	0.2	0.5
Reach 3	R105.5 -	R99	6,239	30'	0.8	0.3	1.1
Reach 4	R99 -	R93	5,603	dune	0.1	0.1	0.2
Reach 5	R93 -	R83	9,029	10'	0.3	0.6	0.9
Reach 6	R83 -	R75.4	7,207	dune	0.0	0.0	0.1
					1.8	1.2	3.0

	Reach Limits			Locally Preferred Plan			
	FDEP Monuments		Length (ft)	Design Fill Template	Design Template Rock Impact (acres)	Advance Template Rock Impact (acres)	Rock Impact* (acres)
Reach 1	R119 -	R109	9,599	10'	0.2	0.2	0.3
Reach 2	R109 -	R105.5	3,406	20'	0.3	0.1	0.4
Reach 3	R105.5 -	R99	6,239	20'	0.5	0.3	0.8
Reach 4	R99 -	R93	5,603	10'	0.3	0.2	0.5
Reach 5	R93 -	R83	9,029	10'	0.3	0.6	0.9
Reach 6	R83 -	R75.4	7,207	dune	0.0	0.0	0.1
					1.6	1.4	3.0

* The total predicted impact represents the maximum (seaward extent) of the anticipated toe of beach fill after cross-shore equilibration and alongshore diffusion. For this reason, and likewise due to rounding, the numeric sum of impacts from the design and advance templates are in some cases different from the numeric value of the anticipated total impacts.

SEABED MITIGATION

A-138. Both the NED and Locally Preferred plans would impact 3.0 acres of the 31.3 acres of rock in the Mid Reach. It will be necessary to construct mitigation reefs to replace the function of these impacted regions of the nearshore rock. Numerous reef designs were considered for this study with the dual goals of finding a structure that would replicate the natural reef as closely as practicable and one that would be constructible and stable in the energetic nearshore environment. This section details the engineering challenges of constructing a reef in the project area and the chosen design for the Mid Reach mitigation structures.

Nearshore Reef Engineering Challenges

A-139. The Mid Reach's native reef is located within a strip of the beach that extends approximately 300 feet seaward from the MLW line. Nearshore reef installations from many other locations inside and outside of Florida were evaluated for their suitability in the Mid Reach. This included structures in Palm Beach, Indian River, Broward, and St Lucie counties as well as installations in the Bahamas and elsewhere. These other reefs included a range of structures from simple limestone boulder structures to more elaborate rock-filled marine mattresses, monolithic concrete slabs and reef balls. To the best of the study teams knowledge, there are no man-made reef structures that are located at the MLW shoreline, on an unprotected, open coast that is subject to the strong tropical and subtropical weather that the project beach is subjected to.

A-140. The structural failure modes that could occur in the nearshore environment include instability (movement of the structure due to wave forces), material failures (breakage of individual reef units), and subsidence (vertical settling and/or burial). Structural stability could potentially be accomplished through either sufficient mass or rigidity to resist vertical and horizontal forces or through anchoring of the structure to the seabed through mechanical means. There are considerable challenges associated with constructing a massive concrete structure and placing it in the surfzone; there are also many uncertainties regarding the durability of a 'lighter' structure that would be anchored to the bottom. Additionally, either type of structure would still be subject to subsidence and burial due to wave-induced longshore and cross-shore currents. Based on subsurface investigations by the local sponsor, locations that are potential sites for mitigation reefs (i.e. locations without native reefs) do not generally have a subsurface rock layer that would serve as a foundation for a mitigation reef and prevent subsidence of a structure. As a result of these forces in the very-near shore zone, a low-relief structure in a similar location to the native reef would be prohibitively difficult and expensive to construct and would encounter very strong hydrodynamic forces that could cause any or all of these failure modes.

A-141. An additional challenge to the siting of mitigation reef structures near the MLW shoreline would be its impact on recreation in the Mid Reach. Mitigation reefs would need to be located away from the native reef structures (in order to avoid damaging them), and thus would be constructed within segments of beach that do not presently have rock. The presence of these structures would pose a hazard to beach goers who enter the water and would almost certainly result in strong local resistance to the project.

A-142. Based on the technical concerns for structural stability and constructability, along with the recreational impacts outlined above it was determined that construction of a mitigation reef along the MLW shoreline of the Mid Reach would not fulfill the project goals and would be infeasible to construct.

Mitigation Reef Design
A-143. A nearshore reef is proposed which consists of a concrete articulated mattress that a series of interlocking, cable-connected slabs (see Figure A-29). The slabs are cast with limestone cobbles embedded in the exposed surfaces to better replicate the natural rock's surface. The structure would mimic the natural reef's relief, texture and function; however, it is located seaward of the native rock. The proposed nearshore reef mitigation area is located between FDEP monuments R-80 and R-118 in nominally 14-16 feet water depth (MLW).

Figure A-29. Concrete Articulated Mattress.

A-144. Consultation with marine contractors by both the local sponsor and SAJ staff indicates that the ocean-based equipment (barges) that would be used for construction of the reef cannot safely go into water shallower than approximately 14-feet MLW due to the hazards presented by the native reef and the relatively energetic wave conditions that prevail in the Mid Reach. Siting of the reef seaward of the surfzone greatly reduces the wave-induced forces on the structure—eliminating the need for anchoring it to the bottom. Additionally, currents near the structure will be much lower outside of the surfzone, reducing the chance of scour, settlement, and burial of the mitigation reef.

A-145. The mattresses consist of 18 individual 2.4-foot square slabs, arranged in a 3-by-6 pattern connected to one another by cables. Each reef will be a matrix of 44 mattresses with a footprint of approximately 60 x 115 feet; the surface area of each reef will be 0.15 acres (Figure A-29). Three of the 45 mattresses will be placed atop the reef along the landward edge to make an overhanging ledge, as shown in Figure A-30, to emulate the physical relief of crevices and ledges within the existing reef.

A-146. The Mid Reach project design will impact 3.0 acres of native reef, which must be mitigated at a ratio of 1.6:1. The total required mitigation reef surface area is thus:

3.0 acres x 1.6 = 4.8 acres / 0.15 acres per reef = 32 mitigation reefs

The mitigation sites will consist of 3—5 reefs arranged in a longshore-oriented linear pattern as shown in Figure A-31.

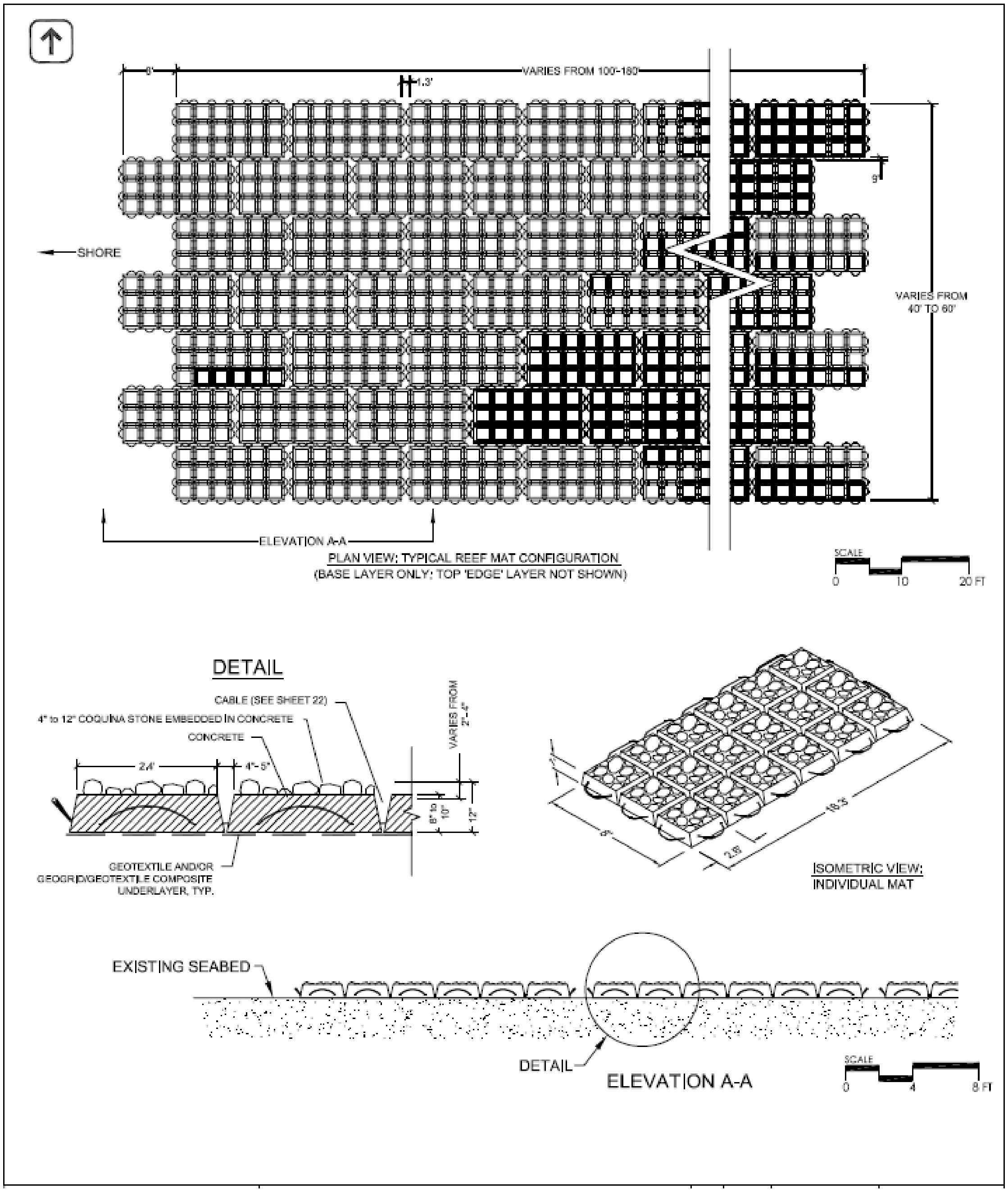

Figure A-29. Mitigation reef detail (courtesy of Olsen Associates, Inc)

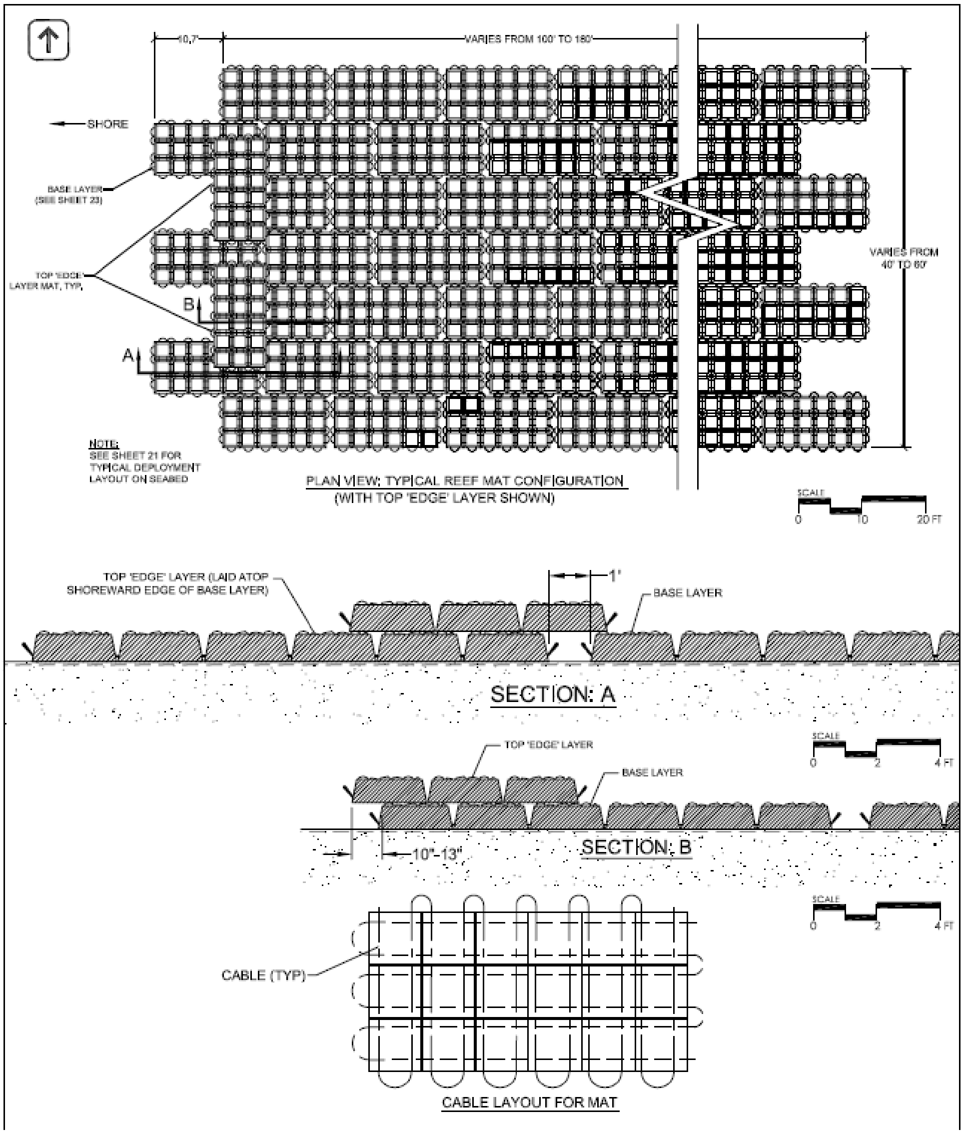

Figure A-30. Mitigation reef, including detail of additional edge layer that is to be laid atop the shoreward edge of the reef.

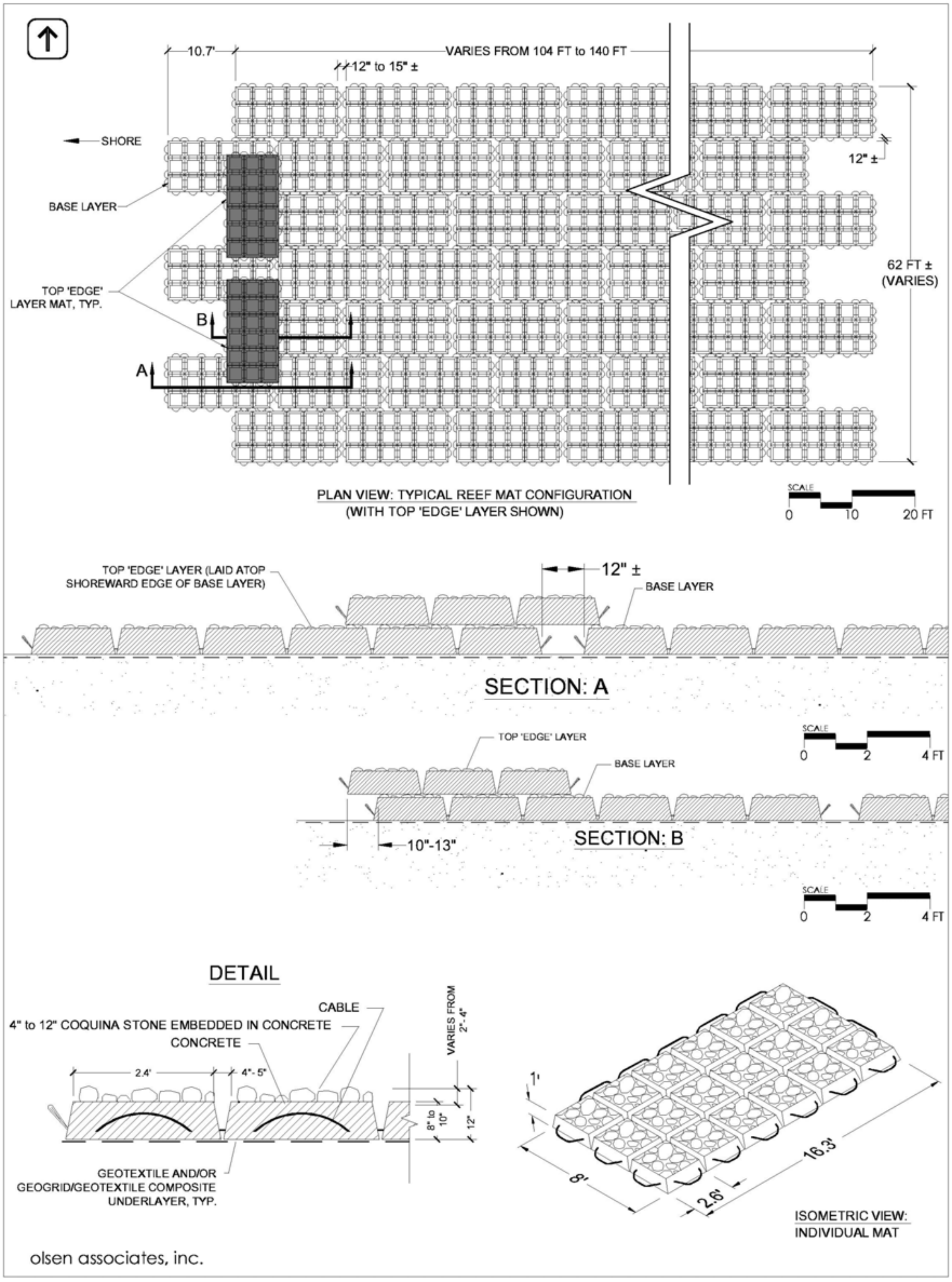

Figure A-31. Mitigation site layout (courtesy of Olsen Associates, Inc)

Project Benefits.

A-147. The Brevard County Mid Reach project area experienced an average erosion rate of -110,500 cy/yr from 1986—2005; this equates to -2.7 CY per foot, per year of erosion. During this same period the bluff/dune line (measured at +13.0 feet NGVD) receded at an average rate of -0.8 ft/yr and the MHW shoreline (+1.9 ft NGVD) receded -0.3 ft/yr. Based on the relatively mild long-term shoreline change rates, it is expected that regular re-nourishment of the dune/beach face would alleviate the long-term MHW line recession and result in a stable beach with no long-term MHW line recession.

A-148. In the case of a dune feature which is perched on top of the beach berm, in front of the existing dune/bluff, there is no MHW line advancement. This material would be redistributed only once storm surge and wave heights were sufficient to overtop the berm height. This redistribution of the dune fill would coincide with storm-induced MHW recession; thus, the MHW line is not advanced by the dune fill option. This alternative provides benefits over the 50-year project life by alleviating long-term MHWL recession, which is taken into account in the storm damage economic model. The beach face fill alternatives provide the same relief from long-term recession of the MHWL as the dune alternative along with some additional benefits from the extension of the MHWL.

A-149. It is important to note that the long-term MHW recession rate is not equivalent to the storm-induced erosion. In fact the storm recession rates would remain the same. Beach response to storm energy is typically a movement of sand seaward along the active profile. This movement causes the shoreline and dune positions to recede dramatically in very short time scales. Property damage occurs when this recession reaches oceanfront development or infrastructure. Once the storm energy subsides the beach will typically recover over a period of weeks or months, but the amount of recovery is not predictable.

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APPENDIX A-2

COST ENGINEERING AND RISK ANALYSIS APPENDIX

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TABLE OF CONTENTS

A. COST ESTIMATES

A.1 GENERAL INFORMATION

Corps of Engineers cost estimates for planning purposes are prepared in accordance with the following guidance:

- Engineer Technical Letter (ETL) 1110-2-573, Construction Cost Estimating Guide for Civil Works, 30 September 2008
- Engineer Regulation (ER) 1110-1-1300, Cost Engineering Policy and General Requirements, 26 March 1993
- ER 1110-2-1302, Civil Works Cost Engineering, 15 September 2008
- ER 1110-2-1150, Engineering and Design For Civil Works Projects, 31 August 1999
- ER 1105-2-100, Planning Guidance Notebook, 22 April 2000, as amended
- Engineer Manual (EM) 1110-2-1304 (Tables revised 30 March 2007), Civil Works Construction Cost Index System, 31 March 2000
- CECW-CP Memorandum For Distribution, Subject: Initiatives To Improve The Accuracy Of Total Project Costs In Civil Works Feasibility Studies Requiring Congressional Authorization, 19 Sep 2007
- CECW-CE Memorandum For Distribution, Subject: Application of Cost Risk Analysis Methods To Develop Contingencies For Civil Works Total Project Costs, 3 Jul 2007
- Cost and Schedule Risk Analysis Process, March 2008

The goals of the cost estimating for the Brevard County, Mid-Reach Shore Protection Project study are to present a Total Project Cost (construction and non-construction costs) for the recommended plans at the current price level to be used for project justification/authorization and to project costs forward in time for budgeting purposes. In addition, the costing efforts are intended to produce a final product (cost estimate) that is reliable and accurate and that supports the definition of the Government's and the non-Federal sponsor's obligations. The cost estimating effort for the study also yielded a series of alternative plan formulation cost estimates for decision making. The final set of plan formulation cost estimates used for plan selection rely on construction feature unit pricing and are prepared in Civil Works Breakdown Structure (CWBS) format to the sub-feature level. The cost estimate supporting the National Economic Development (NED) plan (Recommended Plan/Locally Preferred Alternative Plan) is prepared in MCACES/MII format to the CWBS sub-feature level. This estimate is supported by the preferred labor, equipment, materials and crew/production breakdown. A fully funded (escalated for inflation through project completion) cost estimate, the Baseline Cost Estimate or Total Project Cost Summary, has also been developed. A risk analysis was prepared that addresses uncertainties in and sets contingencies for the Recommended Alternative Plans cost items. A discussion of the risk analysis is included at the end of this appendix.

A.1.1 Recommended Alternative Plans

The final Recommended Plan (NED and Locally Preferred Alternative) were chosen by the Project Delivery Team according to Cost Effectiveness/Incremental Cost Analysis procedures and resulted directly from the plan formulation described above. The Economics

Appendix fully describes the plan selection. The scope of work for the Recommended Alternative Plans is found in Appendix A, Engineering. The MCACES/MII cost estimate for the Recommended Alternative Plans (Section B.3, below) is based on that scope and is formatted in the CWBS. The notes provided in the body of the estimate detail the estimate parameters and assumptions. These include pricing at the Fiscal Year 2009 price level (1 October 2008-30 September 2009). For project justification purposes the estimate cost are categorized under the appropriate CWBS code and include both construction and non-construction costs.

The construction costs fall under the following feature codes:

- 17 Beach Replenishment

The non-construction costs fall under the following feature codes:

- 01 Lands and Damages
- 30 Planning, Engineering and Design
- 31 Construction Management
- 99 Project Monitoring

A.1.2 Construction Cost

The MCACES/MII estimate on the final Recommended Plan contains contingencies as noted in the estimate (below). These contingencies were determined as a result of the risk analysis. Additional information follows on the risk analysis. Major risk factors are shown in the sensitivity analyses.

A.1.3 Non-construction Cost

Non-construction costs include Real Estate, Planning, Engineering and Design (PED), and Construction Management (Supervision and Administration, S&A). Real Estate costs were provided by Real Estate Division. These costs are best described in the Real Estate Appendix, Appendix D. They include lands costs and administrative costs and are distinguished as non-Federal sponsor costs or government costs. Contingencies for the Real Estate costs were also determined during risk analysis based on direct input from the Real Estate PDT representative. The Real Estate risk analysis is further described below. Planning, Engineering and Design costs are broken down into Preconstruction, Engineering and Design (PED), or preparation of contract plans and specifications; Engineering During Construction (EDC); and the Project Implementation Report (PIR). PED costs were solicited from Engineering Division via the Project Manager, as suggested by the guidance. Ten percent of the total construction cost is used as the total rate for engineering costs through construction, as is customary in Jacksonville District's Cost Branch. The cost for the PIR was provided to Cost Branch via the Project Manager and represents funds spent to date plus funds expected to be spent through report completion.

Construction Management costs was solicited from Construction-Operations Division via the Project Manager, again as suggested by the guidance. Eight and one-half percent is used as the rate for Construction Management costs for the cost estimate for the Recommended Plan. This percentage is based on actual funds spent for construction management on past contracts. When this percentage is calculated by Construction-Operations Division for planning projects it is itemized to show amounts allocated for each task anticipated to occur during construction. Only the gross percentage is shown herein.

The main report details both cost allocation and cost apportionment for the Federal government and the non-Federal sponsor. Also included in the main report are the non-Federal sponsor's obligations (items of local cooperation).

A.1.4 Plan Formulation Cost Estimates

For the plan formulation cost estimates, unit prices for each major or variable construction element were developed in MCACES/MII. These unit prices were entered into spreadsheets that differentiated each plan by the quantities required to construct the plans. Designs and quantities for the construction elements were provided to Cost Branch by the Engineering Technical Lead (see the Engineering Appendix for construction methods, design assumptions and design data). Preconstruction, Engineering and Design costs and Construction Management costs were calculated using percentages at this level of estimating.

The plan formulation process for this study involved numerous iterations. Since the costs for the plans were calculated via spreadsheet software it was fairly simple to adjust them as time went by (for example, as unit prices increased due to changes in price level), as plan components changed and as plans were added or removed from consideration. Refer to the Economics Section in the Main Report for the final Plan Formulation cost tables.

A.1.5 Construction Schedule

A construction schedule was prepared by the Engineering PDT in conjunction with the Planning Technical Lead and the construction-operations team member that reflected all project construction components. The schedule considered not only durations of individual components but also timing of construction contracts. It is based on multiple crews with shift work and overtime due to the environmental windows for beach nesting sea turtles. This schedule was coupled with the project schedule in preparation for the generation of the Total Project Cost Summary as well as for the completion of the risk analysis. The construction schedule will change as design of the project proceeds in the plans and specifications phase and then it will change again when the contract is awarded and the contractor provides his schedule, which may be based on multiple crews with shift work and overtime. Both the construction schedule and the project schedule are provided below. The official schedule is the project schedule and it is given precedence herein wherever a conflict appears between these two schedules.

A.1.6 Total Project Cost Summary

The Total Project Cost Summary includes escalation through project completion. The cost estimate for the Recommended Plan is prepared with an identified price level date. Inflation factors are used to adjust the pricing to the project schedule. This estimate is known as the Fully Funded Cost Estimate or Total Project Cost Summary. It includes all Federal and non-Federal costs: Lands, Easements, Rights of Way and Relocations; construction features; Preconstruction Engineering and Design; Construction Management; Contingency; and Inflation.

A.5 SCHEDULE

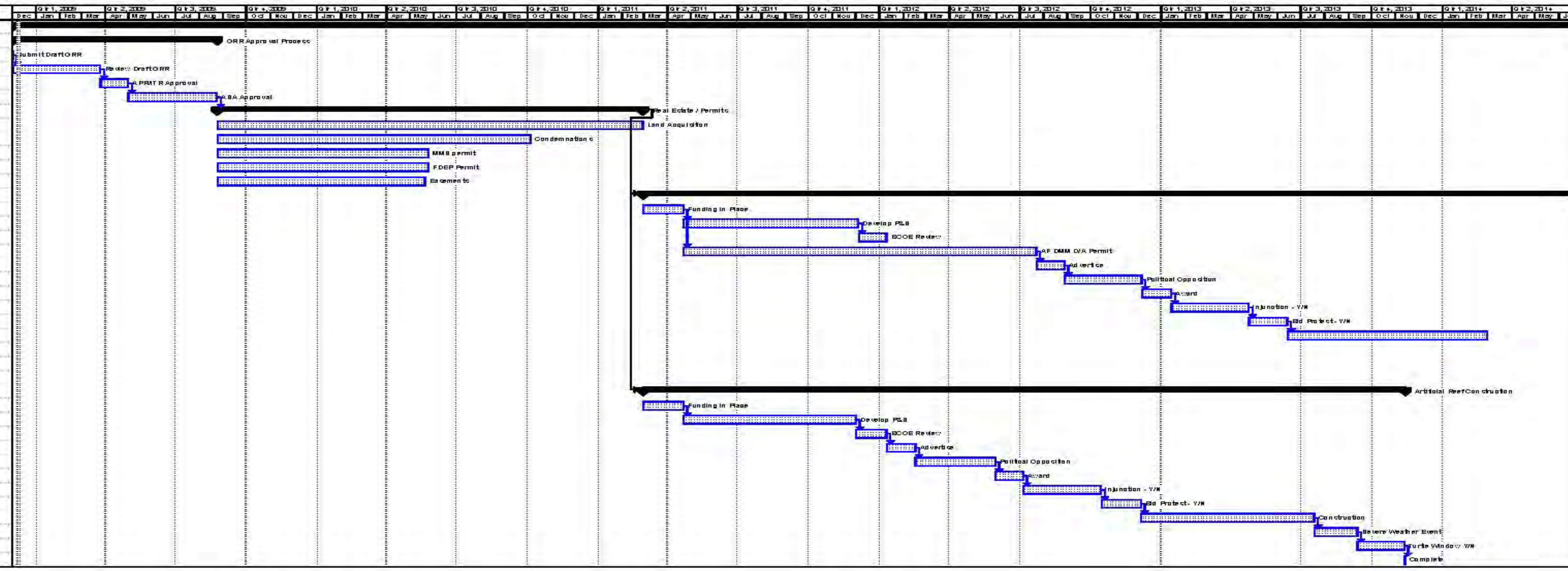
A.5.1 Schedule vs. Risk

												Calendar Days	Work Days	Initial Days	Assumption Days	
	ESTIMATED INCREMENTAL DURATIONS				Random Risk Events											
Brevard Midrange GRR	Most Likely	Min	Max	CB Value	Probability	Risk occurs?	Extra Days	Total Days	Percentile	Value		Most Likely	Most Likely	Min	Max	
												Conversic	**0.57**	**-10%**	**50%**	
Brevard Midreach	Days are Work Days (5 days / week)												-10%	50%		
Initial Renourishment - Single Contract	n/a	n/a	n/a	n/a	n/a	n/a	n/a									
Funding in Place	0	0	65	0	10%	0	0	0	80%			0	0	0	51	Max + 90 days
Develop P&S	130	117	195	130				130	80%			180	103	92	154	
BCOE Review	20	18	30	20				20	80%			30	17	15	26	
AF DMM D/A Permit	150	135	225	150				150	80%			365	208	187	312	
Advertise	20	18	30	20				20	80%			30	17	15	26	
Political Opposition	0	0	130	0	1%	0	0	0	80%			0	0	0	103	Max + 6 months
Award	20	18	30	20				20	80%			30	17	15	26	
Injunction - Y/N	0	0	130	0	1%	0	0	0	80%			0	0	0	103	Max + 6 months
Bid Protest - Y/N	0	0	65	0	5%	0	0	0	80%			0	0	0	51	Max + 90 days
Construction	130	117	195	130				130	80%			176	100	90	150	
Severe Weather Event	0	0	20	0	15%	0	0	0	80%			0	0	0	51	Max + 90 days
Turtle Window Y/N	0	0	65	0	25%	0	0	0	80%			0	0	0	51	Max + 90 days
Complete	n/a	n/a	n/a	n/a	n/a	n/a	n/a									
								470	80%							
Initial Renourishment - Dredging	n/a	n/a	n/a	n/a	n/a	n/a	n/a					n/a				
Funding in Place	0	0	65	0	10%	0	0	0	80%			0	0	0	51	Max + 90 days
Develop P&S	130	117	195	130				130	80%			180	103	92	154	
BCOE Review	20	18	30	20				20	80%			30	17	15	26	
AF DMM D/A Permit	150	135	225	150				150	80%			365	208	187	312	
Advertise	20	18	30	20				20	80%			30	17	15	26	
Political Opposition	0	0	130	0	1%	0	0	0	80%			0	0	0	103	Max + 6 months
Award	20	18	30	20				20	80%			30	17	15	26	
Injunction - Y/N	0	0	130	0	1%	0	0	0	80%			0	0	0	103	Max + 6 months
Bid Protest - Y/N	0	0	65	0	5%	0	0	0	80%			0	0	0	51	Max + 90 days
Construction	65	59	98	65				65	80%				0	0	0	
Severe Weather Event	0	0	20	0	15%	0	0	0	80%			0	0	0	51	Max + 90 days
Complete	n/a	n/a	n/a	n/a	n/a	n/a	n/a									
Initial Renourishment -Placement	n/a	n/a	n/a	n/a	n/a	n/a	n/a					n/a				
Funding in Place	0	0	65	0	10%	0	0	0	80%			0	0	0	51	Max + 90 days
Develop P&S	130	117	195	130				130	80%			180	103	92	154	
BCOE Review	20	18	30	20				20	80%			30	17	15	26	
Advertise	20	18	30	20				20	80%			30	17	15	26	
Political Opposition	0	0	130	0	1%	0	0	0	80%			0	0	0	103	Max + 6 months
Award	20	18	30	20				20	80%			30	17	15	26	
Injunction - Y/N	0	0	130	0	1%	0	0	0	80%			0	0	0	103	Max + 6 months
Bid Protest - Y/N	0	0	65	0	5%	0	0	0	80%			0	0	0	51	Max + 90 days
Construction	65	59	98	65				65	80%				0	0	0	
Severe Weather Event	0	0	20	0	15%	0	0	0	80%			0	0	0	51	Max + 90 days
Turtle Window Y/N	0	0	65	0	25%	0	0	0	80%			0	0	0	51	Max + 90 days
Complete	n/a	n/a	n/a	n/a	n/a	n/a	n/a									
								660	80%							

A.5.2 Project Schedules with Contingency

A.5.2.1 Initial Construction of Mid-Reach Fill

ID	Task Name	Duration	Start	Finish	Predecessors
1	Brevard Midrange GRR - With Contingency	1181 days	Tue 12/2/08	Wed 8/26/14	
2	GRR Approval Process	162 days	Tue 12/2/08	Mon 8/24/09	
3	Submit Draft GRR	1 day	Tue 12/2/08	Wed 12/3/08	
4	Review Draft GRR	65 days	Wed 12/3/08	Thu 3/26/09	3
5	APR/ITR Approval	21 days	Thu 3/26/09	Fri 5/1/09	4
6	ASA Approval	65 days	Fri 5/1/09	Mon 8/24/09	5
7	Real Estate / Permits	218 days	Tue 8/25/09	Mon 2/28/11	6
8	Land Acquisition	316 days	Tue 8/25/09	Mon 2/28/11	
9	Condemnations	233 days	Tue 8/25/09	Wed 10/6/10	
10	MMS permit	157 days	Tue 8/25/09	Wed 5/26/10	
11	FDEP Permit	157 days	Tue 8/25/09	Wed 5/26/10	
12	Easements	156 days	Tue 8/25/09	Fri 5/21/10	
13	Initial Construction	883 days	Tue 3/1/11	Wed 8/26/14	7
14	Funding In Place	31 days	Tue 3/1/11	Fri 4/22/11	
15	Develop P&S	129 days	Fri 4/22/11	Mon 12/5/11	14
16	BCOE Review	21 days	Tue 12/6/11	Wed 1/11/12	15
17	AF DMM D/A Permit	261 days	Fri 4/22/11	Mon 7/23/12	14
18	Advertise	21 days	Tue 7/24/12	Wed 8/29/12	17
19	Political Opposition	58 days	Wed 8/29/12	Fri 12/7/12	18
20	Award	21 days	Fri 12/7/12	Mon 1/14/13	19
21	Injunction - Y/N	58 days	Tue 1/15/13	Thu 4/25/13	20
22	Bid Protest - Y/N	29 days	Thu 4/25/13	Fri 6/14/13	21
23	Construction	148 days	Fri 6/14/13	Fri 2/28/14	22
24	Severe Weather Event	31 days	Fri 2/28/14	Thu 4/24/14	23
25	Turtle Window Y/N	34 days	Thu 4/24/14	Mon 6/23/14	24
26	Complete	1 day	Tue 6/24/14	Wed 6/25/14	25
27	Artificial Reef Construction	688 days	Tue 3/1/11	Thu 11/14/13	7
28	Funding In Place	31 days	Tue 3/1/11	Fri 4/22/11	
29	Develop P&S	128 days	Fri 4/22/11	Fri 12/2/11	28
30	BCOE Review	22 days	Fri 12/2/11	Wed 1/11/12	29
31	Advertise	22 days	Wed 1/11/12	Fri 2/17/12	30
32	Political Opposition	59 days	Fri 2/17/12	Thu 5/31/12	31
33	Award	21 days	Thu 5/31/12	Fri 7/6/12	32
34	Injunction - Y/N	57 days	Fri 7/6/12	Mon 10/15/12	33
35	Bid Protest - Y/N	30 days	Tue 10/16/12	Thu 12/6/12	34
36	Construction	129 days	Thu 12/6/12	Fri 7/19/13	35
37	Severe Weather Event	32 days	Fri 7/19/13	Fri 9/13/13	36
38	Turtle Window Y/N	34 days	Fri 9/13/13	Wed 11/13/13	37
39	Complete	1 day	Wed 11/13/13	Thu 11/14/13	38



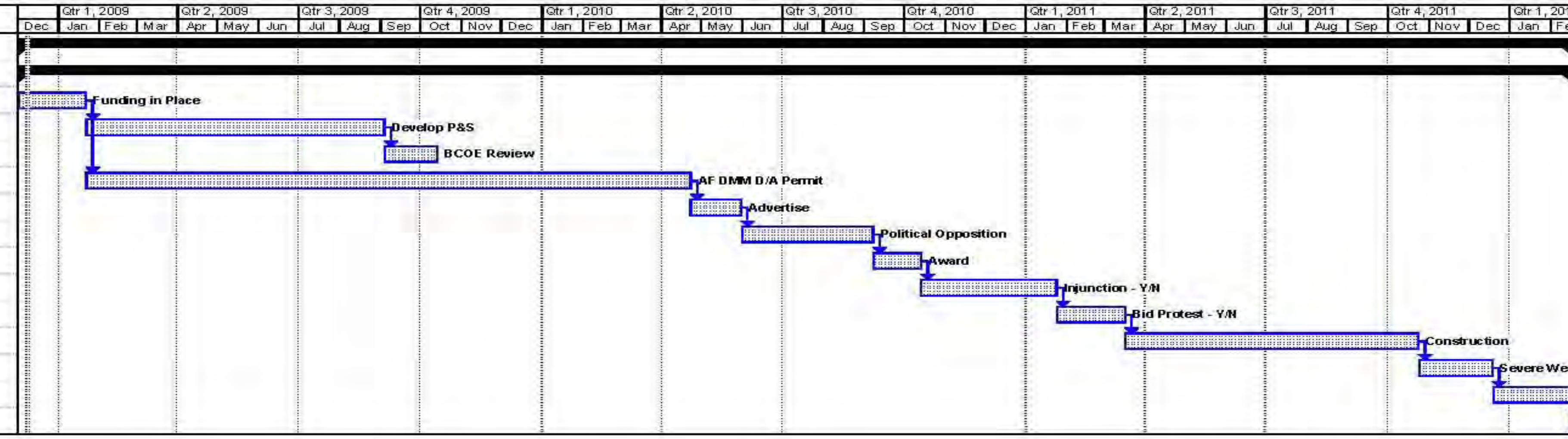
Project: Brevard Midrange GRR Sched
Date: Mon 12/8/08

Task | Split | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Split | Rolled Up Milestone | Rolled Up Progress | External Tasks | Project Summary

Page 1

A.5.2.2 Periodic Nourishment of Mid-Reach Fill

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Brevard Midrange Renourishment**	**671 days**	**Tue 12/2/08**	**Fri 2/17/12**	
2	**Initial Renourishment w/ Contingency**	**671 days**	**Tue 12/2/08**	**Fri 2/17/12**	
3	Funding in Place	30 days	Tue 12/2/08	Thu 1/22/09	
4	Develop P&S	129 days	Thu 1/22/09	Fri 9/4/09	3
5	BCOE Review	22 days	Fri 9/4/09	Wed 10/14/09	4
6	AF DMM D/A Permit	261 days	Thu 1/22/09	Fri 4/23/10	3
7	Advertise	21 days	Fri 4/23/10	Mon 5/31/10	6
8	Political Opposition	57 days	Tue 6/1/10	Wed 9/8/10	7
9	Award	21 days	Wed 9/8/10	Thu 10/14/10	8
10	Injunction - Y/N	58 days	Thu 10/14/10	Mon 1/24/11	9
11	Bid Protest - Y/N	30 days	Tue 1/25/11	Thu 3/17/11	10
12	Construction	126 days	Thu 3/17/11	Mon 10/24/11	11
13	Severe Weather Event	32 days	Tue 10/25/11	Mon 12/19/11	12
14	Turtle Window Y/N	34 days	Tue 12/20/11	Thu 2/16/12	13
15	Complete	1 day	Thu 2/16/12	Fri 2/17/12	14



Project: Brevard Midrange GRR Schec
Date: Mon 12/8/08

Task | Progress | Summary | Rolled Up Split | Rolled Up Progress | Project Summary
Split | Milestone | Rolled Up Task | Rolled Up Milestone | External Tasks

Page 1

A.6 RISK AND UNCERTAINTY ANALYSIS

A.6.1 Risk Analysis Methods

The risk analysis was conducted according to the procedure outlines in the manual entitled, ‘Cost and Schedule Risk Analysis Process,’ dated March 2008 and downloaded from the Corps’ Cost Center of Expertise website. First, members of the PDT met to identify risk items, in both the construction cost estimate and the construction schedule. Then, the Risk Register was completed. After that, the Risk Model was customized using commercially available ‘Crystal Ball’ software. ‘Most likely,’ ‘high,’ and ‘low’ values were assigned to estimate items using the software’s ‘Assumption’ function and the triangular distribution. ‘Forecasts’ were defined and the model run.

For the features costed by the Corps it is assumed that the work will be performed by a prudent contractor at a fair and reasonable cost. While the cost estimate analyzed in the risk analysis may contain adjustments due to quotations on direct and indirect costs, it contains no separate adjustment due to competitiveness or bid strategies (ETL 1110-2-573, 30 Sep 2008). Market conditions such as the current price of fuel are included in the estimate.

After the model was run the results were documented by extracting the sensitivity chart, the forecast chart and the percentiles table for major items. The percentiles were used to determine the contingency at the 80% confidence level. At this time, risk reduction efforts were discussed within the Engineering PDT for further discussion.

The appropriate contingencies were then applied to the MCACES/MII estimate for the NED and Locally Preferred Plans, producing the ‘After Risk Analysis’ cost estimate contained herein. Upon completion of this estimate the Total Project Cost Summary was prepared.

A.5.2 Risk analysis results

Results of the risk analysis are shown below cover only the NED Plan but were applied equally to both the NED and Locally Preferred Plans as contingency percentages since the scope of both plans are basically the same other than slight variations in beach fill placement and select reaches. First, the risk register is presented. Then, results are given for each cost item examined. For each major item studied, the results include 1)a sensitivity chart, 2)a forecast chart, 3)a percentile table including the most likely cost and contingencies and 4)an S-curve chart (only developed for Corps-constructed features). Finally, a table is shown providing contingencies.

A.5.2.1 Risk register

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Project Cost			Project Schedule			Distribution	Initial Only or Recurring	Responsibility/POC	Affected Project Component	Project Implications
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*					
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)													
CO-1	Placement of marine mats in surf zone	May require special / proprietary equipment or contractor, or extra precautions / special methods to ensure safety.	Unlikely	Significant	Moderate	n/a	n/a	n/a		R	Construction Division	Construction Cost	Cost
CO-2	Availability of staging areas	Impacts contractor's operations	Very Unlikely	Significant	Low	n/a	n/a	n/a		R	Construction Division	Construction Cost	Cost
CT-1	Acquisition strategy (multiple or single contracts for repetitive project implementation)	Increased cost / time to implement multiple awards	Unlikely	Significant	Moderate	Unlikely	Significant	Moderate		R	Contracting Division	Construction Cost	Cost & Schedule
CT-4	Acquisition type, IFB, RFP, IDIQ, 8a, etc	Impacts effort in award, some contract vehicles more conducive to lower cost	Very Unlikely	Significant	Low	n/a	n/a	n/a		R	Acquisition Strategy Board	Construction Cost	Cost
CT-5	Acquisition Plan	The estimate was based on full and open competition, with minimal tiering of contractor subs. The Acq Plan has not been finalized, therefore there is a potential for additional tiering of the contracts.	Very Unlikely	Significant	Low	n/a	n/a	n/a		R	Acquisition Strategy Board	Construction Cost	Cost
DP/CT-2	Project Component Sequencing	Subsequent project execution, if separate contracts for each renourishment (dredge / placement)	n/a	n/a	n/a	Unlikely	Significant	Moderate		R	Project Manager/Planner/ Contracting	Project Schedule	Schedule

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Project Cost			Project Schedule			Distribution	Initial Only or Recurring	Responsibility/POC	Affected Project Component	Project Implications
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*					
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)													
DP-4	Scope Definition	*Scope is well defined, There is little likelihood of scope increase or changes from the current documents used for estimate development*	Very Unlikely	Critical	Low	n/a	n/a	n/a		I	Project Manager/Planner	Construction Cost	Cost
EC-1	Production Estimates, dredging	Unit price per cubic yard.	Likely	Marginal	Moderate	n/a	n/a	n/a		R	Cost Engineering	Equipment/Production Rates	Cost
EC-4	Awardable range increase	An additional 15% above the approximate 10% profit	Likely	Significant	High	n/a	n/a	n/a		R	Cost Engineering	Funding	Cost
ED-1	Quantity Estimates	Quantity over / under runs	Likely	Marginal	Moderate	n/a	n/a	n/a		R	Design Branch	Construction Cost	Cost
EG-1 / EH-2	Availability of suitable beach quality sand	Need to develop alternate sources (See EH-2)	Very Unlikely	Marginal	Low	n/a	n/a	n/a		R	Geotechnical / H&H Branch	Construction Cost	Cost
EH-1	Modeling Accuracy of Marine Mats	May need to replace or upgrade mats	Unlikely	Marginal	Low	n/a	n/a	n/a		R	H&H Brtanch	Construction Cost	Cost
EH-3	Behavior of fill, impact to near shore rock	Varying quantity of reef to construct	Unlikely	Significant	Moderate	n/a	n/a	n/a		R	H&H Brtanch	Construction Cost	Cost

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Project Cost			Project Schedule			Distribution	Initial Only or Recurring	Responsibility/POC	Affected Project Component	Project Implications
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*					
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)													
LS-1	Truck Haul Working hours: Sunrise to sunset, 7 days per week.	Reducing the available hours would increase project duration. Has never interfered with accomplishing identical work in past (2005-08), where over 500,000 cy have been placed in less than 5 months, working daylight hours only, 6 to 7 days/wk.	Unlikely	Negligible	Low	Unlikely	Negligible	Low		R	Sponsor	Project Cost & Schedule	Cost & Schedule
LS-2	Site Access points.	Reduced number of access points increases haul distance on beach. Access points are on public land so are likely to remain available.	Unlikely	Marginal	Low	n/a	n/a	n/a		R	Sponsor	Project Cost	Cost
LS-3	Community restrictions on truck hauling from D/A to beach access points.	Reduces available routes available to contractor(s). Routes are on state roads so restriction very unlikely.	Very Unlikely	Significant	Low	n/a	n/a	n/a		R	Sponsor	Project Cost	Cost
LS-4	Local Sponsor Funding Stream	Ability to cost share on subsequent renourishments. Local dedicated funding stream is identified.	n/a	n/a	n/a	Unlikely	Critical	Moderate		R	Sponsor	Project Schedule	Schedule
LS-5	D/A Access restrictions due to security shutdowns (USAF)	Delays contractor during construction	Unlikely	Critical	Moderate	Unlikely	Critical	Moderate		R	Sponsor	Project Cost & Schedule	Cost & Schedule

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Project Cost			Project Schedule			Distribution	Initial Only or Recurring	Responsibility/POC	Affected Project Component	Project Implications
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*					
Internal Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)													
LS-RE-2	Land Acquisition	Number of acquisitions unknown. Unwilling sellers may force condemnation proceedings.	Likely	Crisis	High	Likely	Crisis	High		I	Real Estate - Sponsor	Project Cost & Schedule	Cost & Schedule
LS-RE-3	Mineral Management Services	Need MMS permission to mine offshore borrow areas. Permit acquisition may be delayed or denied.	Unlikely	Crisis	High	Unlikely	Crisis	High		I	Real Estate - Sponsor	Project Cost & Schedule	Cost & Schedule
LS-RE-4	FDEP Consent of use of lands below MHW	Acquiring State Permit may result in delays	n/a	n/a	n/a	Unlikely	Crisis	High		I	Real Estate - Sponsor	Project Schedule	Schedule
OC-1	Obtaining Cooperative agreements.	Delay in project implementation	n/a	n/a	n/a	Unlikely	Marginal	Low		I	Counsel	Project Schedule	Schedule
PN-2	Establishment of 902 limit, inflation in excess of escalation	Project exceeds authorized funding	Unlikely	Marginal	Low	n/a	n/a	n/a		I	PD-PN	Project Cost	Cost
RE-1	Air Force Permit for Stockpile in DMMA D/A	No area for offloading dredges and dewatering material.	n/a	n/a	n/a	Very Unlikely	Crisis	High		R	Real Estate	Project Schedule	Schedule

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Project Cost			Project Schedule			Distribution	Initial Only or Recurring	Responsibility/POC	Affected Project Component	Project Implications
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*					
External Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)													
CT-6	Bidding Climate	Severe Economic Swings can increase / decrease number of potential bidders.	Likely	Significant	High	n/a	n/a	n/a		R	Acquisition Professional	Construction Cost	Cost
CT-3	Bid Protests	Delay in project execution.	n/a	n/a	n/a	Unlikely	Significant	Moderate		#REF!	Contracting Dvsion	Project Schedule	Schedule
DP-1	Funding Stream	Delay in execution of project components	n/a	n/a	n/a	Unlikely	Significant	Moderate		R	Project Manager/Planner	Project Schedule	Schedule
DP-3	Project Review and Authorization delays.	Delay in execution of project components	n/a	n/a	n/a	Unlikely	Marginal	L		R	Project Manager/Planner	Project Schedule	Schedule
EC-1	Weather	Severe weather causing damage to project during construction.	Likely	Marginal	Moderate	Likely	Marginal	Moderate		R	Cost Engineering	Labor/Production Rates	Cost & Schedule
EC-2	Dredge Availability	Dredge may have to come from further away, increasing mobilization costs or size / type of equipment available.	Likely	Significant	High	n/a	n/a	n/a		R	Cost Engineering	Equipment	Cost
EC-3	Fuel Prices	$3.60 per gallon was used in the Dec 08 MII, increases will effect equipment operating costs.	Very Likely	Significant	High	n/a	n/a	n/a		R	Cost Engineering	Equipment	Cost
EC-5	Labor Availability	*Labor Prices are fixed by Davis Bacon wage rates. Labor availability is subject to bidding climate.*	Very Unlikely	Marginal	Low	n/a	n/a	n/a		R	Cost Engineering	Labor/Production Rates	Cost
OC-1	Political Support/Opposition	Project is highly visible. Delays due to political ramifications are possible and could delay the work.	n/a	n/a	n/a	Unlikely	Significant	Moderate		R	Counsel	Project Schedule	Schedule
OC-2	Court injunctions.	Delay in project implementation	n/a	n/a	n/a	Very Unlikely	Crisis	High		R	Counsel	Project Schedule	Schedule

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Project Cost			Project Schedule			Distribution	Initial Only or Recurring	Responsibility/POC	Affected Project Component	Project Implications
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*					
External Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)													
PE-1	Sea Turtle Nesting; Construction Window 15 Nov - 1 May	Limits Placement Operations during the construction period	Very Likely	Marginal	Moderate	Very Likely	Marginal	Moderate		R	Planning Environmental	Project Cost & Schedule	Cost & Schedule
PE-2	Hardbottom Mitigation; Quantify the area of reef impacts	Changes the amount (area) of mitigation required. Impacts subsequent re-nourishment operation.	Unlikely	Significant	Moderate	n/a	n/a	n/a		I	Planning Environmental	Project Cost	Cost
PE-3	Gopher Tortoise Nesting at Canaveral West Dump Site, With / without tortoise fence	Varying numbers of tortoise that would need to be relocated prior to operations in the D/A	Very Likely	Marginal	Low	n/a	n/a	n/a		R	Planning Environmental	Project Cost	Cost
PN-1	ASA Approval	Delay of project implementation	n/a	n/a	n/a	Unlikely	Significant	Moderate		I	PD-PN	Project Schedule	Schedule
PEC-1	Economic Changes to Benefits	Need to Periodically Re-evaluate benefits	Unlikely	Significant	Moderate	n/a	n/a	n/a		R	Planning Economics	Project Cost	Cost

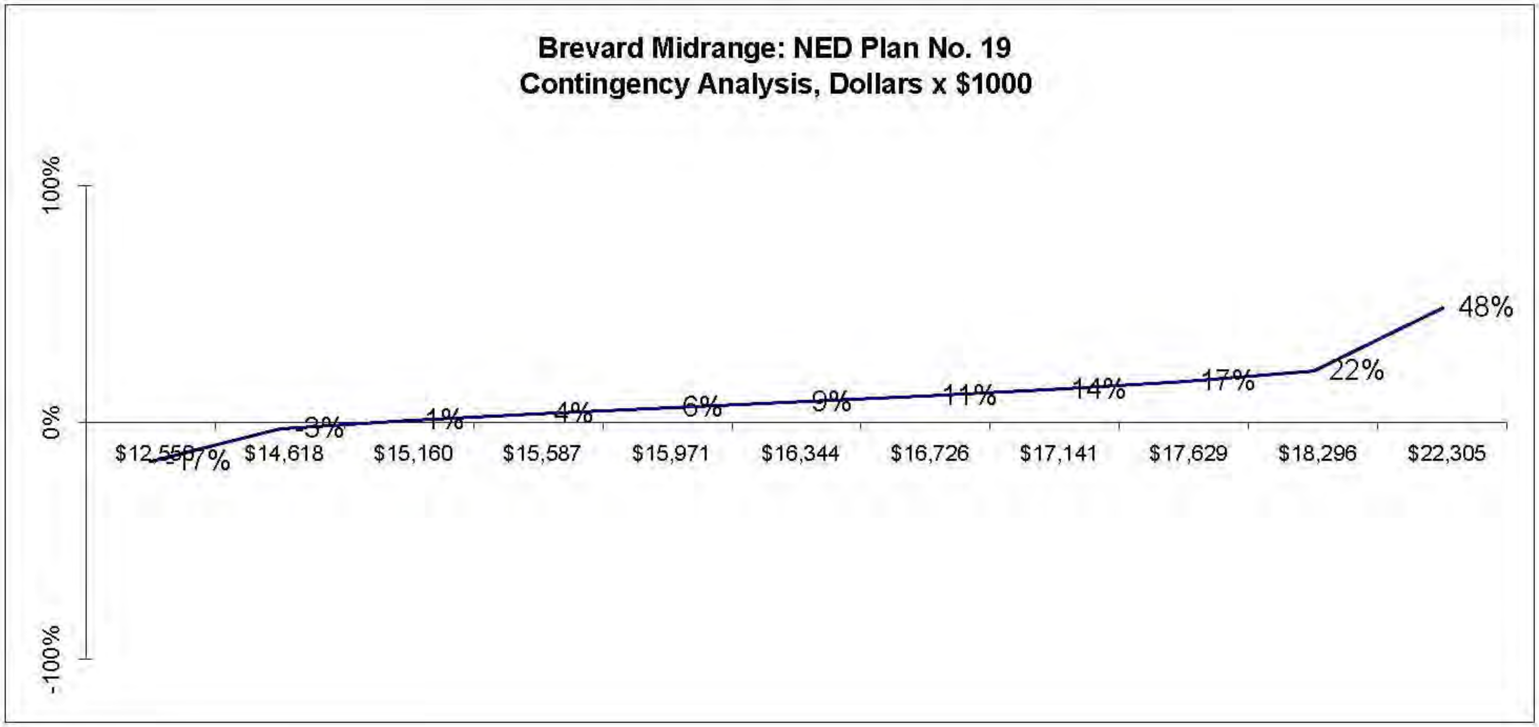
*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk or opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborate on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring—**Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** Likelihood of the event is the same for both Cost and Schedule.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule—**Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may not be the same for impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**.

6. Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) on the PDT for the identified risk or opportunity.
8. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
9. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
10. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

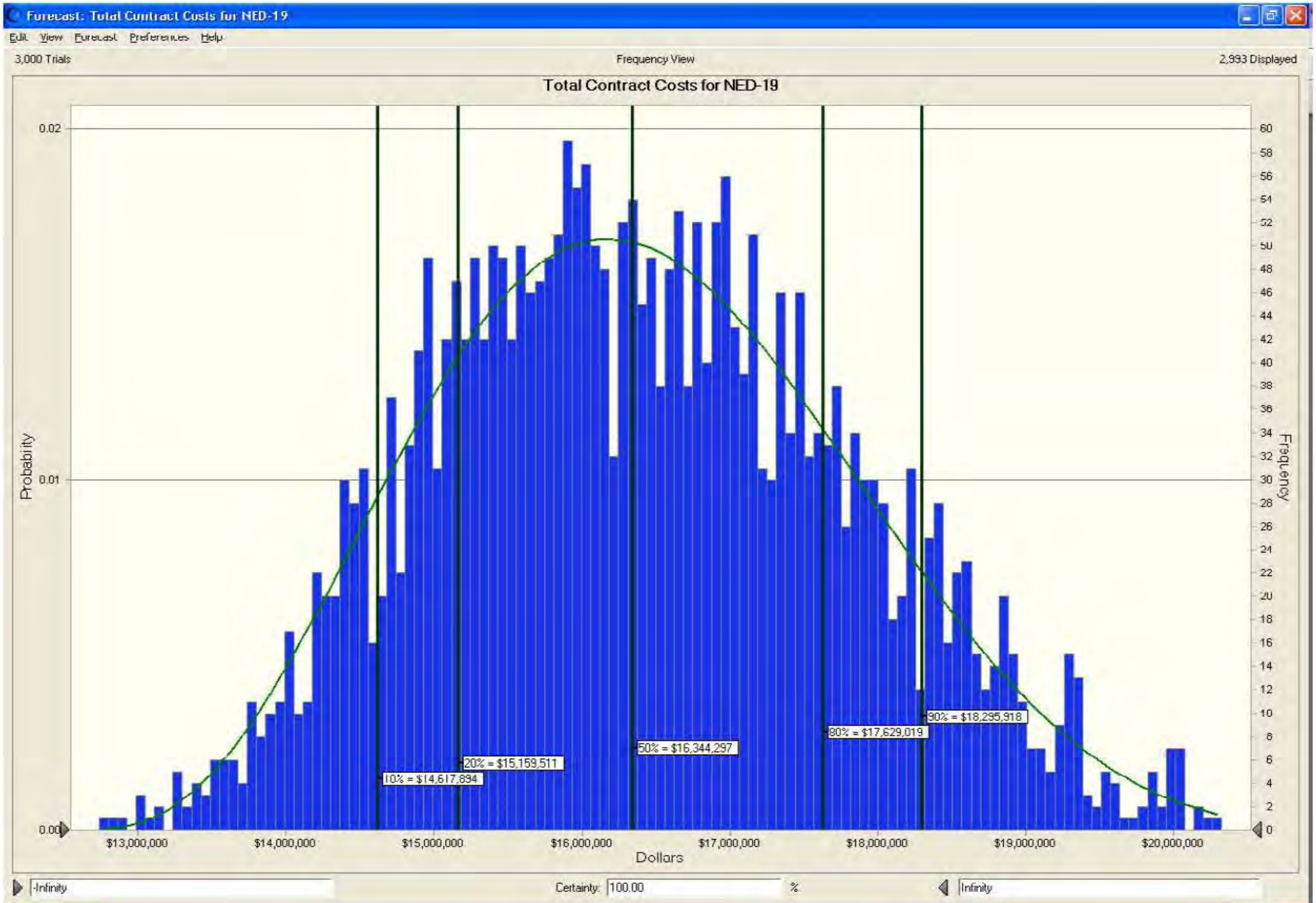
A 5.2.2 Risk Analysis of Construction Features

Initial Construction of Mid-Reach Beach Fill Segment (NED and Locally Preferred Plans)

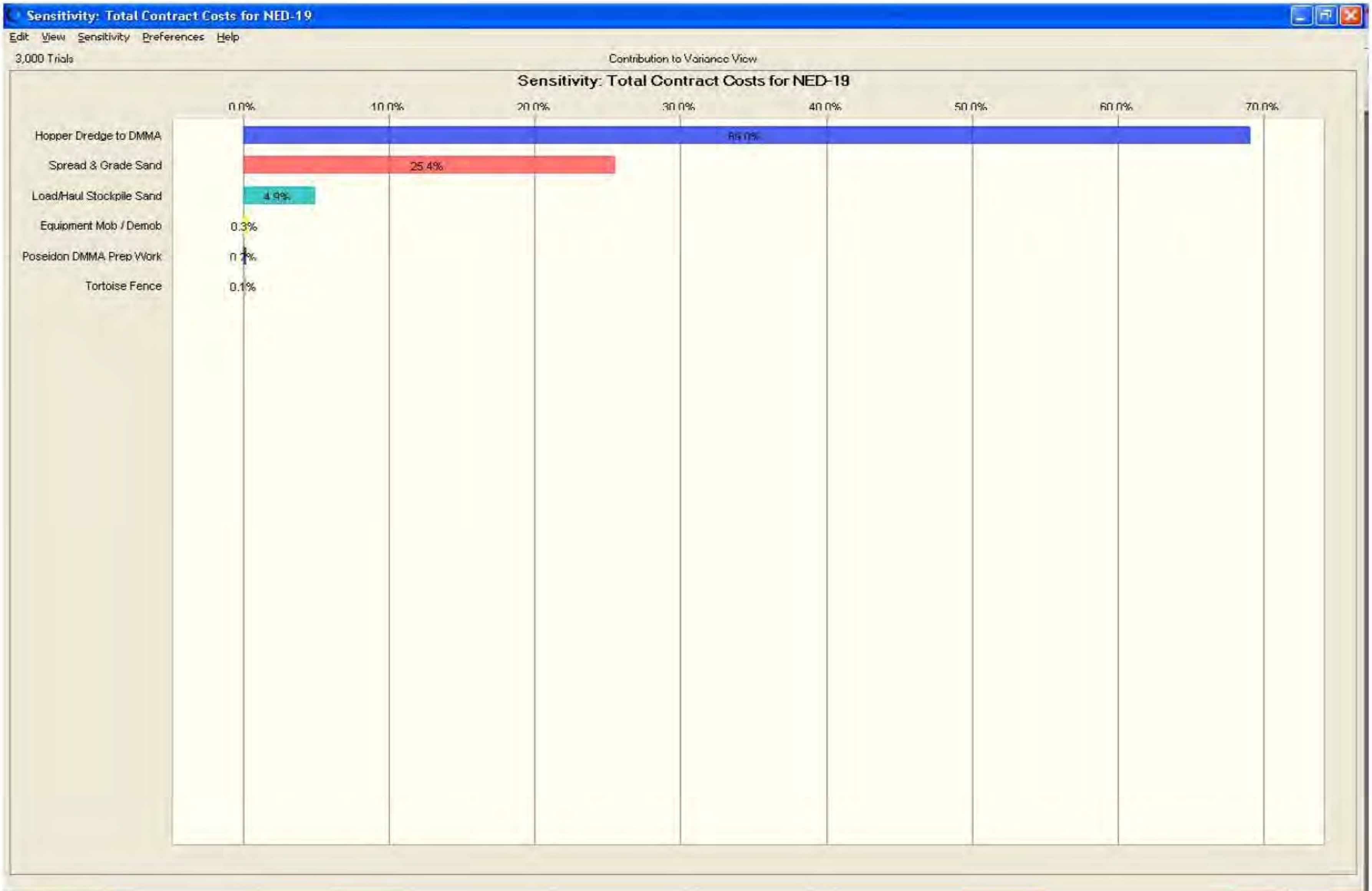


Total Contract Costs $ 15,057,714.66

Percentile		Forecast values		Forecast values	Contingency
0%	$	12,549,665	$	12,550	-17%
10%	$	14,617,894	$	14,618	-3%
20%	$	15,159,511	$	15,160	1%
30%	$	15,586,557	$	15,587	4%
40%	$	15,971,424	$	15,971	6%
50%	$	16,344,297	$	16,344	9%
60%	$	16,726,405	$	16,726	11%
70%	$	17,141,353	$	17,141	14%
80%	$	17,629,019	$	17,629	17%
90%	$	18,295,918	$	18,296	22%
100%	$	22,305,181	$	22,305	48%



Forecast: Total Contract Costs for NED-19
Edit View Forecast Preferences Help
3,000 Trials
Frequency View
2,993 Displayed
Total Contract Costs for NED-19
Probability
Frequency
Dollars
10% = $14,617,894
20% = $15,159,511
50% = $16,344,297
80% = $17,629,019
90% = $18,295,918
$13,000,000
$14,000,000
$15,000,000
$16,000,000
$17,000,000
$18,000,000
$19,000,000
$20,000,000
-Infinity
Certainty: 100.00 %
Infinity



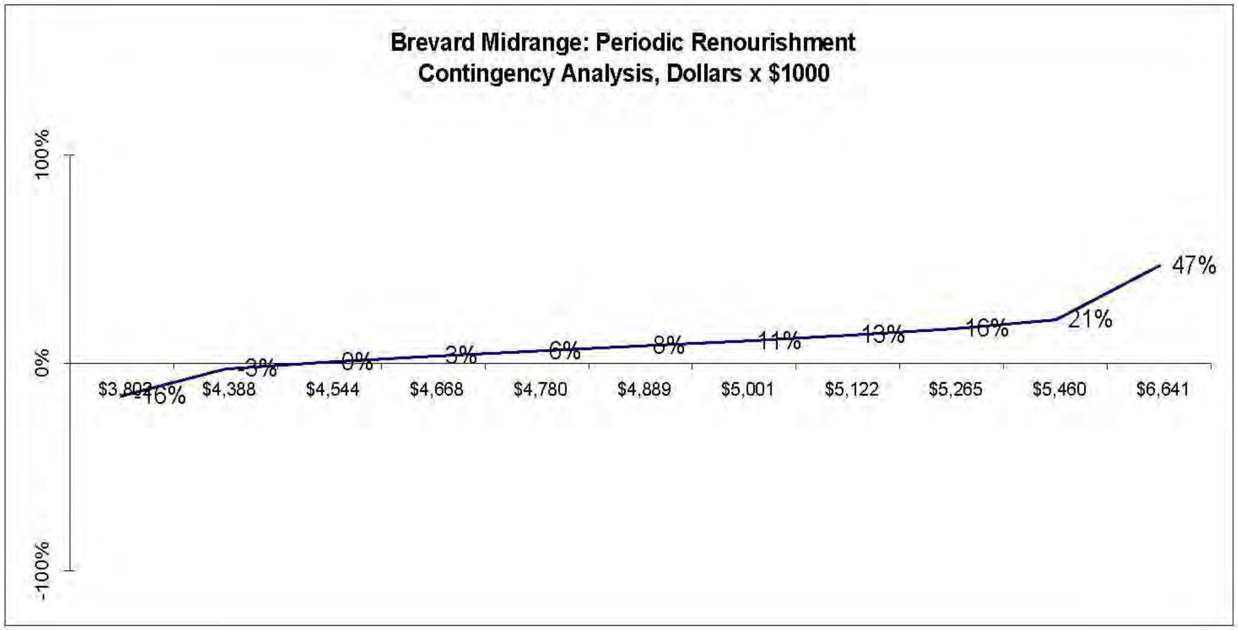
Sensitivity: Total Contract Costs for NED-19
Edit View Sensitivity Preferences Help
3,000 Trials
Contribution to Variance View
Sensitivity: Total Contract Costs for NED-19
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
Hopper Dredge to DMMA
Spread & Grade Sand
25.4%
Load/Haul Stockpile Sand
4.9%
Equipment Mob / Demob
0.3%
Poseidon DMMA Prep Work
Tortoise Fence
0.1%

Cost Evaluation for: **Brevard Midreach NED Plan No. 19**

WBS	Description	QTY	UOM	Lower Bound Contract U/P	Expected Value Contract U/P	Upper Bound Contract U/P	Expected Value Contract Cost	Percentage of Total Cont. Cost	Greater than 1.0% of TCC ?
	Initial Nourishment								
1	Equipment Mob / Demob	1	LS	$ 741,374.00	$ 899,168.00	$ 1,083,178.00	$ 899,168.00	5.97%	Yes
2	Poseidon DMMA Prep Work	1	LS	$ 149,716.00	$ 220,148.00	$ 331,429.00	$ 220,148.00	1.46%	Yes
3	Tortoise Fence	7700	LF	$ 51.84	$ 58.32	$ 68.41	$ 449,064.00	2.98%	Yes
4	Traffic Control	6.9	MO	$ 13,378.00	$ 16,024.00	$ 19,139.00	$ 110,565.60	0.73%	No
	R1	1.56							
	R2	1.14							
	R3	1.7							
	R4	0.14							
	R5	2.17							
	R6	0.19							
5	Hopper Dredge to DMMA	530149	CY	$ 7.30	$ 9.83	$ 14.84	$ 5,211,364.67	34.61%	Yes
	R1	147972							
	R2	84068							
	R3	161793							
	R4	15219							
	R5	103220							
	R6	17877							
6	Load/Haul Stockpile Sand	530149	CY	$ 6.71	$ 8.03	$ 9.59	$ 4,257,096.47	28.27%	Yes
	R1	147972							
	R2	84068							
	R3	161793							
	R4	15219							
	R5	103220							
	R6	17877							
7	Spread & Grade Sand	530149	CY	$ 6.08	$ 7.18	$ 10.39	$ 3,806,469.82	25.28%	Yes
	R1	147972							
	R2	84068							
	R3	161793							
	R4	15219							
	R5	103220							
	R6	17877							
8	End. Species Mon	6.9	MO	$ 12,564.00	$ 15,049.00	$ 17,974.00	$ 103,838.10	0.69%	No
	R1	1.56							
	R2	1.14							
	R3	1.7							
	R4	0.14							
	R5	2.17							
	R6	0.19							

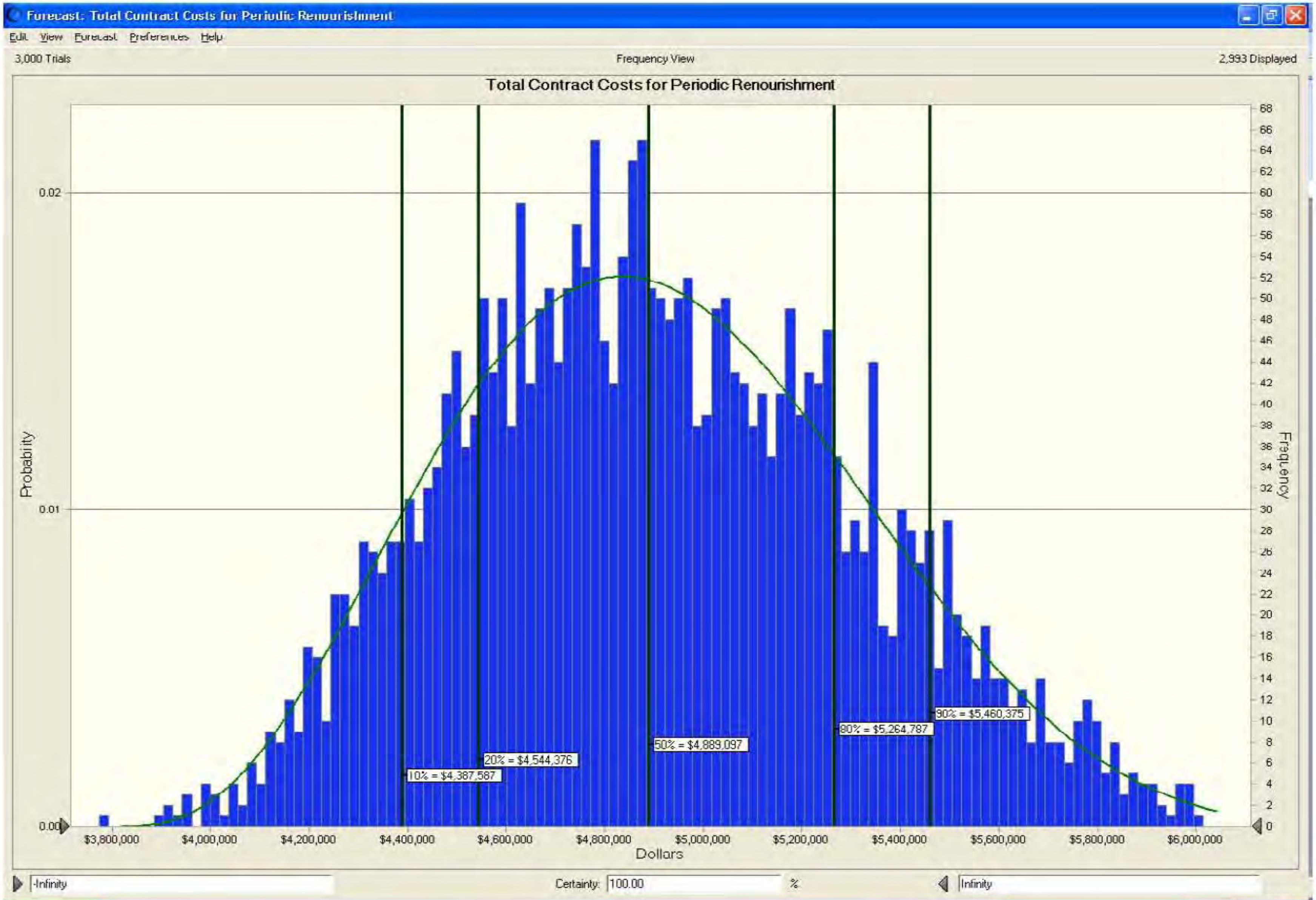
Total Contract Costs		**$ 15,057,714.66**	
	TCC MII	$ 15,048,388.00	
	delta	$ 9,326.66	0.06%
Risk Threshold of TCC 1.00% %		$ 150,577.15	

Periodic Renourishment of Mid-Reach Beach Fill Segment (NED Plan No. 19)



Total Contract Costs $ 4,525,113.81

Percentile	Forecast values	Forecast values	Contingency
0%	$ 3,801,525	$ 3,802	-16%
10%	$ 4,387,587	$ 4,388	-3%
20%	$ 4,544,376	$ 4,544	0%
30%	$ 4,668,388	$ 4,668	3%
40%	$ 4,780,393	$ 4,780	6%
50%	$ 4,889,097	$ 4,889	8%
60%	$ 5,000,664	$ 5,001	11%
70%	$ 5,121,992	$ 5,122	13%
80%	$ 5,264,787	$ 5,265	16%
90%	$ 5,460,375	$ 5,460	21%
100%	$ 6,640,931	$ 6,641	47%


Forecast: Total Contract Costs for Periodic Renourishment
Edit View Forecast Preferences Help
3,000 Trials
Frequency View
2,993 Displayed
Total Contract Costs for Periodic Renourishment
Probability
Frequency
Dollars
10% = $4,387,587
20% = $4,544,376
50% = $4,889,097
80% = $5,264,787
90% = $5,460,375
-Infinity
Certainty: 100.00 %
Infinity

Cost Evaluation for: **Brevard Midreach Periodic Renourishment**

WBS	Description	QTY	UOM	Lower Bound Contract U/P	Expected Value Contract U/P	Upper Bound Contract U/P	Expected Value Contract Cost	Percentage of Total Cont. Cost	Greater than 1.0% of TCC ?
	Initial Nourishment								
1	Mob / Demob / Prep	1	LS	464418	$ 554,862.00	$ 691,220.00	$ 554,862.00	12.26%	Yes
2	Traffic Control	4.31	MO	$ 13,378.00	$ 16,024.00	$ 19,139.00	$ 69,063.44	1.53%	Yes
	R1	0.71							
	R2	0.34							
	R3	0.58							
	R4	0.28							
	R5	0.9							
	R6	1.5							
3	Hopper Dredge to DMMA	153246	CY	$ 7.30	$ 9.82	$ 14.84	$ 1,505,455.52	33.27%	Yes
	R1	33609							
	R2	16050							
	R3	27524							
	R4	15219							
	R5	42967							
	R6	17877							
4	Load/Haul Stockpile Sand	153246	CY	$ 6.71	$ 8.03	$ 9.59	$ 1,230,565.38	27.19%	Yes
	R1	33609							
	R2	16050							
	R3	27524							
	R4	15219							
	R5	42967							
	R6	17877							
5	Spread & Grade Sand	153246	CY	$ 6.08	$ 7.18	$ 10.39	$ 1,100,306.28	24.32%	Yes
	R1	33609							
	R2	16050							
	R3	27524							
	R4	15219							
	R5	42967							
	R6	17877							
6	End. Species Mon	4.31	MO	$ 12,564.00	$ 15,049.00	$ 17,974.00	$ 64,861.19	1.43%	Yes
	R1	0.71							
	R2	0.34							
	R3	0.58							
	R4	0.28							
	R5	0.9							
	R6	1.5							

Total Contract Costs **$ 4,525,113.81**

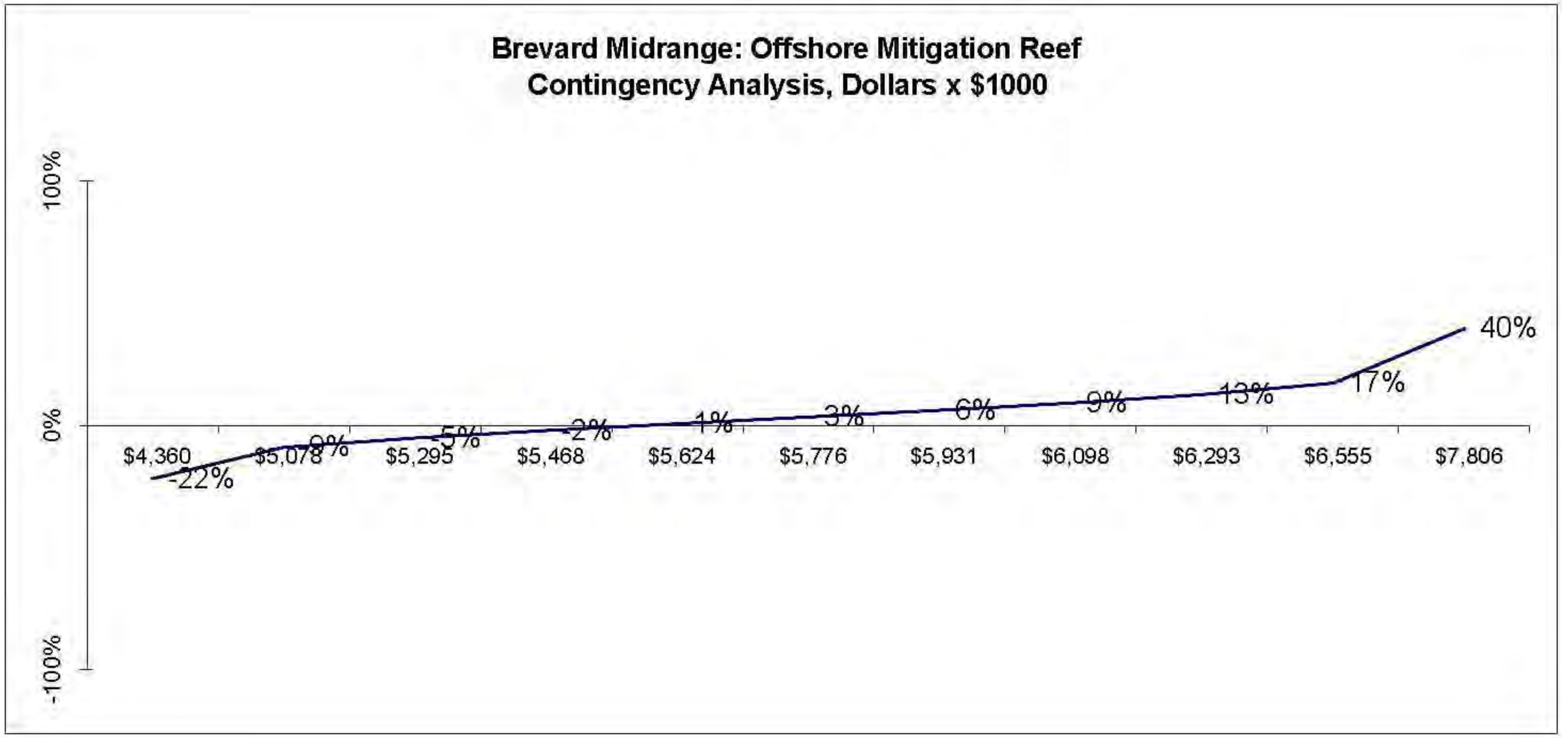
TCC MII $ 4,525,959.00
delta $ (845.19) -0.02%

Risk Threshold of TCC 1.00% % $ 45,251.14

Risk Model For: **Brevard Midreach** **Periodic Renourishment**

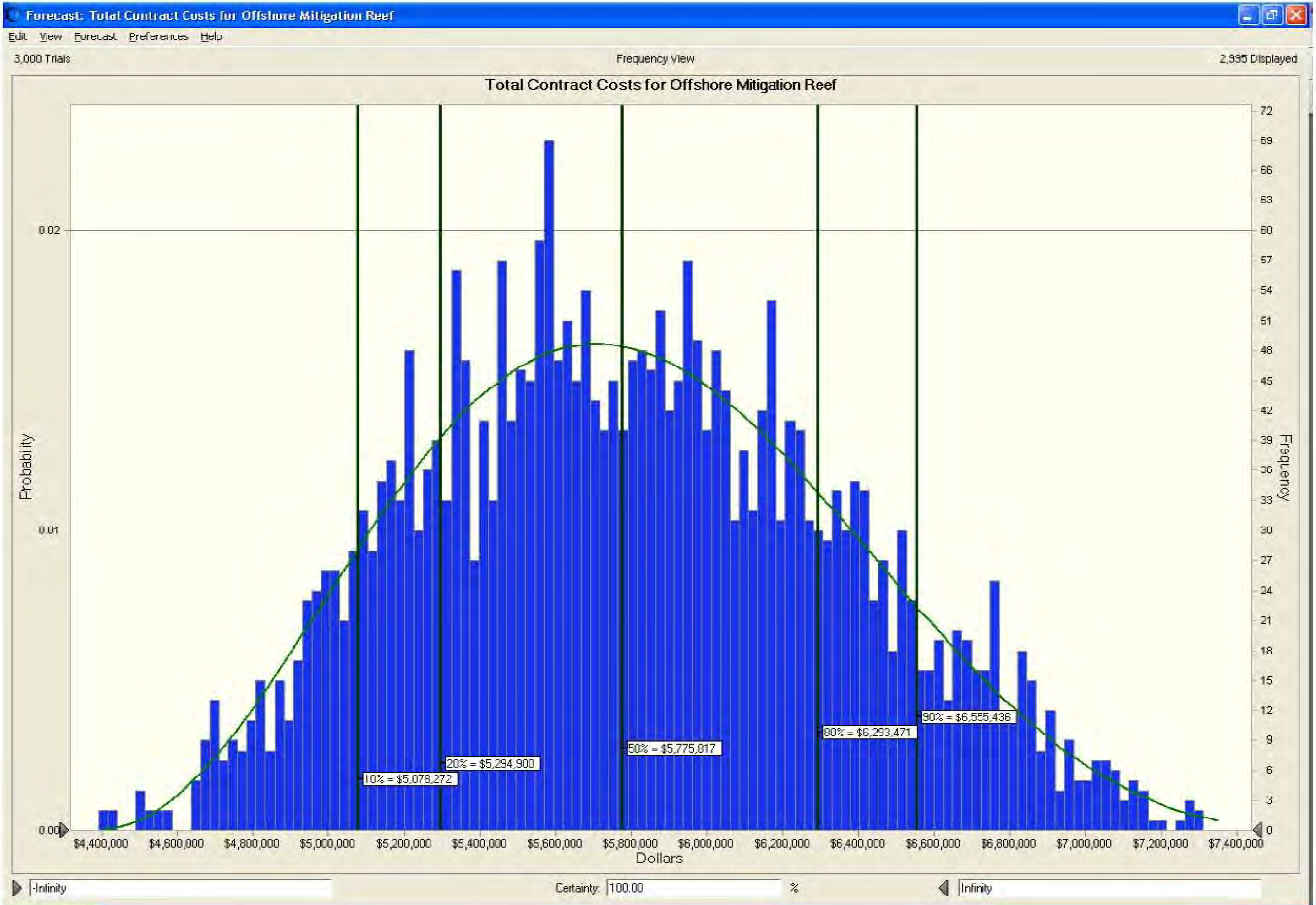
Critical Elem.?	WBS	Risk Name	Quantity	UOM	Assumption Definitions	Direct Contract Cost	Lower Bound	Copntract U/P Expected Value	Upper Bound	Variation Lower, %	Variation Upper, %	Magnitude of Variation	Cumulative Magnitude of Variation	Std Dev ~ Cum Mag div by 6	Distribution
Yes	1	Mob / Demob / Prep	1	LS	$554,862	$554,862	$ 464,418.00	$ 554,862.00	$ 691,220.00	16%	25%	$226,802			Triangular
			1	LS			1	$ 554,862.00	1	0%	0%	$0		Scale	
							$ 464,418		$ 691,220						
Yes	2	Traffic Control	4.31	MO	$69,063	$69,063	$ 13,378.00	$ 16,024.00	$ 19,139.00	17%	19%	$24,830			
			4.3	MO			4	$ 16,024.00	5	10%	15%	$17,266			
							$ 51,893		$ 94,862				$42,096	$7,016	
Yes	3	Hopper Dredge to DMMA	153246	CY	$1,505,456	$1,505,456	$ 7.30	$ 9.82	$ 14.84	26%	51%	$1,155,164			Triangular
			153246	CY			137,921	$ 9.82	176,233	10%	15%	$376,364			
							$ 1,007,459		$ 2,615,748				$1,531,528	$255,255	
Yes	4	Load/Haul Stockpile Sand	153246	CY	$1,230,565	$1,230,565	$ 6.71	$ 8.03	$ 9.59	16%	19%	$441,348			Triangular
			153246	CY			137,921	$ 8.03	176,233	10%	15%	$307,641			
							$ 1,028,281		$ 1,469,629				$441,348	$73,558	
Yes	5	Spread & Grade Sand	153246	CY	$1,100,306	$1,100,306	$ 6.08	$ 7.18	$ 10.39	15%	45%	$660,490			
			153246	CY			137,921.40	$ 7.18	176,232.900	10%	15%	$275,077		Scale	Triangular
							$ 838,562		$ 1,831,060				$935,567	$155,928	
Yes	6	End. Species Mon	4.31	MO	$64,861	$64,861	$ 12,564.00	$ 15,049.00	$ 17,974.00	17%	19%	$23,317			
			4.3	MO			4	$ 15,049.00	5	10%	15%	$16,215		Scale	
							$ 48,736		$ 89,088				$39,532	$6,589	
		Total Contract Costs for Periodic Renourishment			$ 4,525,114	$ 4,525,114									
					Check delta = $0	$0 OK									

Offshore Mitigation Reef for Mid-Reach



Total Contract Costs $ 5,591,972.32

Percentile		Forecast values	Forecast values	Contingency
	0%	$ 4,359,958	$ 4,360	-22%
	10%	$ 5,078,272	$ 5,078	-9%
	20%	$ 5,294,900	$ 5,295	-5%
	30%	$ 5,467,702	$ 5,468	-2%
	40%	$ 5,624,142	$ 5,624	1%
	50%	$ 5,775,817	$ 5,776	3%
	60%	$ 5,930,909	$ 5,931	6%
	70%	$ 6,098,444	$ 6,098	9%
	80%	$ 6,293,471	$ 6,293	13%
	90%	$ 6,555,436	$ 6,555	17%
	100%	$ 7,805,547	$ 7,806	40%



Forecast: Total Contract Costs for Offshore Mitigation Reef
Edit View Forecast Preferences Help
3,000 Trials
Frequency View
2,995 Displayed
Total Contract Costs for Offshore Mitigation Reef
Probability
Frequency
Dollars
10% = $5,078,272
20% = $5,294,900
50% = $5,775,817
80% = $6,293,471
90% = $6,555,436
-Infinity
Certainty: 100.00 %
Infinity

Cost Evaluation for: **Brevard Midreach Offshore Mitigation Reef**

WBS	Description	QTY	UOM	Lower Bound Contract U/P	Expected Value Contract U/P	Upper Bound Contract U/P	Expected Value Contract Cost	Percentage of Total Cont. Cost	Greater than 1.0% of TCC ?
	Initial Nourishment								
1	Mob / Demob / Prep	1	LS	173055	$ 190,036.00	$ 212,977.00	$ 190,036.00	3.40%	Yes
2	Articulated Conc Mattress	1632	EA	2010.01	$ 2,429.00	$ 2,897.11	$ 3,964,128.00	70.89%	Yes
3	ACM Placement	1632	EA	666.83	$ 881.01	$ 1,097.68	$ 1,437,808.32	25.71%	Yes

Total Contract Costs				**$ 5,591,972.32**	
			TCC MII	$ 5,591,372.00	
			delta	$ 600.32	0.01%
Risk Threshold of TCC	1.00%	%		$ 55,919.72	

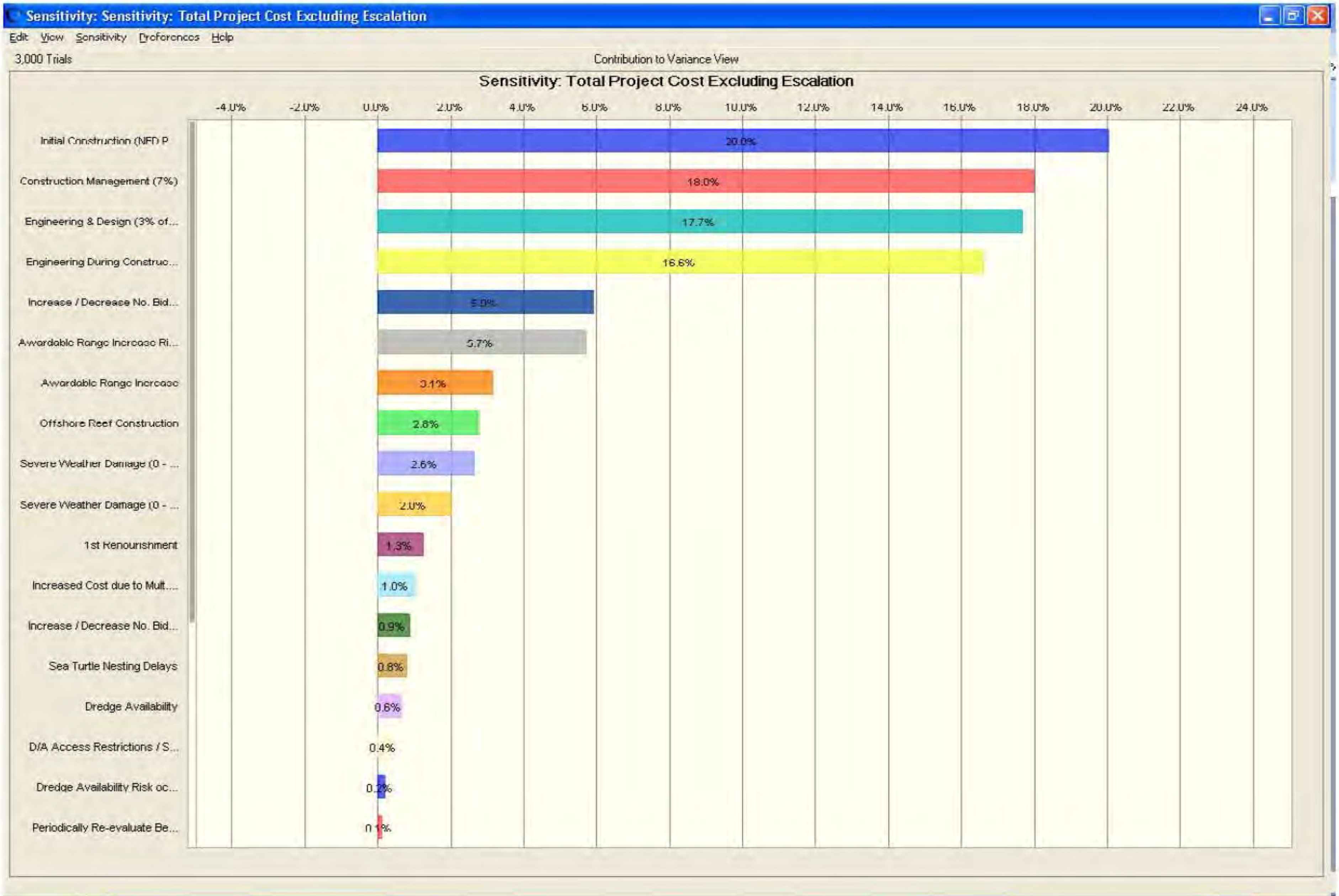
Risk Model For: Brevard Midreach Offshore Mitigation Reef

Critical Elem.?	WBS	Risk Name	Quantity	UOM	Assumption Definitions	Direct Contract Cost	Lower Bound	Copntract U/P Expected Value	Upper Bound	Variation Lower, %	Variation Upper, %	Magnitude of Variation	Cumulative Magnitude of Variation	Std Dev ~ Cum Mag div by 6	Distribution
Yes	1	Mob / Demob / Prep	1	LS	$190,036	$190,036	$ 173,055.00	$ 190,036.00	$ 212,977.00	9%	12%	$39,922			Triangular
			1	LS			1	$ 190,036.00	1	0%	0%	$0		Scale	
							$ 173,055		$ 212,977						
Yes	2	Articulated Conc Mattress	1632	EA	$3,964,128	$3,964,128	$ 2,010.01	$ 2,429.00	$ 2,897.11	17%	19%	$1,447,747			
			1632.0	EA			1,469	$ 2,429.00	1,877	10%	15%	$991,032			
							$ 2,952,303		$ 5,437,296				$2,438,779	$406,463	
Yes	3	ACM Placement	1632	EA	$1,437,808	$1,437,808	$ 666.83	$ 881.01	$ 1,097.68	24%	25%	$703,147			Triangular
			1632	EA			1,469	$ 881.01	1,877	10%	15%	$359,452			
							$ 979,440		$ 2,060,126				$1,062,599	$177,100	
		Total Contract Costs for Offshore Mitigation Reef			$ 5,591,972	$ 5,591,972									
					Check delta = $0	$0 OK									

External Risk Analysis Results

Total Contract Costs $ 29,001,195.91

Percentile		Forecast values		Forecast values	Contingency
0%	$	25,789,153	$	25,789	-11%
10%	$	29,583,427	$	29,583	2%
20%	$	30,754,857	$	30,755	6%
30%	$	31,594,577	$	31,595	9%
40%	$	32,316,542	$	32,317	11%
50%	$	33,066,991	$	33,067	14%
60%	$	33,794,530	$	33,795	17%
70%	$	34,652,636	$	34,653	19%
80%	$	35,589,677	$	35,590	23%
90%	$	37,011,264	$	37,011	28%
100%	$	42,849,119	$	42,849	48%



Sensitivity: Sensitivity: Total Project Cost Excluding Escalation
Edit View Sensitivity Preferences Help
3,000 Trials
Contribution to Variance View
Sensitivity: Total Project Cost Excluding Escalation
-4.0% -2.0% 0.0% 2.0% 4.0% 6.0% 8.0% 10.0% 12.0% 14.0% 16.0% 18.0% 20.0% 22.0% 24.0%
Initial Construction (NED P
20.0%
Construction Management (7%)
18.0%
Engineering & Design (3% of...
17.7%
Engineering During Construc...
16.6%
Increase / Decrease No. Bid...
Awardable Range Increase Ri...
5.7%
Awardable Range Increase
3.1%
Offshore Reef Construction
2.8%
Severe Weather Damage (0 - ...
2.6%
Severe Weather Damage (0 - ...
2.0%
1st Renourishment
1.3%
Increased Cost due to Mult....
1.0%
Increase / Decrease No. Bid...
0.9%
Sea Turtle Nesting Delays
0.8%
Dredge Availability
0.6%
D/A Access Restrictions / S...
0.4%
Dredge Availability Risk oc...
Periodically Re-evaluate Be...

Brevard Mid-Reach External Risk

Correlations???

Risk No.	Description	ESTIMATE RANGE: Most Likely	Low	High	Source	VALUE RANGE: Low	CB Value	High
LS-RE-2	Real Estate	$ 25,000	-5%	15%	Estimating Judgement	$ 23,800	$ 25,000	$ 28,800
	Engineering & Design (3% of TCC)	$ 783,140	-5%	15%	Estimating Judgement	$ 744,000	$ 783,140	$ 900,700
	Initial Construction (NED Plan No. 19)	n/a	n/a	n/a	From Internal CRA, 0/50/100 values	$12,038,875	$15,175,895	$19,598,512
	Offshore Reef Construction	n/a	n/a	n/a	From Internal CRA, 0/50/100 values	$5,080,967	$6,002,919	$7,653,492
	1st Renourishment	n/a	n/a	n/a	From Internal CRA, 0/50/100 values	$4,203,497	$4,925,867	$6,092,183
	Engineering During Construction (1%)	$ 261,047	-5%	15%	Estimating Judgement	$ 248,000	$ 261,047	$ 300,300
	Construction Management (7%)	$ 1,827,328	-5%	15%	Estimating Judgement	$ 1,736,000	$ 1,827,328	$ 2,101,500
	PROJECT COST					$ 24,075,139	**$ 29,001,196**	$ 36,675,487

Import Values for Copying

Low	CB Value	High
$12,549,665	$16,344,297	$22,305,181
$4,359,958	$5,775,817	$7,805,547
$3,801,525	$4,889,097	$6,640,931

Daily Rates based on OH
30% Total Markup (10/5/10/2)
Initial Const 207 days
$21,994.05 OH per day

Correlations???

Risk No.	Risk Description	ESTIMATED INCREMENTAL COSTS: Most Likely	Min	Max	CB Value	Probability	Risk occurs?	Extra cost	
CT-1	**Increased Cost due to Mult. Awards**	$ 39,157	$ -	$ 78,314	$ 39,157	13%	0	$ -	0 - 10% of E&D
CT-6	**Increase / Decrease No. Bidders**	$ -	$ (2,610,468)	$ 5,220,936	$ -	63%	0	$ -	Range of -10% to +20% of TCC
EC-1	**Severe Weather Damage (0 - 10% of TCC)**	$ 1,305,234	$ -	$ 2,610,468	$ 1,305,234	63%	0	$ -	
EC-2	**Dredge Availability**	$ -	$ -	$ 1,000,000	$ -	63%	0	$ -	Mob of up to $ 1 million
EC-4	**Awardable Range Increase**	$1,957,851	$ -	$ 3,915,702	$ 1,957,851	63%	0	$ -	0 - 15% above TCC
LS-RE-3	**MMS Permission to Mine Offshore B/A**	$ -	$ -	$ 500,000	$ -	13%	0	$ -	"Develop new Borrow Area
LS-5	**D/A Access Restrictions / Security**	$ -	$ -	$ 439,881	$ -	13%	0	$ -	Max 20 days
PE-1	**Sea Turtle Nesting Delays**	$ -	$ -	$ 1,099,703	$ -	75%	0	$ -	From Schedule RA, 80% value is ~ 50 days at $21,994.05 per day
PE-2	**Changes in Amount of Reef Mitigation**	$ -	$ (562,701)	$ 2,250,806	$ -	13%	0	$ -	-1/2 acre to + 2 acres
PEC-1	**Periodically Re-evaluate Benefits**	$ -	$ -	$ 750,000	$ -	13%	0	$ -	"Implement LRR Process

TOTAL COST	$ 29,001,196

A.7 TOTAL PROJECT COST SUMMARY

The Total Project Cost Summary (TPCS) addresses inflation through project completion (accomplished by escalation to mid-point of construction per ER 1110-2-1302, Appendix C, Page C-2). It is based on the scope of the SAP and the official project schedule. The TPCS includes Federal and non-Federal costs for lands and damages, all construction features, PED, and S&A, along with the appropriate contingencies and escalation associated with each of these activities. The TPCS is formatted according to the WBS and uses Civil Works Construction Cost Indexing System factors for escalation (EM 1110-2-1304) of construction costs and Office of Management and Budget (EC 11-2-18X, 20 Feb 2008) factors for escalation of PED and S&A costs.

The Total Project Cost Summary prepared using the MCACES/MII cost estimate on the Recommended Plans with contingencies set by the risk analysis (and the exceptions as described above) and the official project schedule. In performing the risk analysis by meeting with the PDT to discuss the construction schedule to prepare the risk register, a schedule was derived that is slightly different from the official schedule in that it has slightly shorter construction duration. A risk analysis was run on that schedule taking into consideration variations in construction duration, authorization date and appropriation date, and yet a third schedule developed, this one based on the risk analysis results at the 80% confidence level. A TPCS (Figure X+1) was prepared using this schedule as well. These timelines and costs are summarized in Table 18. They show the impact of delayed authorization and appropriation on the fully funded cost despite a slightly shorter construction duration.

The Cost Risk Analysis based total project contingency of 23 percent determined under the External Risk analysis in was applied to the Total Project Cost Summary along with the contingency adjusted total project schedule presented in Table B.5.3.

A.8 TOTAL PROJECT COST SUMMARY WITH COST RISK ANALYSIS, CONTINGENCY AND SCHEDULE ANALYSIS ESCALATION (NED)

****** TOTAL PROJECT COST SUMMARY ******

Printed:8/4/2010
Page 1 of 10

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA

DISTRICT: SAJ   PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

						Program Year (Budget EC): 2011	Effective Price Level Date: 1 OCT 10			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)	Spent Thru: 1-Oct-09 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
17	BEACH REPLENISHMENT	114,538	26,344	23%	140,881	0.8%	115425.2	26547.8	141973.0			157660.8	36262.0	193922.8
x	-			-		-								
x	-			-		-								
x	-			-		-								
x	-			-		-								
	CONSTRUCTION ESTIMATE TOTALS:	114,538	26,344		**140,881**	0.8%	115425.2	26547.8	141973.0			157660.8	36262.0	193922.8
01	LANDS AND DAMAGES	1,190	274	23%	1,464	0.8%	1199.2	275.8	1475.0			1655.4	380.7	2036.1
30	PLANNING, ENGINEERING & DESIGN	5,321	1,224	23%	6,545	0.8%	5362.2	1233.3	6595.5			7425.9	1708.0	9133.8
31	CONSTRUCTION MANAGEMENT	12,201	2,806	23%	15,007	0.8%	12295.4	2828.0	15123.4			16739.2	3850.0	20589.2
	PROJECT COST TOTALS:	133,250	30,647	23%	**163,897**	0.8%	134282.1	30884.9	165167.0			183481.2	42200.7	225681.9

CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

PROJECT MANAGER, Osvaldo Rodriguez, P.E.

ESTIMATED FEDERAL COST: **121,868**
ESTIMATED NON-FEDERAL COST: **103,814**

ESTIMATED TOTAL PROJECT COST: 225,682

Filename: TPCS-Brevard Co Mid-Reach GRR NED PLAN 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #1 - Initital Fill & Offshore Reef Mitigation													
17	BEACH REPLENISHMENT	$ 23,352	$ 5,371	23%	$ 28,722	0.8%	23532.5	5412.5	28944.9	2013Q1	3.1%	24266.5	5581.3	29847.8
x	-	$ -	$ -	23%	$ -									
x	-		$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	23,352	5,371	23%	**28,722**		23532.5	5412.5	28944.9			24266.5	5581.3	29847.8
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2011Q2	0.3%	70.8	16.3	87.0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management		$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2011Q2	0.3%	15.2	3.5	18.7
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2011Q2	0.3%	202.2	46.5	248.7
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2011Q2	0.3%	20.2	4.6	24.9
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2011Q2	0.3%	8.1	1.9	9.9
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2013Q1	3.1%	20.8	4.8	25.6
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2013Q1	3.1%	10.4	2.4	12.8
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2011Q2	0.3%	40.4	9.3	49.7
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 1,985	$ 457	23%	2,441	0.8%	2000.3	460.1	2460.3	2013Q1	3.1%	2062.7	474.4	2537.1
2.0%	Project Operation:	$ 633	$ 146	23%	779	0.8%	638.1	146.8	784.9	2013Q1	3.1%	658.0	151.3	809.4
2.5%	Project Management		$ -	23%										
	CONTRACT COST TOTALS:	26,353	6,061		**32,414**		26556.8	6108.1	32664.9			27375.2	6296.3	**33671.5**

Filename: TPCS-Brevard Co Mid-Reach GRR NED PLAN 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

DISTRICT: SAJ
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.
PREPARED: 5/17/2010

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #2 - 1st Renourishment													
17	BEACH REPLENISHMENT	$ 5,699	$ 1,311	23%	$ 7,010	0.8%	5743.3	1321.0	7064.3	2016Q1	8.5%	6229.7	1432.8	7662.5
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,699	1,311	23%	**7,010**		5743.3	1321.0	7064.3			6229.7	1432.8	7662.5
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2014Q2	5.3%	74.3	17.1	91.4
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2014Q2	5.3%	15.9	3.7	19.6
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2014Q2	5.3%	212.3	48.8	261.1
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2014Q2	5.3%	21.2	4.9	26.1
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2014Q2	5.3%	8.5	2.0	10.4
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2016Q1	8.5%	21.9	5.0	26.9
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2016Q1	8.5%	10.9	2.5	13.4
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2014Q2	5.3%	42.5	9.8	52.2
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.2	112.3	600.5	2016Q1	8.5%	529.5	121.8	651.3
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2016Q1	8.5%	125.2	28.8	153.9
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,681	1,537		**8,218**		6732.8	1548.6	8281.4			7291.8	1677.1	**8968.9**

Filename: TPCS-Brevard Co Mid-Reach GRR NED PLAN 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #3 - 2nd Renourishment													
17	BEACH REPLENISHMENT	$ 5,699	$ 1,311	23%	$ 7,010	0.8%	5743.3	1321.0	7064.3	2019Q1	14.4%	6569.7	1511.0	8080.7
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,699	1,311	23%	**7,010**		5743.3	1321.0	7064.3			6569.7	1511.0	8080.7
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2017Q2	10.9%	78.2	18.0	96.2
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2017Q2	10.9%	16.8	3.9	20.6
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2017Q2	10.9%	223.5	51.4	274.9
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2017Q2	10.9%	22.3	5.1	27.5
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2017Q2	10.9%	8.9	2.1	11.0
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2019Q1	14.4%	23.1	5.3	28.4
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2019Q1	14.4%	11.5	2.7	14.2
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2017Q2	10.9%	44.7	10.3	55.0
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.2	112.3	600.5	2019Q1	14.4%	558.4	128.4	686.9
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2019Q1	14.4%	132.0	30.4	162.3
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,681	1,537		**8,218**		6732.8	1548.6	8281.4			7689.1	1768.5	**9457.6**

Filename: TPCS-Brevard Co Mid-Reach GRR NED PLAN 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contract #4 - 3rd Renourishment													
17	BEACH REPLENISHMENT	$ 5,699	$ 1,311	23%	$ 7,010	0.8%	5743.3	1321.0	7064.3	2022Q1	20.7%	6930.8	1594.1	8524.9
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,699	1,311	23%	**7,010**		5743.3	1321.0	7064.3			6930.8	1594.1	8524.9
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2020Q2	17.0%	82.5	19.0	101.5
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2020Q2	17.0%	17.7	4.1	21.7
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2020Q2	17.0%	235.8	54.2	290.0
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2020Q2	17.0%	23.6	5.4	29.0
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2020Q2	17.0%	9.4	2.2	11.6
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2022Q1	20.7%	24.3	5.6	29.9
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2022Q1	20.7%	12.2	2.8	15.0
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2020Q2	17.0%	47.2	10.8	58.0
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.2	112.3	600.5	2022Q1	20.7%	589.1	135.5	724.6
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2022Q1	20.7%	139.2	32.0	171.3
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,681	1,537		**8,218**		6732.8	1548.6	8281.4			8111.8	1865.7	**9977.5**

Filename: TPCS-Brevard Co Mid-Reach GRR NED PLAN 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	ESC (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	Contract #5 - 4th Renourishment													
17	BEACH REPLENISHMENT	$ 5,699	$ 1,311	23%	$ 7,010	0.8%	5743.3	1321.0	7064.3	2025Q1	27.3%	7311.9	1681.7	8993.7
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,699	1,311	23%	**7,010**		5743.3	1321.0	7064.3			7311.9	1681.7	8993.7
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2023Q2	23.4%	87.1	20.0	107.1
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2023Q2	23.4%	18.7	4.3	22.9
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2023Q2	23.4%	248.7	57.2	305.9
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2023Q2	23.4%	24.9	5.7	30.6
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2023Q2	23.4%	9.9	2.3	12.2
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2025Q1	27.3%	25.7	5.9	31.6
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2025Q1	27.3%	12.8	3.0	15.8
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2023Q2	23.4%	49.7	11.4	61.2
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.2	112.3	600.5	2025Q1	27.3%	621.5	142.9	764.5
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2025Q1	27.3%	146.9	33.8	180.7
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,681	1,537		**8,218**		6732.8	1548.6	8281.4			8557.8	1968.3	**10526.2**

Filename: TPCS-Brevard Co Mid-Reach GRR NED PLAN 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

DISTRICT: SAJ
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.
PREPARED: 5/17/2010

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contract #6 - 5th Renourishment													
17	BEACH REPLENISHMENT	$ 5,699	$ 1,311	23%	$ 7,010	0.8%	5743.3	1321.0	7064.3	2028Q1	34.3%	7713.9	1774.2	9488.2
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,699	1,311	23%	**7,010**		5743.3	1321.0	7064.3			7713.9	1774.2	9488.2
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2026Q2	30.2%	91.8	21.1	113.0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2026Q2	30.2%	19.7	4.5	24.2
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2026Q2	30.2%	262.4	60.4	322.8
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2026Q2	30.2%	26.2	6.0	32.3
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2026Q2	30.2%	10.5	2.4	12.9
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2028Q1	34.3%	27.1	6.2	33.3
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2028Q1	34.3%	13.5	3.1	16.6
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2026Q2	30.2%	52.5	12.1	64.6
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.2	112.3	600.5	2028Q1	34.3%	655.7	150.8	806.5
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2028Q1	34.3%	155.0	35.6	190.6
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,681	1,537		**8,218**		6732.8	1548.6	8281.4			9028.4	2076.5	**11104.9**

Filename: TPCS-Brevard Co Mid-Reach GRR NED PLAN 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #7 - 6th Renourishment													
17	BEACH REPLENISHMENT	$ 5,699	$ 1,311	23%	$ 7,010	0.8%	5743.3	1321.0	7064.3	2031Q1	41.7%	8138.0	1871.7	10009.7
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,699	1,311	23%	**7,010**		5743.3	1321.0	7064.3			8138.0	1871.7	10009.7
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2029Q2	37.3%	96.9	22.3	119.2
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2029Q2	37.3%	20.8	4.8	25.5
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2029Q2	37.3%	276.8	63.7	340.5
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2029Q2	37.3%	27.7	6.4	34.0
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2029Q2	37.3%	11.1	2.5	13.6
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2031Q1	41.7%	28.6	6.6	35.1
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2031Q1	41.7%	14.3	3.3	17.6
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2029Q2	37.3%	55.4	12.7	68.1
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.2	112.3	600.5	2031Q1	41.7%	691.7	159.1	850.8
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2031Q1	41.7%	163.5	37.6	201.1
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,681	1,537		**8,218**		6732.8	1548.6	8281.4			9524.7	2190.7	**11715.3**

Filename: TPCS-Brevard Co Mid-Reach GRR NED PLAN 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

DISTRICT: SAJ
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.
PREPARED: 5/17/2010

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contract #8 - 7th Renourishment													
17	BEACH REPLENISHMENT	$ 5,699	$ 1,311	23%	$ 7,010	0.8%	5743.3	1321.0	7064.3	2034Q1	49.5%	8585.5	1974.7	10560.1
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,699	1,311	23%	**7,010**		5743.3	1321.0	7064.3			8585.5	1974.7	10560.1
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2032Q2	44.9%	102.2	23.5	125.7
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2032Q2	44.9%	21.9	5.0	26.9
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2032Q2	44.9%	292.0	67.2	359.2
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2032Q2	44.9%	29.2	6.7	35.9
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2032Q2	44.9%	11.7	2.7	14.4
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2034Q1	49.5%	30.1	6.9	37.1
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2034Q1	49.5%	15.1	3.5	18.5
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2032Q2	44.9%	58.4	13.4	71.8
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.2	112.3	600.5	2034Q1	49.5%	729.8	167.8	897.6
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2034Q1	49.5%	172.5	39.7	212.2
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,681	1,537		**8,218**		6732.8	1548.6	8281.4			10048.4	2311.1	**12359.5**

Filename: TPCS-Brevard Co Mid-Reach GRR NED PLAN 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - NED PLAN (NO. 19)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	ESC (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	Contracts #9 thru #17 - 8th thru 16th Renourishments													
17	BEACH REPLENISHMENT	$ 51,292	$ 11,797	23%	$ 63,089	0.8%	51689.7	11888.6	63578.3	2037Q1	58.5%	81914.8	18840.4	100755.2
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	51,292	11,797	23%	**63,089**		51689.7	11888.6	63578.3			81914.8	18840.4	100755.2
01	LANDS AND DAMAGES	$ 630	$ 145	23%	$ 775	0.8%	634.9	146.0	780.9	2035Q2	53.0%	971.6	223.5	1195.1
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 135	$ 31	23%	166	0.8%	136.0	31.3	167.3	2035Q2	53.0%	208.2	47.9	256.1
8.5%	Engineering & Design	$ 1,800	$ 414	23%	2,214	0.8%	1813.9	417.2	2231.2	2035Q2	53.0%	2776.0	638.5	3414.5
2.0%	Engineering Tech Review ITR & VE	$ 180	$ 41	23%	221	0.8%	181.4	41.7	223.1	2035Q2	53.0%	277.6	63.8	341.4
2.0%	Contracting & Reprographics	$ 72	$ 17	23%	89	0.8%	72.6	16.7	89.2	2035Q2	53.0%	111.0	25.5	136.6
3.0%	Engineering During Construction	$ 180	$ 41	23%	221	0.8%	181.4	41.7	223.1	2037Q1	58.5%	287.5	66.1	353.6
2.0%	Planning During Construction	$ 90	$ 21	23%	111	0.8%	90.7	20.9	111.6	2037Q1	58.5%	143.7	33.1	176.8
2.0%	Cost Engineering	$ 360	$ 83	23%	443	0.8%	362.8	83.4	446.2	2035Q2	53.0%	555.2	127.7	682.9
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 4,360	$ 1,003	23%	5,363	0.8%	4393.6	1010.5	5404.2	2037Q1	58.5%	6962.8	1601.4	8564.2
2.0%	Project Operation:	$ 1,031	$ 237	23%	1,268	0.8%	1038.5	238.9	1277.3	2037Q1	58.5%	1645.7	378.5	2024.2
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 60,130	13,830		**73,959**		60595.5	13937.0	74532.4			95854.1	22046.5	**117900.6**

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A.9 TOTAL PROJECT COST SUMMARY WITH COST RISK ANALYSIS, CONTINGENCY AND SCHEDULE ANALYSIS ESCALATION (LPP)

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

						Program Year (Budget EC): 2011 Effective Price Level Date: 1 OCT 10				FULLY FUNDED PROJECT ESTIMATE				
										Spent Thru:				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	1-Oct-09 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
17	BEACH REPLENISHMENT	114,366	26,304	23%	140,670	0.8%	115252.2	26508.0	141760.2			157477.7	36219.9	193697.5
x	-			-		-								
x	-			-		-								
x	-			-		-								
x	-			-		-								
	CONSTRUCTION ESTIMATE TOTALS:	114,366	26,304		**140,670**	0.8%	115252.2	26508.0	141760.2			157477.7	36219.9	193697.5
01	LANDS AND DAMAGES	1,190	274	23%	1,464	0.8%	1199.2	275.8	1475.0			1655.4	380.7	2036.1
30	PLANNING, ENGINEERING & DESIGN	5,321	1,224	23%	6,545	0.8%	5362.2	1233.3	6595.5			7425.9	1708.0	9133.8
31	CONSTRUCTION MANAGEMENT	12,186	2,803	23%	14,989	0.8%	12280.5	2824.5	15105.1			16723.4	3846.4	20569.8
	PROJECT COST TOTALS:	133,063	30,605	23%	**163,668**	0.8%	134094.2	30841.7	164935.8			183282.3	42154.9	225437.3

CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

PROJECT MANAGER, Osvaldo Rodriguez, P.E.

ESTIMATED FEDERAL COST:	**121,736**
ESTIMATED NON-FEDERAL COST:	**103,701**
ESTIMATED TOTAL PROJECT COST:	**225,437**

Filename: TPCS-Brevard Co Mid-Reach GRR LPP 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #1 - Initital Fill & Offshore Reef Mitigation													
17	BEACH REPLENISHMENT	$ 23,191	$ 5,334	23%	$ 28,525	0.8%	23370.7	5375.3	28746.0	2013Q1	3.1%	24099.7	5542.9	29642.7
x	-	$ -	$ -	23%	$ -									
x	-		$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	23,191	5,334	23%	**28,525**		23370.7	5375.3	28746.0			24099.7	5542.9	29642.7
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2011Q2	0.3%	70.8	16.3	87.0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management		$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2011Q2	0.3%	15.2	3.5	18.7
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2011Q2	0.3%	202.2	46.5	248.7
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2011Q2	0.3%	20.2	4.6	24.9
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2011Q2	0.3%	8.1	1.9	9.9
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2013Q1	3.1%	20.8	4.8	25.6
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2013Q1	3.1%	10.4	2.4	12.8
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2011Q2	0.3%	40.4	9.3	49.7
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 1,971	$ 453	23%	2,425	0.8%	1986.5	456.9	2443.4	2013Q1	3.1%	2048.5	471.1	2519.6
2.0%	Project Operation:	$ 633	$ 146	23%	779	0.8%	637.9	146.7	784.6	2013Q1	3.1%	657.8	151.3	809.1
2.5%	Project Management		$ -	23%										
	CONTRACT COST TOTALS:	26,178	6,021		**32,199**		26381.1	6067.7	32448.8			27194.0	6254.6	**33448.6**

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TPCS

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

DISTRICT: SAJ
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.
PREPARED: 5/17/2010

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contract #2 - 1st Renourishment													
17	BEACH REPLENISHMENT	$ 5,698	$ 1,311	23%	$ 7,009	0.8%	5742.6	1320.8	7063.4	2016Q1	8.5%	6228.9	1432.6	7661.6
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,698	1,311	23%	**7,009**		5742.6	1320.8	7063.4			6228.9	1432.6	7661.6
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2014Q2	5.3%	74.3	17.1	91.4
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2014Q2	5.3%	15.9	3.7	19.6
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2014Q2	5.3%	212.3	48.8	261.1
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2014Q2	5.3%	21.2	4.9	26.1
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2014Q2	5.3%	8.5	2.0	10.4
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2016Q1	8.5%	21.9	5.0	26.9
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2016Q1	8.5%	10.9	2.5	13.4
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2014Q2	5.3%	42.5	9.8	52.2
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.1	112.3	600.4	2016Q1	8.5%	529.5	121.8	651.2
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2016Q1	8.5%	125.2	28.8	153.9
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,680	1,536		**8,217**		6732.1	1548.4	8280.4			7291.0	1676.9	**8967.9**

Filename: TPCS-Brevard Co Mid-Reach GRR LPP 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #3 - 2nd Renourishment													
17	BEACH REPLENISHMENT	$ 5,698	$ 1,311	23%	$ 7,009	0.8%	5742.6	1320.8	7063.4	2019Q1	14.4%	6568.8	1510.8	8079.7
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,698	1,311	23%	**7,009**		5742.6	1320.8	7063.4			6568.8	1510.8	8079.7
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2017Q2	10.9%	78.2	18.0	96.2
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2017Q2	10.9%	16.8	3.9	20.6
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2017Q2	10.9%	223.5	51.4	274.9
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2017Q2	10.9%	22.3	5.1	27.5
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2017Q2	10.9%	8.9	2.1	11.0
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2019Q1	14.4%	23.1	5.3	28.4
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2019Q1	14.4%	11.5	2.7	14.2
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2017Q2	10.9%	44.7	10.3	55.0
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.1	112.3	600.4	2019Q1	14.4%	558.4	128.4	686.8
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2019Q1	14.4%	132.0	30.4	162.3
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,680	1,536		**8,217**		6732.1	1548.4	8280.4			7688.2	1768.3	**9456.5**

Filename: TPCS-Brevard Co Mid-Reach GRR LPP 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #4 - 3rd Renourishment													
17	BEACH REPLENISHMENT	$ 5,698	$ 1,311	23%	$ 7,009	0.8%	5742.6	1320.8	7063.4	2022Q1	20.7%	6930.0	1593.9	8523.9
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,698	1,311	23%	**7,009**		5742.6	1320.8	7063.4			6930.0	1593.9	8523.9
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2020Q2	17.0%	82.5	19.0	101.5
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2020Q2	17.0%	17.7	4.1	21.7
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2020Q2	17.0%	235.8	54.2	290.0
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2020Q2	17.0%	23.6	5.4	29.0
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2020Q2	17.0%	9.4	2.2	11.6
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2022Q1	20.7%	24.3	5.6	29.9
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2022Q1	20.7%	12.2	2.8	15.0
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2020Q2	17.0%	47.2	10.8	58.0
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.1	112.3	600.4	2022Q1	20.7%	589.0	135.5	724.5
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2022Q1	20.7%	139.2	32.0	171.3
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,680	1,536		**8,217**		6732.1	1548.4	8280.4			8110.9	1865.5	**9976.4**

Filename: TPCS-Brevard Co Mid-Reach GRR LPP 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contract #5 - 4th Renourishment													
17	BEACH REPLENISHMENT	$ 5,698	$ 1,311	23%	$ 7,009	0.8%	5742.6	1320.8	7063.4	2025Q1	27.3%	7311.0	1681.5	8992.6
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,698	1,311	23%	**7,009**		5742.6	1320.8	7063.4			7311.0	1681.5	8992.6
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2023Q2	23.4%	87.1	20.0	107.1
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2023Q2	23.4%	18.7	4.3	22.9
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2023Q2	23.4%	248.7	57.2	305.9
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2023Q2	23.4%	24.9	5.7	30.6
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2023Q2	23.4%	9.9	2.3	12.2
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2025Q1	27.3%	25.7	5.9	31.6
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2025Q1	27.3%	12.8	3.0	15.8
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2023Q2	23.4%	49.7	11.4	61.2
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.1	112.3	600.4	2025Q1	27.3%	621.4	142.9	764.4
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2025Q1	27.3%	146.9	33.8	180.7
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,680	1,536		**8,217**		6732.1	1548.4	8280.4			8556.9	1968.1	**10525.0**

Filename: TPCS-Brevard Co Mid-Reach GRR LPP 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contract #6 - 5th Renourishment													
17	BEACH REPLENISHMENT	$ 5,698	$ 1,311	23%	$ 7,009	0.8%	5742.6	1320.8	7063.4	2028Q1	34.3%	7713.0	1774.0	9487.0
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,698	1,311	23%	**7,009**		5742.6	1320.8	7063.4			7713.0	1774.0	9487.0
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2026Q2	30.2%	91.8	21.1	113.0
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2026Q2	30.2%	19.7	4.5	24.2
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2026Q2	30.2%	262.4	60.4	322.8
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2026Q2	30.2%	26.2	6.0	32.3
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2026Q2	30.2%	10.5	2.4	12.9
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2028Q1	34.3%	27.1	6.2	33.3
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2028Q1	34.3%	13.5	3.1	16.6
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2026Q2	30.2%	52.5	12.1	64.6
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.1	112.3	600.4	2028Q1	34.3%	655.6	150.8	806.4
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2028Q1	34.3%	155.0	35.6	190.6
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,680	1,536		**8,217**		6732.1	1548.4	8280.4			9027.3	2076.3	**11103.6**

Filename: TPCS-Brevard Co Mid-Reach GRR LPP 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

DISTRICT: SAJ
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.
PREPARED: 5/17/2010

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #7 - 6th Renourishment													
17	BEACH REPLENISHMENT	$ 5,698	$ 1,311	23%	$ 7,009	0.8%	5742.6	1320.8	7063.4	2031Q1	41.7%	8137.0	1871.5	10008.5
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,698	1,311	23%	**7,009**		5742.6	1320.8	7063.4			8137.0	1871.5	10008.5
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2029Q2	37.3%	96.9	22.3	119.2
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2029Q2	37.3%	20.8	4.8	25.5
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2029Q2	37.3%	276.8	63.7	340.5
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2029Q2	37.3%	27.7	6.4	34.0
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2029Q2	37.3%	11.1	2.5	13.6
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2031Q1	41.7%	28.6	6.6	35.1
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2031Q1	41.7%	14.3	3.3	17.6
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2029Q2	37.3%	55.4	12.7	68.1
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.1	112.3	600.4	2031Q1	41.7%	691.6	159.1	850.7
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2031Q1	41.7%	163.5	37.6	201.1
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,680	1,536		**8,217**		6732.1	1548.4	8280.4			9523.6	2190.4	**11714.0**

Filename: TPCS-Brevard Co Mid-Reach GRR LPP 080410 BCB Revised.xls
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contract #8 - 7th Renourishment													
17	BEACH REPLENISHMENT	$ 5,698	$ 1,311	23%	$ 7,009	0.8%	5742.6	1320.8	7063.4	2034Q1	49.5%	8584.4	1974.4	10558.8
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	5,698	1,311	23%	**7,009**		5742.6	1320.8	7063.4			8584.4	1974.4	10558.8
01	LANDS AND DAMAGES	$ 70	$ 16	23%	$ 86	0.8%	70.5	16.2	86.8	2032Q2	44.9%	102.2	23.5	125.7
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 15	$ 3	23%	18	0.8%	15.1	3.5	18.6	2032Q2	44.9%	21.9	5.0	26.9
8.5%	Engineering & Design	$ 200	$ 46	23%	246	0.8%	201.5	46.4	247.9	2032Q2	44.9%	292.0	67.2	359.2
2.0%	Engineering Tech Review ITR & VE	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2032Q2	44.9%	29.2	6.7	35.9
2.0%	Contracting & Reprographics	$ 8	$ 2	23%	10	0.8%	8.1	1.9	9.9	2032Q2	44.9%	11.7	2.7	14.4
3.0%	Engineering During Construction	$ 20	$ 5	23%	25	0.8%	20.2	4.6	24.8	2034Q1	49.5%	30.1	6.9	37.1
2.0%	Planning During Construction	$ 10	$ 2	23%	12	0.8%	10.1	2.3	12.4	2034Q1	49.5%	15.1	3.5	18.5
2.0%	Cost Engineering	$ 40	$ 9	23%	49	0.8%	40.3	9.3	49.6	2032Q2	44.9%	58.4	13.4	71.8
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 484	$ 111	23%	596	0.8%	488.1	112.3	600.4	2034Q1	49.5%	729.7	167.8	897.5
2.0%	Project Operation:	$ 115	$ 26	23%	141	0.8%	115.4	26.5	141.9	2034Q1	49.5%	172.5	39.7	212.2
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 6,680	1,536		**8,217**		6732.1	1548.4	8280.4			10047.2	2310.9	**12358.1**

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TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: SHORE PROTECTION PROJECT, MID-REACH
LOCATION: BREVARD COUNTY, FLORIDA
This Estimate reflects the scope and schedule in report; GENERAL REEVALUTION REPORT - LOCALLY PREFERRED PLAN (OPTION 6)

DISTRICT: SAJ PREPARED: 5/17/2010
POC: CHIEF, COST ENGINEERING, Tracy Leeser, P.E.

Estimate Prepared: 27-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2011
Effective Price Level Date: 1 OCT 10

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	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contracts #9 thru #17 - 8th thru 16th Renourishments													
17	BEACH REPLENISHMENT	$ 51,286	$ 11,796	23%	$ 63,082	0.8%	51683.3	11887.2	63570.5	2037Q1	58.5%	81904.7	18838.1	100742.8
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
x	-	$ -	$ -	23%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	51,286	11,796	23%	**63,082**		51683.3	11887.2	63570.5			81904.7	18838.1	100742.8
01	LANDS AND DAMAGES	$ 630	$ 145	23%	$ 775	0.8%	634.9	146.0	780.9	2035Q2	53.0%	971.6	223.5	1195.1
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$ -	$ -	23%										
2.0%	Planning & Environmental Compliance	$ 135	$ 31	23%	166	0.8%	136.0	31.3	167.3	2035Q2	53.0%	208.2	47.9	256.1
8.5%	Engineering & Design	$ 1,800	$ 414	23%	2,214	0.8%	1813.9	417.2	2231.2	2035Q2	53.0%	2776.0	638.5	3414.5
2.0%	Engineering Tech Review ITR & VE	$ 180	$ 41	23%	221	0.8%	181.4	41.7	223.1	2035Q2	53.0%	277.6	63.8	341.4
2.0%	Contracting & Reprographics	$ 72	$ 17	23%	89	0.8%	72.6	16.7	89.2	2035Q2	53.0%	111.0	25.5	136.6
3.0%	Engineering During Construction	$ 180	$ 41	23%	221	0.8%	181.4	41.7	223.1	2037Q1	58.5%	287.5	66.1	353.6
2.0%	Planning During Construction	$ 90	$ 21	23%	111	0.8%	90.7	20.9	111.6	2037Q1	58.5%	143.7	33.1	176.8
2.0%	Cost Engineering	$ 360	$ 83	23%	443	0.8%	362.8	83.4	446.2	2035Q2	53.0%	555.2	127.7	682.9
		$ -												
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$ 4,359	$ 1,003	23%	5,362	0.8%	4393.1	1010.4	5403.5	2037Q1	58.5%	6961.9	1601.2	8563.1
2.0%	Project Operation:	$ 1,031	$ 237	23%	1,268	0.8%	1038.5	238.9	1277.3	2037Q1	58.5%	1645.7	378.5	2024.2
2.5%	Project Management	$ -	$ -	23%										
	CONTRACT COST TOTALS:	$ 60,123	13,828		**73,951**		60588.6	13935.4	74524.0			95843.2	22043.9	**117887.2**

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TPCS

BREVARD COUNTY, FLORIDA
SHORE PROTECTION PROJECT MID-REACH GRR
USACE – JACKSONVILLE DISTRICT
COST ENGINEERING DX TPCS RE-CERTIFICATION

As of August 5, 2010, Walla Walla District, Cost Engineering Directory of Expertise (Dx) for Civil Works re-certifies the cost revisions made in April, May and August of 2010 by Jacksonville District to the Brevard County Florida Shore Protection Project Mid-Reach. This certification supersedes all previous certifications due to corrections made for Lands and Damages future renourishments. The cost re-certification presents the total project cost values of both the national economic development plan (NED) and the locally preferred plan (LPP). The presented value includes the initial project plus 16 re-nourishments through year 2060:

NED

Program Year 2011	$165,167,000
Fully Funded Estimate:	$225,682,000

LPP

Program Year 2011	$164,936,000
Fully Funded Estimate:	$225,437,000

The Walla Walla Cost Dx representatives have provided an adequate Agency Technical Review (ATR) of the Total Project Cost baseline, studying the project scope, report, cost estimates, schedules, escalation, risk analysis and contingencies in accordance with ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

6 AUG 2010
Date

John P. Skarbek
CH, Cost Engineering Branch
Walla Walla District